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Reeves, Katherine Wilkie

Publication Date

2022

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Within-Person Patterns of Adolescent Suicidal Ideation and Related Risk Factors

by
Katherine Reeves

DISSERTATION
Submitted in partial satisfaction of the requirements for degree of
DOCTOR OF PHILOSOPHY

in

Nursing

in the

GRADUATE DIVISION
of the
UNIVERSITY OF CALIFORNIA, SAN FRANCISCO

Approved:

DocuSigned by:
Sandra Weiss Sandra Weiss
29B9816487EE497... Chair

DocuSigned by:
Heather Leutwyler Heather Leutwyler

DocuSigned by:
Cherry Cherry Leung

DocuSigned by:
Nilam Ram Nilam Ram
483B7CE851CC495...

Committee Members

This work is for those I merely knew but didn't see,
and for those who may be known but have yet to be seen.

...

Thank you to friends, family, colleagues, and advisors. Your guidance and support have allowed me to
evolve in a time characterized by immobility.

A special thank you to Albert Lee whose data science expertise propelled this work forward.

This work was supported by the Western Institute of Nursing (WIN) and the Council for the Advancement of Nursing Science (CANS) 2021 Martha J. Lentz Dissertation Grant, and the Biobehavioral Research Training Program in Symptom Science funded by the National Institute for Nursing Research (T32NR016920)

“The floor seemed wonderfully solid. It was comforting to know I had fallen and could fall no farther.”

— Sylvia Plath, *The Bell Jar* (1963)

Within-Person Patterns of Adolescent Suicidal Ideation and Related Risk Factors

Katherine Reeves

Abstract

Suicide is a leading cause of death among adolescents in the United States 13-21 years. As rates rise, little remains known about the experience of suicidal ideation (SI) – suicide’s most closely linked symptom. Recent research suggests that dynamic characteristics of SI may help reveal risk for suicide. The aims of this study were to describe patterns of SI characteristics in a sample of adolescents at risk for suicide and describe within-person associations among adolescent’s SI characteristics and potential risk factors over time, using intensive longitudinal design. SI characteristics and SI risk factors of 10 adolescents were measured nine times daily for two weeks with brief electronic surveys in response to regularly scheduled text messages. Survey questions built upon empirical and theoretical foundations from the Columbia Suicide Severity Rating Scale and the Interpersonal Theory of Suicide. Participants ranged from 13 to 19 years of age, reported histories of SI with a planned method for suicide, and were receiving regular mental health treatment while in the study. Participants completed 1,054 surveys resulting in 11,594 individual data points. Aims were explored by computing intraindividual item means, item variability statistics, time-of-day effects on SI using a one-way Analysis of Variance, and time-series network models using unified structural equation modeling (uSEM). Results indicated that SI characteristics and SI risk factors varied significantly over hours, days, and weeks. However, there was substantial between-person heterogeneity in the occurrence, patterns, and relationships between SI characteristics and SI risk factors. Additionally, results show the consistent presence of an important bi-directional relationship between SI characteristics and SI risk factors, indicating that, not only did risk factors influence the severity of SI, but fluctuations in SI may have important impacts on factors such as loneliness, anger, and hopelessness. Findings from this research suggest promising strategies for future research, implications for precision-based suicide risk assessment, and important considerations for suicide theory.

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Chapter 1

INTRODUCTION

Suicide is the second leading cause of death in people ages 10 to 24 years (Heron, 2019) and rates continue to rise (Curtin, 2020; Twenge, 2019). After a period of stability between 2000 and 2007, rates of suicide in this age group increased by 57.4% between 2007 and 2018 (Curtin, 2020). Although data is not yet available regarding suicide deaths since the emergence of COVID-19, there is evidence that the pandemic has exacerbated these trends (Czeisler et al., 2020).

Suicidal Ideation (SI), defined by the National Institute of Mental Health (NIMH) as thinking about, considering, or planning suicide, is a strong predictor of suicide (Beck et al., 1999; Brown et al., 2000) and is reported by an alarming number of adolescents (Ivey-Stephenson et al., 2019). In a nationally representative survey conducted by the Centers for Disease Control and Prevention (CDC) in 2017, about 17% of high school students reported having seriously considered suicide within the year, with rates as high as 24% among females and 54% among those who reported having sex with the same or both sexes (Ivey-Stephenson et al., 2019). SI rates have also increased significantly between 2007 and 2018 (Twenge et al., 2019), following similar patterns to that of suicide rates. Rates of SI among teens, prior to the COVID-19 pandemic, were almost quadruple that of their adult counterparts (17% and 4% respectively). However, since the emergence of the pandemic in 2020, rates of adult SI have more than doubled to about 11% (Czeisler et al., 2020) suggesting a potential increase among the adolescent population as well.

Although the rate of death by suicide among young people is below 1% (10.7 in 100,000; Curtin, 2020), about half of adolescents who report SI also report having made a suicide attempt (Ivey-Stephenson et al., 2019). The large gaps between the number of adolescents who report serious thoughts of suicide (17%), who report attempting suicide (8.9%) and who die by suicide (0.0107%) have motivated suicide researchers to identify who, among those with SI, are at greatest risk for suicide, to better target suicide prevention efforts (Klonsky et al., 2017; May and Klonsky, 2016). However, these efforts have

largely been unsuccessful (Franklin, et al., 2017). A meta-analysis by Franklin et al. in 2017 aimed to provide a summary of risk factors for suicidal behavior across all ages and populations. Results instead found that the accumulated list of risk factors was only able to predict a suicide attempt slightly better than chance, and that the predictive ability of these risk factors has not improved in 50 years. These findings have also been substantiated in large epidemiologic studies showing that predictors of SI, such as depression, impulsivity, and hopelessness, do not differentiate between those who make attempts and those who do not (Mars et al., 2019; May and Klonsky, 2016; Klonsky & May, 2015; Klonsky et al., 2012). Although sobering, these conclusions have catalyzed a new subfield of suicide research aiming to shine light on the field's largest gap: the nuances of suicidal thought.

STATEMENT OF THE PROBLEM

Historically SI has been understood to be a unidimensional phenomenon; either an individual has considered suicide, or they have not. It has been listed as a symptom of other mental disorders in the Diagnostic and Statistical Manual of Mental Disorders (5th ed.; DSM-5; American Psychiatric Association, 2013) and its prevalence has been calculated using single item surveys asking whether individuals have ever considered suicide, “yes or no” (CDC, 2017). SI is also largely understood as a unidimensional concept in suicide research. This is evidenced by the frequent use of single item SI measures and dichotomous SI variables (e.g., Nock et al., 2008; Nock et al., 2013; Rudd et al., 2006). However, tools that use a continuous scale, such as the Beck Scale for Suicidal Ideation (BSSI; Beck & Steer, 1991) do exist, and claim to provide more nuance than dichotomous measures. Although many of these scales have been validated in predicting risk for suicide attempts, they typically result in a single score, further homogenizing the SI experience. Detangling the assumption that SI is a unidimensional concept, and better understanding the nuances of the SI experience, may be a key to understanding the lack of progress in the field.

SI Characteristics

New evidence suggests that contrary to previous assumptions, SI is in fact, a multidimensional concept (Posner et al., 2011; Nock et al., 2013; Klonsky et al., 2016; Kleiman et al., 2017; Rizk et al.,

2018). Researchers have begun to measure characteristics of the SI experience (e.g., duration, frequency, controllability, etc.) and have found that these characteristics vary between and within individuals (Posner et al., 2011; Nock et al., 2013; Klonsky et al., 2016; Kleiman et al., 2017; Rizk et al., 2018).

One of the first delineations of SI characteristics in suicide research was in the Columbia Suicide Severity Rating Scale (C-SSRS), developed in 2011 (Posner et al., 2011). This measure asks specifically about five distinct characteristics of the SI experience: severity, duration, frequency, controllability, deterrents, and reasons for ideating. Instead of aggregating these domains to generate a score, they provide distinct instructions to identify suicide risk based on answers to specific items within the measure. Although the tool has become a gold standard measure of SI in clinical and research settings, there continues to be little consensus regarding the nomenclature and conceptualization of SI characteristics in research, resulting in a dearth of generalizable information regarding these characteristics and how they individually relate to suicide risk (Reeves et al., 2022). To address this gap in knowledge and continue to explore what SI characteristics can tell us about suicidal thought and suicide risk, standardized approaches to SI nomenclature and measurement are needed in research.

SI Risk Factors

Risk factors refer to any psychological, social, environmental, or biological element that may make someone more likely to experience thoughts of suicide. Suicide research has identified a myriad of risk factors. Demographic identifiers such as female gender, gender/sexual minority status, being younger, and having a history of a mental disorder all increase one's likelihood for suicidal thoughts (Nock et al., 2008). Family alcohol and drug problems, violence exposure, lifetime depression, and posttraumatic stress disorder (PTSD) are specifically linked to increased suicidal thoughts among adolescents (Waldrop et al., 2007). Descriptive risk factors, however, are difficult to implement into clinical or practical suicide prevention strategies. Alternatively, suicide researchers have identified psychological states that may increase one's risk for suicidal thought. The *Interpersonal Theory of Suicide* (IPTS) suggests that suicidal thoughts are the result of two psychological states – perceived burdensomeness and thwarted belongingness – suggesting that both are risk factors of SI. The IPTS

identified perceived burdensomeness and thwarted belongingness as latent concepts derived from literature additionally identifying sub-concepts such as loneliness, hopelessness, feeling ignored, feeling excluded, and anger as risk factors for suicidal thought. Further discussion of the IPTS and SI risk factors can be found in Chapter 2.

Suicidal Ideation Dynamics

Researchers have also begun to consider how one's thoughts of suicide change over time, and how these changes may contribute to our understanding of suicide risk. Witte et al. (2006) was one of the first to find that SI, does not remain stable over time and, and varies within individuals from day to day. These findings raise questions about the timescale of suicidal thought. Measures such as the C-SSRS that assess frequency and duration of SI, assume SI to occur in episodes with a beginning and an end. However, studies measuring SI variability contradict this assumption, suggest SI to be a continuous experience that fluctuates on a spectrum. Although exciting to the field, studying SI dynamics proves to be difficult, and has been inhibited by researchers' ability to capture real time analysis of the SI experience. Studies like these involve cumbersome methods where participants are asked to complete surveys daily over weeks or months, complicating how researchers navigate and monitor data collection.

In recent years, however, new technologies, such as smartphones and wearable sensors, have allowed for more regular and naturalistic measurement of subjective participant experiences, resulting in a surge of studies exploring SI dynamics. These new methods proved fruitful, resulting in a myriad of findings that have illuminated components of the SI experience. For example, studies have shown that, not only does SI fluctuate over time, but it presents in bouts, lasting anywhere from seconds to hours (Nock et al., 2009). SI variability has also been linked to suicide risk. A few studies have suggested that larger fluctuations in SI are associated with suicide attempts (Kleiman et al., 2017), and that such fluctuations have been found to increase in magnitude leading up to a suicide attempt (Bryan et al. 2018; Bryan, Butner et al., 2019). Although progress is being made, the study of SI dynamics remains an emerging field. Little is known about how SI fluctuates over time among adolescents. Few studies have looked at how distinct characteristics of SI (specifically beyond SI severity or intensity) change over time.

additionally, few studies have looked at how or why these changes occur and how they interact with theorized risk factors.

STUDY PURPOSE

The purpose of this study was to improve understanding of the within-person SI experience among adolescents. Specifically, we looked at how SI characteristics change over time within-individuals, and how the within-person fluctuation of these characteristics relates to SI risk factors. The study has the following specific aims:

Aim 1: Describe patterns of suicidal ideation and its characteristics in a sample of adolescents at risk for suicide.

Aim 2: Describe the within-person associations among adolescent's SI characteristics and potential risk factors (loneliness, feeling ignored, feeling as though they fit in, burdensomeness, interpersonal anger, interpersonal closeness, and hopelessness) and how they change over time.

SIGNIFICANCE

The identification of SI patterns may allow for more accurate prediction, not only of *who* is at risk for suicide, but *when* someone is most at risk for suicide. Knowing when teens are at greatest suicide risk can improve the efficacy of suicide prevention interventions by making them more specific and individualized. Understanding how SI changes over time will provide the foundation for examining mechanisms that may be responsible for such change. Identifiable mechanisms of acute SI change could act as targets of clinical intervention as well as starting points for further etiological investigation. Furthermore, investigation of the relationship between SI characteristics and SI risk factors over time may add insights into SI fluctuation patterns and their causes.

Chapter 2

THEORY

Suicide is incomprehensible. Despite capturing the intellectual curiosity of philosophers like Locke, Plato, Kant, and Hume (Papadimitriou et al., 2007; Windstrup, 1980), and the attention of the modern scientific community, scientists still do not fully understand why people kill themselves. Suicide theory is paramount in the effort to better understand suicide and to reduce burden associated with it. However, suicide theory continues to have gaps. Theoretical frameworks have largely assumed suicidal ideation (SI) to be a unidimensional concept, suggesting that suicidal thoughts are simply something that one either experiences or does not. Because theory can only be as precise as the concepts it includes, suicide theory is inhibited by this fact, limiting how we understand suicidality and its mechanisms. Modern and emerging theories, however, are beginning to acknowledge SI as a multidimensional and dynamic concept.

In this chapter I will discuss theories that guide the subsequent dissertation work. I will review a brief history of suicide theory, highlight the most common ideological framework in suicide research and its seminal work, discuss SI as a dynamic system, and make a theoretical case for measuring characteristics of the SI experience in suicide research. I will also present an original conceptual framework used to develop the following dissertation aims.

Brief History of Suicide Theory

Historically, suicide theory has been centered around a singular *reason* for why people commit suicide. Beck et al. (1975) theorized that there must be a cataclysmic event that allows one to overcome their primal desire for survival. They proposed that hopelessness is the driving force for all suicidal thoughts. At the turn of the 21st century Abramson expanded on this idea by developing the *Hopelessness Theory of Suicide* (Abramson et al., 2002). This theory further suggested that hopelessness is a key component in the development of “hopelessness depression”, of which SI is a key symptom.

In the early 90’s, Baumeister (1990) and Schneidman (1998) developed theories of suicide based on the idea that one ends their own life in order to escape their immediate reality. Baumeister’s *Escape Theory of Suicide* proposes that suicide is merely one escaping a negative state of mind (Baumeister, 1990). He referenced a progression of negative self-esteem which results in risky behavior and eventually, as one’s fear of death reduces, SI and SB. Schneidman similarly proposed that all suicidal thoughts stemmed from a concept called “psychache”, or “the pain of shame or guilt, or humiliation, or loneliness, or fear, or angst, or dread of growing old” (Shneidman, 1998). He stated that “suicide is not necessarily a wish to die, but rather a means to ending psychological pain” (Shneidman, 1998).

Although these theories, and others, anticipated important concepts which continue to be integrated into current suicide research, they often conflate the risk for suicidal thoughts and behaviors, ignoring the important fact that not all those who consider suicide make suicide attempts. The *Ideation to Action Framework*, and related theories, have attempted to make the important distinction between suicidal thoughts and suicidal behavior.

Ideation to Action Framework

The *Ideation to Action Framework* consists of multiple theories and was specifically delineated after the development of three primary theories of suicide: *The Interpersonal Theory of Suicide* (IPT), the *Integrated Motivational Volitional Theory* (IMV), and the *Three Step Theory of Suicide* (3ST). In contrast to early suicide theory, the *Ideation to Action Framework* clearly separates suicidal thoughts and behaviors, proposing two distinct processes: 1) the development of suicidal thoughts, and 2) the transition from suicidal thoughts to behaviors. It suggests that each process has distinct mechanisms and, therefore, separate risk factors (see Figure 2.1).

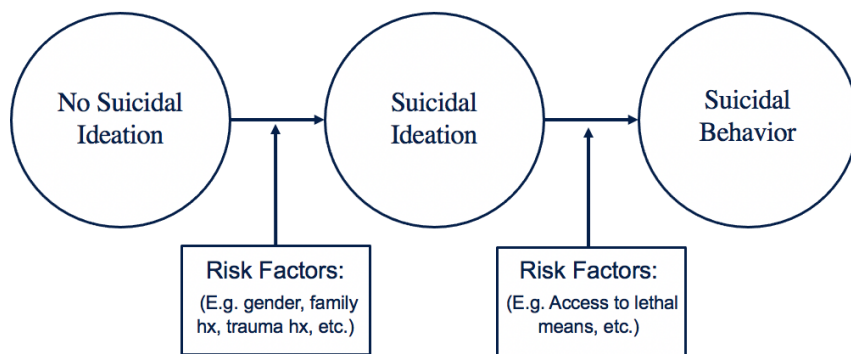


Figure 2.1. Ideation to Action Framework

The popularization of the *Ideation to Action Framework*, which experts have argued will ‘guide the next generation of suicide theory’ (Klonsky et al, 2016), represented a paradigmatic shift in suicide research. Up to this point factors such as depression, most mental disorders, and impulsivity were commonly identified as risk factors for suicide (Nock et al., 2013). Although these factors have been found to predict suicidal thoughts, they have not been proven to predict risk for suicidal behavior among those with SI (Klonsky & May, 2014; Klonsky et al., 2016). This conflation of suicidal thoughts and behaviors created large gaps in suicide research. For instance, not all those who consider suicide make a suicide attempt. Without the separation of risk factors for SI and suicide attempts, researchers could not identify who, among those considering suicide, were most at risk. The *Ideation to Action Framework* clearly identified the two phenomena providing a theoretical basis for studies looking to better understand suicide risk.

Interpersonal Theory of Suicide

The IPTS, proposed by Thomas Joiner and his colleagues in 2005, was an important development for suicide theory. At this time there appeared to be a dearth of empirically based theory development. The IPTS attempted to fill that gap.

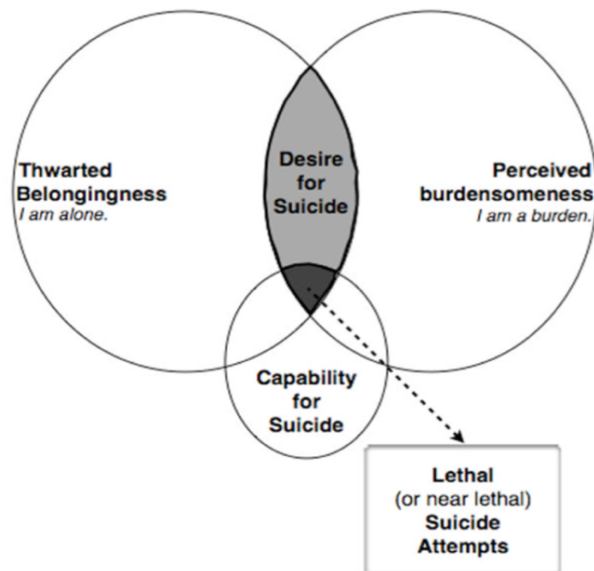


Figure 2.2. The Interpersonal Theory of Suicide (Van Orden et al., 2010)

The IPTS assumes that people die by suicide because 1) they want to, and 2) they can. The ‘want’, or desire to die, is foundational to the process of suicidality, however, without the capability of killing oneself, would not lead to eventual death by suicide. Moreover, the IPTS distinguishes suicidal thoughts and behaviors by saying that SI is characterized by the desire to die, and suicidal behavior occurs when people acquire the capability and means to kill themselves (see Figure 2.2).

Thwarted Belongingness

The desire to die, (commonly used as a proxy for suicidal thoughts in this literature), is theorized to be the result of two interacting concepts: thwarted belongingness and perceived burdensomeness. The IPTS describes thwarted belongingness as a multidimensional construct consisting of loneliness and the absence of reciprocal care or feeling as though there is no one to turn to for support. The concept was developed by integrating many social connectedness variables that were empirically associated with suicide such as a lack of social integration and a lack of social connectedness. Thwarted belongingness acts as a latent characterization of these constructs, anticipating that one’s report may relate more to loneliness or feelings of isolation rather than a direct report of a lack of perceived belonging (Van Orden, 2010).

Perceived Burdensomeness

Perceived burdensomeness is also considered a latent variable by the IPTS, comprised of the belief that the self is a liability to others and self-hatred. As with thwarted belongingness, one might express feelings of perceived burdensomeness by suggesting their family would be better off without them, that they hate themselves, or that their actions have caused pain in other's lives. The idea that burdensomeness may be linked to suicide was developed from Joiner and his colleagues' review of suicide risk factors. They found that family conflict, unemployment and psychological illness were three of the most potent risk factors for suicide and agreed that all three scenarios make one susceptible to interpersonal stressors (Van Orden et al., 2011). For example, when one is experiencing illness, they likely need additional support from family and friends. Or, when one loses a job, they are no longer able to help support their family and may feel like the cause of familial strain. The IPTS accounted for these risk factors by listing observable characteristics of the larger construct. However, instead of listing scenarios such as job loss or incarceration, they suggest that suicide risk increases with one's distress associated with these events (e.g., distress associated with job loss).

Acquired Capability for Suicide

As previously mentioned, for one to die by suicide they must both have the desire to die and the capability to die. So, assuming one is experiencing suicidal thoughts, what does it take for someone to gain the capability to attempt suicide? The IPTS suggests that in order to attempt suicide one must lose the innate fear of death that most humans inherently have (Ohman and Mineka, 2001). They posit that this fear is lost over time by desensitization to the fear of death by repeated exposure to physically painful and/or fearful events. This process of habituation to pain and fear of death allows for one to engage in increasingly painful and fear inducing activities, potentially (when combined with a desire to die) resulting in suicide. Furthermore, if someone does not have access to lethal means, or access to something that will assist in suicide (e.g., firearms, poison, etc.), they will not die by suicide.

Ideation to Action Framework Application

The IPTS and Ideation to Action Framework have been important in recent suicide prevention efforts globally. Specifically, the idea of acquired capability has been easily implemented into clinical and public health scenarios by simply restricting access to lethal means for people at risk of suicide. Despite its positive impact, researchers continue to struggle when attempting to predict who is at greatest risk for suicide (Franklin et al., 2016), suggesting further critique of suicide theory is necessary.

The IPTS and the *Ideation to Action Framework* provide fodder for further investigation of the SI experience. By distinguishing SI as a unique phenomenon with unique risk factors, it became clear that there was a dearth of information regarding its nuances. Although the *Ideation to Action Framework* and

the IPTS distinguished SI as its own phenomenon, they do not discuss SI characteristics or its dynamic properties.

Suicidal Thought as a Dynamical System

The *Ideation to Action Framework* emphasized the transition in suicide theory from understanding suicide as an outcome of a singular factor or phenomenon (e.g., psychache) to looking at suicidal thoughts and behaviors as outcomes of a set of factors that interact with each other (e.g., belongingness, burdensomeness, etc.). However, in the last few years, suicide researchers have suggested that in order to accurately predict suicidal behavior we must move away from the idea that suicide is merely the result of a group of intercorrelating concepts (Bryan et al., 2020; Millner et al., 2020). Instead of a simple cause and effect process, these researchers propose a complex system that incorporates the interaction of multiple processes changing over time that, under unique conditions, generate suicidal thoughts and behaviors, or what they refer to as a *dynamical system* (Bryan et al., 2020).

Using a dynamical systems approach to predict suicidal thoughts and behaviors is analogous to predicting the weather (Bryan et al., 2020; Millner et al., 2020). To predict an uncommon weather event, like a tornado, meteorologists, instead of relying on unidimensional factors like wind speed, air humidity or atmospheric pressure, use mathematical models which look at the interaction of multiple weather systems, how they change over time, and how they interact with each other. Although tornados are partially a result of thunderstorms, only about one in a thousand thunderstorms generate a tornado. Instead of preparing for a tornado in every thunderstorm, a dynamical systems approach allows us to more accurately predict which thunderstorms are dangerous.

The same framework has been applied to uncommon human behavior, such as suicide (Bryan et al., 2020; Millner et al., 2020). Suicidal ideation as a dynamical system suggests that mathematical models incorporating the presence of multiple complex human systems that change over time can predict suicidal behavior far more accurately than the interaction of single item risk factors. The IPTS posits that one's feelings of belonging or burdensomeness are dynamic states, rather than traits, with the capability of shifting over time. This means that one's feeling of belonging is affected by outside factors like friends, family, time of year, time of day, etc. Moreover, each phenomenon represents a system of human life that contributes to the mechanism by which one develops suicidal thoughts, changing over time and therefore changing the likelihood of SI from moment to moment and day to day.

Although this is a promising proposal, scientists have only speculated which systems may inform suicide risk assessment. Bryan et al. (2020) hypothesizes that we should focus on self-regulatory systems, stating "when self-regulatory systems fail...the system destabilizes and the likelihood of shifting to [suicidal behavior] occurs." However, it is also possible that suicidal thoughts and behaviors are not a result of a maladaptive coping process, but rather are tragic outcomes of typical human dynamics. Millner

et al. (2020) suggests that, rather than being inherently dysfunctional, “suicide results from a dynamic interaction of multiple evolutionary adaptive processes”. Adaptive processes include things such as the biological stress response (e.g., fight or flight), self-doubt, risk taking behavior, etc. Although these processes exist in order to produce resilience in humans, they also each exist on a spectrum, whereby extreme instances of each may result in negative outcomes. For example, risk taking behavior is thought to promote exploration, however when experienced on the extreme end of the spectrum, may result in life threatening behavior. When these adaptive processes interact, all independently triggered by biological and environmental factors, they result in psychological states prone to self-destructive behavior, such as suicide.

To identify which systems are responsible for fluctuations in suicide risk, exploratory studies will need to map how potential risk factors interact with SI over time. The following study will begin to address this gap by exploring risk factors identified in the IPTS (*burdensomeness, belongingness, hopelessness, loneliness, feeling ignored, interpersonal anger, interpersonal closeness*) and how these dynamic factors interact with SI within individuals over time.

SI Characteristics

The only way to prevent suicide is to target interventions toward people who are still living with a risk of suicide. Suicidal thoughts are the strongest predictor of suicide (Nock et al., 2017), and thus, suicide prevention efforts are typically targeted toward people with SI. In taking this wide sweeping approach, all those experiencing SI are homogenized. The *Ideation to Action Framework*, although progressing SI research by delineating its presence and identifying that it has a unique set of risk factors, does not theorize nuances of the SI experience, further suggesting that SI is a unidimensional concept.

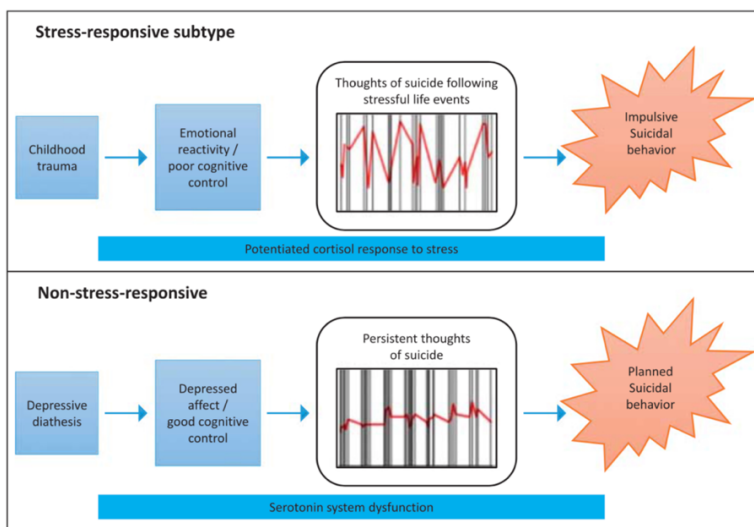


Figure 2.3. Bernanke Framework: Two proposed suicidal subtypes distinguished by the pattern of suicidal thinking (Bernanke, Stanley & Oquendo, 2017).

Additional alternative theories exist, however, suggesting the importance of identifying characteristics of the SI experience. Bernanke, Stanley and Oquendo (2017) published a piece in *Nature* theorizing that there are two distinct pathways that lead to the development of SI and suicidal behavior. The first is thought to be a stress responsive pathway triggered by life events, such as childhood trauma. The second is a non-stress responsive pathway mediated by depressive symptomatology. Subsequently, this theory identified two types of SI, one for each pathway, distinguishing the two by their observable characteristics. The first type of SI is characterized by fleeting and sudden suicidal thoughts and the second by persistent thoughts of suicide (see Figure 2.3).

Evidence presented in Bernanke et al. (2017) suggests that identifying and exploring SI characteristics may lead to the delineation of SI subtypes and their mechanisms, further leading to more effective and individualized SI treatment and subsequently more effective suicide prevention efforts. However, further exploration of SI characteristics is sorely needed. Not only do we need to identify relevant characteristics of SI (Reeves et al., 2022), but we need to understand how they change over time and interact with risk factors, such as burdensomeness and belongingness.

An Idiographic Model of Risk-Related Suicidal Ideation

The conceptual model for this dissertation is characterized in Figure 2.4 and will be described below. The model highlights two concepts: SI characteristics and SI risk factors. SI characteristics refer to defining qualities of the SI experience. This may be anything from intensity of a SI episode, to how easily one can control thoughts of SI at any given moment (i.e., controllability). Using the generic concept of SI characteristics in the model (rather than identifying specific characteristics) acknowledges that there has yet to be a comprehensive assessment of possible SI characteristics in SI research. This *Ideographic Model of Risk-Related Suicidal Ideation* will inform selection of variables and methods for this study, including mapping how adolescent SI characteristics fluctuate over time in tandem with risk factors.

Risk factors represent within person conditions that fluctuate moment to moment and day to day, potentially affecting changes in SI characteristics. In the general literature, risk factors often refer to any factor that may make someone more likely to experience thoughts of SI, such as demographic identifiers, like race or SES, or the presence of life events, such as trauma. However, in this model, risk factors only represent dynamic states, or conditions that can change from moment to moment – especially emotional states (e.g., loneliness) perceived by the individual rather than life events. The conceptual model does not identify any specific risk factors (e.g., burdensomeness, loneliness, etc.). Instead, it uses generic terminology (“risk factors”) that brings attention to the fact that dynamic risk factors for suicidal thoughts have yet to be identified and may include a myriad of possibilities, not only those being examined in this study.

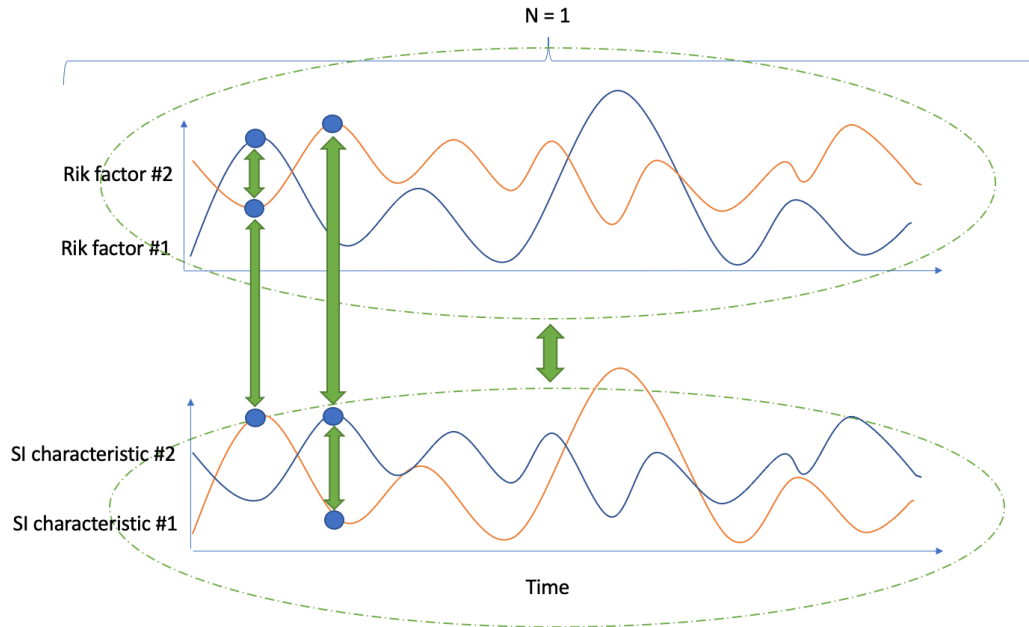


Figure 2.4. An Idiographic Model of Risk-Related Suicidal Ideation

As in previous suicide theory, I propose that SI risk factors are related to the presence of SI characteristics. However, I propose here that SI risk factors and SI characteristics function as individual systems (indicated by a green dashed circle), consisting of individual factors/characteristics that fluctuate over time. Furthermore, I propose that the two systems have a bi-directional relationship, where shifts in one affect shifts in the other. Possible relationships between the two systems are represented by bi-directional green arrows. Blue dots represent arbitrary points in each system. There are three potential relationships highlighted in this model. The first are bi-directional relationships between factors within each system, indicating that SI risk factors may influence other SI risk factors, and that individual SI characteristics may influence other SI characteristics. The second are bi-directional relationships between individual factors of one system on individual factors of the other, suggesting that a specific SI risk factor may affect changes in a single SI characteristic and vice versa. The third is a bi-directional relationship between the two overarching systems, suggesting shifts in one system affect shifts in the other.

Chapter 3

The following chapter consists of the manuscript “Characteristics of Suicidal Ideation: a systematic review” published in *Archives of Suicide Research* January of 2022. Permission from all authors have been granted for the use of this manuscript as a part of this dissertation. Beyond formatting changes, no edits have been made to the published manuscript.

Reeves, K., Vasconez, G. & Weiss, S. (2022). **Characteristics of suicidal ideation: A systematic review**. *Archives of Suicide Research*. Jan 18, 1-21. doi: 10.1080/13811118.2021.2022551.

INTRODUCTION

Suicide is a growing public health concern in the United States (US). It is the 10th leading cause of death among adults (Centers for Disease Control & Prevention, 2021) and the 2nd leading cause of death among those age 10–30 (Curtin & Heron, 2019). Death by suicide claimed more than 47,000 American lives in 2017 (Centers for Disease Control & Prevention, 2021), and continues to rise rapidly across all demographics (Hedegaard, Curtin, & Warner, 2020). Between 1999 and 2018, rates of suicide in US adults increased 35%, (Hedegaard et al., 2020) and, between 2007 and 2017, more than doubled among young people ages 10–24 (Curtin & Heron, 2019). Recent evidence suggests that the failure of suicide prevention efforts may be due to a lack of understanding surrounding the experience of suicidal ideation (SI), one of suicide’s strongest predictors (Klonsky et al., 2016).

The National Institute on Mental Health (National Institution on Mental Health, 2021) defines SI as “thinking about, considering or planning suicide” (National Institution on Mental Health, 2021). SI rates are highest among US high school students, with about 20% reporting having seriously considering suicide in 2018 (Ivey- Stephenson et al., 2020). However, the COVID-19 crisis has greatly impacted the mental health of Americans. Prior to the emergence of COVID-19, SI occurred in about four percent of American adults at any given time (Czeisler et al., 2020). In June 2020, these rates more than doubled to about 11% (Czeisler et al., 2020), further suggesting that the burden of suicide in the US is increasing.

SI research has primarily focused on identifying risk for SI, as well as identifying who, among those who experience SI, are at risk for suicidal behavior (SB), which includes suicide attempts and death by suicide. Despite a research emphasis on suicide prevention in the US, there has been no substantial progress over the last 50 years in the ability to predict who is at risk for SB among those with SI (Franklin et al., 2017). Although predicting risk is vital to preventing suicide, our ability to do so may be limited by what we know about the experience of SI itself.

SI is phenotypically heterogeneous, varying in its presentation by duration, frequency, quality, and severity within and between individuals (Kleiman et al., 2017; Rizk et al., 2018; Witte, Fitzpatrick, Joiner, & Schmidt, 2005). However, as evidenced by the frequent use of binary SI variables in research, much of suicide literature has operationalized the concept of SI as homogenous—either one has considered suicide, or they have not. Although it is important to measure prevalence rates and trends of the larger phenomenon, this approach may yield results that overlook vital scientific variability. Measures which use continuous scales, such as the Beck Scale for Suicidal Ideation (Beck & Steer, 1991), offer more depth than dichotomous measures, typically consisting of many items and resulting in a composite score. Although these scales have demonstrated validity in measuring suicide risk and sometimes include questions regarding characteristics of the SI experience, they do not typically delineate specific SI characteristics or offer subscales for such characteristics. For example, one individual may have continuous and intense suicidal thoughts, but has varying levels of intent to act on those thoughts. In contrast, another individual may have short bursts of suicidal thought in which intent spikes, offset by moments of no intent between bouts. The distinct characteristics within these two experiences are not likely represented in a single score yet may have enormous implications for their suicide risk or points of intervention. Labeling someone as simply having SI, or even assessing degree of SI on a continuous scale without further characterization, homogenizes the experience. These approaches limit consideration of nuance that may potentially be crucial in understanding the mechanisms responsible in SI development and more accurately identifying who among those with SI is at greatest risk for suicidal behavior.

In an effort to move beyond homogeneity, some recent studies have alluded to the presence of SI subtypes (Bernanke, Stanley, & Oquendo, 2017; Kleiman et al., 2017; Rizk et al., 2018; Oquendo, Baca-Garcia, Mann, & Giner, 2008). Subtyping has become popular in depression research as groups of people with similar sets of depressive symptoms often share etiological mechanisms of the disorder and similar responses to specific treatments. This approach can lead to scientific advances such as empirically based etiological theory and precisely targeted interventions. Depression and suicide, although related, have one relevant distinction. Depression is a diagnosis or disorder identified in the DSM-V, with a set of subsequent symptoms, whereas SI is not. Although experts have made the case to include SI as a diagnosis in the DSM (Oquendo et al., 2008), SI has predominately been classified as one of depression's symptoms and has no identified set of unique characteristics. The lack of agreed upon characteristics makes the process of subtyping more challenging for researchers. Identifying a standardized set of SI characteristics could shed light on the nature of such SI symptoms and assist in identifying SI subtypes. Elaboration of SI characteristics would also allow for the quantitative measurement of nuance in the SI experience on the individual level, leading to more accurate, precision-based results and improved efficacy of personalized suicide prevention interventions (Odgers & Jensen, 2020; Rabasco, 2021).

Recently an important body of research has begun to examine SI at the individual level. These investigators propose that data collected at the interindividual (group) level are largely not generalizable to the individual in suicide research. Fisher, Medaglia, and Jeronimus (2018) argue that group-based findings are only generalizable to the individual when the distribution of the phenomenon is from a sufficiently large sampling of random points, and that lack of this more individualized focus in research will likely result in flawed theory and systematically biased clinical assessments. Rather than looking for predictors of SI across large groups, this cadre of emerging researchers acknowledge SI's heterogeneity, both between and within individuals, mostly by using intensive longitudinal methodologies (Rabasco, 2021). Intensive longitudinal studies repeat measures frequently (at least daily) in order to identify within person changes and get an accurate understanding of how suicidal thoughts evolve over time (Shiffman, Stone, & Hufford, 2008; Rabasco, 2021). With these methods, researchers can better describe the

experience of SI, as well as address when individuals may be more at risk for suicide, informing more precise safety assessments and clinical interventions.

The purpose of this review was to identify SI characteristics that are measured in this progressive literature. We synthesized how these characteristics are named, measured, and defined across studies. From our findings we generate recommendations for future SI research regarding nomenclature, definition, and measurement of SI characteristics. A standardized approach in these areas could enhance more accurate and reliable measurement as well as lead to a more integrated body of knowledge in the field of SI research.

The Columbia Suicide Severity Rating Scale as an Organizational Framework

The Columbia Suicide Severity Rating Scale (C-SSRS) is a gold standard SI measure and one of the first assessments to acknowledge distinct SI characteristics. We used the C-SSRS as a guide to organize the characteristics identified by individual studies in the literature. Table 3.1 highlights the SI characteristics measured by the C-SSRS and the corresponding characteristic definition. Because the C-SSRS does not explicitly provide definitions for the characteristics that it measures, SI characteristics listed in Table 1 were defined by the study authors. The C-SSRS was developed in 2011 in response to a lack of consistent nomenclature in suicide research and has since been validated in both clinical and research settings amongst diverse populations (Posner et al., 2011). Along with measuring components of suicidal behavior, the C-SSRS aims to measure two distinct concepts within SI—severity and intensity. The measure of intensity includes five distinct characteristics of SI: frequency, duration, controllability, deterrents, and reason for ideating. These C-SSRS characteristics provide a structure for comparing and analyzing nomenclature, measures, and definitions of SI characteristics reported in the literature.

Aims

1. Identify specific characteristics of suicidal ideation (SI) that have been examined in research.
2. Describe the ways in which these characteristics of SI have been measured.
3. Assess the degree to which SI characteristics examined in research are aligned with characteristics of SI included in the Columbia Suicide Severity Rating Scale (C-SSRS)

METHODS

This systematic review followed guidelines published by the Preferred Reporting Items for Systematic Review and Meta-Analyses (Moher et al., 2009). No protocol was registered.

Eligibility Criteria

All studies published on or before June 1st, 2020 that met the following criteria were included in this review.

Inclusion Criteria

1. Original research published in peer reviewed journals.
2. Studies that measured specific characteristics of the SI experience in any population.
3. Studies which, if using a repeated measures design, examined characteristics of SI at least once per day in order to access the ongoing nature of the SI trajectory.

Exclusion Criteria

1. Articles that were not published in English.
2. Literature reviews, meta-analyses, case studies, qualitative studies or editorials.
3. Studies that analyzed SI as a binary variable.
4. Studies that conflate, or combine, characteristics of the individual (i.e., demographics, environmental factors, personality traits, diagnoses, etc.) with characteristics of SI in their analysis.

As this is the first literature review to analyze SI characteristics and in order to delineate the full body of literature, no publication dates were specified for inclusion. For the same reasons, no specific populations (e.g., age groups) were targeted.

The following databases were searched for relevant articles on June 1st, 2020: Pubmed, Embase, Web of Science and PsychInfo. The following is an example search string: ("suicidal ideation"[MeSH] OR "suicidal ideation"[ti] OR "suicidal ideation"[ot]) AND (biotype OR subtype OR subgroup OR phenotype OR "variability"). Filters were used to select only peer reviewed journal articles. Articles

obtained from database searches were supplemented with articles that were listed in selected articles' reference lists and found through individual searches.

Study Selection

Article titles and abstracts were initially reviewed for inclusion and exclusion criteria by the primary reviewer after being uploaded to Covidence, a systematic review software. If studies appeared to meet inclusion criteria, the full text was obtained and reviewed. If the article, once again, met inclusion criteria, it was saved, and the reference was added to a list of eligible studies. A second reviewer assessed a random selection of 100 discarded articles. Articles identified as meeting inclusion criteria from this sample of articles were discussed between both reviewers. The second reviewer also assessed all full text articles for inclusion or exclusion. Decisions for inclusion or exclusion required unanimous consensus between both reviewers. All disputes were settled by discussing with a third reviewer until consensus was obtained. Once all eligible studies were identified, each was reviewed and relevant data was extracted.

Data Extraction

Using tables in Microsoft Word, the following data was extracted from the included studies: study author, year, setting, sample characteristics, data collection methods, name of reported characteristics of SI, measure of SI characteristic, and definition of SI characteristic (if reported). If definitions of SI characteristics were not explicitly stated, the definition was interpreted by the primary reviewer based on the measure used. Definitions were then discussed among all three reviewers until consensus was reached. Data was extracted initially by the primary reviewer. The second reviewer independently extracted the same data. The two data sets were compared, and all discrepancies were reviewed by both reviewers until consensus was reached.

RESULTS

The initial literature search generated 1,473 articles. Individual searches also yielded nine articles resulting in a total of 1,482 articles. Five hundred and eighteen duplicates were removed resulting in 955 unique titles for abstract review. Of those, 48 appeared to meet inclusion/exclusion criteria and were

selected for full text review. After a comprehensive reading, 10 articles continued to satisfy inclusion/exclusion and were ultimately included in the review (see Figure 3.1).

Sample and Design

There were 7 unique studies represented in this review. However, three of the 7 studies were associated with more than one article, resulting in 10 articles for final inclusion. For example, Witte et al. (2005) published preliminary results; whereas, Witte, Fitzpatrick, Warren, Schatschneider, and Schmidt (2006) reported complete results from the same study. Although there was no range of dates identified for inclusion a priori, the publication dates of the literature ranged from 2005 to 2019, with 7 of the 10 articles published in or after 2017.

Setting. Of the 7 studies, three took place in the community (Kleiman et al., 2017, 2018; Nock, Prinstein, & Sterba, 2009; Witte et al., 2005, 2006), four were conducted on psychiatric in-patient units (Czyz, Horwitz, Arango, & King, 2019; Hallensleben et al., 2018, 2019; Kleiman et al., 2017, 2018), one was an experiment performed in a laboratory (Rizk et al., 2018), and one was conducted in an active-duty military environment (Nock et al., 2018).

Population. Three of the seven studies included adolescents or young adults (under 25 years; Czyz et al., 2019; Nock et al., 2009; Witte et al., 2005, 2006), two included adults (Hallensleben et al., 2018, 2019; Rizk et al., 2018) and two looked at both young adults and adults (Kleiman et al., 2017, 2018; Nock et al., 2018). Two studies did not restrict inclusion based on psychiatric history (Nock et al., 2018; Witte et al., 2005, 2006). One study included participants who had a suicide attempt within the last year (Kleiman et al., 2017, 2018). One study included participants with a suicide attempt within the last month and/or SI within the last week (Czyz et al., 2019). The final study included only participants with a diagnosis of Major Depressive Disorder (MDD; Rizk et al., 2018). Sample sizes ranged primarily from 20 to 108 participants, with one outlier looking at 3,916 participants. Six of the studies consisted of over 60% women (with five studies having more than 70% women). The majority of the samples included primarily white participants, with four studies reporting over 70% white participants. Only two studies reported between 45 and 67% white participants while two did not report the race of their participants.

Design. Five of the seven studies used longitudinal methods, one used a prospective design, and one was an experiment performed in a laboratory. As per inclusion criteria, all five studies that used a longitudinal design used at least once daily measures of SI. Measurement of SI occurred once daily (Czyz et al., 2019; Witte et al., 2005, 2006), twice daily (with the addition of unlimited participant-initiated entries; Nock et al., 2009), four times daily (Kleiman et al., 2017) and ten times daily (Hallensleben et al., 2018, 2019). The duration of data collection ranged from six days to 6 weeks with one study duration depending on the length of in-patient stay (Kleiman et al., 2017, 2018). Four studies used Ecological Momentary Assessment (EMA) to collect SI data; three of which were smartphone based and one which used paper questionnaires. Czyz et al. (2019) also conducted surveys via smartphone.

Identification of SI Characteristics

Results of the review were divided into three sections: (1) the identification of SI characteristics, (2) measures or operational definitions used to collect data on each SI characteristic, and (3) the congruence of SI characteristics in the literature with those used in the C-SSRS based on their names, measurement and definition.

From the 7 studies, 12 characteristics of SI were identified: intensity, duration, frequency, desire to die, intent to die, ability to resist suicide urge, controllability, level of passive SI, level of active SI, urge severity and SI variability. Four studies reported duration of SI (Czyz et al., 2019; Nock et al., 2018, 2009; Rizk et al., 2018; Witte et al., 2006, 2005), three reported frequencies of SI (Czyz et al., 2019; Kleiman et al., 2017, 2018; Nock et al., 2009), and three reported intensity of SI (Kleiman et al., 2017, 2018; Nock et al., 2009; Witte et al., 2005, 2006). Two studies reported SI variability (Kleiman et al., 2017; Witte et al., 2005, 2006). Two studies reported on controllability, although one named it “ability to resist urge” (Kleiman et al., 2017, 2018; Nock et al., 2018). The following characteristics were only measured in one study: desire to die (Kleiman et al., 2017, 2018), intent (Kleiman et al., 2017, 2018), level of passive SI (Hallensleben et al., 2018, 2019), level of active SI, (Hallensleben et al., 2018, 2019), and urge severity (Czyz et al., 2019; See Table 3.2).

SI Measurement

Two of the seven studies in this review used individual items taken from validated SI measures. Two studies reported using tools developed from validated SI measures to measure SI characteristics. One study used an aggregate score of the 36-item Suicide Probability Scale (SPS) to measure SI intensity and duration (Witte et al., 2005, 2006). One study used a single item from the Beck Scale for Suicidal Ideation to measure SI duration (Rizk et al., 2018). Two studies developed items from the C-SSRS (Nock et al., 2018; Czyz et al., 2019), and one reported developing items based on the Self Injurious Thoughts and Behaviors Survey (SITBS; Nock et al., 2009). Over half of the SI characteristic measures used a single item. All but one measure included between 1 and 4 items. The SPS, used by Witte et al. (2005, 2006) had 36 items. Table 3.3 provides details on the names, measures and operational definitions of SI characteristics across all studies.

Table 3.4 provides information about the validity and reliability of the measures used. Five of the studies adapted their measure(s) of SI characteristics from a larger measure of SI. Although, in most cases, the original measure from which the item was taken had established validity and reliability, there was no evidence that the adapted item(s) being used from the larger measure were assessed for validity or reliability as distinct, stand-alone measures of the SI characteristic. Two of the studies created new items/measures of the SI characteristics and provided no information regarding their validity or reliability.

Congruence of SI Characteristics with the C-SSRS

SI characteristics identified in this review were compared with the SI characteristics measured in the C-SSRS, based on the operational definitions associated with each SI characteristic measure. Table 3.5 provides a comparison of SI characteristics identified in this review with characteristics included in the C-SSRS.

Five of the names used to describe the 12 SI characteristic were also used in the C-SSRS (intensity, severity, frequency, duration, and controllability). However, many studies did not operationally define these characteristics as they are operationally defined in the C-SSRS. Only two of the seven studies adapted SI measures specifically from the C-SSRS and none used the same items as those in the C-SSRS.

The studies also examined five SI characteristics not measured by the C-SSRS (variability, “desire to die,” “level of passive SI,” “level of active SI,” and “urge severity”). One study appears to measure the concept of controllability, but instead uses the name “ability to resist urge.”

Severity. There was a high level of congruence between studies reviewed and the C-SSRS for inclusion of “Severity” as a SI characteristic. All but one study (Rizk et al., 2018) measured a characteristic with a similar operational definition to the one used in the C-SSRS. However, only one of these studies actually used a similar name—“urge severity”—to identify the characteristic (Czyz et al., 2019). Although their measurement approach indicated they were measuring “severity,” two studies referred to it as “intensity” (Nock et al., 2009; Witte et al., 2005, 2006), one as the “level” of SI (Hallensleben et al., 2018, 2019), and another as “self-injurious thoughts and behaviors” (Nock et al., 2018). A fourth study referred to what was ostensibly “severity” of SI using three separate terms: general SI, “desire to die” and “intent” to die (Kleiman et al., 2017, 2018).

Frequency and Duration. Five studies measured frequency, as defined by the C-SSRS. However, only three used the name “frequency” (Czyz et al., 2019; Kleiman et al., 2017, 2018; Nock et al., 2009) while two labeled measures of frequency as “duration” (Nock et al., 2018; Witte et al., 2005, 2006). Four studies actually measured duration (Czyz et al., 2019; Nock et al., 2009, 2018; Rizk et al., 2018), with all four calling the variable “duration.”

Controllability. Controllability, as defined by the C-SSRS, was measured as a characteristic of SI in two studies (Kleiman et al., 2017, 2018; Nock et al., 2018). One study named the characteristic “controllability” (Nock et al., 2018), while one study named it “ability to resist urge” (Kleiman et al., 2017, 2018).

Deterrents/Reason for Ideating and Variability. No studies in this review identified characteristics of SI similar to “deterrents” or “reason for ideating,” as defined in the C-SSRS. Two studies identified variability as a characteristic of SI. This was a novel characteristic that is not measured in the C-SSRS (Kleiman et al., 2018; Witte et al., 2006).

DISCUSSION

The purpose of this review was to identify specific characteristics of SI delineated in SI research to date, determine how they are operationally defined and measured, and assess their alignment with SI characteristics included in the C-SSRS. Twelve SI characteristics were identified in the literature.

However, after comparing measures and operational definitions of all 12 SI characteristics, they were essentially measuring five core domains: severity, temporality (frequency and duration), controllability, deterrents/reasons for ideating, and variability. For many of the characteristics, their names, measures and operational definitions were conflated in the literature, representing a significant conceptual problem in SI research. Four of the five characteristics were congruent with characteristics included in the C-SSRS. No standardized measures of the SI characteristics were used across studies.

SI Characteristics

Twelve characteristics were initially identified across the studies. However, after reviewing the nature of their measurement and related operational definitions, it became apparent that 5 characteristic domains were actually being measured: severity, temporality (frequency and duration), controllability, deterrents/reasons for ideating, and variability. There was inconsistency and lack of clarity in terms used to describe specific characteristics across studies, and in some cases, apparent mislabeling of certain characteristics. These problems were augmented by a lack of standardized measures for assessing the same characteristics across studies. Such conceptual and methodologic discrepancies could inhibit scientific progress if not addressed. Exemplars of conceptual inconsistency are highlighted below for severity and temporality—the most commonly reported characteristics.

Severity. The term “severity” suggests gravity or seriousness and possesses a worrisome quality. In comparison, “intensity” indicates strength or power without being adverse in nature. The C-SSRS uses the 2 terms to describe different components of SI. It operationally defines the term “severity” by assessing for the presence of suicidal thoughts, a plan for suicide, or intention to act on that plan. It then uses the term “intensity” as the title for the section of questions measuring the remaining 5 characteristics

(frequency, duration, controllability, deterrents, and reasons for ideating). However, across the studies reviewed these two terms were operationally defined as if they were the same variable.

Temporality. Frequency and duration are well defined concepts in any thesaurus. Frequency refers to the number of times an event occurs, while duration is the length of time over which the event occurs. However, the two appear to be conflated at times in in the current SI literature. The confusion seems to lie in their application to suicidal thoughts and how to measure the temporality of a thought. Evidence suggests that people have episodes of SI that last between seconds and hours (Nock et al., 2009; Rizk et al., 2018). Chronicity appears to lie in the high frequency of SI episodes rather than true sustained thoughts of suicide (Nock et al., 2009; Rizk et al., 2018). If it is assumed that SI is experienced in episodes, then the concept's duration and frequency can be applied more easily. The duration of SI would be the length of an SI episode, whereas frequency would refer to the number of episodes.

Variability. Variability refers to the change in SI over a designated period of time. Variability of SI is not assessed in the C-SSRS but was identified as an SI characteristic in two studies. This review suggests its importance to the field of SI research. Witte et al. (2006) found that SI variability was predictive of a multiple suicide attempt history. Kleiman et al. (2017) found that SI variability helped differentiate five SI subtypes and that low variability of SI predicted a recent history of a suicide attempt. Although noteworthy as a SI characteristic, the nature of variability is complicated by the unit of time between measurements and the feature of SI that is measured. When variability is studied, it is imperative to determine what is fluctuating (e.g., severity, controllability) and for how long. For example, one researcher may choose to measure daily changes in SI severity while another chooses to measure hourly changes of SI controllability. Both would report findings of SI variability. Future research looking at SI variability should be aware of this potential pitfall and clearly state the time period and quality of variability being examined.

Controllability and deterrents/reasons for ideating were the least measured characteristics of SI. It is not clear why these characteristics have received little attention in SI research. Both are characteristics included in the C-SSRS and, therefore, are considered by experts to have potential

importance to the field (Posner et al., 2011). Future research is needed to develop appropriate measures and enhanced understanding of these SI characteristics.

Standardization in Measurement

Although individual studies in this review generally provided appropriate rationale for the use of SI measures, no standardized measures were used to assess individual SI characteristics. Appropriate and valid measures are generally developed secondary to agreement about concept names and definitions. The lack of consistency in names and definitions of SI characteristics is likely the reason for a lack of standardized measures. There is an urgent need for universal nomenclature to describe SI characteristics, along with clear conceptual definitions and subsequent development of psychometrically sound, standardized measures. Without these, it will not be possible to effectively integrate results across studies and develop a cohesive body of knowledge regarding SI.

Congruence of SI Characteristics in the Literature with Those in the C-SSRS

The SI characteristics studied to date measure all but one of the characteristics found in the C-SSRS. This overlap has significant potential to advance the field, in light of the C-SSRS's standing as a valid clinical measure of suicidal ideation and behavior. As this body of literature grows, synthesis of study results will be imperative in order to impact meaningful clinical change. Future integration of the literature should use names, definitions, and measures of SI characteristics consistent with the C-SSRS. The C-SSRS is already well established in clinical settings as a screening tool. If future research identifies a specific SI characteristic from the C-SSRS that has particular relevance for a SI subtype or population, then clinical settings can readily use the C-SSRS (or other SI measure) to screen for that characteristic. In addition, interventions can be developed that address specific characteristics such as controllability or frequency of SI rather than depending on more general, imprecise interventions that may not be as useful to individuals in managing their unique struggles with SI.

The field should also be open to research that can improve clinical and research efficacy of the C-SSRS. Building on discoveries from SI research, studies to refine the interview's assessment of various SI characteristics may be warranted. Based on findings from this review, potential measurement of new

characteristics such as variability should also be considered for the C-SSRS. Lastly, further psychometric testing for each characteristic subscale is warranted, including validity and reliability testing across varied populations and contexts to assure cultural and sociodemographic integrity of SI assessment.

Limitations

Although this study followed guidelines for systematic reviews proposed by PRISMA, limitations still exist. Because characteristics of SI do not have consistent nomenclature, the search for relevant articles was difficult. Although we started with about one thousand articles, it is possible that different search terms would have rendered articles that were missed. Similarly, the targeted body of literature appears to be small. However, because this review intentionally delineated an emerging literature, a small number of relevant articles was expected.

In addition, the lack of well-defined characteristics required inference at times regarding the definitions of reported SI characteristics. Although this was done as objectively as possible, some degree of subjective interpretation was necessary.

CONCLUSIONS

This review highlighted inconsistencies in the emerging field of SI research, specifically in the nomenclature, definition, and measurement of SI characteristics. Although some conceptual disparity is common in new areas of research, clearer consensus regarding the conceptualization and measurement of SI characteristics is needed to advance the field.

Although the quantification of SI on a granular and individual level is a new approach to suicide prevention, the promise of this research is substantial. The identification of phenotypic SI subtypes may lead to better etiological understanding of SI. Subsequently, by breaking down those who experience SI into groups based on distinct etiologies, more targeted interventions can be derived. Similarly, intensive longitudinal methods are beginning to explain the dynamics of suicidal thought. These methods can generate insights regarding moment-to-moment environmental mechanisms that may be responsible for changes in suicidal thought (e.g., time of day, interpersonal difficulties). Findings could be directly

implemented into effective suicide prevention interventions by targeting person and group specific triggers of SI.

This research is timely, as SI and suicide rates skyrocket. In order to meet the challenge, researchers must build essential scaffolding for this emerging field by standardizing approaches to SI measurement. Standardization will allow for findings to be synthesized across studies, enhance more accurate and reliable measurement of SI, and lead to a more integrated and useful body of knowledge.

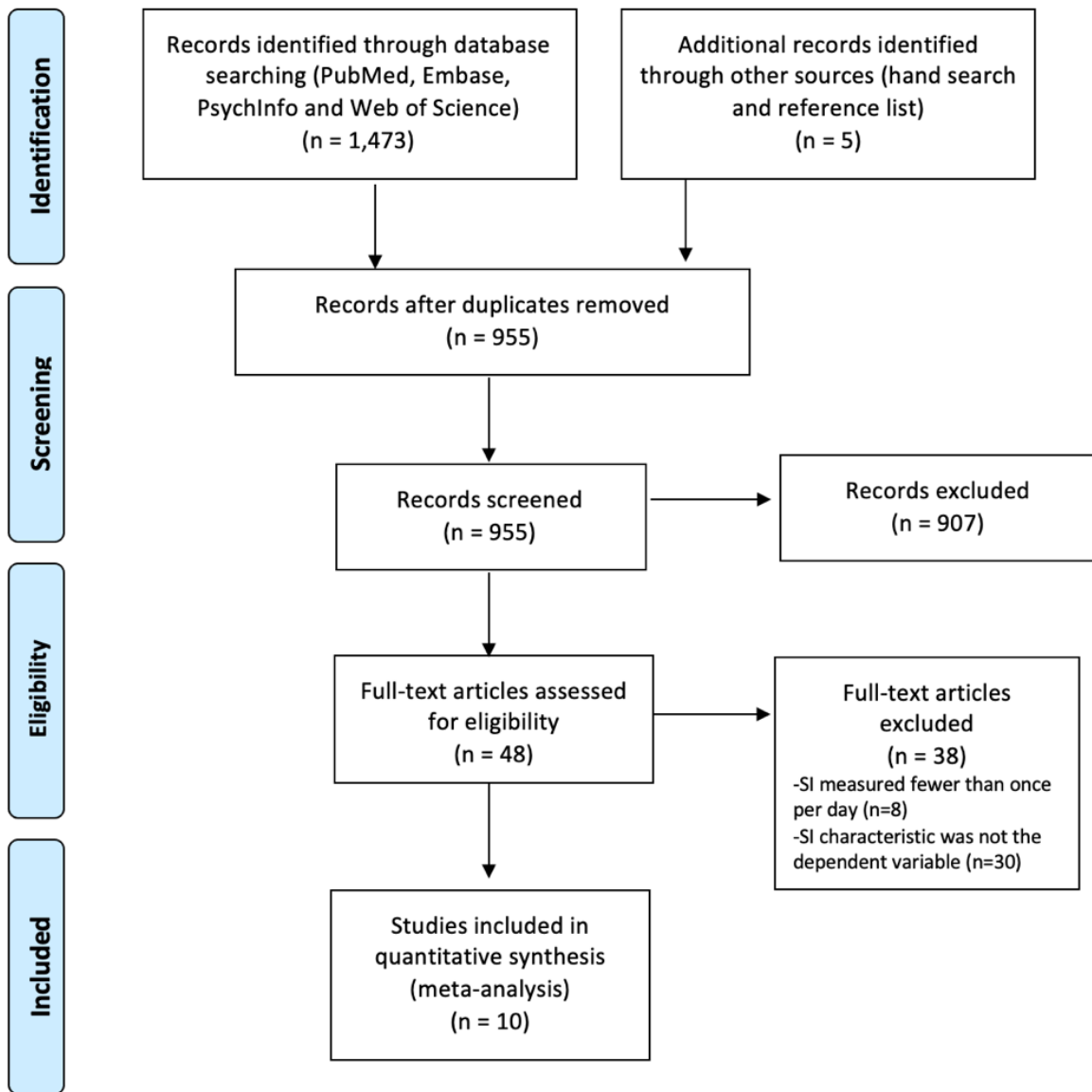


Figure 3.1. PRISMA Flowchart

Table 3.1. C-SSRS SI Characteristics Defined

C-SSRS SI Characteristic Name	Item Wording	Item Response Options	Definition
Severity	<i>Have you wished you were dead or wished you could go to sleep and not wake up?</i>	Yes/No	“The strength of feeling during which one contemplates acting on suicidal thoughts.”
	<i>Have you actually had any thoughts of killing yourself?</i>	Yes/No	
	<i>Have you been thinking about how you might do this?</i>	Yes/No	
	<i>Have you had these thoughts and had some intention of acting on them?</i>	Yes/No	
	<i>Have you started to work out or worked out the details of how to kill yourself? Do you intend to carry out this plan?</i>	Yes/No	
Frequency	<i>How many times have you had these thoughts?</i>	(1) Less than once a week (2) Once a week (3) 2-5 times in week (4) Daily or almost daily (5) Many times each day	“How often one experiences suicidal thoughts.”
Duration	<i>When you have the thoughts how long do they last?</i>	(1) Fleeting - few seconds or minutes (2) Less than 1 hour/some of the time (3) 1-4 hours/a lot of time (4) 4-8 hours/most of day (5) More than 8 hours/persistent or continuous	“The length of time one has a continuous suicidal thought.”
Controllability	<i>Could/can you stop thinking about killing yourself or wanting to die if you want to?</i>	(1) Easily able to control thoughts (2) Can control thoughts with little difficulty (3) Can control thoughts with some difficulty (4) Can control thoughts with a lot of difficulty (5) Unable to control thoughts (0) Does not attempt to control thoughts	“The ease with which one could stop themselves from considering suicide.”
Deterrents	<i>Are there things - anyone or anything (e.g., family, religion, pain of death) - that stopped you from wanting to die or acting on thoughts of committing suicide?</i>	(1) Deterrents definitely stopped you from attempting suicide (2) Deterrents probably stopped you (3) Uncertain that deterrents stopped you (4) Deterrents most likely did not stop you (5) Deterrents definitely did not stop you (0) Does not apply	“The presence of a person or thing that stops one from wanting to die or commit suicide.”
Reasons for Ideating	<i>What sort of reasons did you have for thinking about wanting to die or killing yourself? Was it to end the pain or stop the way you were feeling (in other words you couldn't go on living with this pain or how you were feeling) or was it to get attention, revenge or a reaction from others? Or both?</i>	(1) Completely to get attention, revenge or a reaction from others (2) Mostly to get attention, revenge or a reaction from others (3) Equally to get attention, revenge or a reaction from others and to end/stop the pain (4) Mostly to end or stop the pain (you couldn't go on living with the pain or how you were feeling) (5) Completely to end or stop the pain (you couldn't go on living with the pain or how you were feeling) (0) Does not apply	“The reason for thoughts of suicide.”

Table 3.2. Study Sample and Design

Author (Year)	Setting	Sample Characteristics					Data Collection Methods				
		Age (mean age in years)	Inclusion Criteria – Psychiatric History	Sample size	Female (%)	White (%)	Design	Method	Frequency (per day)	Duration	
Witte (2005)	Community	College Students (19.3)	None	108	60	NR	Longitudinal	Questionnaire	1	6 weeks	
Witte (2006)	Community	College Students (19.3)	None	108	60	NR	Longitudinal	Questionnaire	1	6 weeks	
Nock (2009)	Community	Adolescent/Young adult (17.3)	Recent history of NSSI	30	87	87	Longitudinal	Smart phone EMA	2+	2 weeks	
Kleinman (2017)	Community	Young adult (23.59)	Suicide attempt in last year	54	79	73	Longitudinal	Smart phone EMA	4	4 weeks	
	In-patient	Adult (42.53)	Recent suicide attempt and/or SI	32	43	81			4	While in-patient	
Kleinman (2018)	Community	Young adult (23.59)	Suicide attempt in last year	54	79	73	Longitudinal	Smart phone EMA	4	4 weeks	
	In-patient	Adult (42.53)	Recent suicide attempt and/or SI	32	43	81			4	While in-patient	
Nock (2018)	Military	Young adult/Adult (NR)	None	3,916	20	67	Prospective	Questionnaire	One-time	N/A	
Rizk (2018)	Laboratory	Adults (33.6)	MDD and SI	58	59	45	Experiment	Questionnaire	One time	N/A	
Hallensleben (2018)	In-patient	Adults (35.9)	MDD and/or lifetime SI	20	80	NR	Longitudinal	Smart phone EMA	10	6 days	
				74	72	NR	Longitudinal	Smart phone EMA	10	6 days	
Czyz (2019)	In-patient	Adolescent (NR)	suicide attempt in Last month and/or SI in last week	34	76	85	Longitudinal	Smart phone survey	1	2 weeks	

NR = Not Reported; NSSI = Non-Suicidal Self Injury

Table 3.3. SI Characteristic Name, Measure and Operational Definition

Author (Year)	Name	Measure						Scoring Method
		Adapted from validated measure?	If yes, what measure?	# of Items Used	Example of Item	Item Response Options		
Severity								
Witte (2005) & Witte (2006)	Intensity	Yes	SPS	36	NR		4-point scale indicating how often each statement applies	Mean Score
Nock (2009)	Intensity	Yes	SITBS	1	"Rate how intense the urge was to do the behavior you selected"		5-point-scale from "not present" to "very severe"	NR
Kleiman (2017) & Kleiman (2018)	Desire to die	No	NA	1	"How intense is your desire to kill yourself right now"		4-point scale; 0 (not strong at all) to 4 (very strong) scale	Analyzed as reported
Kleiman (2017) & Kleiman (2018)	Intensity	No	NA	3	"How intense is your desire to kill yourself right now"		4-point scale; 0 (not strong at all) to 4 (very strong) scale	Sum score of three items
Kleiman (2017) & Kleiman (2018)	Intent	No	NA	1	"How strong is your intention to kill yourself right now"		4-point scale; 0 (not strong at all) to 4 (very strong) scale	Analyzed as reported
Hallensleben (2018)	Level of passive SI	No	NA	2	1) "Life is not worth living for me" 2) "There are more reasons to die than to live"		5-point scale from 1 (not at all) to 5 (very much)	Not analyzed
Hallensleben (2018)	Level of active SI	No	NA	2	3) "I'm thinking about taking my own life" 4) "I want to die"		5-point scale from 1 (not at all) to 5 (very much)	No analyzed
Hallensleben (2018)	Composite SI	No	NA	4	1) "Life is not worth living for me" 2) "There are more reasons to die than to live" 3) "I'm thinking about taking my own life" 4) "I want to die"		5-point scale from 1 (not at all) to 5 (very much)	Total score of four items summed (range = 4–20).
Hallensleben (2019)	Level of passive SI	No	NA	2	1) "Life is not worth living for me" 2) "There are more reasons to die than to live"		5-point scale from 1 (not at all) to 5 (very much)	Not analyzed
Hallensleben (2019)	Level of active SI	No	NA	2	3) "I'm thinking about taking my own life" 4) "I want to die"		5-point scale from 1 (not at all) to 5 (very much)	No analyzed
Hallensleben (2019)	Composite SI	No	NA	4	1) "Life is not worth living for me" 2) "There are more reasons to die than to live" 3) "I'm thinking about taking my own life" 4) "I want to die"		5-point scale from 1 (not at all) to 5 (very much)	Total score of four items summed (range = 4–20).
Nock (2018)	Self-Injurious Thoughts and Behavior Urge Severity	Yes	C-SSRS	3	"Did you ever make a suicide attempt; that is, purposefully hurt yourself with at least some intention to die?"		NR	Composite Score of 3 items
Cava (2019)	Urge Severity	Yes	(Nock et al., 2009)	1	"How strong was the urge to act on your thoughts of suicide?"		Scale from 1 (low) to 7 (high)	Analyzed as reported

Author (Year)	Name	Measure					Scoring Method
		Adapted from validated measure?	If yes, what measure?	# of Items Used	Example of Item	Item Response Options	
Temporality							
Witte (2005) & Witte (2006)	Duration	Yes	SPS	36	NR	4-point scale indicating how often each statement applies	Number of days above a T- score of 70
Witte (2006)	Variability	Yes	SPS	36	NR	4-point scale indicating how often each statement applies	MSSD statistic ¹
Nock (2009)	Frequency	Yes	SITBS	1	“Are you having thoughts of self-destructive behavior”	Yes/no	Number of yes responses
Nock (2009)	Duration	Yes	SITBS	1	“Indicate how long you thought about doing the behavior”	6-point-scale from “<5 seconds” to “5- hrs to 1-day”	Analyzed as reported
Kleiman (2017) & Kleiman (2018)	Frequency	No	NA	1	“How intense is your desire to kill yourself right now?”	4-point scale; 0 (not strong [intense] at all) to 4 (very strong [intense]) scale	Number of non-zero answers
Nock (2018)	Duration	Yes	C-SSRS	2	“How many days during worst week did you have SI” and “How long did those thoughts usually last when you had them?”	NR	Analyzed as reported
Rizak (2018)	Duration	Yes	BSSI (Item 6)	1	NR	3 categorical responses: 1) brief, fleeting periods, 2) longer periods, and 3) continuous (chronic) or almost continuous.	Ideators, separated into two groups 1) brief ideators and 2) longer and continuous ideators, then longer and continuous ideators added together to form second group
Czyz (2019)	Duration	Yes	C-SSRS	1	“How long did these thoughts last?”	5 point-scale, ranged from ‘a few seconds or minutes’ to ‘more than 8 hr/continuous.’	Analyzed as reported
Czyz (2019)	Frequency	Yes	C-SSRS	1	“How many times did you have thoughts of killing yourself”	4-point scale, ranged from ‘only one time’ to ‘all the time.’	Analyzed as reported
Controllability							
Kleiman (2017) & Kleiman (2018)	Ability to resist urge	No	NA	1	“How strong is your ability to resist the urge to kill yourself	4-point scale; 0 (not strong [intense] at all) to 4 (very strong [intense]) scale	Reverse coded
Nock (2018)	Control- libility	Yes	C-SSRS	1	“During that worst week, how easy was it for you to control those thoughts?”	NR	Analyzed as reported
Deterrents/Reasons for Ideating							
No articles measured characteristics operationally defined to fit under deterrents/reasons for ideating.							

SI characteristics were organized into four domains after comparing each characteristic’s measurement and operational definition. SPS = Suicide Probability Scale; SITBS = Self Injurious Thoughts and Behaviors Survey; BSSI = Beck Scale for Suicidal Ideation; NR = Not Reported; NA = Not Applicable. ¹MSSD = Mean Squared Successive Differences

Table 3.4. Validity and reliability of SI characteristic measures

Author (Year)	Name	Measure Adapted from validated measure? (Name of measure)	Validity		Reliability	
			Content/Face Validity	Criterion- Related Validity	*Internal Consistency	Test-Retest
Witte (2005)	Intensity	Yes (SPS)	1	1	1	1
	Duration	Yes (SPS)	1	1	1	1
	Intensity	Yes (SPS)	1	1	1	1
Witte (2006)	Duration	Yes (SPS)	1	1	1	1
	Variability	Yes (SPS)	1	1	1	1
	Frequency	Yes (SITBS)	1	1	NA	1
Nock (2009)	Intensity	Yes (SITBS)	1	1	NA	1
	Duration	Yes (SITBS)	1	1	NA	1
	Frequency	No	0	0	NA	0
Kleinman (2017) & Kleinman (2018)	Desire to die	No	0	0	NA	0
	Intent	No	0	0	NA	0
	Ability to resist urge	No	0	0	NA	0
Nock (2018)	Intensity	No	0	0	0	0
	Duration	Yes (C-SSRS)	1	1	1	1
	Controllability	Yes (C-SSRS)	1	1	NA	1
Rizk (2018) Hallensleben (2018) & Hallensleben (2019)	Self-Injurious Thoughts and Behavior	Yes (C-SSRS)	1	1	1	1
	Duration	Yes (BSSI)	1	1	NA	1
	Level of passive SI	No	0	0	0	0
Czyz (2019)	Level of active SI	No	0	0	0	0
	Composite SI	No	0	0	0	0
	Duration	Yes (C-SSRS)	1	1	NA	1
Czyz (2019)	Frequency	Yes (C-SSRS)	1	1	NA	1
	Urge Severity	Yes (C-SSRS)	1	1	NA	1

0 = study did not mention the validity or reliability of the measure used for the corresponding SI characteristic. 1 = sufficient validity or reliability reported for SI measure, but not for measure of SI characteristic. 2= sufficient validity or reliability reported for the specific SI characteristic measure. SPS = Suicide Probability Scale; SITBS = Self Injurious Thoughts and Behaviors Survey; BSSI = Beck Scale for Suicidal Ideation. NA = Not Applicable
*Internal consistency is not relevant to single item measures.

Table 3.5. Comparison of SI Characteristic Name and Definitions to C-SSRS

Author (Year)	Severity		Intensity				Reason for Ideating
	“The strength of feeling during which one contemplates acting on suicidal thoughts.”	“How often one experiences suicidal thoughts.”	Duration	Controllability	Deterrents		
	Was ‘severity’ defined similarly to definition above?	Was the name severity used? (If not, what label was used?)	Was ‘duration’ defined similarly to definition above?	Was ‘duration’ used? (If not, what label was used?)	Was ‘controllability’ defined similarly to definition above?	Did they use the name ‘controllability’? (If not, what label was used?)	“The presence of a person or thing which stops one from wanting to die or commit suicide.”
Witte (2005)	Yes	No (Intensity)	No	NA	No	NA	Was ‘reason for ideating’ defined similarly to definition above?
Witte (2006)							
Nock (2009)	Yes	No (Intensity)	Yes	Yes	No	NA	No
Kleinman (2017)	Yes	No (SI (Desire (Intention))	No	No	Yes	No (Ability to resist urge)	No
Kleinman (2018)							
Nock (2018)	Yes	No (SITB)	Yes	Yes	Yes	Yes	No
Rizk (2018)	No	NA	Yes	Yes	No	NA	No
Hallensleben (2018)	Yes	No (Level)	No	NA	No	NA	No
Hallensleben (2019)							
Cazz (2019)	Yes	No (Urge severity)	Yes	Yes	No	NA	No

C-SSRS = Columbia Suicide Severity Rating Scale; SI = Suicidal Ideation; SITB = self-injurious thoughts and behaviors. Dark Blue = studies that used the same name as the C-SSRS to describe the corresponding characteristic as operationally defined by the C-SSRS. Light Blue = studies that did not use the same name as the C-SSRS to describe the corresponding characteristics as operationalized by the C-SSRS

Chapter 4

METHODS

This study used an intensive longitudinal (IL) design (Liu et al., 2016; Borsboom et al., 2021) to study how specific suicidal ideation (SI) characteristics fluctuate over time, and the within-person relationship between these SI characteristics and SI risk factors among a sample of adolescents at risk for suicide. The study consisted of two parts: descriptive data collection and IL data collection. Cross-sectional descriptive data was collected through survey and virtual semi-structured interviews. IL data collection, assessing SI characteristics (*desire to die, controllability, deterrents, and intent*) and SI risk factors (*loneliness, feeling ignored, burdensomeness, feeling excluded, belongingness, anger, and hopelessness*), included virtual surveys sent to participant's smart phones through text message nine times daily for 14 days.

Participant Recruitment

Inclusions/Exclusion Criteria. This study included adolescents aged 13 to 21 years with a recent history of suicidal thoughts (passive or active thoughts within the month prior to the study), receiving regular (at least bi-weekly) mental health treatment (e.g., individual therapy, group therapy, psychiatric medication management, etc.). This study excluded participants without access to Android or iOS smart phone, and participants not able to complete questions sent to their mobile device periodically for any reason.

Recruitment Methods. Participants were recruited at an outpatient child/adolescent mental health facility serving publicly and privately patients in a suburban area. Recruitment included electronic disbursement of study flyers to mental health clinicians, and an announcement of the study opportunity to clinic staff at a staff meeting. Clinic staff provided recruitment material to potential participants. Potential participants then contacted the research team directly using the e-mail and phone number listed on recruitment material to schedule a virtual meeting with a member of the research team. Eligibility criteria was reviewed, and eligibility was confirmed, at the first virtual meeting with the participant, their

guardian (when the participant was under 18 years old), and a member of the research team. One research team member was responsible for all communication with participants.

Participants under the age of 18 were joined by their legal guardian for the initial virtual meeting with the research team member. At this meeting consent (and assent when appropriate) was collected in the form of an electronic signature after in depth review of study protocol, safety protocol, and informed consent material. Participants and their parents were reminded that they could stop study protocol at any time. Participants were compensated \$30 for completing baseline data collection, \$100 for completing two weeks of IL data collection, and an additional \$20 for a compliance rate over 75% (maximum compensation total was \$150). All compensation was delivered to participants via electronic VISA gift card. All study procedures were approved by the University of California, San Francisco Institutional Review Board (#20-31121).

Descriptive Data Collection

Participants completed several measures to acquire descriptive information about the sample; these were completed electronically. Initially, they responded to a demographic questionnaire. Participants were asked to complete measures prior to a descriptive data collection interview that occurred via Zoom. This semi-structured interview used the Columbia Suicide Severity Rating Scale (C-SSRS) as a measure to elicit descriptions of each participant's experience with suicidal thoughts. Following the interview, the research team member reviewed procedures for IL data collection.

Descriptive Measures.

Information on participant demographics (including age, sex, race, and ethnicity), psychiatric history, illicit drug use, and current psychiatric medications were assessed through the demographic questionnaire (see Appendix A). Twenty-six Items were chosen to represent factors that have been shown to be associated with SI in previous research (Nock & Kazdin, 2002; Nock et al., 2008; Twenge et al., 2019; Nock et al., 2013).

The C-SSRS was used to elicit participant's self-reflections about their own suicidal thoughts and behavior. The C-SSRS is semi-structured interview regarding an individual's baseline and lifetime

suicidal ideation that takes between fifteen and forty-five minutes to complete. It asks participants about the intensity, duration, frequency, controllability, deterrents, and reasons of ideating of recent and lifetime suicidal thoughts. SI intensity is measured by a five item SI subscale which has been found to be predictive of a history of suicidal behavior (Posner et al., 2011). It also asks about one's history of suicidal behaviors. The C-SSRS that has been found to be valid with good convergent and divergent validity compared with other suicidal ideation measures and an independent suicide evaluation board of experts among adolescents (Posner et al., 2011). The C-SSRS has quickly become the field's gold standard measure of suicidality and is recommended for use in research by the NIMH (Pearson et al., 2001).

Intensive Longitudinal Data Collection

To collect data specific to the study aims, participants were sent nine text messages per day for 14 days. Each text message had a link to a brief survey. The surveys were powered by Qualtrics and were identical at each time point. Surveys consisted of 11 questions and took about 30 seconds to complete. Seven questions asked about suicide risk factors (independent variables) and four questions asked about SI characteristics (dependent variables). All questions asked how true statements were on a scale of 0-100. The survey questions are included in Appendix B.

Text messages were sent at the same time daily starting at 7:30am and ending around 10pm. Start times and end times were chosen to balance the desire to include as much wake time as possible, without sending assessments while participants were sleeping. Text messages were sent at an interval of 1 hour and 36 minutes. This interval was chosen to fit nine surveys within the allotted time frame. Participant surveys were worded to capture how the participant was feeling in the moment they took the survey. Survey times were recorded. Participants were not expected to change their typical schedule to answer surveys. Participants were asked to complete the survey as close to the time the text was received as possible. As these were teenagers, most were in school on weekdays. We instructed participants not to answer surveys when in class, but rather to wait until the class was over. They were also asked to indicate the time they woke up, so surveys that weren't completed because they were sleeping could be deleted

from the compliance analysis. The number of timepoints and the study length were chosen to balance feasibility and participant burden with the desire to collect the largest sample of intra-individual data possible.

Measures of Independent Variables

The independent variables in this study were putative risk factors of SI. We sought to examine how they are linked with SI variability over time. Because there is no evidence identifying risk factors associated with SI fluctuations, we decided to measure factors that have been routinely associated with the presence of SI in established suicide theory. The Interpersonal Theory of Suicide (IPT) lists risk factors for suicide (Van Orden et al., 2011). We identified and developed single item measures for seven key concepts/factors that are core to the IPT, have particular salience for an individual's emotional state, and were most relevant to the population of adolescents being studied: burdensomeness, belongingness, closeness to others, loneliness, feeling ignored, anger, and hopelessness.

Although validated measures of thwarted belongingness and perceived burdensomeness exist (e.g., Interpersonal Needs Questionnaire; INQ), they consist of at least five items per concept (Van Orden et al., 2012). Instead, to measure burdensomeness, we asked participants to indicate how true this statement was on a scale of 0-100: *I feel like a burden*. This question was adapted from question three on the INQ. To measure belongingness, we adapted questions eight and 14 from the INQ, asking participants to indicate how true these statements were: *I feel like I fit in* and *I feel close to other people*. The IPT describes thwarted belongingness as a multidimensional construct consisting of other subordinate factors. One such variable is loneliness. In order to measure loneliness (Van Orden et al., 2011), we asked participants to indicate how true the two following statements were: *I feel lonely* and *I feel ignored*.

We also asked participants to indicate how true the following statement was: *I feel angry with people in my life*." Anger has been known to be one negative emotion associated with loneliness, social isolation and other latent variables present in the IPT (Van Orden et al., 2011). In addition, anger is an emotion that is colloquially known to fluctuate throughout the day and is associated with moments of

agitation, suggesting that it may be a plausible indicator of suicidal thought. Furthermore, the C-SSRS suggests that there are two reasons for ideating: to reduce pain or to gain attention or revenge from others (Posner et al., 2011). Thus, anger may be a reason for why someone would want to gain attention from or revenge on others in their life.

Lastly, we asked participants about their levels of hopelessness. The IPT suggests that hopelessness regarding feelings of burdensomeness or belongingness may lead to one's capability of a suicide attempt (Van Orden et al., 2005). Other theories of suicide have also utilized hopelessness as a key construct for identifying suicide risk (Beck et al., 1990; Beck et al., 1985) and hopelessness has been identified as a key predictor of suicide (Beck et al., 1989; Nock & Kazdin, 2002; Wen-Hung et al., 2004).

Measures of Dependent Variables

The dependent variables for this study were characteristics of SI. As noted in earlier chapters of this dissertation, there is almost no consensus on the nomenclature and measurement of SI characteristics in suicide research (Reeves et al., 2021). In an attempt to collect data that will be generalizable to a larger literature, we chose to assess SI characteristics identified in the C-SSRS. The C-SSRS is validated as a retrospective report of one's SI. A novel feature of this study was our focus on experience in real time. Thus, we included only the four C-SSRS characteristics that we believed could possibly fluctuate over time: *desire to die*, *intent*, *controllability*, and *deterrents*. We asked participants to report on their experience in the moment they answered the survey. Although the C-SSRS does not have a validated single item self-report measure for each characteristic, we developed each item to be as consistent with the C-SSRS as possible.

The first section of the C-SSRS measures severity of SI using five items that ask about one's wish to be dead, one's non-specific desire to kill themselves, one's active SI and methods, one's plan for suicide, and finally whether the individual intends to act on this plan. We synthesized these items into 2 salient questions that could be easily and rapidly completed by the adolescents. Firstly, we asked the participant to rate their current desire to die (passive suicidal thoughts) on a scale from 0-100. The *desire to die* item was chosen to act as a proxy for SI severity for analysis because it includes passive thoughts of

SI (i.e., thoughts of not wanting to be alive without the need for specific thoughts of killing oneself), which are present prior to and during thoughts of suicide. Although it is not a perfect or validated measure of SI severity, it is a sensitive representation of when a teen may be having thoughts of suicide and seems appropriate for this assessment of diurnal patterns of SI fluctuation.

Secondly, we asked participants to rate their intent to kill themselves on a scale of 0-100. On scales of 0 to 100, participants also rated the controllability of their suicidal thoughts (i.e., how easily they could stop themselves from thinking about suicide), and the degree to which potential deterrents in their lives (things that keep them from wanting to kill themselves) actually stopped them from acting on their suicidal thoughts. We did not collect repeated subjective reports of SI *frequency*, or *duration*. This study attempted to measure SI frequency and episode duration quantitatively by collecting the start and end time of each assessment and asking participants to report their real-time experience of SI. Additionally, the participant's subjective report of SI episode frequency and duration was collected during descriptive data collection. All items in the survey were described and reviewed individually with the participant during the initial virtual interview in the participant's native language. After the initial description of the question, the participant was asked if they had any questions. Participant questions were answered in detail. Participants were also shown an electronic example of how surveys would look on their smartphone.

Safety Protocols

All participants were required to maintain mental health treatment as usual while participating in this study. Survey responses were reviewed twice daily for safety concerns at 9am and 4pm. If surveys indicated severe risk of suicide, suggested by high scores for the *desire to die* item or moderate scores for intent to kill oneself (>20 on a scale of 0-100), then the participant and their caregiver (if under 18) were contacted by the researcher (a mental health clinician with expertise in suicide risk assessment), and a risk assessment was initiated. This risk assessment included direct participant interview and conversation with guardian (if under 18). The researcher then used their clinical judgement to assess the safety of the participant. If the participant was deemed safe, or not a risk to themselves, they would return to the study.

Otherwise, crisis intervention was initiated. Crisis intervention was not triggered during this study but would have included coordination of immediate mental health intervention by guardian, mental health provider, or emergency service provider.

Data Analysis

All analyses were at the individual level, examining each adolescent's data for its unique patterns and associations, rather than through aggregation of group data. This analytic approach allowed for detailed assessment of individual variability instead of central tendencies across all participants. These within-person analyses represent an important foundation for development of knowledge in this nascent field of study (Sedano-Capdevila et al., 2021; Gee et al., 2020; Fisher et al., 2018; Yang et al., 2018; Fisher et al., 2015).

Aim 1

The first aim of this study was to describe patterns of suicidal thoughts, among a sample of teens at risk for suicide. To do this we summarize data provided by each of 10 participants with respect to the number of assessments completed, intraindividual mean, standard deviation (SD), minimum value, maximum value, skew, and kurtosis for each of 11 variables. We also calculated the intraindividual coefficient of variation (CV). The CV calculates the ratio of the standard deviation to the mean within each individual for each variable. This statistic is useful for comparing the magnitude of variability between variables with drastically different means. Studies using similar EMA methods have commonly calculated the mean of squared successive differences (MSSD) for their assessment of intraindividual variability (Kleiman et al., 2017; Hallensleben et al., 2018). The MSSD is useful when variable scores are measured on different scales and can accommodate for slow moving trends in the data (unlike the Mean, SD or CV). In this study, however, all variables were measured on the same scale, and we did not anticipate slow moving trends over the relatively short two-week period of data collection as slow-moving trends tend to occur over longer periods of time. Therefore, the CV was used instead of the MSSD to measure the magnitude of variability of each item as the CV accommodates for discrete shifts which we thought were more likely to occur in our two-week timeframe.

We then examined whether and how desire to die (as a key SI characteristic indicating severity of SI) differed across time of day for each individual. Specifically, we used an intraindividual analysis of variance (ANOVA) to assess patterns of differences in *desire to die* across morning, mid-day, afternoon, evening, and night.

Aim 2

The second aim of this study was to determine the relationship between adolescent's SI characteristics and potential risk factors (loneliness, feeling ignored, feeling as though they fit in, burdensomeness, interpersonal anger, interpersonal closeness, and hopelessness) over time. The observed within-person variation in four SI characteristics and seven risk factors was modeled as a person-specific network using a unified structural equation modeling (uSEM) approach and the R package, pompom. After the models were run, they were tested for fit. Fit was confirmed when three of four fit criteria were met. The four fit criteria include a root mean square error of approximation (RMSEAs) of less than or equal to 0.08, a standardized root mean squared residual (SRMR) of equal to or less than 0.08, a comparative fit index (CFI) greater than or equal to 0.95, and a non-normed fit index (NNFI) greater than or equal to 0.95. This approach was initially developed by Gates and Molenaar (2012) and has been used in a variety of research studies looking at intraindividual variability of psychological phenomena (e.g., Yang et al., 2018; Yang et al., 2019). This analytic approach aligns with the dynamical systems model of suicide (Bryan et al., 2020), in which suicidal thoughts are thought to be the outcomes of complex dynamic systems. Here, we consider suicidal thought and its risk factors to be part of a system that spans different levels of analysis, functional domains, and time scales.

In these models, the person-specific temporal relations among variables in the time series data is depicted as a network of paths between nodes/variables (Gates and Molenaar, 2012; Yang, 2018). Each variable is represented by a node (labeled circles) and each statistical relationship between two nodes is represented by an edge (arrows). Edges are directional paths that show how one variable subsequently affects the other. The direction of the relation is indicated by color. Green indicates a positive relationship. Red indicates a negative relationship. The strength is represented by line width. Wider lines

suggest stronger relationships. And temporal lag of the relations is indicated by line type. Dashed lines represent a time lag (lag-1) and solid lines represent contemporaneous relationships, or directional relationships that occur within the period of time between assessments. Lines beginning and ending at the same node represent autoregressions. Autoregressions indicate a variable's effect on itself over time. An autoregression predicts future scores of a variable when the same variable becomes elevated. A time series network may also include excitatory loops. These loops are found when two nodes increase scores in each other. For example, increases in node A increase scores for node B, and increased scores for node B increase scores of node A.

To further interpret the function of each network we calculated the predicted *recovery time* of each variable. We did this by taking a bootstrap approach using the iRAM command in the pompom package in R. We measured the length of time it takes one variable in the network (e.g., *desire to die*) to recover, or return to a predetermined equilibrium, after artificial perturbation of another variable (e.g., *burdensomeness*). Perturbation refers to the artificial stimulation, or increase, of a variable. Predicted recovery times not only expose the presence of a relation between two variables, but they also measure the magnitude of effect (in units of time) an increase in one variable has on another, providing improved understanding of how potential changes occurring in life might influence each participant's results.

Intensive longitudinal data was collected through Qualtrics. Each participant's data was downloaded and merged through Excel, where it was cleaned. Three variables (*deterrents*, *fitting in*, and *closeness to others*) were reverse coded and renamed (*lack of deterrents*, *feeling excluded*, and *lack of closeness*) prior to analysis. Reverse coding was done to align the positive and negative valence of all variables so that low scores were more positive (e.g., "I feel close to others in my life.") and high scores were more negative (e.g., "I don't feel close to others in my life."). There was no missing data throughout IL data collection. All analyses were conducted in R using R Studio and R Markdown (RStudio Team, 2015). Specific R Packages used for analysis are noted above.

Chapter 5

RESULTS

The results of this study will be presented in line with the intraindividual approach described under methods of analysis. The sample of participants and their compliance statistics will be described, followed by summaries for each participant's ($N=10$) data. This approach is designed to illustrate the full depth and breadth of information accrued through a within-person analytic strategy.

Participants

Ten adolescents between ages 13 and 19 years participated in the study. Four of the ten identified their gender as female (cis-gender), one identified as male (cis-gender), and five identified as gender nonconforming or gender variant. Two participants identified their sexual orientation as heterosexual, and eight identified as gay, bisexual, homosexual or "other". Six participants reported their race as white or from European decent, one identified as Chinese, one identified as Middle Eastern, and two reported that they identified as "other". Three of the ten participants identified as Mexican, Mexican American, or Chicana. All ten participants were receiving regular outpatient mental health treatment. Nine of the ten participants took at least one psychiatric medication at the time of the study. Four of the ten had been psychiatrically hospitalized in their lifetime. All ten participants had been diagnosed with depression by a provider and all participants believe they have an anxiety disorder (even if not formally diagnosed).

All ten participants reported a lifetime history of suicidal ideation on the C-SSRS with scores (on 0-5 scale) ranging from 3 (active suicidal ideation, with any method, without intent) to 5 (active suicidal ideation with plan and intent), suggesting all participants have experienced active thoughts of suicide where they had considered at least one method for killing themselves. Suicidal ideation scores for past month ideation ranged from 0 (Participant 9 denied even passive desire to die within the past month) to 4 (active suicidal thoughts, without specific plan, with some intent). All ten participants also replied with "it depends" on at least two of the 10 C-SSRS questions, suggesting the presence of nuance to item answers not picked up by C-SSRS scores.

Data Collection Compliance

All participants were asked to complete 14 days of data collection, however, were told they could do additional days if they'd like. No additional incentives were offered for continued data collection. One participant completed 16 days of data collection, four completed 15 days, three completed 14 days and two completed only 13 days. The number of days for each participant was chosen prior to beginning data collection based on the participant's preference. In total, the ten participants completed 1,054 unique questionnaires ($M = 105.4$ questionnaires/participant, $SD = 17.37$), each with 11 items, resulting in a total of 9,486 unique data entries.

As seen in Table 1, participants had very good compliance (Wen et al., 2017). Depending on the number of days teens participated in the study, they received between 117 and 144 text messages containing the eleven-item questionnaires. The average raw rate of compliance was 82%. However, when controlling for the time participants woke up, consequently eliminating all questionnaires they missed while asleep from the compliance calculation, the average rate of compliance among this sample of teenagers increased to 90% (min = 70%, max = 100%). This was particularly relevant for a few teens who regularly woke up after noon, missing at least three questionnaires.

Table 5.1. Compliance of Participants in Responses to Questionnaires

ID	Number of Days in Study	Number of Texts Received	Number of Texts Received While Awake (and While Asleep)	Number of Completed Questionnaires	Percent of Overall Compliance	Percent of Compliance While Awake
<i>1</i>	14	126	122 (4)	112	.90	.92
<i>2</i>	16	144	140 (4)	135	.93	.97
<i>3</i>	14	126	123 (3)	103	.82	.84
<i>4</i>	13	117	111 (6)	110	.94	.99
<i>5</i>	13	117	109 (8)	108	.92	.99
<i>6</i>	15	135	120 (15)	110	.82	.92
<i>7</i>	15	135	113 (22)	89	.66	.79
<i>8</i>	15	135	125 (10)	105	.78	.84
<i>9</i>	14	126	114 (12)	114	.91	1.0
<i>10</i>	15	135	99 (36)	68	.50	.70
<i>Avg.</i>					.818 = 82%	.896 = 90%

The number of texts delivered while the participant was awake was calculated by subtracting the number of texts missed while asleep at every reported wake time. For example, if a participant reported waking up at 10am, they would have already received one text at 7:30 and one at 9:30am. They still had time to answer the 9:30am questionnaire before their next text at 11:30, resulting in the subtraction of one expected questionnaire for the day.

Intraindividual Patterns of Suicidal Ideation Characteristics and their Relationship to Risk Factors

Participant #1

Quantitative summaries of the data provided by Participant 1 are presented in Table 5.2.1, with accompanying visualizations shown in Figure 5.1.1. As seen in Table 5.2.1, average level of *desire to die* was 32.7 on the 0 to 100 scale. This score is relatively low, potentially indicating low levels of SI. However, as seen in the left (a) panel of Figure 5.1.1, three SI characteristics, *desire to die*, *controllability*, and *lack of deterrents* all fluctuated substantially across the two weeks of observation ($CV = 73.2, 110.5, \text{ and } 460.9$ respectively). The average score for *lack of deterrents* was low ($M < 1$). Although the coefficient of variation (CV) suggests that the item fluctuates greatly, even low scores relative to a mean less than one will generate high CVs, resulting in a score that may not be relevant to interpretation. As seen in the left (a) panel of Figure 5.2.1, *lack of deterrents* remains low across the two weeks, suggesting that this participant's deterrents had a strong impact on their decision against suicide. The participant's intent to act on suicidal thoughts remained at zero and did not vary across the 2 weeks of observation. Consistency in the magnitude of variability may indicate that *lack of deterrents* and *intent* are relatively stable characteristics of SI for this participant.

Scores for SI risk factors ranged from relatively low levels of *anger* ($M = 13.3$) to higher levels of *burdensomeness*, *lack of closeness* and *feeling excluded* ($M = 51.9, 67.0$ and 68.9 respectively). As seen in the lower portion of Table 5.2.1 and in the right (b) panel of Figure 5.1.1, the seven SI risk factors all exhibited substantial variation over the two-week observation period. Accounting for the relative differences in mean level, *Anger* had the highest relative magnitude of variability of the SI risk factors ($CV = 86.9$); however, all risk factors appear to have smaller magnitudes of variability than the three

dynamic SI characteristics. Consistency in item variability, even when the relative magnitude of change is high, is indicative of a stable patient profile.

Table 5.2.1. Descriptive and Variability Statistics for Participant 1

Variable ²	N	Mean	SD	Min	Max	Skew	Kurtosis	CV
SI Risk Factors								
Loneliness	112	32.375	22.1794991	0	100	0.97070278	0.24774084	68.5081053
Feeling Ignored	112	33.9821429	24.2490762	0	100	0.98702525	0.07737463	71.3582904
Burdensomeness	112	51.8482143	27.2407385	0	100	-0.0049654	-1.1798682	52.5393958
Feeling Excluded ¹	112	68.8839286	19.9224066	6	95	-1.2029549	1.03223161	28.9241133
Lack of Closeness ¹	112	67.0446429	20.3878556	4	99	-1.0369312	0.76381882	30.4093731
Anger	112	13.3125	11.5672972	0	54	1.44531654	2.24415204	86.8904955
Hopelessness	112	38.7232143	25.1454184	0	96	0.6251382	-0.6417277	64.9362893
SI Characteristics								
Desire to Die	112	32.6964286	23.9352879	0	91	0.72946004	-0.4849278	73.2045942
Controllability	112	19.4821429	21.4807612	0	89	1.40388853	1.25881197	110.258719
Lack of Deterrents ¹	112	0.41964286	1.93422654	0	13	5.13268827	26.9570761	460.922069
Intent	112	0	0	0	0	NA	NA	NA

¹Variables were reverse coded prior to analysis. ²All variables were measured on a scale from 0 to 100.

Differences in *desire to die* (an indicator of SI severity) across time of day are shown in Figure 5.2.1. For this participant, results indicate that there are differences in SI severity across the day, ($F(3,108) = 4.26, p = 0.007$). As we can see in Figure 5.2.1, average scores appear higher in the afternoon and evening, raising questions about the presence of potential stressors that regularly occur during these times.

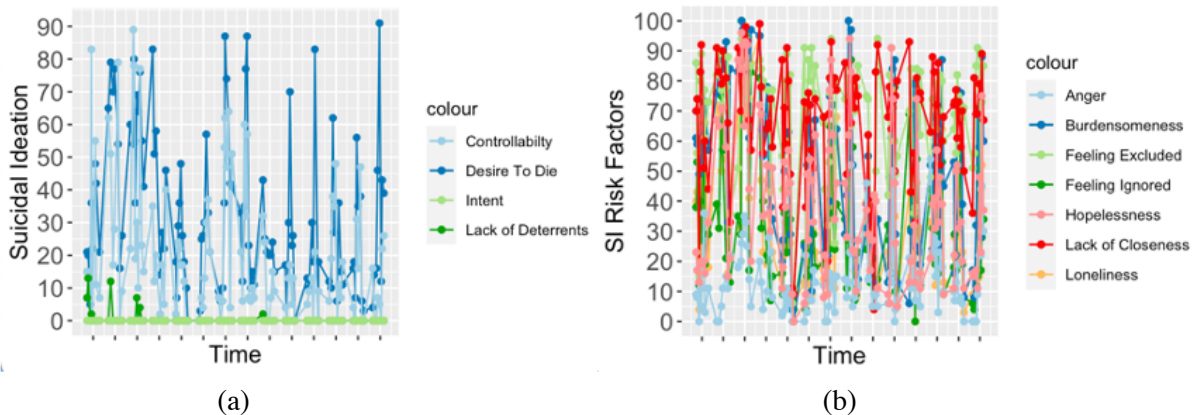


Figure 5.1.1. (a) Intraindividual Variability of SI Characteristics for Participant 1; (b) Intraindividual Variability of SI Risk Factors for Participant 1. Dashes along the x-axis (“Time”) represent 12:00pm and occur ever 24 hours.

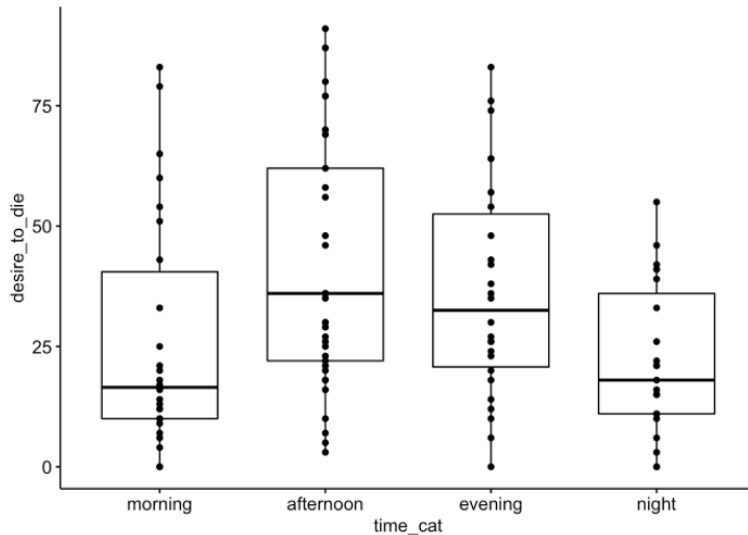


Figure 5.2.1. Distribution of “Desire to Die” by Time of Day for Participant 1; Morning = 5:00am to 11:59am, Afternoon = 12:00pm to 4:59pm, Evening = 5:00pm to 7:59pm, Night = 8:00pm to 4:59am.

The network analysis for Participant 1’s multivariate time series data consisted of 10 variables, with the intent variable being removed because there was no variance. The SI network model for participant 1 fit the data well (RMSEAs = 0.00, SRMRs = 0.04, CFIs = 1, NNFI = 1.05). Results are presented in Figure 5.3.1.

Overall, the network generated by participant 1’s time series data shows 15 total paths, 14 positive contemporaneous paths, three lagged paths (two negative and one positive), and 10 autoregressions (one for each node) seven of which are positive and three that are negative. The large number of contemporaneous paths suggests that many of the variables tend to move together and that the causal process linking these nodes likely occurs within the two-hour window between assessments.

Desire to die (node 8 and an indicator of SI severity) has a strong contribution to the network. It impacts three nodes suggesting that when this participant is feeling more intense urges to die, feelings of *loneliness*, *burdensomeness*, and difficulty controlling their thoughts of suicide (*controllability*) increase as well. Although the strength of relations between variables remains relatively consistent throughout the network, *hopelessness* (node 7) appears to have the strongest relation to *desire to die* (node 8), making it an important risk factor for this individual.

their feelings of loneliness, and so on. This loop and the effect on this SI characteristic emphasize the importance of loneliness for this participant.

The strongest time-lagged autoregression (represented by the dashed line from a node to itself) was on *hopelessness* (node 7), suggesting that when this person experiences high levels of hopelessness, hopelessness tends to carry-forward to the next time-period. Notably, the negative autoregression for *controllability* (node 9) suggests that when controllability is high at one time point, that level tends to be low at the next time point (an oscillating pattern).

Predicted recovery times from perturbations of each node, as implied by the network obtained for Participant 1, are reported in Figure 5.4.1. They range from 0.0 to 8.78 time-steps. Recovery times are longest across node 7 (*hopelessness*). *Burdensomeness* (node 3), for example, takes 8.78 time-steps to recover from a perturbation of node 7 (*hopelessness*). This means that, absent other interventions, when this person’s feelings of hopelessness increase, their feelings of burdensomeness remain elevated for a full day before naturally decaying to equilibrium (one time step is equal to about two hours, without accounting for sleep).

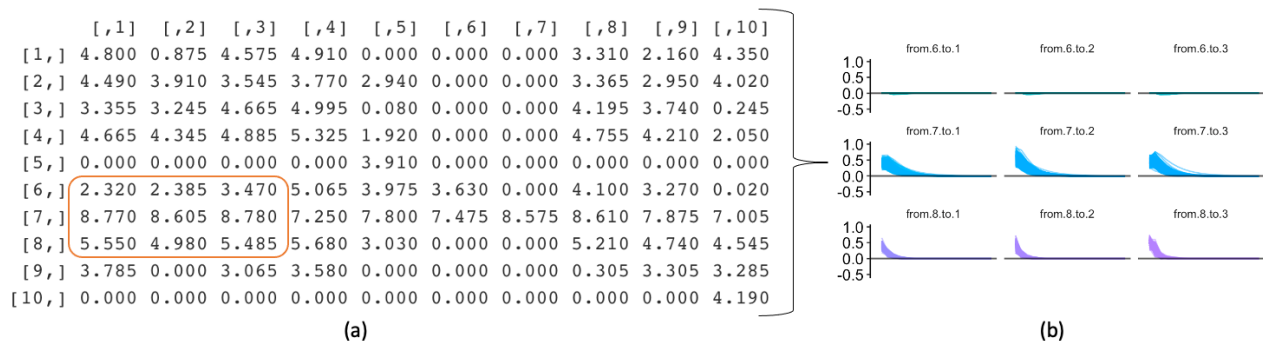


Figure 5.4.1. Recovery Time Following Node Perturbation for Participant 1; Figure (a) presents the number of time-steps taken for node X (columns) to recover after perturbation of node Y (rows). Figure (b) presents a visual for six cells in figure (a). One time-step = about two hours. 1 = Loneliness, 2 = Feeling Ignored, 3 = Burdensomeness, 4 = Feeling Excluded¹, 5 = Lack of Closeness¹, 6 = Anger, 7 = Hopelessness, 8 = Desire to Die, 9 = Controllability, 10 = Lack of Deterrents¹, 11= Intent

Participant 2

Quantitative summaries of the data provided by Participant 2 are presented in Table 5.2.2, with accompanying visualizations shown in Figure 5.1.2. As seen in the top portion of Table 5.2.1, the average level of *desire to die* was 10.0 on a 0 to 100 scale. This score is low, which could indicate low levels of

SI. However, as seen in the left (a) panel of Figure 5.1.2, there appears to be a significant increase in SI during the second week of the study. The average score for *lack of deterrents* was high ($M = 76.9$), suggesting that deterrents do not have a strong impact on this participant's decision against suicide.

Although *desire to die*, *controllability*, *lack of deterrents* and *intent* vary substantially over the two-week period ($CV = 142.88, 386.82, 17.67$ and 184.89 respectively), the magnitudes of change appear to act differently over time between variables. In contrast to *desire to die*, *controllability*, and *intent*, which appear to fluctuate more widely in the second week, the magnitude of variability for *lack of deterrents* appears to remain relatively stable over the course of both weeks (see the left (a) panel of Figure 5.1.2). Consistency may indicate that *lack of deterrents* is a relatively stable characteristic of SI for this participant.

Table 5.2.2. Descriptive and Variability Statistics for Participant 2

Variable ²	N	Mean	SD	Min	Max	Skew	Kurtosis	CV
SI Risk Factors								
Loneliness	135	49.4740741	29.6582096	3	100	0.10598339	-1.0900531	59.9469726
Feeling Ignored	135	52.0148148	30.0923914	0	100	0.0579575	-1.1808072	57.8535009
Burdensomeness	135	60.2222222	27.3055313	4	100	-0.0367764	-1.1279353	45.3412881
Feeling Excluded ¹	135	71.9481481	14.3876598	36	100	-0.188026	-0.4418301	19.9972621
Lack of Closeness ¹	135	72.3777778	15.4228299	7	100	-0.6912522	1.62819887	21.3087917
Anger	135	58.3481481	26.3719997	9	100	-0.0686755	-1.0470602	45.1976635
Hopelessness	135	62.4444444	26.8048967	4	100	-0.0500936	-1.1921816	42.9259912
SI Characteristics								
Desire to Die	135	10.0296296	14.3308147	0	68	1.88337732	3.29090766	142.884785
Controllability	135	2.68888889	10.4012533	0	100	7.06100731	57.7095085	386.823469
Lack of Deterrents ¹	135	76.9333333	13.5999342	40	100	-0.3150232	-0.2802203	17.6775574
Intent	135	2.03703704	3.7663225	0	20	2.27324426	5.47353165	184.892196

¹Variables were reverse coded prior to analysis. ²All variables measured on a scale from 0 to 100.

As reported in Table 5.2.2, mean scores for SI risk factors all fell in a middle range between *loneliness* ($M = 49.5$) and *lack of closeness* ($M = 72.3$); however, all seven SI risk factor variables exhibited some variation ranging from a minimum relative magnitude of change in *feeling excluded* ($CV = 20.0$) to a maximum relative magnitude of change for *loneliness* ($CV = 60.0$). The right (b) panel of Figure 5.1.2., however, shows distinct differences in the data between week 1 and week 2 aligning with aforementioned shifts in SI characteristic data. During the first week, although there appear to be shifts in

average scores (*lack of closeness* and *feeling excluded* trend downward, and low scores of *anger*, *burdensomeness*, *hopelessness*, *feeling ignored*, and *loneliness* trend upward), relative magnitudes of variability appear consistent across all risk factor variables over time. At the beginning of the second week variables converge, scores generally get higher, and relative magnitude of variability appears to increase, suggesting an event or change in this participant’s environment. For this participant, the increase in magnitude of variability across risk factors coincides with high levels of *desire to die* and *intent* to act on thoughts of suicide, further suggesting that an increase in the magnitude of variability may indicate periods of heightened suicide risk and need for subsequent intervention.

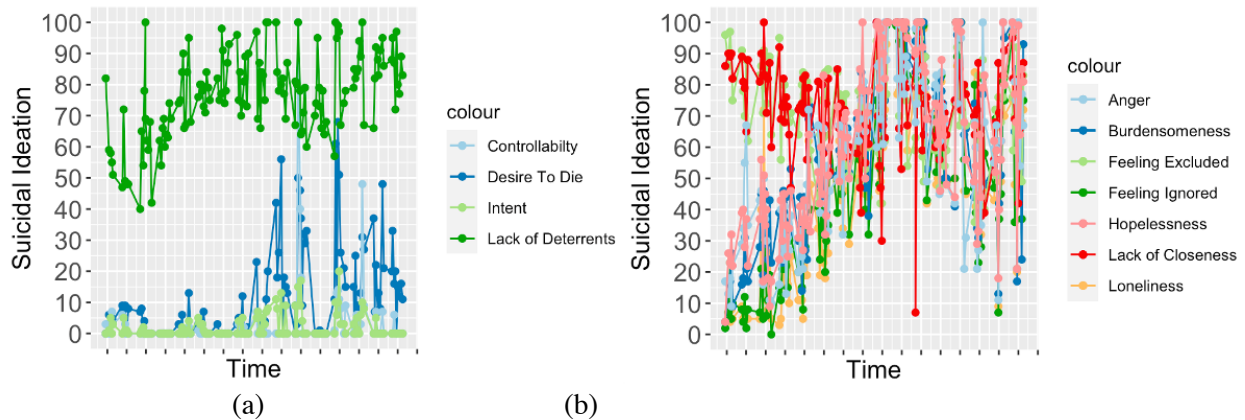


Figure 5.1.2. (a) Intra-individual Variability of SI Characteristics for Participant 2; (b) Intra-individual Variability of SI Characteristics for Participant 2; Dashes along the x-axis (“Time”) represent 12:00pm and occur ever 24 hours.

Differences in SI severity (*desire to die* item) across time of day are shown in Figure 5.2.2. Results indicate that there are no differences in SI severity across the day, ($F(3, 131) = 1.03, p = 0.383$). As we can see in Figure 5.2.2, average scores appear consistent, although highest SI scores appear in the morning and afternoon.

The network analysis for Participant 2’s multivariate time series data consisted of all 11 variables. The SI network model for participant 2 fit the data well (RMSEAs = 0.00, SRMRs = 0.04, CFIs = 1, NNFI = 1.05). Results are presented in Figure 5.3.2. Overall, the network generated by Participant 2’s time series data shows 16 positive contemporaneous paths, three lagged paths (two negative and one positive), and 11 positive autoregressions (one for each node). The large number of contemporaneous

paths suggests that many of the variables tend to move together and that the causal process linking these nodes likely occurs within the two-hour window between assessments.

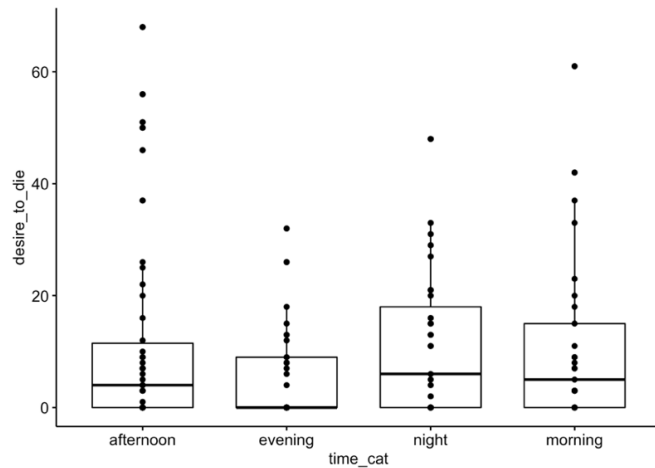


Figure 5.2.2. Distribution of “Desire to Die” by Time of Day for Participant 2; Morning = 5:00am to 11:59am, Afternoon = 12:00pm to 4:59pm, Evening = 5:00pm to 7:59pm, Night = 8:00pm to 4:59am.

This network shows a bidirectional relationship between SI risk factors and SI characteristics. For example, *feeling excluded* (node 4) and *lack of closeness* (node 5) increase scores for *desire to die* (node 8). *Desire to die* (node 8), in turn, increases *loneliness* (node 1), which impacts the rest of the network. Similarly, scores for *lack of deterrents* (node 10) increase with increases in *loneliness* (node 1) and *lack of closeness* (node 5).

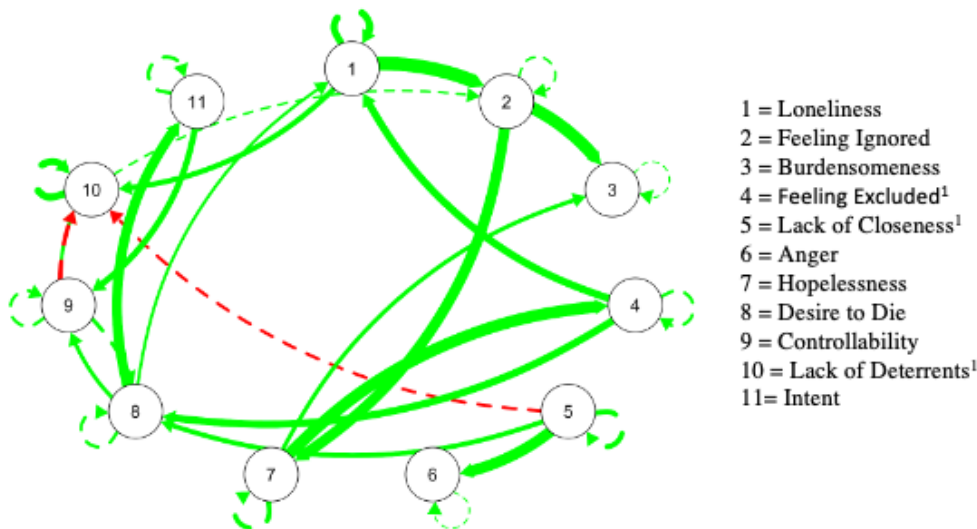


Figure 5.3.2. Intraindividual Time Series Network Analysis of SI Characteristics and Risk Factors for Participant 2; ¹Variables were reverse coded prior to analysis. Arrow = direction of the relation between two variables. Green = positive relation. Red = negative relation. Solid line = contemporaneous relation. Dashed line = time lag relation.

There are more direct connections, however, from SI characteristic nodes to SI characteristic nodes, and SI risk factor nodes to SI risk factor nodes, suggesting that SI characteristics fluctuate together, and SI risk factors fluctuate together. For example, *desire to die* (node 8) has a strong relation to *intent* (node 11). For this participant, when the desire to die increases, their intent to act on those thoughts also increases, suggesting that increases in *desire to die* may signal increased risk for suicidal behavior. Increases in one's desire to die are not always followed by intent to act; however, their relationship appears very important in understanding suicide risk for this participant. SI risk factors are also highly connected in this network. For example, *loneliness* (node 1) strongly influences *feeling ignored*, *feeling ignored* (node 2) strongly influences *hopelessness* (node 7), and *hopelessness* (node 7) strongly influences *feeling excluded* (node 4).

Predicted recovery times after perturbations of each node, as implied by the network obtained for Participant 2, are reported in Figure 5.4.2. They have a large range from 0.0 to 19.75 time-steps. Recovery times are longest across nodes 1 (*loneliness*), 2 (*feeling ignored*), 4 (*burdensomeness*), and 7 (*hopelessness*). Notably, when this participant's feelings of loneliness, being ignored or burdensomeness increase, their levels of intent to act on thoughts of suicide will remain elevated for about two days before naturally decaying to equilibrium, suggesting that periods where these feelings are elevated are periods of increased risk.

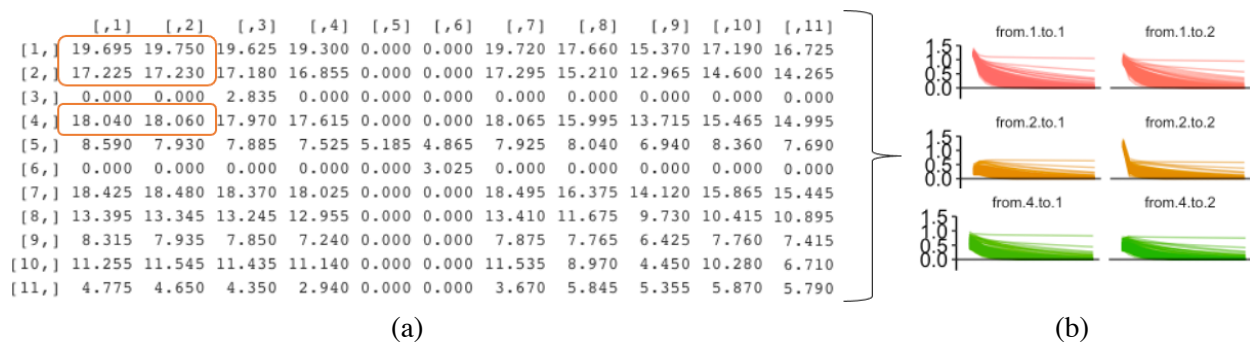


Figure 5.4.2. Recovery Time Following Node Perturbation for Participant 2; Figure (a) presents the number of time-steps taken for node X (columns) to recover after perturbation of node Y (rows). Figure (b) presents a visual for six cells in figure (a). One time-step = about two hours. 1 = Loneliness, 2 = Feeling Ignored, 3 = Burdensomeness, 4 = Feeling Excluded¹, 5 = Lack of Closeness¹, 6 = Anger, 7 = Hopelessness, 8 = Desire to Die, 9 = Controllability, 10 = Lack of Deterrents¹, 11= Intent

Participant 3

Quantitative summaries of the data provided by Participant 3 are presented in Table 5.2.3, with accompanying visualizations shown in Figure 5.1.3. Mean scores of *desire to die*, *controllability*, *lack of deterrents*, and *intent* ($M = 11.2, 5.9, 26.4$ and 3.7 respectively) were relatively low, initially suggesting low suicide risk. Average scores for SI risk factors were also relatively low, except for *feeling excluded* ($M = 40.51$), *lack of closeness* ($M = 45.4$) and *hopelessness* ($M = 31.5$) which were moderately high.

Table 5.2.3. Descriptive and Variability Statistics for Participant 3

Variable ²	N	Mean	SD	Min	Max	Skew	Kurtosis	CV
SI Risk Factors								
Loneliness	103	13.8252427	9.25925841	0	45	1.140654	1.52777311	66.9735686
Feeling Ignored	103	11.0679612	10.0822715	0	61	1.74724775	4.90918641	91.0942075
Burdensomeness	103	22.7864078	17.1325001	0	68	0.54191313	-0.4534611	75.1873671
Feeling Excluded ¹	103	40.5145631	22.2507387	3	91	0.1198699	-0.9960043	54.9203472
Lack of Closeness ¹	103	45.3592233	27.6794871	0	92	-0.1733855	-1.2125715	61.0228419
Anger	102	13.8137255	15.232021	0	75	1.72009777	3.20448423	NA
Hopelessness	103	31.5436893	17.2415235	0	81	0.29959157	-0.2350722	54.6591849
SI Characteristics								
Desire to Die	103	11.1747573	10.6765523	0	47	1.46754915	2.1304922	95.5416928
Controllability	103	5.86407767	5.8595465	0	31	1.08456828	1.74026354	99.92273
Lack of Deterrents ¹	103	26.4174757	14.8730077	0	60	0.22986053	-0.9998854	56.2998822
Intent	102	3.66666667	4.10585994	0	15	0.82072798	-0.394928	NA

¹Variables were reverse coded prior to analysis. ²All variables measured on a scale from 0 to 100.

As seen in the left (a) panel of Figure 5.1.3, the relative magnitude of change of *desire to die* increases toward the end of the two-week study, complicating interpretation of their suicide risk. This larger trend in the data isn't considered by the CV, so comparing CVs between variables becomes less relevant for this participant. We can see, however, in Figure 5.1.3, that despite this increase in *desire to die*, the magnitude of change for *intent* remains moderate and consistent throughout the study. The relation between the dynamic shift of one variable and the consistency of the other may suggest distinct mechanisms responsible for the increase in SI and intent to act on SI.

The relative magnitude of variability for *lack of deterrents* appears to be much higher than the other SI characteristics for the first week. It then shrinks for a few days, then increases again for the last days of the study. This change in magnitude of variability suggests instability in the strength of this participant's deterrents over time.

All SI risk factors fluctuated substantially across the observation period (CV ranging from *hopelessness* at 54.7 to *feeling ignored* at 91.1). And, as seen in the right (b) panel of figure 5.1.3, they appear to maintain relative consistency in their magnitude of change.

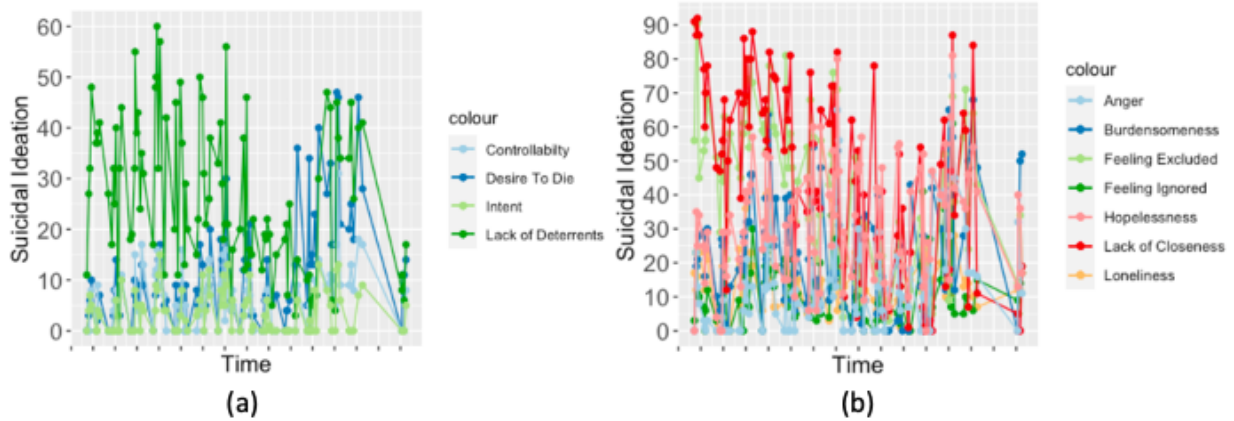


Figure 5.1.3. (a) Intraindividual Variability of SI Characteristics for Participant 3; (b) Intraindividual Variability of SI Characteristics for Participant 3; Dashes along the x-axis (“Time”) represent 12:00pm and occur ever 24 hours.

Differences in SI severity (*desire to die* item) across time of day are shown in Figure 5.2.3. For this participant, results indicate that there are no differences in mean SI severity across the day, ($F(3, 99) = 2.087, p = 0.107$). As we can see in Figure 5.2.3, however, scores in the afternoon have a smaller SD, suggesting more consistency than other times of day. Highest scores appear in the evening or night. This may suggest that, although SI is not always triggered, Participant 3 is more susceptible to stressors or causal mechanisms of SI later in the day.

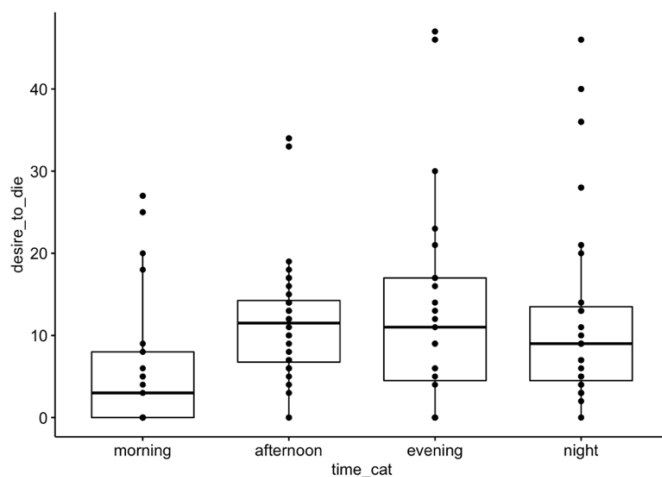


Figure 5.2.3. Distribution of “Desire to Die” by Time of Day for Participant 3; Morning = 5:00am to 11:59am, Afternoon = 12:00pm to 4:59pm, Evening = 5:00pm to 7:59pm, Night = 8:00pm to 4:59am.

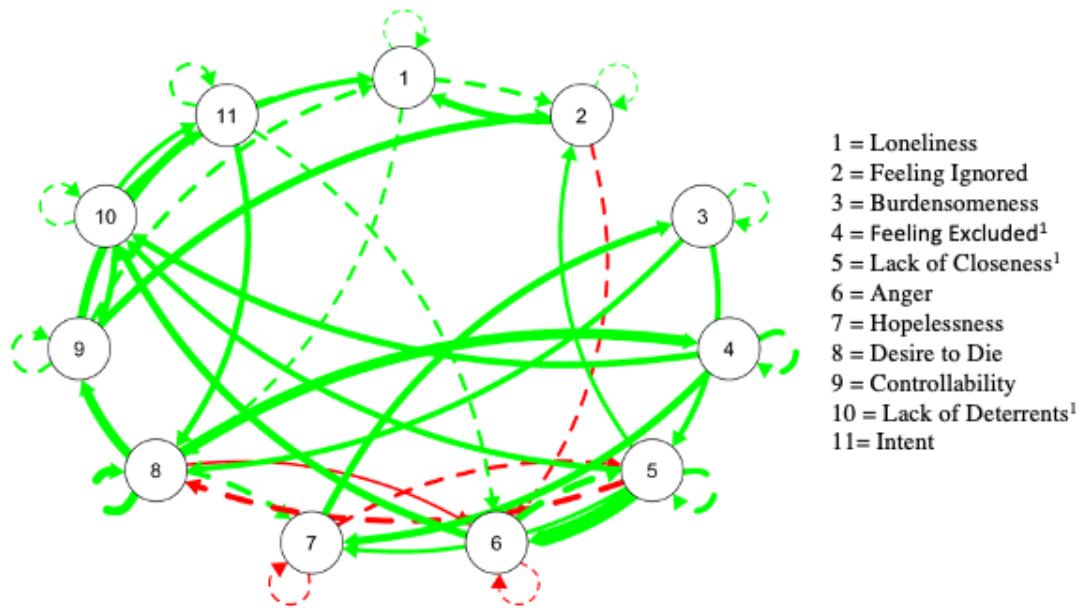


Figure 5.3.3. Intra-individual Time Series Network Analysis of SI Characteristics and Risk Factors for Participant 3; ¹Variables were reverse coded prior to analysis. Arrow = direction of the relation between two variables. Green = positive relation. Red = negative relation. Solid line = contemporaneous relation. Dashed line = time lag relation.

The network analysis for Participant 3’s multivariate time series data consisted of 11 variables. The SI network model for participant 3 fit the data well (RMSEAs = 0.00, SRMRs = 0.04, CFIs = 1, NNFI = 1.05). Results are presented in Figure 5.3.3.

Overall, the network generated by Participant 3’s time series data shows 28 paths. Nineteen contemporaneous paths (18 positive and one negative), 9 time-lagged paths (six positive and three negative), and 10 autoregressions (one for each node) nine of which are positive and two that are negative.

For this participant, SI characteristics appear to increase together. Within two-hour time periods, increases in *desire to die* (node 8) increased *controllability* (node 9), which increased *intent* (node 11). Increases in *lack of deterrents* (node 10) increased *controllability* (node 9) and *intent* (node 11). And increases in *intent* (node 11) increased *desire to die* (node 8), creating an extended excitatory loop with the potential to exacerbate suicide risk. *Intent* (node 11), clinically a node of great importance, plays an important role in the network. Higher levels of intent to act on thoughts of suicide tend to cause increased *loneliness* (node 1) and predicted increases in the participant’s *anger* (node 6).

Lack of closeness (node 5) appeared to have the largest contribution to the network. It had moderate positive contemporaneous relations to two variables (*feeling ignored* and *lack of deterrents*), a strong contemporaneous relationship with *anger* (node 6), and a moderately strong negative time-lagged relation to *desire to die*. This relation to *desire to die* seems counterintuitive. It suggests that when Participant 3 is not feeling close to other people in their life, they experience unusually low levels of SI. This may mean that, for this participant, interpersonal closeness is a stressor rather than a protective factor. *Lack of deterrents* appears to be directly impacted by many SI risk factors (*feeling excluded*, *lack of closeness*, and *anger*); however, it is not directly related to changes in other SI characteristics.

Notably, there is a bidirectional relationship between SI risk factors and SI characteristics. For example, *loneliness* (node 1) predicts increases in *desire to die* (node 8) and *controllability* (node 9), and *desire to die* (node 8) has a strong positive impact on feeling excluded (node 4). *Desire to die* (node 8) also has a negative impact on *anger* (node 6), suggesting that thoughts of dying may have a calming effect, reducing feelings of anger for this participant. The strongest time-lagged autoregression was in *desire to die* (node 8), suggesting that when this person experiences high levels of the desire to die, that desire extends to the next time-period.

	[,1]	[,2]	[,3]	[,4]	[,5]	[,6]	[,7]	[,8]	[,9]	[,10]	[,11]
[1,]	8.080	7.875	7.045	11.460	8.380	8.720	9.310	11.440	8.610	8.545	7.415
[2,]	7.375	7.235	3.625	11.925	11.900	11.750	8.325	12.365	7.440	10.430	6.000
[3,]	10.015	9.660	8.515	12.885	12.975	12.705	10.505	13.105	10.050	11.715	9.605
[4,]	8.445	7.840	7.030	12.480	11.875	11.685	9.445	12.125	8.240	10.990	7.875
[5,]	14.430	13.970	14.515	21.135	20.310	20.105	18.240	21.345	16.670	18.765	14.535
[6,]	11.970	11.245	10.195	17.475	17.165	16.895	14.550	17.755	13.115	15.630	11.475
[7,]	8.260	7.765	7.145	13.630	13.130	12.905	10.710	13.730	9.205	11.625	7.780
[8,]	12.655	12.445	12.125	18.560	17.535	17.430	15.850	18.790	14.420	16.200	12.690
[9,]	7.935	7.875	6.040	9.340	8.440	9.160	8.100	9.985	7.860	8.105	7.250
[10,]	7.150	7.185	5.355	9.050	6.745	7.910	7.805	8.915	7.560	7.200	6.660
[11,]	8.070	8.190	6.855	11.760	10.860	10.865	9.380	11.820	8.810	9.770	7.895

(a)

Figure 5.4.3. Recovery Time Following Node Perturbation for Participant 3; Figure (a) presents the number of time-steps taken for node X (columns) to recover after perturbation of node Y (rows). One time-step = about two hours. 1 = Loneliness, 2 = Feeling Ignored, 3 = Burdensomeness, 4 = Feeling Excluded¹, 5 = Lack of Closeness¹, 6 = Anger, 7 = Hopelessness, 8 = Desire to Die, 9 = Controllability, 10 = Lack of Deterrents¹, 11 = Intent

Predicted recovery times after perturbations of each node, as implied by the network obtained for Participant 3, are reported in Figure 5.4.3. Recovery times are long for this participant. *Lack of closeness*

(node 5), for example, appears to have the largest impact, resulting in the participant's desire to die to remain elevated for 21.3 time-steps or around two to three days, before returning to equilibrium. Notably, the quickest recovery time is about 6 time-steps (*intent* after perturbation of *feeling ignored*), suggesting a densely connected and sensitive network where increases in any variability will impact other variables for long periods of time.

Participant 4

Table 5.2.4. Descriptive and Variability Statistics for Participant 4

Variable ²	N	Mean	SD	Min	Max	Skew	Kurtosis	CV
SI Risk Factor								
Loneliness	110	55.2818182	9.5457679	19	80	-0.4830299	2.17944466	17.2674637
Feeling Ignored	110	26.6636364	10.6126783	0	71	1.44116109	3.70906007	39.8020666
Burdensomeness	110	30.0727273	10.9801398	0	75	0.63459516	1.9255004	36.5119521
Feeling Excluded ¹	110	84.4818182	6.97009578	45	100	-2.1560501	8.78723735	8.2504093
Lack of Closeness ¹	110	84.3	5.83024383	65	96	-0.7821424	1.02631856	6.91606623
Anger	110	25.1363636	9.3007618	5	63	0.59630301	2.13129346	37.0012224
Hopelessness	110	39.7818182	12.3862767	0	69	-0.670387	0.61526681	31.1355218
SI Characteristics								
Desire to Die	110	36.6727273	16.1325411	5	80	0.46669319	-0.0875332	43.9905682
Controllability	110	23	12.7509669	0	65	1.11703888	1.3455258	55.4389864
Lack of Deterrents ¹	110	66.5090909	15.0325308	0	93	-1.391074	4.05435892	22.6022196
Intent	110	0.01818182	0.19069252	0	2	10.2037833	103.054298	1048.80885

¹Variables were reverse coded prior to analysis. ²All variables measured on a scale from 0 to 100.

Quantitative summaries of the data provided by Participant 4 are presented in Table 5.2.4, with accompanying visualizations shown in Figure 5.1.4. The mean score for *desire to die* and *controllability* ($M = 36.7$ and 23 respectively) were moderate to low. The mean score for *lack of deterrents* ($M = 66.5$) was higher. Average scores for SI risk factors varied widely. *Lack of closeness* and *feeling excluded* had the highest scores ($M = 84.3$ and 84.5) while *anger* and *feeling ignored* had the lowest ($M = 25.1$ and 26.7).

As seen in the left (a) panel of Figure 5.1.4, average scores for *desire to die* and *controllability* appear to increase steadily over the two-week observation period, while scores for *lack of deterrents* decreased. The slow change in mean scores over time for three characteristics, in contrast to consistent zero scores for *intent* suggest that mechanisms responsible for changes in *controllability*, *desire to die*,

and *lack of deterrents*, are not responsible for increases in this Participant’s intent to act on thoughts of suicide.

Intent scores remained at zero for the duration of the study without fluctuation ($M = 0.02, SD = 0.19$) suggesting stability in this variable and indicating that the participant has no intent to act on suicidal thoughts, a potential protective factor for this individual. Excluding *intent*, the variables with the lowest relative magnitude of change over the two weeks were *lack of closeness* ($CV = 6.91$) and *feeling excluded* ($CV = 8.3$). The variables with the highest relative variability were *controllability* ($CV = 55.43$), *desire to die* ($CV = 43.9$) and *anger* ($CV = 37.0$). As seen in Figure 5.1.4, the relative magnitude of change for all variables remained relatively consistent throughout the study. This may suggest some stability in the participant’s presentation of SI risk factors.

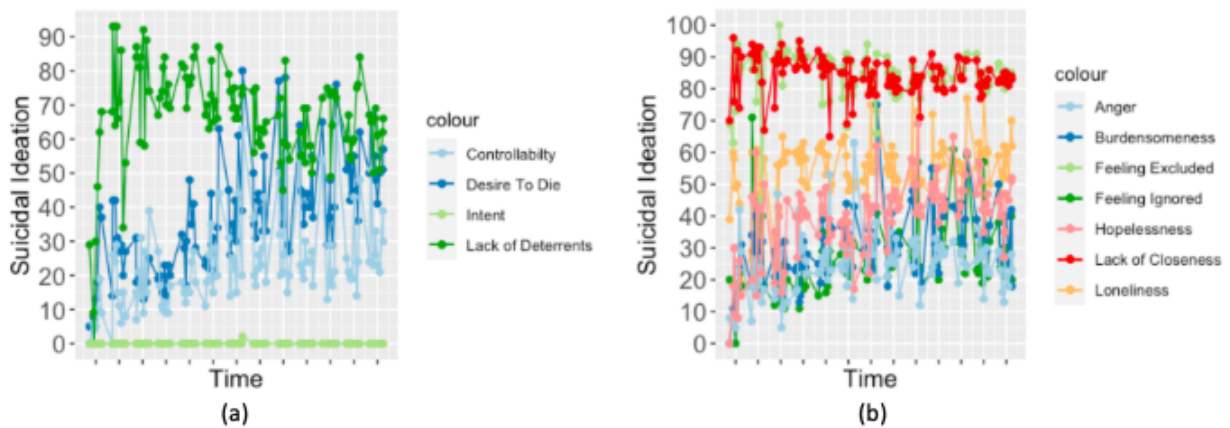


Figure 5.1.4. (a) Intraindividual Variability of SI Characteristics for Participant 4; (b) Intraindividual Variability of SI Characteristics for Participant 4; Dashes along the x-axis (“Time”) represent 12:00pm and occur ever 24 hours.

Differences in participant reports of the *desire to die* across time of day are shown in Figure 5.2.4. For this participant, results indicate that there are no differences in mean SI severity across the day ($F(3, 106) = .883, p = 0.452$). As we can see, spikes in SI (above 75 on scale from 0 to 100) did not happen often, but also occurred in across the day, suggesting that triggers for *desire to die* for this participant are not time dependent.

The network analysis for Participant 4’s multivariate time series data consisted of 10 variables, with the intent variable removed because there was no variance. The SI network model for Participant 4

fit the data well (RMSEAs = 0.00, SRMRs = 0.049, CFIs = 1, NNFI = 1.048). Results are presented in Figure 5.3.4. The network generated by Participant 4’s time series data shows 18 paths: twelve contemporaneous paths (10 positive and two negative), 6 time-lagged paths (four negative and two positive), and 10 autoregressions (one for each node), nine of which are positive and one that was negative.

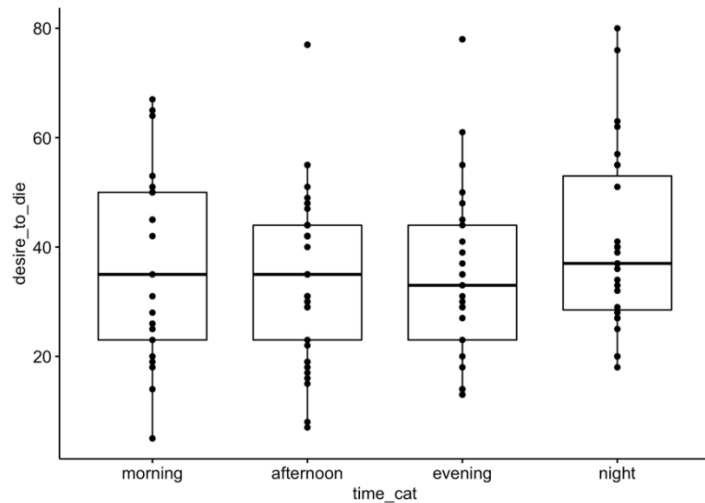


Figure 5.2.4. Distribution of “Desire to Die” by Time of Day for Participant 4; Morning = 5:00am to 11:59am, Afternoon = 12:00pm to 4:59pm, Evening = 5:00pm to 7:59pm, Night = 8:00pm to 4:59am.

There is an important negative time-lagged relation between *desire to die* (node 8) and *anger* (node 6). This suggests that *desire to die* acts as a calming phenomenon, reducing anger over time. Conversely, when Participant 4 experiences high levels of *desire to die*, decreased levels of anger will follow. In turn, elevated *anger* (node 6) predicts decreased *desire to die*. These results suggest that both suicidal thoughts and anger, typically though to be problematic and burdensome experiences, may instead be clinically relevant protective factors for this participant.

Desire to die (node 8) appears to have a large impact on this network. Increases in *desire to die* increase scores of three SI risk factors (*burdensomeness*, *feeling excluded*, and *anger*) and one SI characteristic (*controllability*). There also appear to be many bi-directional relations between SI risk factors and SI characteristics. For example, *feeling ignored* (node 2), *lack of closeness* (node 5) and *anger* (node 6) all decrease the impact deterrents have on the participant’s suicidality (*lack of deterrents*, node

10). While, contrary to popular suicide theory (Van Orden et al., 2011), *desire to die* (node 8) appears to increase *burdensomeness* (node 3), *feeling excluded* (node 4), and *anger* (node 6) for this participant.

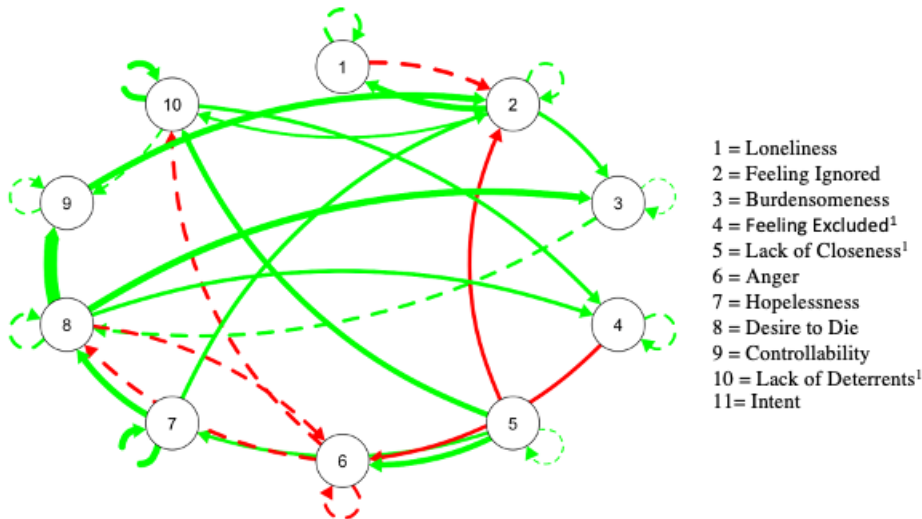


Figure 5.3.4. Intraindividual Time Series Network Analysis of SI Characteristics and Risk Factors for Participant 4; ¹Variables were reverse coded prior to analysis. Arrow = direction of the relation between two variables. Green = positive relation. Red = negative relation. Solid line = contemporaneous relation. Dashed line = time lag relation.

Predicted recovery times from perturbations of each node, as implied by the network obtained for Participant 4, are reported in Figure 5.4.4. Recovery times for this network are relatively low, ranging from 0.00 time-steps to 8.45 time steps. For example, the model predicts scores for *desire to die* about a day and a half to return to equilibrium, when *hopelessness* scores increase. *Hopelessness* (node 7) appears to have the largest impact on the network, highlighting its clinical relevance.

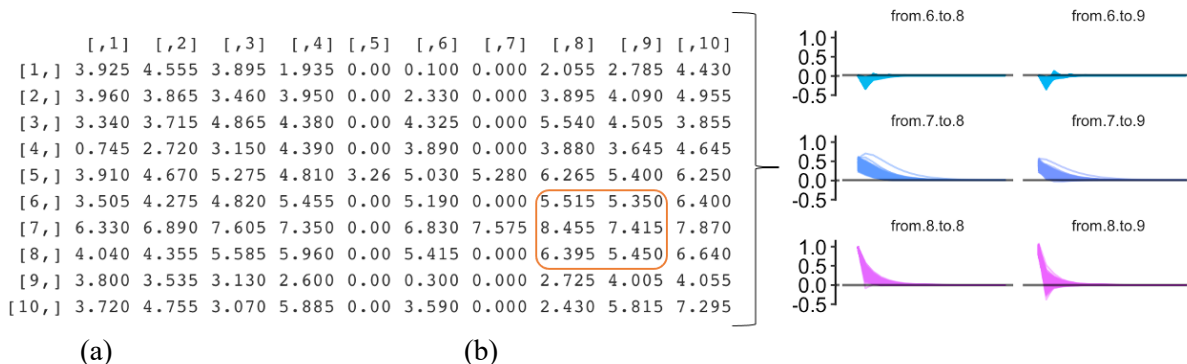


Figure 5.4.4. Recovery Time Following Node Perturbation for Participant 4; figure a and b (zoomed in on six cells) shows the number of time steps it takes for the variable to recover after perturbation of another variable. One time-step = about two hours. 1 = Loneliness, 2 = Feeling Ignored, 3 = Burdensomeness, 4 = Feeling Excluded¹, 5 = Lack of Closeness¹, 6 = Anger, 7 = Hopelessness, 8 = Desire to Die, 9 = Controllability, 10 = Lack of Deterrents¹, 11= Intent

Participant 5

Table 5.2.5. Descriptive and Variability Statistics, for Participant 5

Variable ²	N	Mean	SD	Min	Max	Skew	Kurtosis	CV ²
SI Risk Factors								
Loneliness	108	22.287037	16.8334619	0	88	1.31811949	2.17214673	75.5302817
Feeling Ignored	108	23.1481481	19.2367516	0	100	0.99688309	1.27890128	83.1027671
Burdensomeness	108	29.787037	24.29032	0	90	0.64487184	-0.5495882	81.5466135
Feeling Excluded ¹	108	48.462963	20.5878223	4	95	0.31784552	-0.6948135	42.4815593
Lack of Closeness ¹	108	56.787037	28.2780093	0	100	-0.1871808	-1.2278613	49.7965923
Anger	108	21.1388889	23.9155283	0	100	1.66112736	2.5048404	113.135219
Hopelessness	108	19.9814815	18.2398257	0	81	1.25390097	1.20263227	91.2836505
SI Characteristics								
Desire to Die	108	7.10185185	10.999524	0	65	2.51875641	8.26061351	154.882477
Controllability	108	1.90740741	8.34595099	0	80	7.8335216	68.5516081	437.554712
Lack of Deterrents ¹	108	17.7777778	8.9163646	0	49	0.64754409	0.95201722	50.1545509
Intent	108	0.07407407	0.52424764	0	5	8.18857325	70.951174	707.734308

¹Variables were reverse coded prior to analysis. ²All variables measured on a scale from 0 to 100.

Quantitative summaries of the data provided by Participant 5 are presented in Table 5.2.5, with accompanying visualizations shown in Figure 5.1.5. The mean scores for *desire to die*, *controllability*, and *lack of deterrents* were low ($M = 7.1, 1.9,$ and 17.8 respectively). *Intent* remained around zero ($M = 0.1, SD = 0.5$) throughout the observation period. Consistency suggests stability in the participant's absence of intent to act on thoughts of suicide, further suggesting a low risk for suicidal behavior.

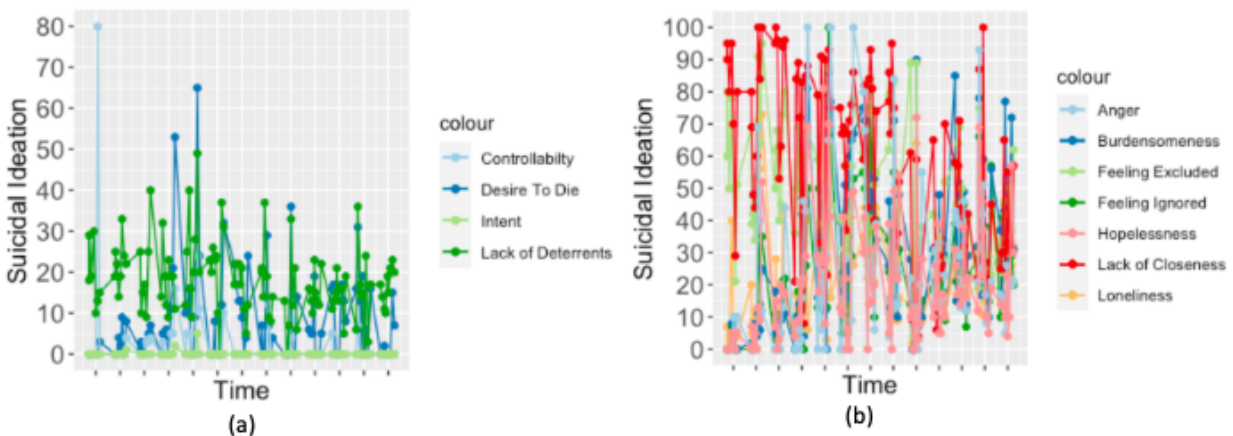


Figure 5.1.5. (a) Intraindividual Variability of SI Characteristics for Participant 5; (b) Intraindividual Variability of SI Characteristics for Participant 5; Dashes along the x-axis (“Time”) represent 12:00pm and occur ever 24 hours.

As seen in the left (a) panel of Figure 5.1.5, *intent* appears to have the lowest relative magnitude of variability ($M = 0.07, SD = 0.52$). *Controllability* and *desire to die* fluctuate significantly, repeatedly

returning to zero between spikes. The desire to die magnitude of variability increases for three or four days at the end of the first week and then falls again. Interestingly, the participant continues to report zero scores intermittently throughout the study; even during periods of heightened magnitude of variability. This pattern – SI denial, followed by an SI spike, followed by SI alleviation and return to SI denial – suggests that SI occurs in distinct episodes that range in length and severity. *Controllability* ($SD = 8.35$) follows the same pattern and appears to fluctuate with scores for *desire to die*, however *lack of deterrents* ($SD = 8.9$) does not. The relative absence of zero scores for *lack of deterrents*, and consistency in the relative magnitude of change seen in the left panel (a) of Figure 5.1.5, suggest that *lack of deterrents* is a stable phenomenon compared to *controllability* and *desire to die*, and may indicate distinct mechanisms responsible for its fluctuation.

As seen in the right (b) panel of Figure 5.1.5, SI risk factors all appear to fluctuate greatly with minimum scores ranging from 0-4 (on a scale of 0-100) and maximum scores ranging from 81-100 (on a scale of 0-100). Variables with the smallest relative magnitude of change after accounting for the relative differences in mean level were *feeling excluded* ($CV = 42.5$) and *lack of closeness* ($CV = 49.8$). Variables with the highest relative magnitude of change were *hopelessness* ($CV = 91.3$) and *anger* ($CV = 113$). Among risk factors, it appears that all magnitudes of variability remained relatively stable.

Figure 5.3.5 indicates significant differences in mean scores for *desire to die* across times of day, ($F(3, 104) = .536, p = 0.003$). As shown in the figure, highest scores (although infrequent) occurred in the evening or at night. The lowest and most consistent scores appear in the afternoon, suggesting that mechanisms responsible for fluctuation may, at least partially, be connected to time of day.

The network analysis for Participant 5's multivariate time series data consisted of 10 variables, with the *intent* variable removed due to lack of variance. The SI network model for Participant 5 fit the data well (RMSEAs = 0.00, SRMRs = 0.057, CFIs = 1, NNFI = 1.062). Results are presented in Figure 5.3.5. The network generated by Participant 5's time series data shows 19 paths: seventeen contemporaneous paths (13 positive and four negative), 2 time-lagged paths (one negative and one positive), and 10 autoregressions (one for each node) eight of which are positive and two that were

negative (*hopelessness*, node 7, and *controllability*, node 9). The large number of directional contemporaneous relations indicates that many of the variables fluctuate together and that the causal process linking these nodes likely occurs within the two-hour window between assessments.

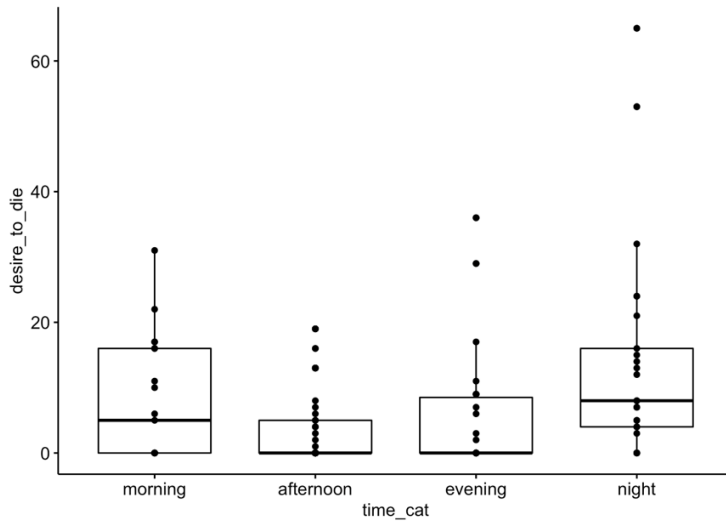


Figure 5.2.5. Distribution of “Desire to Die” by Time of Day for Participant 5; Morning = 5:00am to 11:59am, Afternoon = 12:00pm to 4:59pm, Evening = 5:00pm to 7:59pm, Night = 8:00pm to 4:59am.

There are only two relations between SI characteristics: *desire to die* (node 8) increases *controllability* (node 9), and *lack of deterrents* (node 10) increases *desire to die* (node 8). This suggests a disconnect between individual SI characteristics, and subsequently may suggest unique mechanisms responsible for their fluctuation. There is a bi-directional relation between SI characteristics and SI risk factors in this network. For example, increased *desire to die* (node 8) increases *feeling excluded* (node 4) and *hopelessness* (node 8), suggesting that, for this participant, SI drives an increase in hopelessness.

Predicted recovery times after perturbation of each node, as implied by the network obtained for Participant 5, are reported in Figure 5.4.5. Recovery times for this network are relatively low, ranging from 0.00 to 6.59 time steps (about one day). Quick recovery times suggest a moderately sparse network and weaker responses in one node when another node is increased. This participant’s data suggest that increases in SI characteristics or risk factors would likely return to equilibrium within a day.

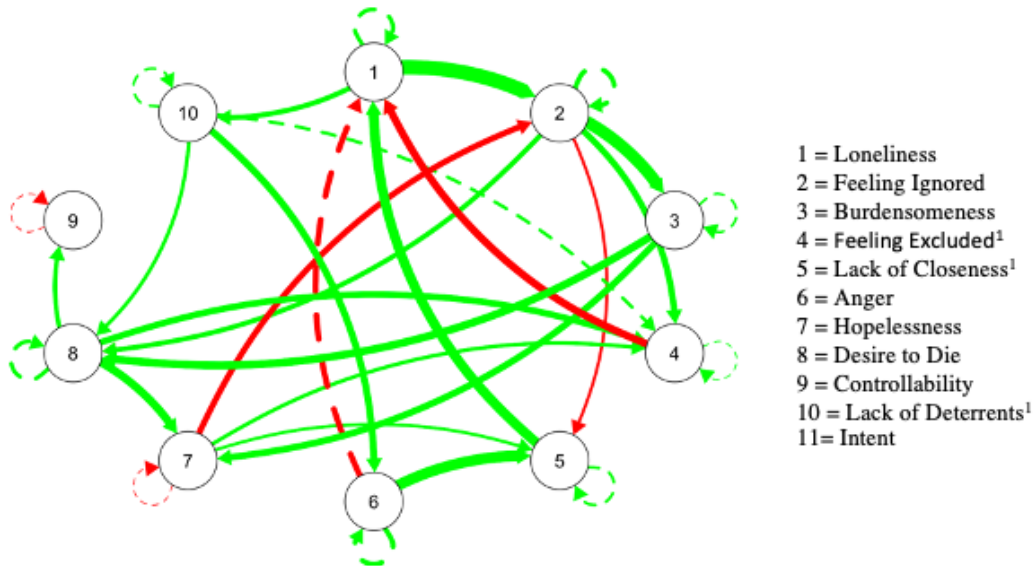


Figure 5.3.5. Intra-individual Time Series Network Analysis of SI Characteristics and Risk Factors for Participant 5; ¹Variables were reverse coded prior to analysis. Arrow = direction of the relation between two variables. Green = positive relation. Red = negative relation. Solid line = contemporaneous relation. Dashed line = time lag relation.

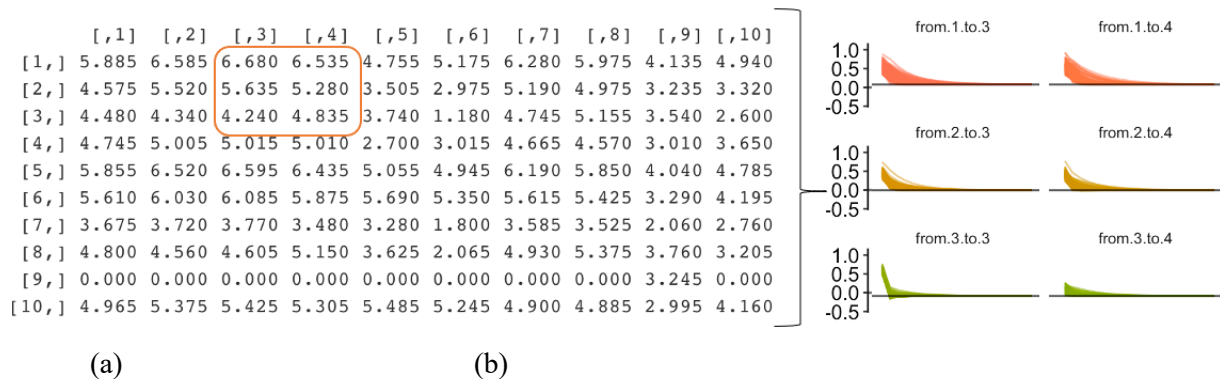


Figure 5.4.5. Recovery Time Following Node Perturbation, for Participant 5; Figure a and b (zoomed in on six cells) show the number of time steps it takes for the variable to recover after perturbation of another variable. One time-step = about two hours. 1 = Loneliness, 2 = Feeling Ignored, 3 = Burdensomeness, 4 = Feeling Excluded¹, 5 = Lack of Closeness¹, 6 = Anger, 7 = Hopelessness, 8 = Desire to Die, 9 = Controllability, 10 = Lack of Deterrents¹, 11 = Intent. ¹Variables were reverse coded prior to analysis.

Participant 6

Quantitative summaries of the data provided by Participant 6 are presented in Table 5.2.6, with accompanying visualizations shown in Figure 5.1.6. Although mean scores of *desire to die* were relatively low throughout the study ($M = 26.8, SD = 7.67$), *intent* scores varied ($M = 19.19, SD = 6.10$), indicating

inconsistency between the two variables. These results indicate that, although the individual's desire to die is relatively low, they still have some intent to kill themselves.

Table 5.2.6. Descriptive and Variability Statistics for Participant 6

Variable ²	N	Mean	SD	Min.	Max.	Skew	Kurtosis	CV
SI Risk Factors								
Loneliness	110	27.2454545	10.2699226	5	59	0.70657016	0.43438198	37.6940768
Feeling Ignored	110	29.5818182	11.5864377	6	64	0.66114246	0.12515804	39.1674291
Burdensomeness	110	47.5727273	9.52876773	18	75	0.13686608	0.24355971	20.0298959
Feeling Excluded ¹	110	95.2818182	1.85794509	90	99	-0.0277479	-0.1626657	1.94994714
Lack of Closeness ¹	110	94.5727273	3.12568258	81	99	-1.2733604	2.59987865	3.30505704
Anger	110	19.5909091	5.75699886	8	40	0.8935454	1.32073201	29.3860731
Hopelessness	110	47.9909091	9.10539255	19	68	-0.092564	0.0828585	18.9731612
SI Characteristics								
Desire to Die	110	26.8181818	7.67598641	8	46	0.32208418	-0.1195999	28.6223222
Controllability	110	44.3363636	12.0787001	15	82	0.49372428	0.58051074	27.243326
Lack of Deterrents ¹	110	61.5090909	16.5167391	14	86	-0.9047121	0.16676119	26.8525169
Intent	109	19.1926606	6.10475993	8	34	0.41581983	-0.5328189	NA

¹Variables were reverse coded prior to analysis. ²All variables measured on a scale from 0 to 100.

Mean scores of SI characteristics varied. *Lack of deterrents* was highest (M = 61.5), indicating that deterrents have little effect on the participant's suicidality. As shown on the left (a) panel of Figure 5.1.6., scores for *lack of deterrents* started low and trended upward throughout the observation period. However, average scores for the other SI characteristics remain relatively consistent and did not follow the same pattern, suggests the presence of mechanisms responsible for the trend in *lack of deterrents* that do not affect trends in other SI characteristics.

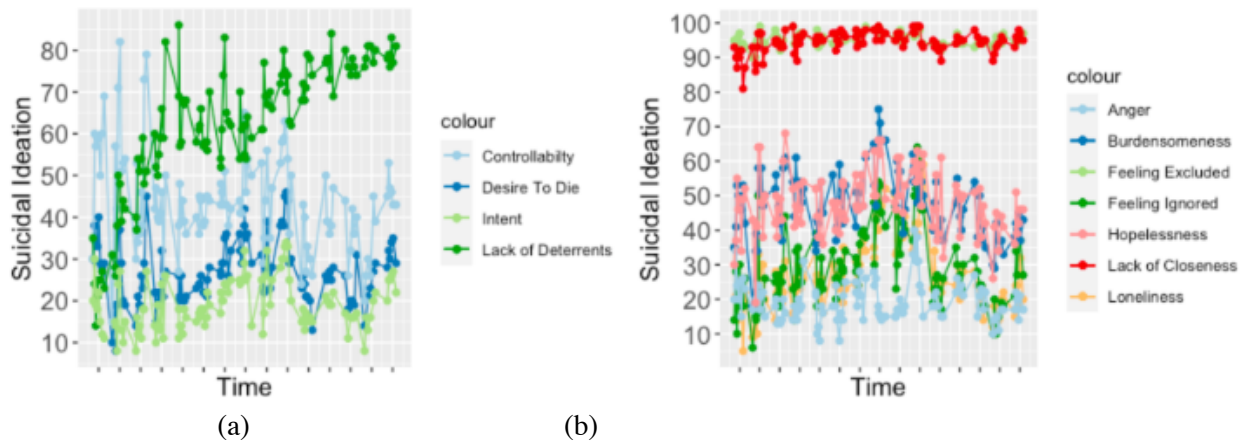


Figure 5.1.6. (a) Intraindividual Variability of SI Characteristics for Participant 6; (b) Intraindividual Variability of SI Characteristics for Participant 6; Dashes along the x-axis (“Time”) represent 12:00pm and occur ever 24 hours.

Among SI risk factors, *lack of closeness* and *feeling excluded* had high average scores ($M = 94.6$ and 95.3 , respectively). The remaining SI characteristics averaged between low to moderate scores ($min = 5$, $max = 72$). After accounting for the differences in mean level, the relative magnitude of variability for SI risk factors remained consistent throughout the study. *Lack of closeness* ($M = 94.6$, $SD = 3.1$, $CV = 3.3$) and *feeling excluded* ($M = 95$, $SD = 1.8$, $CV = 1.9$) had high means and scores remained high throughout the study suggesting that this individual has strong and consistent feelings of disconnectedness from others.

Differences in *desire to die* across time of day are shown in Figure 5.2.6. This participant showed no differences in mean *desire to die* across the day, ($F(3, 106) = 1.129$, $p = 0.341$). As we can see in Figure 5.2.6, this SI characteristic seems evenly distributed across times of day, with the afternoon containing both the lowest and highest scores. This data suggests that mechanisms responsible for SI fluctuations are not time of day dependent.

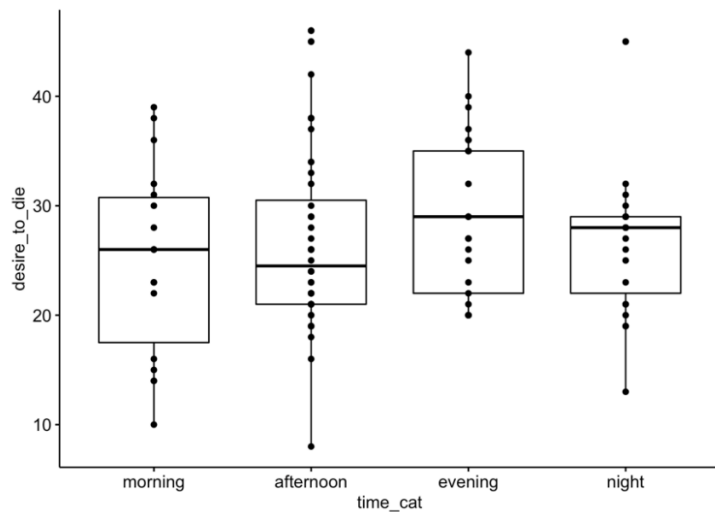


Figure 5.2.6. Distribution of “Desire to Die” by Time of Day for Participant 6; Morning = 5:00am to 11:59am, Afternoon = 12:00pm to 4:59pm, Evening = 5:00pm to 7:59pm, Night = 8:00pm to 4:59am.

The network analysis for Participant 6’s multivariate time series data consisted of 11 variables. The SI network model for Participant 6 fit the data well (RMSEAs = 0.00, SRMRs = 0.034, CFIs = 1, NNFI = 1.016). Results are presented in Figure 5.3.6. Overall, the network generated by Participant 6’s time series data shows 25 paths: sixteen contemporaneous paths (15 positive and one negative), 9 time-

lagged paths (two positive and seven negative), and 10 autoregressions (one for each node) nine of which are positive and two that are negative.

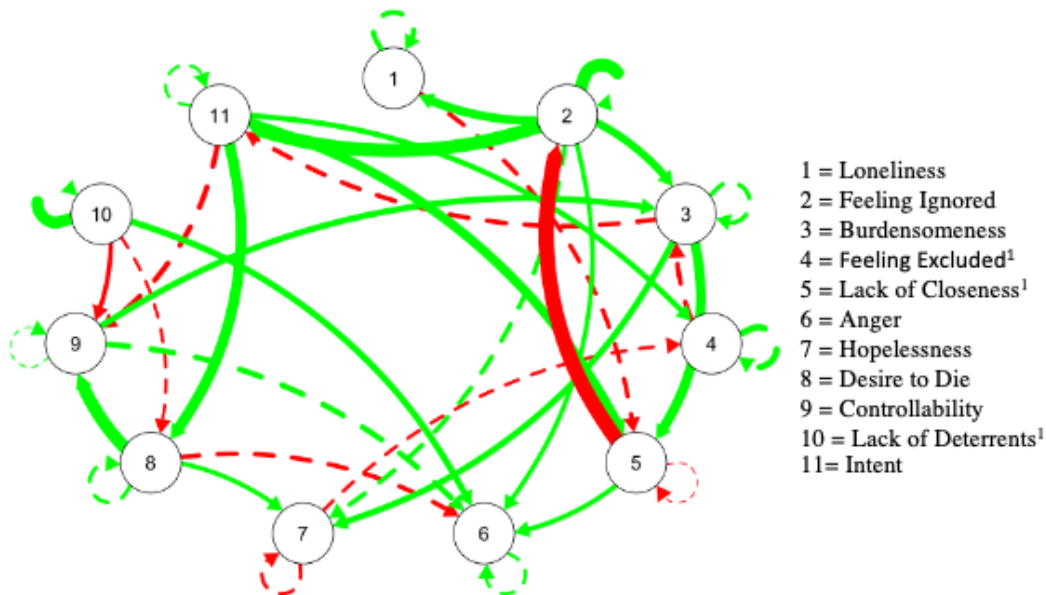


Figure 5.3.6. Intraindividual Time Series Network Analysis of SI Characteristics and Risk Factors for Participant 6; ¹Variables were reverse coded prior to analysis. Arrow = direction of the relation between two variables. Green = positive relation. Red = negative relation. Solid line = contemporaneous relation. Dashed line = time lag relation.

Feeling ignored (node 2) appears to be the most impactful risk factor for this participant.

Increased feelings of being ignored increased levels of *burdensomeness* (node 3), *anger* (node 6), *loneliness* (node 1) and strongly increased scores of *intent* (node 11). *Feeling ignored* also predicted feelings of hopelessness and strongly impacted itself (through autoregression) later in the day.

Additionally, increased intent to act on desire to die (node 11) had a large impact on the network. Increases in *intent* scores moderately increased *feeling excluded* (node 4) and strongly impacted scores for *lack of closeness* (node 5) and *desire to die* (node 8). *Intent* also predicted decreases in *controllability* (node 9).

Desire to die (node 8) had a lagged negative relation to *anger* (node 6), suggesting a calming effect associated with thoughts of suicide. *Anger* scores, while not causing any increases in other variables, were directly impacted by five variables (*lack of closeness*, *feeling ignored*, *lack of deterrents*, *controllability* and *desire to die*).

Predicted recovery times after perturbations of each node, as implied by the network obtained for Participant 6, are reported in Figure 5.4.6. The predicted recovery times for Participant 6 vary widely, with exceptionally high recovery times for many variables. For example, this model predicted that, following a decrease in the strength of this participant’s deterrents on their suicidality (node 10), it would take about 50 time-steps, or almost a week, for levels of *anger* (node 6) to naturally return to equilibrium. This suggests extreme sensitivity to variability of variables in this network.

	[,1]	[,2]	[,3]	[,4]	[,5]	[,6]	[,7]	[,8]	[,9]	[,10]	[,11]
[1,]	29.650	29.035	29.020	25.480	27.885	26.755	28.530	28.775	27.085	0.0	28.465
[2,]	35.790	35.530	35.595	31.840	34.815	33.670	35.015	35.125	33.410	0.0	34.720
[3,]	30.030	29.635	29.375	27.440	28.575	28.105	29.075	30.350	28.585	0.0	29.960
[4,]	29.480	29.245	29.185	27.605	27.900	27.550	27.760	29.980	28.325	0.0	29.525
[5,]	31.770	31.475	31.575	27.995	30.740	29.710	30.940	31.205	29.625	0.0	30.830
[6,]	0.000	0.000	0.000	0.000	0.000	4.165	0.000	0.000	0.000	0.0	0.000
[7,]	23.010	23.510	24.010	25.245	22.515	20.065	23.855	24.810	23.335	0.0	24.625
[8,]	28.455	28.195	28.100	26.290	27.225	26.945	27.515	29.150	26.880	0.0	28.815
[9,]	27.155	26.910	26.715	24.980	26.220	26.405	25.940	27.450	25.730	0.0	27.005
[10,]	45.495	45.805	45.410	44.740	35.995	50.855	38.850	41.355	49.650	44.1	49.805
[11,]	31.225	30.990	31.585	27.970	30.380	29.125	30.570	30.645	28.945	0.0	30.365

Figure 5.4.6. Recovery Time Following Node Perturbation for Participant 6; This figure shows the number of time steps it takes for the variable to recover after perturbation of another variable. 1 = Loneliness, 2 = Feeling Ignored, 3 = Burdensomeness, 4 = Feeling Excluded¹, 5 = Lack of Closeness¹, 6 = Anger, 7 = Hopelessness, 8 = Desire to Die, 9 = Controllability, 10 = Lack of Deterrents¹, 11= Intent. ¹Variables were reverse coded prior to analysis.

Participant 7

Quantitative summaries of the data provided by Participant 7 are presented in Table 5.2.7, with accompanying visualizations shown in Figure 5.1.7. Mean scores for *desire to die*, *lack of deterrents*, *controllability* and *intent*, presented at the bottom of Table 5.2.7, are low ($M = 18.6, 4.4, 1.8,$ and 0.4 respectively). However, as seen in the left (a) panel of Table 5.2.7, there are a few spikes in SI characteristics throughout the observation period. There is one notable spike at the end of the first week where *intent* and *lack of deterrents* increase substantially. In this case *lack of deterrents* goes from a consistently low score with a very small relative magnitude of variability (seen in Figure 5.1.7) to a very high score (>80 on a scale of 0-100), and *intent* increases from zero to above 15 (on a scale of 0-100). During this spike, *desire to die* and *controllability* remain at a moderate level, suggesting that when this participant’s deterrents are not strongly affecting their suicidality, their intent increases simultaneously.

Table 5.2.7. Descriptive and Variability Statistics for Participant 7

Variable ²	N	Mean	SD	Min.	Max.	Skew	Kurtosis	CV
SI Risk Factors								
Loneliness	89	24.8089888	13.9836564	7	76	1.80533024	3.39805486	56.3652816
Feeling Ignored	89	19.011236	10.7835042	4	79	2.22076076	8.95418603	56.721742
Burdensomeness	89	27.3595506	16.2279551	0	92	1.74502365	3.94456633	59.3136758
Feeling Excluded ¹	89	91.0898876	10.5901331	44	100	-2.3843544	6.00244675	11.626025
Lack of Closeness ¹	89	90.9101124	10.2941294	53	100	-2.1596333	4.32983785	11.3234152
Anger	89	4.06741573	8.02665694	0	37	2.35461672	5.11926151	197.340461
Hopelessness	89	25.0674157	13.7243958	0	68	0.82304242	0.67446176	54.7499429
SI Characteristics								
Desire to Die	89	18.6404494	11.7871725	2	60	1.14338449	1.165392	63.2343794
Controllability	89	4.38202247	5.81241934	0	27	1.81645648	3.25564511	132.64239
Lack of Deterrents ¹	89	1.84269663	8.99355688	0	82	8.0267103	68.0114625	488.064977
Intent	89	0.40449438	1.95819433	0	16	6.30071954	44.0676748	484.109153

¹Variables were reverse coded prior to analysis. ²All variables measured on a scale from 0 to 100.

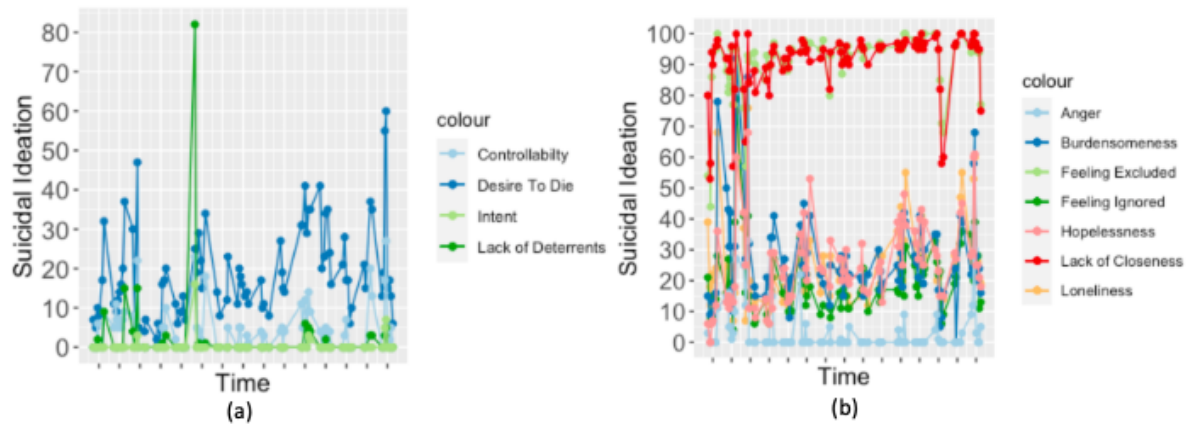


Figure 5.1.7. (a) Intraindividual Variability of SI Characteristics for Participant 7; (b) Intraindividual Variability of SI Characteristics for Participant 7; Dashes along the x-axis (“Time”) represent 12:00pm and occur every 24 hours.

Mean scores for SI risk factors varied. Scores for *lack of closeness* ($M = 90.9$) and *feeling excluded* ($M = 91.1$) were high and had low relative variability ($CV = 11.6$ and 11.2 respectively), suggesting that Participant 7 has relatively fixed feelings of disconnect from others. However, dips in both variables, seen in the left (b) panel of Figure 5.1.7 suggest that they are potentially susceptible to influence. *Anger* had the lowest average score ($M = 4.0$) and the rest of the SI risk factors ranged from 19.0 (*feeling ignored*), on a scale of 0-100, to 27.35 (*burdensomeness*). There also appears to be high

levels of relative variability for risk factors in the first few days of the study, followed by relatively consistent variability through the rest of the study.

Differences in *desire to die* across time of day are shown in Figure 5.3.7. Results show no differences in mean *desire to die* between different times of day, ($F(3, 85) = 0.176, p = 0.913$). As shown in Figure 5.3.7, spikes in SI (>50 on scale of 0 -100), however, occurred in the afternoon.

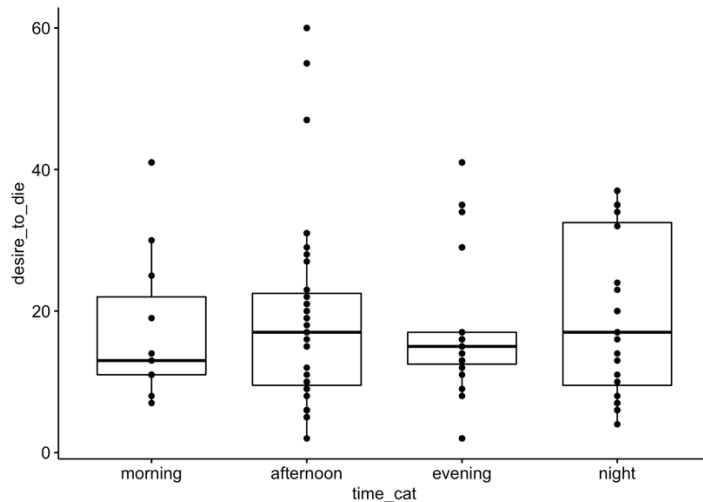


Figure 5.2.7. Distribution of “Desire to Die” by Time of Day for Participant 7; Morning = 5:00am to 11:59am, Afternoon = 12:00pm to 4:59pm, Evening = 5:00pm to 7:59pm, Night = 8:00pm to 4:59am.

The network analysis for Participant 7’s multivariate time series data consisted of 10 variables after removing *intent* due to a lack of variability. The SI network model for participant 7 fit the data well (RMSEAs = 0.06, SRMRs = 0.049, CFIs = 0.97, NNFI = 0.96). Results are presented in Figure 5.3.7. Overall, the network generated by Participant 7’s time series data shows 28 paths: fifteen positive contemporaneous paths, 13 time-lagged paths (four positive and nine negative), and 10 autoregressions (one for each node), eight of which are positive and three that are negative. The relatively high number of time lagged relationships shows that the two-hour window between assessments likely picked up on important variability.

Loneliness (node 1) appears to have a large contribution to the network. It has moderate positive contemporaneous relations to four variables (*feeling ignored*, *burdensomeness*, *lack of closeness* and *lack of deterrents*), and a negative lagged impact on *hopelessness* (node 7). Although *anger* (node 6) is directly

effect deterrents have on this participant’s suicidality. Further suggesting that the participant’s deterrents are different than the people they either feel close to or distant from.

Predicted recovery times after perturbation of each node, as implied by the network obtained for Participant 7, are reported in Figure 5.4.7. Overall, recovery times exhibited moderate range and moderate averages. *Lack of deterrents* (node 10) appears to have the largest impact on other nodes, resulting in *lack of closeness* and *anger* to remain below average for about 12 time-steps, or around a day and a half, before naturally returning to equilibrium.

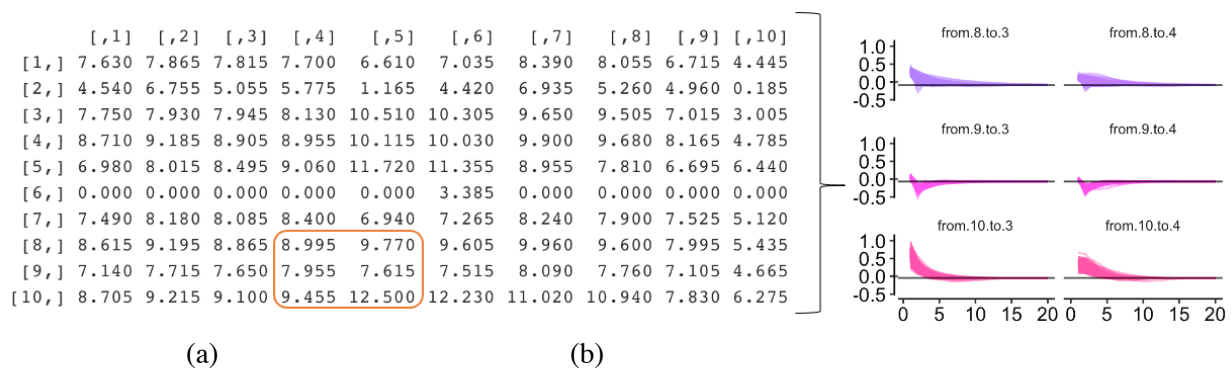


Figure 5.4.7. Recovery Time Following Node Perturbation for Participant 7; Figure a and b (zoomed in on six cells) shows the number of time steps it takes for the variable to recover after perturbation of another variable. 1 = Loneliness, 2 = Feeling Ignored, 3 = Burdensomeness, 4 = Feeling Excluded¹, 5 = Lack of Closeness¹, 6 = Anger, 7 = Hopelessness, 8 = Desire to Die, 9 = Controllability, 10 = Lack of Deterrents¹, 11= Intent. ¹Variables were reverse coded prior to analysis.

Participant 8

Quantitative summaries of the data provided by Participant 8 are presented in Table 5.2.8, with accompanying visualizations shown in Figure 5.1.8. Mean scores for *desire to die* and *controllability* are relatively low ($M = 22.7$ and 4.96 respectively). The average score for *controllability* was low ($M = 4.96$) with moderate variability ($SD = 7.39$) throughout the study (as seen in the left (a) panel of Figure 5.1.8). *Intent* scores also were low on a scale from 0-100 ($M = 5.61$). *Intent* scores varied throughout the study, spiking to a maximum¹ of 25. The average score for *lack of deterrents* was very high ($M = 96.0$) and remained high for most of the study (as seen in the left (a) panel of Figure 5.1.8). The relative lack of change for the *lack of deterrents* item ($SD = 9.42$, $CV = 9.8$) may typically suggest this is a stable item. However, significant dips in scores during the first week implies that this variable is more susceptible to

change than its relative variability may suggest. The relative change in magnitude of variability between *lack of deterrents* and the other three SI characteristics suggests that different mechanisms may be responsible for their variability.

Table 5.2.8. Descriptive and Variability Statistics for Participant 8

Variable ²	N	Mean	SD	Min.	Max.	Skew	Kurtosis	CV ²
SI Risk Factors								
Loneliness	104	26.0480769	16.3287701	0	71	0.30270761	-0.3426301	NA
Feeling Ignored	105	13.1333333	14.8984167	0	64	1.32001874	1.26480885	113.439721
Burdensomeness	105	40.0571429	16.4964032	0	77	-0.446592	-0.3654508	41.1821763
Feeling Excluded ¹	105	61.8952381	7.35098608	39	81	0.09948437	1.23379988	11.876497
Lack of Closeness ¹	105	57.0666667	7.81550071	40	80	0.32299777	0.05272605	13.6953868
Anger	105	7.44761905	11.9163599	0	60	2.05720292	4.36684974	160.002275
Hopelessness	105	27.1047619	15.1504784	0	60	0.35512853	-0.6758433	55.8960026
SI Characteristics								
Desire to Die	105	22.7047619	14.6096147	0	71	0.83872216	0.37847367	64.346038
Controllability	105	4.96190476	7.39402541	0	40	1.89866373	4.49896463	149.015867
Lack of Deterrents ¹	105	96.0857143	9.42798033	40	100	-3.4442754	13.9288158	9.81205209
Intent	103	5.61165049	6.16637468	0	25	0.88133137	-0.0897009	NA

¹Variables were reverse coded prior to analysis. ²All variables measured on a scale from 0 to 100.

Mean scores for SI risk factors all fall within the low to moderate range of our 0-100 scale. *Lack of closeness* ($M = 57.1$) and *feeling excluded* ($M = 61.9$) had the highest mean scores while *anger* ($M = 7.4$) and *feeling ignored* ($M = 13.1$) had the lowest mean scores. *Anger* and *feeling ignored* also had the highest relative variability ($CV = 160.0$ and 113.4 respectively) with maximum scores for *anger* up to moderate range (60 and 64 respectively). *Feeling excluded* was the most stable risk factor, with the lowest relative variability after controlling for differences in means ($SD = 7.3$, $CV = 11.8$). As seen in the right (b) panel of Figure 5.1.8, all risk factor variables appeared to maintain their relative variability throughout the study. This may suggest some stability in this participant's presentation of SI risk factors.

Desire to die mean ratings across time of day are shown in Figure 5.3.8. For this participant, results indicate that there are differences in mean *desire to die* across times of day, ($F(3, 101) = 5.118$, $p = 0.003$). As we can see in Figure 5.2.8, mean scores appear lower in the afternoon with a larger range

and standard deviation in the evening. Highest mean scores are at night, pointing to time-of-day influences on SI in the evening and night.

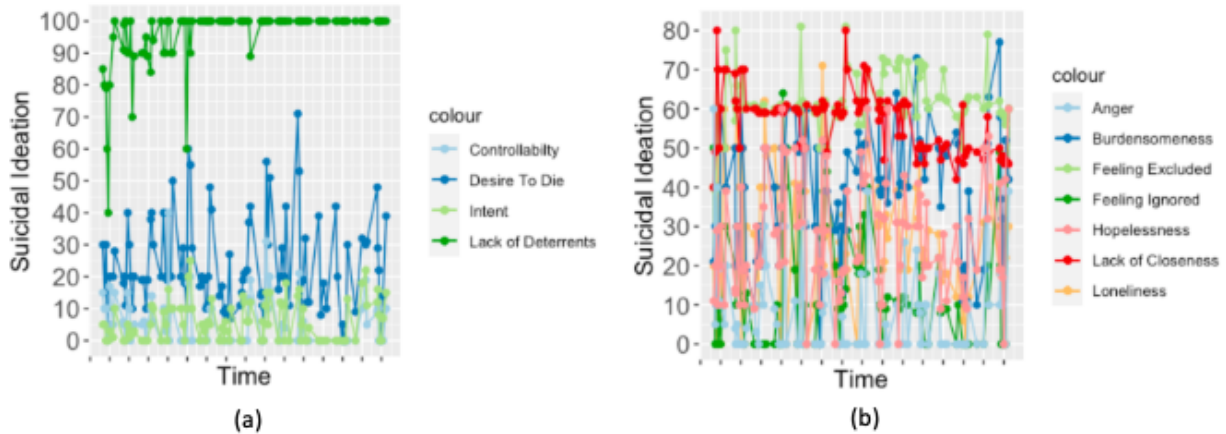


Figure 5.1.8. (a) Intraindividual Variability of SI Characteristics for Participant 8; (b) Intraindividual Variability of SI Characteristics for Participant 8; Dashes along the x-axis (“Time”) represent 12:00pm and occur ever 24 hours.

The network analysis for Participant 8’s multivariate time series data consisted of 11 variables. The SI network model for participant 8 fit the data well (RMSEAs = 0.00, SRMRs = 0.051, CFIs = 1, NNFI = 1.081). Results are presented in Figure 5.3.3.

Overall, the network generated by Participant 8’s time series data shows 24 paths: eleven contemporaneous paths (10 positive and one negative), 13 time-lagged paths (seven positive and six negative), and 11 autoregressions (one for each node) 10 of which are positive and one that are negative. The relatively even number of contemporaneous and time lagged edges indicates that a significant amount of variability is being picked up by the data collection schedule, however, there continues to be some variability within the two-hour window between assessments.

Three SI characteristics, *desire to die* (node 8), *controllability* (node 9) and *intent* (node 11) seem to be highly connected and move together. There is a strong contemporaneous relation from *desire to die* to *intent*, from *intent* to *controllability*, and from *controllability* to *desire to die*. Lack of deterrents (node 10) appears to move separately as its only impact on the other SI characteristics is a negative time lagged relation to *controllability*. This continues to suggest that, for Participant 8, changes in *lack of deterrents*

may be caused by mechanisms distinct from mechanisms responsible for changes in other SI characteristics.

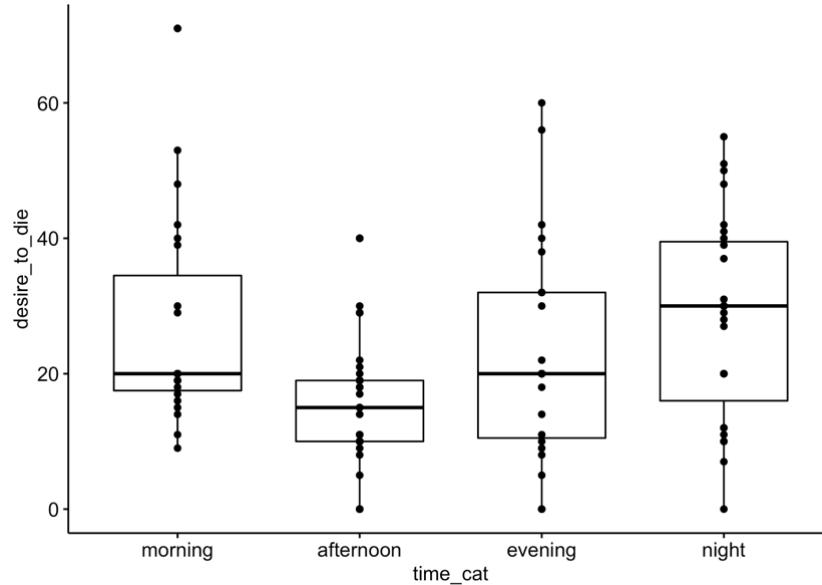


Figure 5.2.8. Distribution of “Desire to Die” by Time of Day for Participant 8; Morning = 5:00am to 11:59am, Afternoon = 12:00pm to 4:59pm, Evening = 5:00pm to 7:59pm, Night = 8:00pm to 4:59am.

Outside of its impacts on other SI characteristics, *desire to die* (node 8) has a moderate positive impact on *hopelessness* (node 7). Increases in this participant’s *desire to die* are also predicted by increases in *burdensomeness* (node 3). However, we also see a bi-directional relationship between SI risk factors and SI characteristics, as increased scores for *desire to die* increased *feelings of hopelessness* (node 7).

Feeling angry seems to have a large impact on Participant 8’s network. *Anger* (node 6) increases scores of *lack of closeness* (node 5), predicts increased scores of *loneliness* (node 1), and predicts decreases in *lack of deterrents* (node 10). *Anger* also has a strong time lagged autoregression, suggesting that increased feelings of anger tend to generate more feelings of anger. *Loneliness* (node 1), although impacted by *feeling excluded* (node 4), *lack of closeness* (node 5), *anger* (node 6), doesn’t have direct impacts on other variables, suggesting that feeling lonely is not an important driver of distress for this individual.

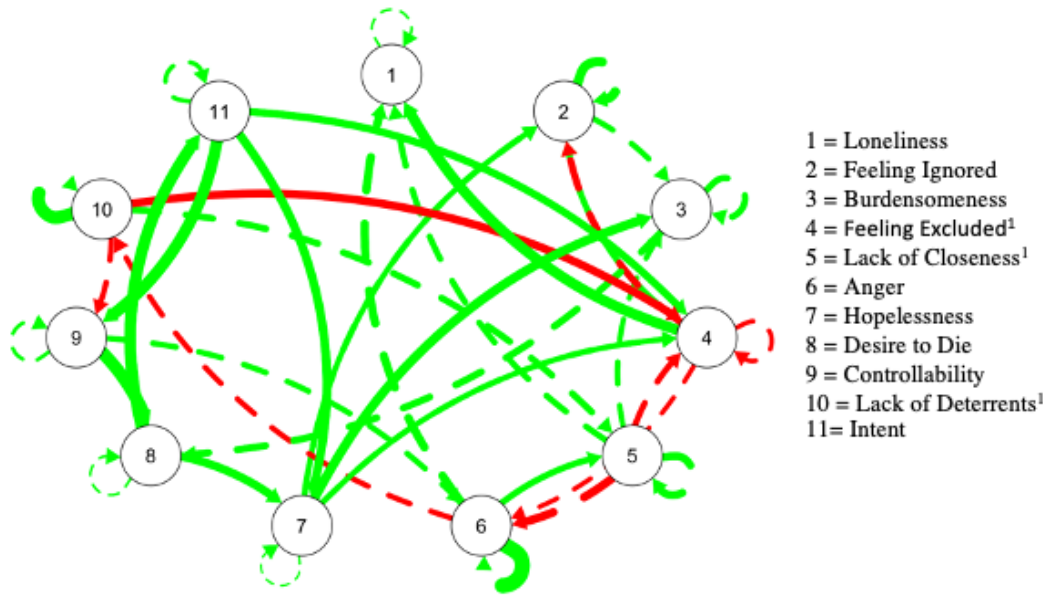


Figure 5.3.8. Intra-individual Time Series Network Analysis of SI Characteristics and Risk Factors for Participant 8; ¹Variables were reverse coded prior to analysis. Arrow = direction of the relation between two variables. Green = positive relation. Red = negative relation. Solid line = contemporaneous relation. Dashed line = time lag relation.

Predicted recovery times after perturbation of each node, as implied by the network obtained for Participant 8, are reported in Figure 5.4.8. Generally, recovery times for this network are low suggesting that, although the network appears dense in Figure 5.3.8, showing many connections between nodes, this individual has high levels of resilience to increases in the presented variables. Recovery times range from 0 time-steps to 12.1 time-steps. Changes in *anger* appear to have the longest impact on the network with recovery times ranging from 4.8 time-steps (*feeling ignored*) to 12.1 time-steps (*lack of deterrents*).

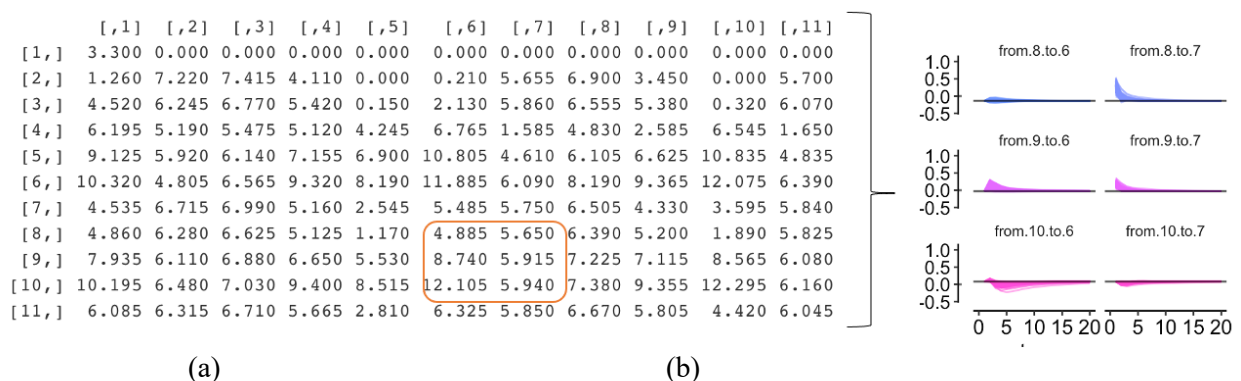


Figure 5.4.8. Recovery Time Following Node Perturbation for Participant 8; Figure a and b (zoomed in on six cells) shows the number of time steps it takes for the variable to recover after perturbation of another variable. 1 = Loneliness, 2 = Feeling Ignored, 3 = Burdensomeness, 4 = Feeling Excluded¹, 5 = Lack of Closeness¹, 6 = Anger, 7 = Hopelessness, 8 = Desire to Die, 9 = Controllability, 10 = Lack of Deterrents¹, 11 = Intent. ¹Variables were reverse coded prior to analysis.

Participant 9

Quantitative summaries of the data provided by Participant 9 are presented in Table 5.2.9, with accompanying visualizations shown in Figure 5.1.9. Mean scores across all variables are low for this participant. *Intent*, *burdensomeness*, and *feeling ignored*, all have means below 1 on a scale of 0-100. Highest mean scores are for *anger* ($M = 7.1$) and *feeling excluded* ($M = 4.7$). However, as seen in Figure 5.1.9, scores remained extremely low until abrupt and drastic increases in scores occurred. As seen in the left (a) panel of Figure 5.1.9, there appear to be two large increases in all four SI characteristics. During these spikes, *lack of deterrents* had the highest scores (60 and 40 on the 0-100 scale), *desire to die* only increased to moderate levels (around 30), and *intent* increased to 10. The simultaneous rise and fall of SI characteristics suggests the presence of a phenomenon responsible for the change in each variable.

Table 5.2.9. Descriptive and Variability Statistics for Participant 9

Variable ²	N	Mean	SD	Min.	Max.	Skew	Kurtosis	CV ²
SI Risk Factors								
Loneliness	114	3.13157895	7.95953612	0	50	3.07995597	11.1345242	254.170061
Feeling Ignored	114	0.43859649	3.08876092	0	30	8.20745408	72.2079891	704.23749
Burdensomeness	114	0.51754386	3.19078445	0	30	7.54095298	62.7453333	616.524453
Feeling Excluded ¹	114	4.66666667	17.2922135	0	100	4.63199405	21.8344494	370.547433
Lack of Closeness ¹	114	3.65789474	13.2222854	0	100	4.96136326	28.326191	361.47255
Anger	114	7.07017544	21.165475	0	100	3.44919945	11.2969706	299.362798
Hopelessness	114	1.6754386	5.8695187	0	31	3.7873805	14.0576738	350.327294
SI Characteristics								
Desire to Die	114	1.88596491	6.79635349	0	30	3.49503038	10.8727989	360.36479
Controllability	114	2.24561404	8.6378068	0	60	4.37528249	20.8579777	384.652334
Lack of Deterrents ¹	114	3.39473684	9.86063814	0	60	3.36037507	11.9373311	290.46841
Intent	114	0.39473684	1.77802924	0	10	4.59574137	20.5995384	450.434074

¹Variables were reverse coded prior to analysis. ²All variables measured on a scale from 0 to 100.

SI risk factors, as seen in the right (b) panel of figure 5.1.9, follow a similar pattern to SI characteristics. They tend to begin at low levels (mostly at zero), spike to high levels, then return to zero. *Anger* appears to have the highest relative magnitude of change ($SD = 21.2$) with five sporadic spikes to scores over 80 (on 0-100 scale). SI risk factors don't have distinct episodes of increase like SI characteristics did, but they do tend to increase in their relative magnitude of change in the second week, suggesting instability in these variables.

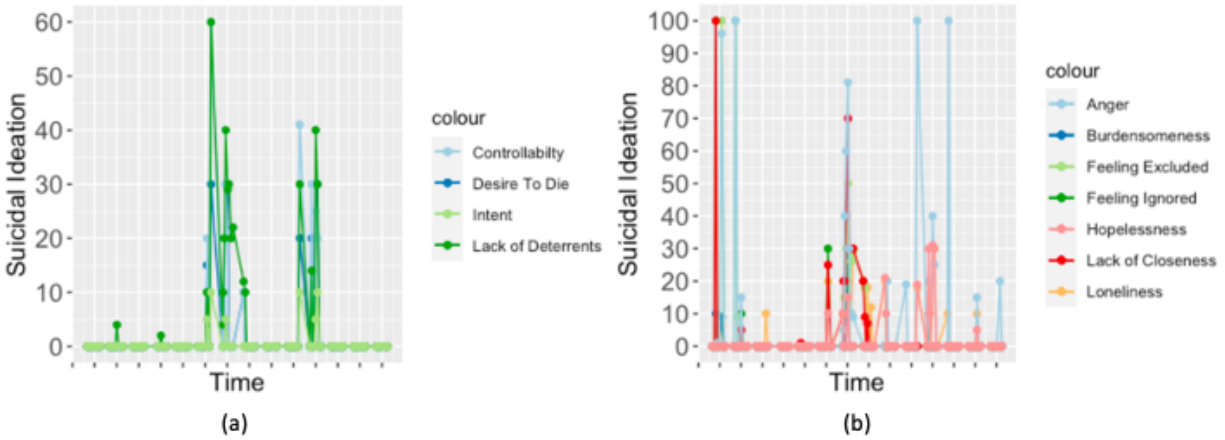


Figure 5.1.9. (a) Intraindividual Variability of SI Characteristics for Participant 9; (b) Intraindividual Variability of SI Characteristics for Participant 9; Dashes along the x-axis (“Time”) represent 12:00pm and occur ever 24 hours.

Differences in *desire to die* across time of day are shown in Figure 5.2.9. For this participant, results indicate that there are no differences in mean *desire to die* across the day, ($F(3, 110) = 1.382, p = 0.252$). As we can see in Figure 5.2.9, elevated scores for *desire to die* were rare and occurred at varying times throughout the day. When considering the contrast between the time series plots in Figure 5.1.9 and the box plot in Figure 5.2.9, this participant appears to have episodes of increased SI that are triggered by events tied to days rather than hours or times of day.

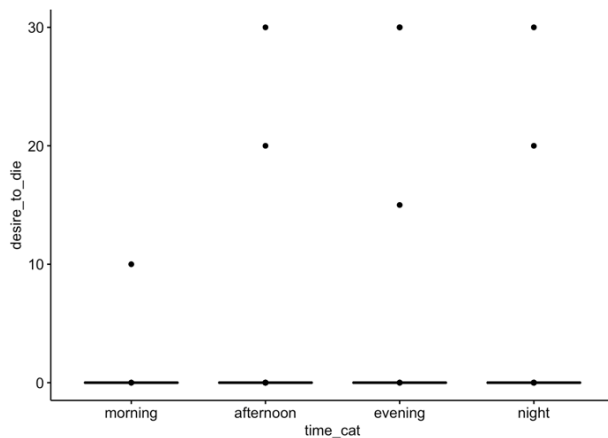


Figure 5.2.9. Distribution of “Desire to Die” by Time of Day for Participant 9; Morning = 5:00am to 11:59am, Afternoon = 12:00pm to 4:59pm, Evening = 5:00pm to 7:59pm, Night = 8:00pm to 4:59am.

The network analysis for Participant 9’s multivariate time series data consisted of 11 variables. The SI network model for participant 9 fit the data well (RMSEAs = 0.00, SRMRs = 0.051, CFIs = 1,

NNFI = 1.081). Results are presented in Figure 5.3.9. Overall, the network generated by Participant 9's time series data shows 32 paths: twenty-two contemporaneous paths (15 positive and seven negative), 10 time-lagged paths (five positive and five negative), and 11 autoregressions (one for each node) five of which are positive and six that are negative.

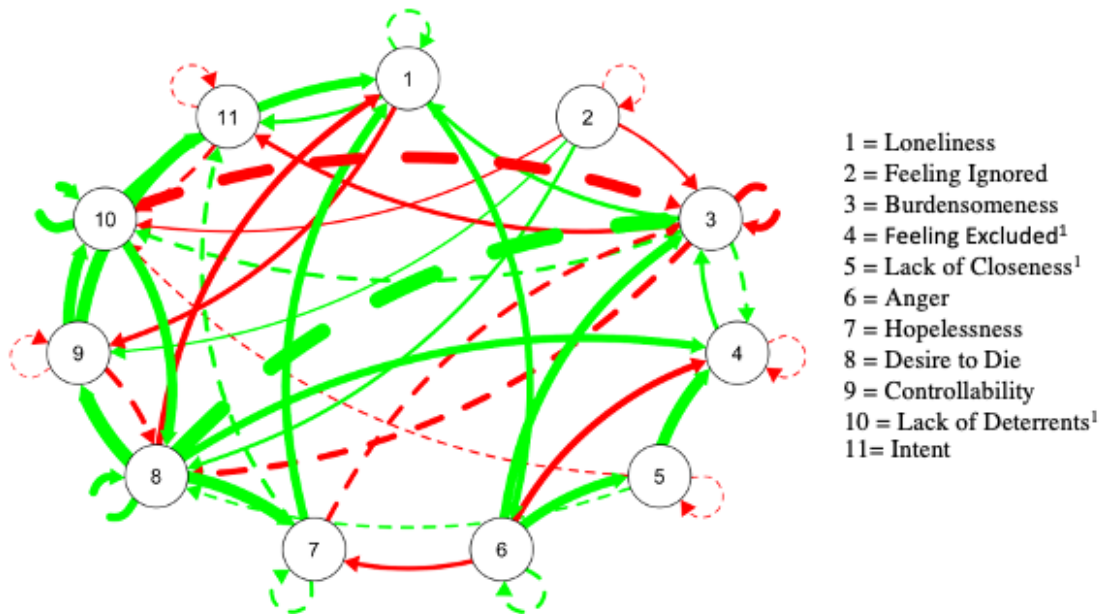


Figure 5.3.9. Intra-individual Time Series Network Analysis of SI Characteristics and Risk Factors for Participant 9; ¹Variables were reverse coded prior to analysis. Arrow = direction of the relation between two variables. Green = positive relation. Red = negative relation. Solid line = contemporaneous relation. Dashed line = time lag relation.

Increases in *desire to die* (node 8) for this participant, strongly predicted a time lagged increase in *burdensomeness* (node 3). Furthermore, increases in *burdensomeness* (node 3) reduced *intent* (node 11) scores and predicted a reduction in *desire to die* (node 8), potentially suggesting that feeling like a burden may be a protective factor when considering risk for suicide for this individual.

There are two excitatory loops in this network. One exists between *burdensomeness* (node 3) and *feeling excluded* (node 4). The other loop is between *intent* (node 11) and *loneliness* (node 1). Feeling lonely increases intent to act on suicidal thoughts, which in turn strongly increases loneliness, creating a compounding cycle. The network, however, suggests a way in which this participant may cope with suicidal thought, breaking the loop. Higher than usual scores of *intent* (node 11) also predicted a decrease

in *lack of deterrents* (node 10), meaning that when this individual experiences greater intent to act on suicidal thoughts, the impact their deterrents have on suicidal thought increases later in the day.

Predicted recovery times after perturbations of each node, as implied by the network obtained for Participant 9, are reported in Figure 5.4.9. Recovery times have a wide range, with some as high as 25 time-steps. *Feeling ignored* (node 2) appears not to be impacted by the rest of the network (min = 0 time-steps, max = 3.2 time-steps), while the rest of the 10 variables appear to have long periods of recovery (min = 6.7 time-steps, max = 25.6 time-steps).

	[,1]	[,2]	[,3]	[,4]	[,5]	[,6]	[,7]	[,8]	[,9]	[,10]	[,11]
[1,]	16.195	0.00	13.880	13.860	12.545	14.245	14.765	15.640	13.870	16.070	13.800
[2,]	15.175	3.18	12.810	12.930	11.355	13.125	13.705	14.525	12.965	15.110	12.890
[3,]	17.020	0.00	14.980	14.760	13.240	15.100	15.690	16.705	14.915	17.115	14.660
[4,]	11.615	0.00	10.555	9.975	6.725	9.615	10.765	11.935	10.515	11.300	10.175
[5,]	13.700	0.00	12.610	12.005	10.830	11.700	12.945	13.650	12.485	13.480	12.265
[6,]	18.840	0.00	16.010	16.525	15.140	15.975	17.070	18.160	15.965	18.755	15.820
[7,]	18.285	0.00	15.040	15.855	14.235	16.245	16.465	17.575	15.435	18.280	15.405
[8,]	21.745	0.00	19.175	19.355	17.735	19.595	20.150	21.280	19.215	21.685	19.060
[9,]	17.535	0.00	16.110	15.515	14.000	15.625	16.605	17.450	16.025	17.435	15.890
[10,]	25.565	0.00	22.145	23.160	21.710	23.565	23.600	24.730	22.160	25.545	22.075
[11,]	20.330	0.00	17.025	17.890	16.490	18.380	18.465	19.485	17.035	20.310	17.075

Figure 5.4.9. Recovery Time Following Node Perturbation for Participant 9; This figure shows the number of time steps it takes for the variable to recover after perturbation of another variable. 1 = Loneliness, 2 = Feeling Ignored, 3 = Burdensomeness, 4 = Feeling Excluded1, 5 = Lack of Closeness1, 6 = Anger, 7 = Hopelessness, 8 = Desire to Die, 9 = Controllability, 10 = Lack of Deterrents1, 11= Intent. ¹Variables were reverse coded prior to analysis.

Participant 10

Quantitative summaries of the data provided by Participant 10 are presented in Table 5.2.10, with accompanying visualizations shown in Figure 5.1.10. Mean scores for *desire to die* (M = 4.1) and *intent* (M = 0.3) were very low. Mean scores for *controllability* (M = 13.9) and *lack of deterrents* (32.8) were low to moderate. However, as seen in the left (a) panel of Figure 5.1.10, *lack of deterrents* varied greatly (SD = 27.35, CV = 83.3), spiking to 100 (on the 0-100 scale) and then repeatedly returning to zero. *Controllability* also had a large relative magnitude of change; however, this magnitude of change varied itself throughout the two-week period, starting off relatively small and increasing toward the middle and end of the study.

Table 5.2.10. Descriptive and Variability Statistics for Participant 10

Variable ²	N	Mean	SD	Min.	Max.	Skew	Kurtosis	CV
SI Risk Factors								
Loneliness	68	48.25	28.8637432	0	98	0.05491237	-1.0970242	59.8212294
Feeling Ignored	68	55.7794118	29.2247317	0	100	-0.0524558	-1.2731808	52.3934025
Burdensomeness	68	39.4705882	28.8617242	0	100	0.0261536	-1.3046589	73.122103
Feeling Excluded ¹	68	64.8088235	26.7426973	11	100	-0.3148125	-1.1890321	41.2639759
Lack of Closeness ¹	68	66.4852941	30.0330627	9	100	-0.3633649	-1.4006826	45.1724898
Anger	68	34.4705882	32.6105333	0	100	0.71864117	-0.8494538	94.6039362
Hopelessness	68	42.4117647	21.9124685	0	94	0.26681348	-0.5028546	51.6660146
SI Characteristics								
Desire to Die	68	4.08823529	4.99472944	0	22	1.18061252	1.02086268	122.173238
Controllability	68	13.8676471	19.116223	0	65	1.16098375	-0.0492052	137.847632
Lack of Deterrents ¹	68	32.8235294	27.3528307	0	100	0.81665076	0.01439533	83.3329968
Intent	68	0.30882353	1.42742177	0	9	4.76567982	22.6459505	462.212765

¹Variables were reverse coded prior to analysis. ²All variables measured on a scale from 0 to 100.

All SI risk factors fluctuated substantially across the two weeks of observation (ranging from *feeling excluded*, CV = 41.3, to *anger*, CV = 94.6). As we can see in the right (b) panel of Figure 5.1.10, there appears to be consistency across the two weeks in the relative variability for each SI risk factor, suggesting some consistency in the participant’s presentation.

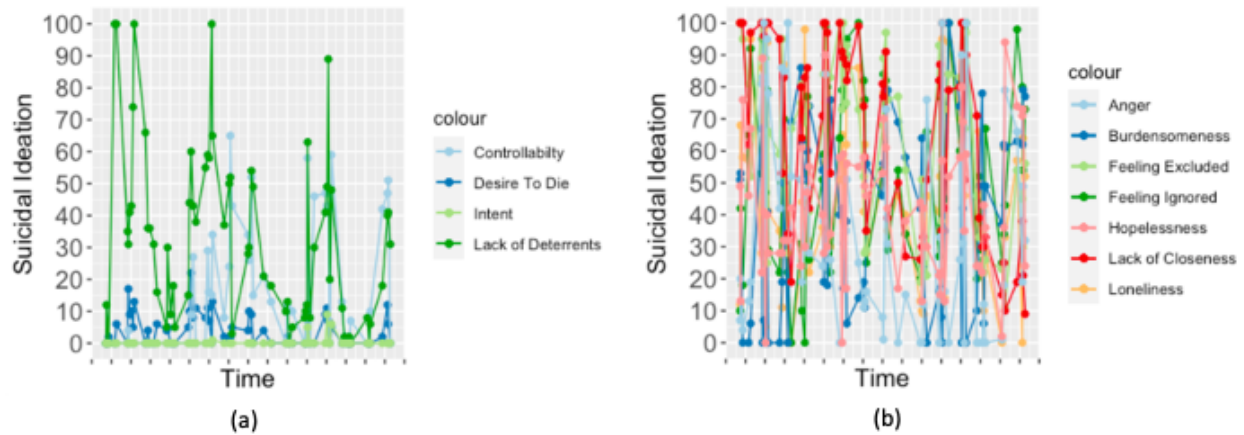


Figure 5.1.10. (a) Intraindividual Variability of SI Characteristics for Participant 10; (b) Intraindividual Variability of SI Characteristics for Participant 10; Dashes along the x-axis (“Time”) represent 12:00pm and occur ever 24 hours.

Differences in *desire to die* across time of day are shown in Figure 5.3.10. For this participant, results indicate that there are no differences in mean *desire to die* across the day, ($F(3, 64) = 3.64, p =$

0.224). As we can see in Figure 5.2.10, however, no scores were over 5 (on a 0-100 scale) in the morning, suggesting that triggers of elevated *desire to die* do not occur in the morning.

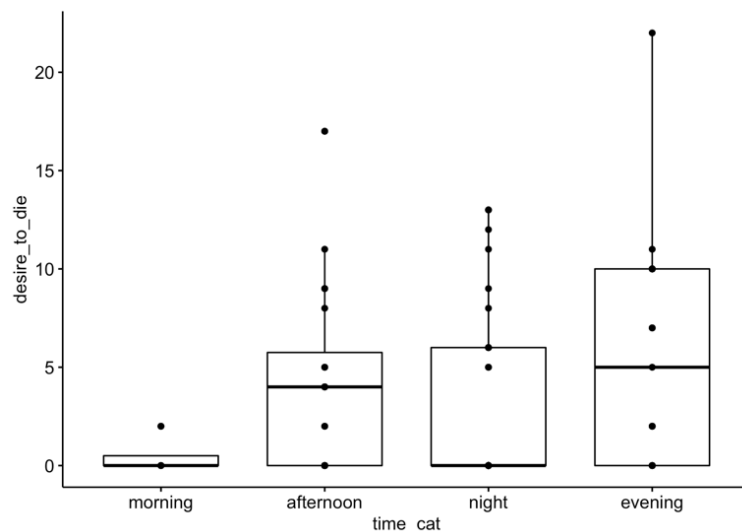


Figure 5.2.10. Distribution of “Desire to Die” by Time of Day for Participant 10; Morning = 5:00am to 11:59am, Afternoon = 12:00pm to 4:59pm, Evening = 5:00pm to 7:59pm, Night = 8:00pm to 4:59am.

The network analysis for Participant 10’s multivariate time series data consisted of 10 variables, excluding intent. The SI network model for participant 10 fit the data well (RMSEAs ≤ 0.08 , SRMRs ≤ 0.08 , CFIs ≥ 0.95 , NNFI ≥ 0.95). Results are presented in Figure 5.3.10. Overall, the network generated by Participant 10’s time series shows 17 paths: thirteen contemporaneous paths (12 positive and one negative), four time-lagged paths (one positive and three negative), and 10 autoregressions (one for each node) eight of which are positive and two that are negative.

There appears to be little connection among nodes of the three SI characteristics. The only direct relation is between *deterrents* and *desire to die*, which suggests that lack of deterrents may be a risk factor for changes in other SI characteristics as well as a characteristic of the SI experience. The lack of connection between SI characteristics may suggest that each characteristic is linked to unique mechanisms or triggers responsible for their rise and fall.

Although *desire to die* (node 8) is positively impacted by *lack of deterrents* (node 10), *feeling excluded* (node 4), and *hopelessness* (node 7), it does not have any direct impact on other variables in this network. Increases in *controllability* (feeling more in control of one’s suicidal thoughts), however, is

related to decreases in two variables, predicting future reductions in *feeling excluded* (node 4) and *anger* (node 6).

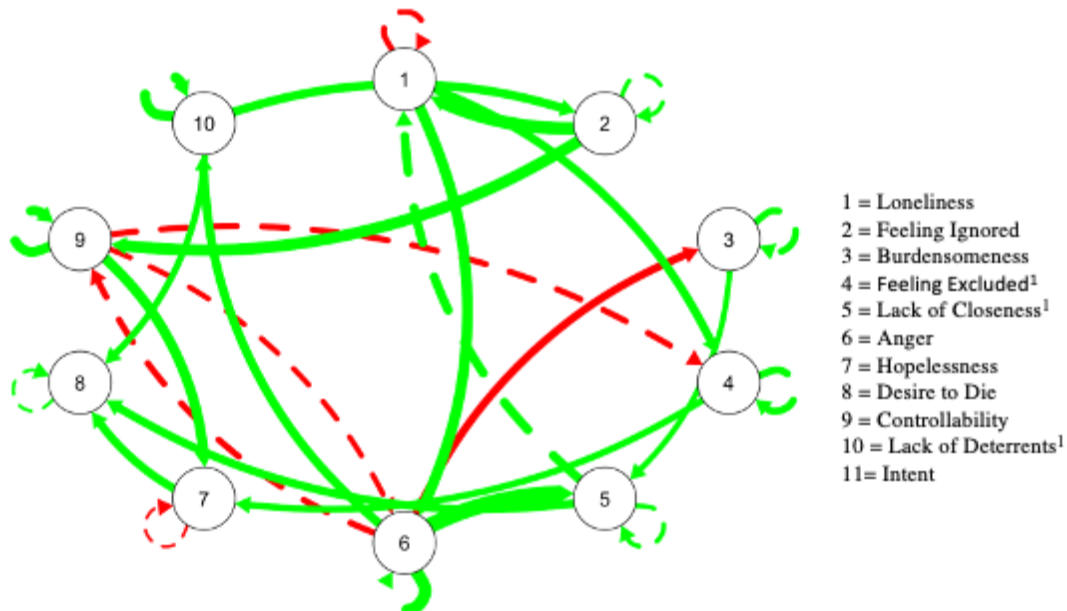


Figure 5.3.10. Intraindividual Time Series Network Analysis of SI Characteristics and Risk Factors for Participant 10; ¹Variables were reverse coded prior to analysis. Arrow = direction of the relation between two variables. Green = positive relation. Red = negative relation. Solid line = contemporaneous relation. Dashed line = time lag relation.

Anger (node 6) appears to have a large impact on the network, although with distinct effects on each variable to which it is related. Anger strongly and contemporaneously increases lack of closeness (node 5), decreases feelings of burdensomeness (node 3), and predicts decreases in controllability.

Predicted recovery times after perturbation of each node, as implied by the network obtained for Participant 10, are reported in Figure 5.4.10. As seen in Figure 5.4.10, there are drastic differences in recovery time for each row of variables. Many are very low, and others are very high. *Anger* (node 6), for example, appears to have the largest impact across all nodes, resulting in *desire to die* to remain elevated for about 15 time-steps or around 1-2 days before returning to equilibrium. This suggests that certain variables are very interconnected while others appear disconnected and less relevant to an understanding of this participant's SI experience.

	[,1]	[,2]	[,3]	[,4]	[,5]	[,6]	[,7]	[,8]	[,9]	[,10]
[1,]	10.860	9.770	10.750	10.900	12.735	13.975	6.065	11.245	10.880	13.155
[2,]	7.240	6.625	7.035	7.925	9.095	10.230	5.255	7.515	8.400	9.175
[3,]	5.930	1.800	5.810	4.835	7.290	7.610	1.140	6.035	2.345	5.465
[4,]	0.000	0.000	0.000	5.230	0.000	0.000	3.915	3.205	0.000	0.000
[5,]	9.140	7.435	8.870	8.960	10.940	12.095	4.595	9.450	8.560	11.160
[6,]	14.580	13.600	14.575	14.570	16.535	17.660	9.270	14.945	14.585	16.900
[7,]	0.000	0.000	0.000	0.000	0.000	0.000	3.475	3.225	0.000	0.000
[8,]	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.585	0.000	0.000
[9,]	12.195	10.835	12.170	12.655	14.225	15.425	7.550	12.665	12.680	14.535
[10,]	6.795	7.535	5.400	6.935	7.610	8.925	5.635	7.590	8.235	8.985

Figure 5.4.10. Recovery Time Following Node Perturbation for Participant 10; This figure shows the number of time steps it takes for the variable to recover after perturbation of another variable. 1 = Loneliness, 2 = Feeling Ignored, 3 = Burdensomeness, 4 = Feeling Excluded¹, 5 = Lack of Closeness¹, 6 = Anger, 7 = Hopelessness, 8 = Desire to Die, 9 = Controllability, 10 = Lack of Deterrents¹, 11= Intent. ¹Variables were reverse coded prior to analysis.

Chapter 6

DISCUSSION

The aims of this study were to describe patterns of suicidal ideation (SI) and their characteristics in a sample of adolescents at risk for suicide and to determine the relationship between these characteristics and potential risk factors (loneliness, feeling ignored, feeling as though they fit in, burdensomeness, interpersonal anger, interpersonal closeness, and hopelessness) over time. The aims were addressed by collecting subjective reports of the adolescents' SI experience nine times daily for two weeks and examining trends using a within-person analytic approach. There were 4 key findings for Aim 1. First, the four SI characteristics (*desire to die*, *deterrents*, *controllability*, and *intent*) each varied significantly over the course of hours, days, and weeks. This was also true for the seven SI risk factors (*loneliness*, *feeling ignored*, *burdensomeness*, *feeling excluded*, *closeness*, *anger*, and *hopelessness*). Second, there was between-person heterogeneity in the average score (on a 0 to 100 scale) for each SI characteristic, as well as heterogeneity in the magnitude and pattern of variability for each characteristic. Third, there was heterogeneity across participants in whether time of day was associated with increases in one's desire to die. Lastly, the SI characteristic *desire to die* was consistently related to rapid, subsequent decreases in the ability to control thoughts of suicide, suggesting that the adolescents tended to lose control of their suicidal thoughts as the thoughts became more severe.

For Aim 2, there were 5 key findings. First, participants differed in whether their SI characteristics fluctuated together, following similar patterns, or were not synchronous in relation to one another. Second, like the SI characteristics, there was between-person heterogeneity in variability patterns for specific SI risk factors. Third, there were strong relationships between risk factors and SI characteristics within each participant's own network of variables. Fourth, participants differed in which risk factors had the greatest influence on desire to die as well as on other SI characteristics and risk factors. Lastly, there were bi-directional relationships between SI characteristics and SI risk factors, suggesting that not only did risk factors influence suicidal thought but fluctuations in suicidal thought had an important impact on factors such as loneliness, anger, and hopelessness as well. In addition, there was

substantial heterogeneity between participants in which risk factors and which SI characteristics showed these bi-directional relationships.

Suicidal Ideation and Risk Factor Variability

This study found significant within-person variability of SI characteristics over short periods of time. These findings are consistent with a growing body of literature assessing short term fluctuations in suicidal thought supporting a consensus that suicidal thoughts vary substantially over short periods of time (e.g., Witte et al., 2005; Witte et al., 2006; Nock et al., 2009; Hallensleben et al., 2018; Lucht et al., 2022; van Ballegooijen et al., 2022). The present study is one of only a few studies to look at SI variability among teens using intensive longitudinal (IL) design, measuring SI more than once daily (Nock et al., 2009; Glenn et al., 2022; Esposito et al., 2022) and one of the only studies to look at SI variability in a clinically diverse (no clinical inclusion/exclusion criteria), outpatient sample of adolescents at risk for suicide. Specific SI characteristic variables (*desire to die*, *controllability*, *deterrents*, and *intent*) were chosen because they are delineated in the Columbia Suicide Severity Rating Scale (C-SSRS), a gold standard measure of suicidal ideation that is commonly used both in clinical suicide risk assessment and in suicide research (Posner et al., 2011). Although this is the first study to explicitly investigate the dynamic properties of C-SSRS items, our findings further emphasize their importance in suicide research and clinical risk assessment.

Although our results align with recent research, they suggest shortcomings of popular suicide theory. The Interpersonal Theory of Suicide (IPTS; discussed in depth in Chapter 2) suggests that key risk factors for suicidal thought (e.g., thwarted belongingness and perceived burdensomeness) are dynamic and change over time (Van Orden et al., 2005). The IPTS, however, does not consider temporal changes in SI itself or the complex bi-directional relationship between risk factors and suicidal thought. Our results suggest that future theory development needs to consider SI as a multidimensional dynamic process that may be influenced by time of day.

The present study also found significant within-person variability for SI risk factors. This finding corroborates studies that have found SI risk factors, such as thwarted belongingness, burdensomeness,

hopelessness, loneliness, etc., to vary substantially over the course of hours and days (Kleiman et al., 2017; Hallensleben et al., 2019; Czyz et al., 2019; Spangenberg et al. 2019). However, much of the literature has focused on the dynamics of SI risk factors in adult samples, or samples of patients recently and concurrently admitted to psychiatric inpatient settings. By studying adolescents recruited from an outpatient clinic with a varying degree of clinical acuity and suicide risk, this study begins to fill a gap in the literature.

Patterns of Suicidal Ideation and Suicidal Ideation Risk Factor Variability

Not only did our results show that SI and its risk factors varied over short periods of time, our intensive intraindividual approach to analysis showed a myriad of important variability patterns.

Means. Our results indicate both within and between person heterogeneity in the mean scores of four SI characteristics and seven SI risk factors across participants, which is consistent with previous literature (e.g., Kleiman et al., 2019). Mean item scores provide a broad description of the individual's overall presentation during the two-week study period. For example, Participant 8 had high mean scores for lack of deterrents, and moderate means for controllability and desire to die. These scores tell us that the participant experienced moderate levels of desire to die, with only some ability to control thoughts of suicide, and felt that deterrents were not helpful in resisting thoughts of suicide. Furthermore, Participant 8 had a mean around 5 (on a scale of 0-100) for intent, suggesting some (even if minor) intention to kill themselves.

Difference between multiple SI characteristic scores within an individual also provide important and clinically relevant information. For example, Participant 1's mean score for desire to die was high, but their intent to act on suicidal thoughts was zero. The difference between the two items suggests that, although the adolescent was experiencing significant distress, they had a low risk for suicide. As we see here, either item would not provide an accurate clinical representation of the individual. Alone, high scores on the desire to die item would suggest high suicide risk, and zero scores for intent would ignore the participant's distress. Comparing both characteristics allows for a more accurate representation of the participant's presentation.

Magnitude of Variability. The magnitude of variability of a given item tells us how much the item fluctuated over time. In the suicide literature, studies have found magnitude of variability to be an important variable. High SI variability has been linked to previous suicidal behavior (Witte et al., 2005; Kleiman et al., 2017; Hallensleben et al., 2019). Our study found between-person heterogeneity in the magnitude of variability for SI characteristic items. For example, Participant 6 had a relatively small magnitude of variability for the desire to die item ($M = 26.8$, $SD = 7.7$, $CV = 28.6$) compared to Participant 8, who had a larger magnitude of variability ($M = 22.7$, $SD = 14.6$, $CV = 64.4$), despite similar mean scores. Contrary to what has been proposed in the literature, however, Participant 6 had higher scores for intent ($M = 19.2$, $SD = 6.1$) than Participant 8 ($M = 5.6$, $SD = 6.2$), even though Participant 6's magnitude of variability was smaller. This more advanced understanding of variability should be incorporated into existing theory and inform how researchers score SI characteristics.

Intraindividual Patterns of Mean Change and Magnitude of Variability Changes. Within-person mean trends (i.e., slow changes in average scores over time), and magnitude of variability patterns implied important nuances of the individual's clinical presentation. Consistency in mean scores or magnitudes of variability suggests stability in the participant's presentation. For example, Participant 1, despite high mean scores for many items, showed consistent mean scores and magnitudes of variability across all variables throughout the study. Consistency in an individual's presentation offers clues about their future presentation. The more consistent someone's presentation has been in the past, the more likely a clinician could predict their presentation in the future. If one's consistency is low (or an item's mean and magnitude of variability changes frequently), then their future presentation is less predictable.

Consistency, or lack thereof, does not inherently suggest high or low suicide risk. The context, or the phenomenon of reference, likely determines its interpretation. Participant 1 exclusively reported zero scores for intent to act on suicidal thoughts, suggesting future zero scores of intent and low suicide risk. Consistency among risk factors, although common psychological phenomena (e.g., anger, loneliness, burdensomeness) also provide relevant context. For instance, Participant 1 had a high magnitude of variability for most risk factors. This pattern might be explained by the individual's sensitivity to

environmental stressors or reactivity of internal mechanisms (e.g., dysfunctional biological stress response). Or, it could suggest positive adaptation. People receiving mental health treatment are often taught to identify and fully process complex emotions. The ability to name and report fluctuations in negative emotion is thought to be a skill that can help reduce uncomfortable psychiatric symptoms such as depression, anxiety, and even suicidal thought (Lenz et al., 2016).

Trends, or changes, in mean item scores over time suggest the presence of potential environmental, psychological or biologically-driven factors responsible for that change. For example, Participant 6's mean score for lack of deterrents trended upward over the two-week observation period (see Figure 5.1.6). This suggests that some factor (endogenous or exogenous) connected to this participant is responsible for the trend in decreased impact their deterrents have on their thoughts of suicide. Similarly, patterns in participant's magnitude of variability may also suggest certain factors responsible for that pattern. Participant 8 had a moderate magnitude of variability in lack of deterrents for the first five days of the study followed by eight days of little to no variability in the item, which remained consistently at 100 (on a scale of 0-100; see Figure 5.1.8). This drastic change in the magnitude of variability likely represents the influence of a factor responsible for this change.

The within-person comparison of mean and magnitude of variability patterns provide further information relevant to suicide theory development and clinical assessment of an individual's presentation. For example, Participant 4's data showed that, although the relative magnitude of variability for three SI characteristics (*controllability*, *desire to die*, and *lack of deterrents*) was similar between variables and remained consistent throughout the observation period. Two characteristics (*controllability* and *desire to die*) showed a trend upward in mean scores, starting low and ending moderately high, while lack of deterrents showed the opposite trend downward, starting high and ending at moderate scores (see Figure 5.1.2). Although the occurrence of each trend suggests the presence of a potential environmental, psychological, or biological factor driving that trend, the simultaneous nature of two distinct trends (upwards for *controllability* and *desire to die*, and downward for *lack of deterrents*) suggests distinct effects of that factor for each characteristic. Additionally, Participant 4's *intent* scores remained

consistently at zero, also suggesting that potential factors responsible for changes in *desire to die*, *controllability*, and *lack of deterrents* are likely different than those contributing to increases in intent.

Conversely, synchronicity in SI characteristic fluctuation suggests that SI characteristics share similar etiologies. For example, Participant 9's data showed two episodes of SI throughout the observation period where scores for all four SI characteristics increased together (see Figure 5.1.9). Each item spiked for about two days at the end of the first week of observation, and again, for about a day, a few days later. Between spikes, all four characteristics remained at zero. This synchronized pattern suggests common factors responsible for increases in all four variables. Similarities and differences in variability patterns may be important factors to consider when assessing suicide risk or designing future research.

Temporal Patterns of Suicidal Ideation

Results also indicate between-person heterogeneity in temporal patterns of one's desire to die. Patterns were specific to the individual and lacked between-person consistency. While three participants appeared to have shifts in SI severity related to the time-of-day, seven participants didn't show any diurnal pattern in SI severity. Furthermore, the participants who did have time-of-day related changes in SI, had distinct temporal patterns compared with each other (e.g., some had higher means in the evening, some had consistently low scores in the middle of the day, etc.). These findings highlight the heterogeneity across domains of the SI experience.

Previous studies have found temporal patterns of suicidality related to time of day, day of the week, and month of the year; however, most studies examine temporal patterns of death by suicide rather than patterns of suicidal thought. Evidence suggests increases in suicide deaths early in the week (Dutta, et al., 2021), early in the morning (Boo et al., 2019), and following major holidays (Plöderl, 2021). But trends change drastically when considering subpopulations with similar geographic, climate and social conditions (Galvão et al., 2018). For example, one study looking at suicides in Japan found that patterns of suicide changed for different genders and age ranges, spiking in the morning for young males and

during the day for young women (Boo et al., 2019). Differences in population subgroups and differences in methodology across studies makes the generalizing of results difficult (Dutta, et al., 2021).

Findings regarding temporal patterns of suicide tend to exclude most teens who seriously consider suicide but do not die by suicide. Because studies assessing real time suicidal thoughts are methodologically difficult, there is a gap in the literature around diurnal shifts in SI. However, recent studies using social media posts as a proxy for subjective SI have reported diurnal trends in suicide-related language on social media that align with diurnal trends in suicide deaths in a general population of internet users (Fahey, et al., 2020).

Relations Between SI Characteristics and SI Risk Factors

Consistent with prior work (Kleiman et al., 2017; van Ballegooijen et al., 2022), results of this study indicate that SI characteristics and SI risk factors are temporally related to each other. The time-series network analyses produced a range of between 15 and 29 relationships between 10 or 11 variables for each of the 10 participants. Research suggests that the relative density of a network indicates the system's sensitivity or resistance to change (Lutkepohl et al., 2005, Barabasi, 2006). Sparse networks allow for variable changes to dissipate before influencing other variables. Thus, increased network density may imply that an adolescent, when experiencing changes in SI characteristics or risk factors, is more susceptible to changes in suicide risk. For example, the network generated from Participant 9's time series data appeared dense and complex (32 total paths, 15 positive paths, and 7 negative; recovery time range from 0.0 to 25.56) compared to the network generated from Participant 1's data (15 total paths, 13 positive and 2 negative; recovery time range from 0.0 to 8.78 time-steps). These findings potentially suggest more drastic changes in suicide risk for Participant 9 than for Participant 1.

Although there was tremendous variability across participants in relations found among SI characteristics and risk factors, one relationship appeared to be consistent between participant networks. The SI characteristic *desire to die* consistently (although at different strengths) was related to rapid, subsequent decreases in the ability to control thoughts of suicide, suggesting that teens tend to lose control of suicidal thoughts as they worsen. Although no other studies have used this analytical approach

to examine relationships among risk factors and SI characteristics, another study determined controllability to be a significant risk factor for suicidal behavior among people with suicidal thoughts (Nock et al., 2017), reinforcing the importance of this study's finding.

Results of the network analyses show that there was between-person heterogeneity in the presence, direction, timing, and strength of relations between specific variables. For example, increases in hopelessness were related to an increase in feeling ignored for Participant 1, but were related to decreased feelings of being ignored for Participant 5. Although this study was one of the first to examine suicidality using a network approach to analysis, our findings are consistent with previous research in other fields of psychology using similar methods. These studies have also found substantial interindividual heterogeneity in intra-individual networks and temporal relations of psychological phenomena (e.g., van Ballegooijen et al., 2022; Yang et al., 2018; Yang et al., 2019).

Bi-Directional Relations Between SI Characteristics and SI Risk Factors

Results of this study indicate a bidirectional relationship between SI risk factors and SI characteristics. For example, at times when participant 8 felt increased feelings of being ignored (an SI risk factor), it appeared to increase their intent to act on suicidal thoughts. However, these increases in suicidal intent (SI characteristic) also predicted increases in anger (SI risk factor). Although this finding contradicts most suicide theory (Van Orden et al., 2011; Klonsky & May, 2015; Milner et al., 2020) which considers SI characteristics to be an outcome of other factors, recent research (Kleiman et al., 2018) and theory development (Bryan et al., 2020) support the finding that SI may influence what are commonly considered risk factors for SI. Our findings are consistent with theories suggesting suicide as a dynamic system (Bryan et al., 2020; Milner et al., 2017). These theories acknowledge the dynamic nature of the relationships between variables, as well as the variables themselves, assuming them to be complex and bi-directional. Furthermore, researchers are beginning to consider the reinforcing or regulating role of suicidal thoughts. For instance, some suicidologists are exploring the potentially calming effects of contemplating suicide (Kleiman et al., 2018). Although this is an example of a bi-directional relationship between SI and SI risk factors, our results indicate heterogeneity in the nature of this relationship. For

Participant 6, increased feelings of desire to die predicted a decrease in feelings of anger (consistent with theory that SI may regulate negative emotions) while Participant 9's increase in desire to die predicted increased feelings of hopelessness and burdensomeness, suggesting that any calming effects of SI may only be present in a subset of individuals.

Future Research

The extensive between-person heterogeneity of the SI experience found in this study complicates suicide research and poses daunting hurdles for researchers. If there is minimal consistency in clinical presentation among adolescents at risk for suicide, then measurement of risk and development of effective suicide prevention interventions become extremely difficult. However, results of this study suggest that future research, instead of focusing on *what* variables are responsible for shifts in suicidality, should focus on *how* variables fluctuate over time, and how features of SI variability may inform suicide risk assessment and theory development. For instance, instead of asking about the relationship between suicidal thoughts and suicidal behavior, studies could build on findings that SI variability predicts suicide risk (Witte et al., 2006; Kleiman et al., 2017) and analyze how patterns in one's magnitude of variability of suicidal thoughts relate to their suicidal behavior. Results also indicate that future work should consider how time of day may influence these patterns. Furthermore, results indicate the continued need to study the bi-directional and often mutually reinforcing relationships between suicidal thoughts and other common psychological phenomena.

As the field expands its focus to an intra-individual approach, intensive longitudinal methods will need improvement. There is a need for universally recognized names, definitions, and measures for SI characteristics. Although new methods are being developed specifically for repeated measures research suicidology (Forkmann et al., 2018; Biernesser 2021), recent work has shown that there is no consistency in the conceptualization and measurement of current SI characteristics in the field (Reeves et al., 2022).

Results from this study suggest that, outside of the SI characteristics *desire to die* and *controllability*, which appear to fluctuate in unison, each characteristic has the potential to fluctuate independently, highlighting the importance of studying and assessing unique SI characteristics. Only four

SI characteristics were examined in this study. Further research is needed to develop and study a comprehensive set of characteristics and the complexities of their changing relationships.

The body of literature investigating daily patterns of SI is growing rapidly. More than 25 manuscripts (e.g., Cxyz et al., 2022 and van Ballegooijen et al., 2022) were published in the first six months of 2022, referencing the use of intensive longitudinal methods to examine SI variability, including more than ten study protocols (e.g., Victor et al., 2022). As this literature grows, a clear gap is emerging. Most studies sample participants with high acuity, likely hospitalized or recently discharged from an inpatient psychiatric unit. This sampling method excludes a large group of teens in the community who experience thoughts of suicide but do not become hospitalized. Research is clearly needed to understand SI characteristics and their association with risk factors across adolescents representing a spectrum of populations and mental health needs.

Limitations

The results of this study should be interpreted in the context of its limitations. Frequent sampling and implementation of safety protocols (which we employed) may inherently act as an intervention, affecting the data being acquired. This appeared particularly relevant for Participant 6 who received frequent calls from the study team as part of our safety protocol. This is a universal phenomenon in intensive longitudinal research. Second, although a within-person approach was employed in data analysis, the small between-person sample size precludes generalization of the findings to the population at large without replication in a larger sample. Third, the two-week observation period may have been too short to identify important within-person trends in the data. However, the study length was chosen to balance feasibility with the desire for a large intraindividual sample of assessments and did appear to generate meaningful results. Similarly, the frequency of assessments may have missed important intraindividual variability in item scores within the period between assessments. Assessment nine times per day was found to be very feasible, suggesting that future research could increase the frequency of daily assessments. Fifth, this study intentionally chose conceptually-informed SI characteristics and SI risk factors consistent with the C-SSRS and the IPTS; however, these variables are not necessarily the

only SI characteristics and risk factors of potential importance in the field. Lastly, the Coefficient of Variability (CV) was selected as a measure of relative magnitude of variability between items. However, slow shifts in mean values over time were not anticipated, which ultimately decreased relevance of the CV measure. In addition, mean scores <1 created mathematical scenarios where the CV did not accurately represent the relative magnitude of change for the variable being examined. To accurately report the relative magnitude of variability, each item's standard deviation and visual assessment of its corresponding time-series figure were included.

Conclusions

This study explored patterns of SI characteristics and their relationships with SI risk factors over short periods of time among a sample of adolescents at risk for suicide, using an intensive intra-individual approach. Results indicate the existence of complex within-person patterns of suicidal thought that vary substantially between individuals. The intra-individual analytic approach and associated measures used to describe these patterns (e.g., mean scores, magnitude of variability, intraindividual relative magnitude of variability) are promising strategies for future suicide research and the development of precision-based suicide risk assessment. Results also support the presence of individual, interconnected networks of suicidal ideation characteristics and risk factors. These networks include bi-directional relationships between SI characteristics and risk which raise important questions for future research, existing suicide theory, and the clinical interpretation of suicidal thought.

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APPENDIX A. Demographic Questionnaire

ID#: _____

Sociodemographic Questionnaire

How well do you speak English?

- Very well
- Well
- Not well

Date of Birth: ___/___/____ **Age:** _____ years

How is the cost of your healthcare covered?

- Private insurance
- Medi-Cal (government funded)
- My own (or my guardian's) money

What is your sex?

- Male (Cisgender)
- Female (Cisgender)

Which best describes your gender?

<input type="radio"/> Male (Cisgender)	<input type="radio"/> Female (Cisgender)
<input type="radio"/> Transgender Male	<input type="radio"/> Transgender Female
<input type="radio"/> Gender Variant/Non-Conforming	<input type="radio"/> Not Listed: _____
<input type="radio"/> Prefer not to answer	

Which best described your sexual orientation?

- Heterosexual or straight
- Lesbian
- Bisexual
- An orientation other than those listed above

What is your racial background? Check all that apply:

- White or European American
- Native Hawaiian or Other Pacific Islander
- Asian Indian/South Asian
- Filipino
- Vietnamese
- Other Asian
- Black or African American
- American Indian or Alaska Native
- Chinese
- Korean
- Middle Eastern
- Other race

Are you Hispanic, Latino, or of Spanish origin? Check all that apply:

<input type="radio"/> No, not Hispanic, Latino, or of Spanish origin	<input type="radio"/> No, not Hispanic, Latino, or of Spanish origin
<input type="radio"/> Yes, Mexican, Mexican American, Chicana	<input type="radio"/> Yes, Mexican, Mexican American, Chicana
<input type="radio"/> Yes, Central American	<input type="radio"/> Yes, Central American
<input type="radio"/> Yes, South American	<input type="radio"/> Yes, South American

Are you currently receiving mental health services?

- No
- Yes

If yes, what kind of services (select all that apply)?

<input type="radio"/> Individual Therapy	<input type="radio"/> Psychiatry/Medication Management
<input type="radio"/> Group Therapy	<input type="radio"/> N/A
<input type="radio"/> Intensive Outpatient Program	<input type="radio"/> Other: _____

Please provide the following information for your current primary mental health provider:

Name: _____

Phone #: _____

E-mail: _____

Have you received any of the following mental health treatments in your lifetime? Select all that apply:

- Outpatient Treatment
(Age of first treatment: ____)
- Psychiatric Hospitalization

(Age of first treatment: ____ ; Number of hospitalizations: ____)

- Partial Hospitalization

(Age of first treatment: ____)

- Residential Treatment

(Age of first treatment: ____)

Have you ever taken prescription medication for a mental health condition (e.g., depression, anxiety, ADHD, etc.)?

- Never in my lifetime
- Yes, but not within the last two years
- Yes, within the last two years, but not currently
- Yes, I am currently taking medication for the treatment of a mental health condition

Please list all medications that you currently take:

1. _____
2. _____
3. _____
4. _____

Please list any psychiatric medication that you have previously taken:

1. _____
2. _____
3. _____

APPENDIX B

EMA Questionnaire

Please indicate your answer by sliding your finger to the appropriate number from 0 to 100.

How true is this statement right now: "I feel lonely"? _____ (0=not at all true; 100=very true)

How true is this statement right now: "I feel ignored"? _____ (0=not at all true; 100=very true)

How true is this statement right now: "I feel like a burden"? _____ (0=not at all true; 100=very true)

How true is this statement right now: "I feel like I fit in"? _____ (0=not at all true; 100=very true)

How true is this statement right now: "I feel close to other people"? _____ (0=not at all true; 100=very true)

How true is this statement right now: "I feel angry with people in my life"? _____ (0=not at all true; 100=very true)

How true is this statement right now: "I feel hopeless"? _____ (0=not at all true; 100=very true)

At this moment, how intense is your desire to die? _____ (0=not present; 100=very present)

At this moment, how difficult is it to control thoughts of wanting to die? _____ (0 = very easy to control; 100 = unable to control)

At this moment, to what degree are certain things in your life (deterrents) preventing you from killing yourself?

_____ (0=not at all - deterrents will not stop me from wanting to kill myself; 100 = to a great extent - deterrents are definitely stopping me from killing myself)

At this moment, how strong is your intention to kill yourself?

_____ (0 = I have no intent to kill myself; 100 = very strong)

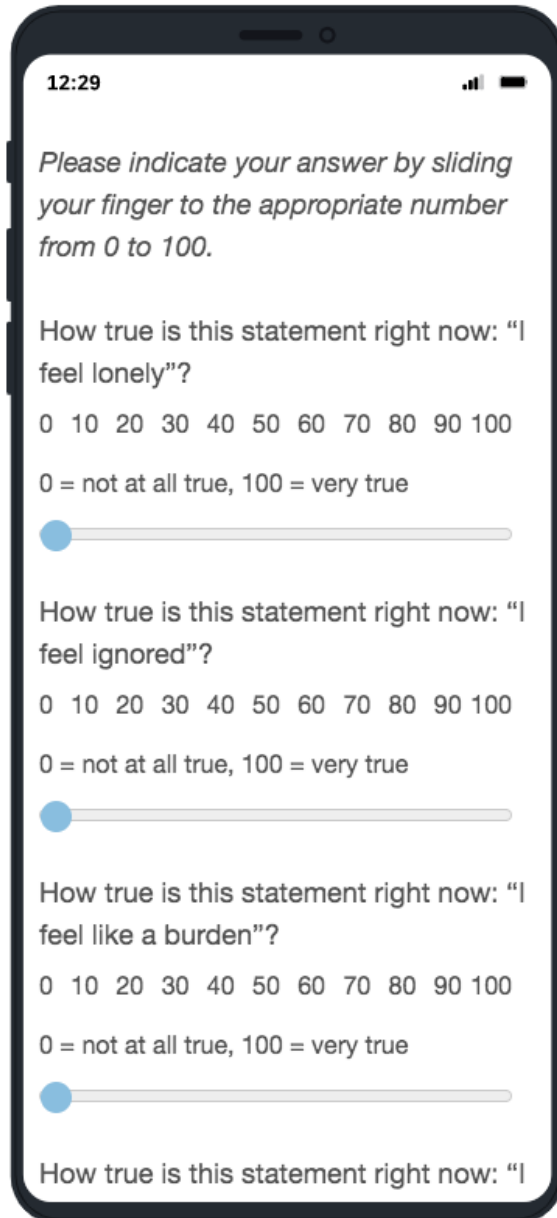
Is this your first questionnaire of the day? Yes

No

(*Dependent question) If yes, what time did you wake up?

Image A. Example of smartphone Qualtrics interface.

This is an example of how the above questions will look to the participant when answering the survey on their smartphone.



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8/24/2022

Date