COMPARING TWO IDEATION-TO-ACTION PERSPECTIVES ON SUICIDE IDEATION AND SUICIDE ATTEMPTS

by

Boaz Yehuda Saffer

M.A., The University of British Columbia, 2015

B.A., The University of British Columbia, 2010

A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

in

THE FACULTY OF GRADUATE AND POSTDOCTORAL STUDIES

(Psychology)

THE UNIVERSITY OF BRITISH COLUMBIA

(Vancouver)

July 2021

The following individuals certify that they have read, and recommend to the Faculty of Graduate and Postdoctoral Studies for acceptance, the dissertation entitled:

Comparing Two Ideation-to-Action Perspectives on Suicide Ideation and Suicide Attempts

submitted by	Boaz Y. Saffer	in partial fulfillment of the requirements for
the degree of	Doctor of Philosophy	
in	Psychology	

Examining Committee:

E. David Klonsky, Professor, Psychology, University of British Columbia

Supervisor

Sheila R. Woody, Professor, Psychology, University of British Columbia

Supervisory Committee Member

Luke A. Clark, Professor, Psychology, University of British Columbia

Supervisory Committee Member

Sheila Marshall, Professor, Social Work, University of British Columbia

University Examiner

John Ogrodniczuk, Professor, Psychiatry, University of British Columbia

University Examiner

Abstract

Suicide is a leading cause of global death and disability. Yet, despite decades of scientific research, suicide rates have remained largely unchanged, in part because previous empirical and theoretical approaches failed to differentiate explanations for suicide ideation from explanations for suicide attempts. The ideation-to-action framework addresses this limitation and states that distinct risk factors, pathways, and mechanisms are involved in (a) the development of suicide ideation and (b) the progression from suicide ideation to suicide attempts. The present study examined the hypotheses made by two recently developed ideation-to-action perspectives (1) Klonsky and May's (2015) Three Step Theory (3ST) and (2) Jollant et al.'s (2011) Neurocognitive Model of Suicide Behaviour (NCM) in a large sample (n=1,014) of undergraduate students. Results provide strong support for the hypotheses posited by the 3ST, including the interactive relationship of psychological pain (psychache) and hopelessness to suicide ideation as well as the unique association of practical capability (i.e., knowledge about using and acquiring lethal means) to suicide attempts. In addition, and consistent with the NCM, emotion dysregulation appeared to moderate the relationship of negative affect to suicide ideation. These findings are discussed in the context of the existing literature, along with their clinical implications for reducing suicidal ideation and preventing suicide attempts.

Lay Summary

Despite decades of scientific research, suicide rates have remained largely unchanged. This is in part due to theories of suicide not differentiating between factors that contribute to thinking about suicide and attempting suicide attempts. The present dissertation therefore empirically tested the hypotheses for thinking and attempting suicide made by two recently developed theories of suicide (1) Klonsky and May's (2015) Three Step Theory (3ST) and (2) Jollant et al.'s (2011) Neurocognitive Model of Suicide Behaviour (NCM) in a large sample (*n*=1,014) of undergraduate students. Results indicate that thinking about suicide is strongly associated with psychological pain (psychache) and hopelessness (as hypothesized by the 3ST), as well as moderately associated with difficulties regulating emotions (as hypothesized by the NCM). Suicide attempts appear to be strongly linked to knowledge about acquiring and using lethal means to attempt suicide, as suggested by the 3ST.

Preface

This dissertation is an original intellectual product of the author, Boaz Y. Saffer.

Approval for this study was obtained from the UBC Behavioral Research Ethics Board. The Approval Certificate Number is H14-01171.

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List of Abbreviations

.95CI	-	95% Confidence Interval
3ST	-	Three-Step Theory
ACSS-FAD	-	Acquired Capability for Suicide Scale – Fearlessness About Death
ADHD	-	Attention-Deficit/Hyperactivity Disorder
AUC	-	Area Under the Curve
BAI	-	Beck Anxiety Inventory
BDI	-	Beck Depression Inventory
BHS	-	Beck Hopelessness Scale
BHS-SF	-	Beck Hopelessness Scale – Short Form
BPD	-	Borderline Personality Disorder
BRI	-	Behavioural Regulation Index
BRIEF-A	-	Behaviour Rating Inventory of Executive Functioning – Adult version
BSI	-	Beck Scale for Suicidal Ideation
CDC	-	Centers for Disease Control and Prevention
CFQ	-	Cognitive Failures Questionnaire
CPT	-	Continuous Performance Task
DASS	-	Depression Anxiety Stress Scale
DASS-21	-	Depression Anxiety Stress Scale – 21 Item Version
DERS	-	Difficulties in Emotion Regulation Scale
DERS-18	-	Difficulties in Emotion Regulation Scale – 18 Item Version
FAS	-	Phonemic Fluency Test
FrSBe	-	Frontal Systems Behaviour Scale

FNES	-	Fear of Negative Evaluation Scale
FT	-	Flanker Task
GBD	-	Global Burden of Disease Study
GEC	-	Global Executive Composite
HSP	-	Human Subject Pool
IGT	-	Iowa Gambling Task
ICC	-	Interclass Correlations
IMV	-	Integrated Motivational-Volitional Model of Suicide Behaviour
INQ	-	Interpersonal Needs Questionnaire
IPTS	-	Interpersonal-Psychological Theory of Suicide
IQR	-	Inter-Quartile Range
MI	-	Metacognitive Index
NCM	-	Neurocognitive Model of Suicidal Behaviours
NSSI	-	Nonsuicidal Self-Injury
OR	-	Odds-Ratio
PB	-	Perceived Burdensomeness
PEBL	-	Psychology Experiment Building Language
PEBLab	-	Personality, Emotion, and Behaviour Laboratory
PFC	-	Prefrontal Cortex
PPV	-	Positive Predictive Value
RA	-	Research Assistant
RMSEA	-	Root Mean Square of Error Approximation
SCS-3	-	Suicide Capacity Scale

SD	-	Standard Deviation
SSI	-	Scale for Suicide Ideation
STAI	-	State-Trait Anxiety Inventory
TB	-	Thwarted Belongingness
TOL	-	Tower of London Test
UBC	-	University of British Columbia
UPPS	-	UPPS Impulsive Behaviour Scale
UPPS-16	-	UPPS Impulsive Behaviour Scale – 16 Item Version
VST	-	Victoria Stroop Test
wAUC	-	weighted Area Under the Curve
WCST	-	Wisconsin Card Sorting Test
WHO	-	World Health Organization

Acknowledgements

I am deeply grateful to my supervisor, Dr. E. David Klonsky, for his mentorship, enthusiasm, and ability to explain things clearly. His unwavering support, patience, and friendship served as the foundation for my graduate education and this dissertation.

I am very grateful to the members of my thesis committee, Dr. Sheila Woody and Dr. Luke Clark for their insightful suggestions, thoughtful advice, and tough questions which have enhanced this dissertation and my research skills more generally.

I would also like to thank the members of my clinical cohort in Kenny 1910 – Ms. Bri Glazier, Ms. Cara Dunkley, Ms. Jennifer Na, Ms. Jennifer Yip, and Ms. Joanne Park – for their friendship, comradery, and support throughout the graduate program.

I thank my mother, Ms. Myriam Morgenstern, who raised me to ask questions, nurtured my curiosity, and encouraged me to pursue higher education. I also thank my father, Mr. Stuart P. Saffer, who fostered my independence, imparted sound advice, and provided calm reassurance. Without his support, I would not have been able to pursue post-secondary education.

Dedication

This dissertation is dedicated to my wife, Yana, and two daughters, Elinor and Eve, who provided me with endless love, patience, and understanding throughout my graduate education. Their presence is a constant reminder of what matters most in life, and I am a better person because of them.

Chapter 1: Introduction

Suicide is a uniquely human phenomenon. It occurs in every continent, region, and country, and by people of all ages, ethnicities, and genders. It is unclear when suicides first started, though the earliest suicide note appears to predate the invention of glass, coins, and saddle (Thomas, 1980). Throughout human history, suicide has been inextricably tied to pain; the physical and psychological pain experienced by individuals considering and/or attempting suicide, as well as the pain experienced by grieving families, friends, and communities. Despite its enduring presence and devastating impact, suicide remains poorly understood, even after a century of scientific inquiry. To better understand this phenomenon, this dissertation starts by reviewing what is known about suicide, its distribution (epidemiology), correlates and risk factors, as well as recent empirical and theoretical advancements. Next, two recent theories of suicide will be introduced and discussed, including their hypotheses on the development of suicidal thoughts (suicide ideation) and the transition from suicidal thoughts to suicidal acts (suicide attempts). Finally, this dissertation will empirically test the assumptions made by these theories, including contrasting them with one another, to better understand the factors associated with suicide ideation and suicide attempts.

1.1 The Epidemiology of Suicide

1.1.1 Fatal Suicide Attempts

Every year, more people die by suicide than by homicide, drug overdose, and all armed conflicts, *combined* (Institute for Health Metrics and Evaluation, 2018; Pettersson et al., 2019; United Nations Office on Drugs and Crime, 2019, 2020; World Health Organization, 2018). Specifically, data from the World Health Organization (WHO; 2018) suggests that 800,000 people die by suicide each year, approximately one person every 40 seconds. Suicide accounts

for 1.4% of all deaths worldwide, resulting in a suicide mortality rate of 10.5 deaths per 100,000 population. It is the 18th leading cause of global mortality and 15th leading cause of years of life lost (World Health Organization, 2018). Given the poor quality and availability of suicide data (World Health Organization, 2019), and the fact that suicide is highly stigmatized (Schomerus et al., 2015) and illegal in some countries (Mishara & Weisstub, 2016), the aforementioned rates likely underestimate suicide's morbidity and mortality.

Suicide mortality varies by economy, region, and country. For example, recent estimates from the WHO (2018) indicate that suicide mortality rates are highest in high-income countries (11.5 deaths per 100,000 population) compared with middle- and low-income countries (rate range=9.0-11.4). Similarly, suicide is ranked as the 12th leading cause of death in high-income countries, 15th in middle-income countries, and is not listed among the 20 leading causes of death in low-income countries (World Health Organization, 2018). However, given the large population of low- and middle-income countries, the majority (78.8%) of suicide deaths occur in low- and middle-income countries. Examining suicide mortality rates in the WHO regions reveals that most suicide deaths occur in South-East Asia (257,000 suicide deaths, representing 34.2% of global suicide deaths), followed by the Western Pacific region (192,000, 24.2%), Europe (141,000, 17.9%), North and South America (97,000, 12.3%), Africa (75,000, 9.5%), and the Eastern Mediterranean region (26,000, 3.3%; World Health Organization, 2018). More granular data from the Global Burden of Disease Study (GBD; Naghavi, 2019) indicates that, within these regions, suicide mortality rates are highest in eastern Europe (27.5 deaths per 100,000 population), Asia Pacific (18.7), Southern Sub-Saharan Africa (16.3), South Asia (15.4), Oceania (14.1), central Europe (13.0), and North America (12.7). Suicide mortality rates per country suggest that, of the 15 countries with the highest suicide mortality rates, seven are in

Africa (Lesotho [suicide mortality rate of 28.9 per 100,000 population; ranked as the country with the 2nd highest global suicide mortality rate], Republic of Côte d'Ivoire [23.0; 6th], Equatorial Guinea [22.0; 8th], Uganda [20.0; 11th], Cameroon [19.5; 12th], Zimbabwe [19.1; 13th], and Nigeria [17.3; 15th]), four are in eastern Europe (Russian Federation [26.5; 3rd], Lithuania [25.7; 4th], Belarus [21.4; 9th], and Ukraine [18.5; 14th]), two are in South America (Guyana [30.2; 1st] and Suriname [23.2; 5th]), one is in central Asia (Kazakhstan [22.8; 7th]), and one in east Asia (Republic of Korea [20.2; 10th]; World Health Organization, 2018).

Suicide mortality rates also appear to vary by sex. For example, males die by suicide more often than females (15.6 and 7.0 per 100,000, respectively; male:female suicide mortality ratio=2.2; Naghavi, 2019). This pattern is observed across the six WHO regions (M:F range=1.2 [Western Pacific] to 3.5 [Europe]; World Health Organization, 2018), the 21 GBD sub-regions (M:F range=1.4 [South Asia] to 6.0 [eastern Europe]; Naghavi, 2019), and in 176 of the 183 (96.2%) countries included in the WHO (2018) database. Of the ten countries with the highest male:female suicide mortality rates, eight are in central and eastern Europe (World Health Organization, 2018), including Ukraine (M:F suicide mortality rate=7.3, ranked 1st in highest M:F suicide mortality rate), Lithuania (7.1; 3rd), Slovakia (7.1 4th), Poland (7.0; 5th), Georgia (6.47; 7th), the Russian Federation (6.4; 8th); Belarus (6.3; 9th), and the Republic of Moldova (6.3; 10th), while two (i.e., Seychelles [7.1; 2nd] and Qatar [6.6; 6th]) are not. In contrast, the ten countries with the lowest male:female suicide mortality rates are more geographically dispersed and located in South Asia, South-East Asia, and East Asia (Pakistan [M:F suicide mortality rate=1.0; 6th lowest M:F suicide mortality rate], Myanmar [0.6; 1st], Bangladesh [0.8; 4th], and China [1.0; 5th]) as well as North, East, West, and South Africa (Morocco [0.7; 2nd], Chad [1.2; 10th], Uganda [1.1; 9th], Nigeria [1.0; 7th], Liberia [1.1; 8th], and Lesotho [0.7; 3rd]).

Of all suicide deaths worldwide, only a relatively small proportion is accounted for by individuals 4-15 years of age (10,000 deaths, or 1.3% of all suicide deaths worldwide) as well as those 70 and older (120,600, 15.2%; World Health Organization, 2018). In contrast, the largest proportions of worldwide suicide deaths are accounted for by individuals in mid-adolescence to early adulthood (ages 15-29; 212,700 deaths, 26.8%), middle aged adults (ages 30-49; 245,300 deaths, 30.9%), and those in late adulthood (ages 50-69; 204,500 deaths, 25.8%; World Health Organization, 2018). In contrast, suicide mortality rates, appear to increase linearly with age (e.g., 1.3 deaths per 100,000 population [age 10-14]; 12.2 [age 25-29]; 12.7 [age 40-45]; 15.7 [age 55-59]; 21.4 [age 70-74]; 35.94 [age $\geq$ 80]; Institute for Health Metrics and Evaluation, 2018). Despite the higher suicide mortality rate in older adults, suicide accounts for far fewer deaths among this age group than other causes of death. For example, across the 21 GBD regions, suicide's rank as a leading cause of death for individuals 70 years of age and older ranged from 20 to 59, with 34 being the median rank (Naghavi, 2019). Conversly, suicide is consistently ranked among the top five leading causes of death for individuals 10 to 24 years of age in 17 of the 21 GBD regions (overall rank range=1-12, median rank=3). Examined by sex, suicide represents the second leading global cause of death (after lower-respiratory tract infections) among adolescent females 15-19 years of age (6.2% of deaths; Patton et al., 2009) and the third global leading cause of death (after road traffic accidents and interpersonal violence) among adolescent males of the same age (6.4% of deaths; Patton et al., 2009).

Suicide mortality rates appear to have changed over time. Results from epidemiological studies suggest that, between 1950 and 1995, global suicide mortality rates increased by approximately 40% (49% in men and 33% in women; Bertolote & Fleischmann, 2002). More recent reports suggest that, between 1990 and 2016, suicide mortality rates have decreased by as

much as 32.7%. (23.8% for men and 49.0% for women; Naghavi, 2019) and by 26% (23% in men and 32% in women) between 2000 and 2012 (World Health Organization, 2014). The greater decrease in female suicide mortality rates has increased the male:female suicide mortality ratio, from 1.4 in 1990 to 2.2 in 2016 (Naghavi, 2019). Consistent with these recent global changes, suicide mortality rates appear to have decreased across 17 of the 21 GBD regions (range of decrease= - 2.3% [North America] to -63.0% [East Asia]) and slightly increased in four regions (range of increase=1.4% [eastern Europe] to 14.6% [Central Latin America]; Naghavi, 2019). During the same period, greater variability in the change of suicide mortality rates was observed across individual countries. For example, between 2000 and 2012, changes in suicide rates ranged from a 69% decline to a 270% increase (World Health Organization, 2014). Even greater variability was observed when examining changes in suicide mortality rates between sexes. For example, during the same period, suicide mortality rates increased by 416.9% among males in Cyprus, decreased by 68.8% among females in Malta, and increased by 109.4% for both males and females in the Republic of Korea (World Health Organization, 2014). Similarly, more recent data (World Health Organization, 2018) suggests that suicide mortality rates have decreased by 81.0% among males in Barbados, increased by 800% among women in Antigua and Barbuda and by 114.3% among men and women in Cyprus. Studies examining changes in suicide mortality rates since the 1950s (Värnik, 2012) report that suicide mortality rates were initially highest in western Europe and have shifted to Eastern Europe over 50 years. The same study also suggests that the highest suicide mortality rates will continue moving eastward from eastern Europe to Asian countries over the coming years.

1.1.2 Nonfatal Suicide Attempts

Approximately 2.7% of people will attempt, but not die by, suicide at least once in their lifetime (Nock, Borges, Bromet, Alonso, et al., 2008). Nonfatal suicide attempts can have negative impacts on the individuals who attempted suicide, including significant psychological and physical suffering, which has been estimated to equal the impairment caused by heroin dependency or the initial stages of Parkinson's Disease (Van Spijker et al., 2011). Furthermore, nonfatal suicide attempts also occur much more frequently than fatal suicide attempts, with estimates suggesting that, for every fatal suicide attempt, approximately 20 (World Health Organization, 2014) to 30 (Substance Abuse and Mental Health Services Administration, 2019) nonfatal suicide attempts are made.

Prevalence data on nonfatal suicide attempts are not included in a large number of databases, including from international organizations (Nock, Borges, Bromet, Alonso, et al., 2008). As a result, prevalence estimates are based on cross-national data obtained from a small number of developed countries (Nock, Borges, Bromet, Alonso, et al., 2008; Nock, Borges, Bromet, Cha, et al., 2008). Examining the available data suggests that, similar to fatal suicide attempts, rates of nonfatal suicide attempts have also been found to differ by country. For example, a systematic review of 26 international epidemiological studies on suicidal behaviours (Nock, Borges, Bromet, Cha, et al., 2008) reported that the prevalence rates for nonfatal suicide attempts varied widely across countries; from 0.4%-5.1% (Inter-Quartile Range[*IQR*]=1.3-3.5%) for lifetime nonfatal attempts and from 0.1%-3.8% (*IQR*=.4-1.5%) for past-year nonfatal attempts. More recent data meta-analytic data (Mortier et al., 2018) from 36 studies using a combined sample of more than 634,000 college students estimated the lifetime and past-12

month prevalence of nonfatal suicide attempts as 3.2% (95% Confidence Interval: .95CI[2.2-4.5%]) and 1.2% (.95CI[0.8-1.6%]), respectively.

Rates of nonfatal suicide attempts do not appear to geographically mirror rates of fatal suicide attempts. For example, cross-national data from 17 countries and more than 84,0000 participants as part of the WHO's World Mental Health Survey (Demyttenaere et al., 2004; Nock, Borges, Bromet, Alonso, et al., 2008) observed no differences in the prevalence of nonfatal suicide attempts between high-income countries (0.5-5.0%) and low- and middle-income countries (0.7-4.7%, respectively; Nock, Borges, Bromet, Alonso, et al., 2008). Furthermore, the same study ranked the United States and Colombia as having the 1st and 2nd highest prevalence of nonfatal suicide attempts (5.0% and 4.7%, respectively) and Ukraine as one of the lowest (1.8%). In contrast, Ukraine is ranked as the 14th country with the highest suicide mortality rate in the world, while the United States is ranked 34th and Colombia 119th (World Health Organization, 2018).

Nonfatal suicide attempts also differ by sex and age. For example, although men are more likely to die by suicide, women are almost twice as likely to engage in a nonfatal suicide attempt (Odds Ratio [*OR*]=1.7; Nock, Borges, Bromet, Alonso, et al., 2008). Similarly, although older adults are more likely to die by suicide, global estimates for lifetime and past 12-month nonfatal suicide attempts are consistently greater among adolescents (1.5-12.1%, *IQR*=2.2-8.8% and 1.8-8.0%, *IQR*=2.7-4.7%, respectively; Nock, Borges, Bromet, Cha, et al., 2008), with young adults 18 to 34 years of age being at more than twelve times the odds of engaging in a nonfatal suicide attempt (*OR*=12.4) compared with those 65 years of age or older (Nock, Borges, Bromet, Alonso, et al., 2008).

1.1.3 Economic Burden

In addition to their devastating and enduring impact on individuals, families, and communities, fatal and nonfatal suicide attempts represent a substantial financial burden on societies. These are typically calculated by combining both direct (e.g., cost of emergency services, medical costs, funeral expenses, and associated administrative costs) and indirect (e.g., lost productivity, future wages, providing housing, nutrition, clothing, care, education, and voluntary work) costs. Estimates from the Republic of Ireland suggest that suicide attempts cost the Irish economy approximately €1 billion each year, roughly 1% of the country's gross national product (Kennelly, 2007). Similarly, suicide attempts are estimated to exceed $2.4 billion annually in Canada (SmartRisk, 2009) and $6.7 billion in Australia (Kinchin & Doran, 2017). In the United States, the Centers for Disease Control and Prevention (CDC) estimates that the cost of fatal and nonfatal suicide attempts amounts to approximately $62.1 billion a year (Florence, Haegerich, et al., 2015; Florence, Simon, et al., 2015), and a recent study (Shepard et al., 2016) suggests that suicide attempts cost the U.S. economy more than $93.5 billion a year ($1.3 million per suicide), approximately $300 per U.S. citizen. Taken together, these estimates suggest that there is an urgent need to reduce the mortality, personal suffering, and societal cost caused by fatal and nonfatal suicide attempts. Identifying risk factors for suicide is crucial to predicting and preventing suicide attempts.

1.2 Correlates and Risk Factors for Fatal and Nonfatal Suicide Attempts

Over a century of research has identified a long and diverse list of factors associated with fatal and nonfatal suicide attempts. For example, results taken solely from meta-analytic studies suggest that sociodemographic factors such as divorce (Kyung-Sook et al., 2018; Yip et al., 2015), non-heterosexual sexual orientations (Hatchel et al., 2019; Hottes et al., 2016; King et al.,

2008; Marshal et al., 2011; Miranda-Mendizábal et al., 2017), long-term unemployment (Milner, Page, et al., 2013), being employed in elementary (Milner, Spittal, et al., 2013) and medical (Schernhammer & Colditz, 2004) professions are associated with increased rates of suicide. Similarly, suicide has been reported to occur more frequently in individuals who have experienced one or more childhood adversities (Arango et al., 2016; Norman et al., 2012), such as sexual abuse (Arango et al., 2016; Devries et al., 2014; Paolucci et al., 2001), physical abuse, emotional abuse, and neglect (Arango et al., 2016; Norman et al., 2012), peer victimization (Arango et al., 2016; van Geel et al., 2014), and parental death by suicide (Geulayov et al., 2012). Meta-analytic findings from biological research suggest an association between suicide and blood-related factors such as cholesterol (Lester, 2002; Wu et al., 2016), cortisol (D. B. O'Connor et al., 2016), cytokines (Black & Miller, 2015), and tryptophan hydroxylase (Lalovic & Turecki, 2002), genetic factors (Voracek & Loibl, 2007) such as brain-derived neurotrophic factors (Zai et al., 2012), serotonin transporters (e.g., 5-HTT and 5-HTTLPR; Li & He, 2007; Lin & Tsai, 2004), and tryptophan hydroxylase (Bellivier et al., 2004; Rujescu et al., 2003), as well as neuroanatomical abnormalities (Grangeon et al., 2010), including patterns of neural activation in specific brain regions (Rentería et al., 2017; van Heeringen et al., 2014).

Perhaps most frequently reported are the associations between psychiatric disorders and suicide. Examining results from meta-analytic studies suggest that individuals diagnosed with depressive disorders (Harris & Barraclough, 1997; Schneider et al., 2006), bipolar disorders (Swartz & Frank, 2010), schizophrenia (S. Brown et al., 2000; Palmer et al., 2005), anxiety disorders (Bentley et al., 2016; Kanwar et al., 2013), borderline personality disorder (BPD; Pompili et al., 2005), substance use disorders (Borges et al., 2017; Darvishi et al., 2015; Tondo et al., 1999; Wilcox et al., 2004) including smoking (Dianjiang Li et al., 2012; Poorolajal &

Darvishi, 2016), sleep disorders (Chiu et al., 2018; Liu, Tu, et al., 2019; Pigeon et al., 2012), attention-deficit/hyperactivity disorder (ADHD; Impey & Heun, 2012), and eating disorders (Arcelus et al., 2011; Pompili et al., 2004; Preti et al., 2011) more often attempt and die by suicide than individuals without these diagnoses. Furthermore, results from systematic reviews suggest that self-harming thoughts and behaviours, such as a history of suicidal ideation (Victor & Klonsky, 2014), nonsuicidal self-injury (NSSI; Hamza, Stewart, & Willoughby, 2012) and previous nonfatal suicide attempts (Hawton et al., 2013), are also more common in individuals who have attempted suicide. Findings from individual studies suggest that suicide is also associated with a range of psychological variables such as hopelessness (Beck et al., 1985; G. K. Brown, Beck, et al., 2000), emotion dysregulation (Pisani et al., 2013), loneliness (Stravynski & Boyer, 2001), and impulsivity (Gvion et al., 2011, 2015; Liu, Trout, et al., 2017).

Despite the size and breadth of this research literature, a common assumption made by the aforementioned studies is that the factors examined (e.g., psychiatric diagnoses) represent risk factors for suicide. Risk factors are variables that are not only associated with an outcome of interest (in this case, attempting suicide) but must also *temporally precede* the same outcome (Kraemer, 1997). However, the vast majority of the meta-analyses cited combined results from cross-sectional studies that measure the presence and intensity of factors at *a single point in time*. Therefore, it is unclear whether the factors of interest (e.g., psychiatric diagnoses) preceded attempting suicide or are the result of the suicide attempt(s). To address this limitation, Franklin et al. (2017) conducted a meta-analysis quantifying the *longitudinal* relationship of a large number of factors (e.g., demographic characteristics, psychiatric diagnoses, NSSI) to fatal and nonfatal suicide attempts. Franklin et al. (2017) reviewed over 2,500 articles and identified 365 studies that prospectively examined the relationship of one or more factors (e.g., psychiatric

diagnoses) to fatal and nonfatal suicide attempts. After analyzing over 3,400 individual effect sizes, Franklin et al. (2017) reported that the strongest risk factors for nonfatal suicide attempts were prior NSSI (*OR*=4.2), prior suicide attempt (*OR*=3.4), being screened for suicide (*OR*=2.5), being diagnosed with a personality disorder (*OR*=2.3), and a history of psychiatric hospitalization (*OR*=2.3). Similarly, psychiatric hospitalization (*OR*=3.5), prior suicide attempt (*OR*=2.2), prior suicidal ideation (*OR*=2.2), low socioeconomic status (*OR*=2.2), and stressful life events (*OR*=2.2) were identified as the factors most predictive of fatal suicide attempts. These risk factors remained predictive of suicide attempts across studies with samples of individuals of different age (e.g., adolescent, adult), different demographic and clinical characteristics (e.g., general, clinical, and self-harming populations), study follow-up periods (3.g., 0-6 months, 7-12 months, 13-24 months, etc.), and decade of publication (e.g., Pre-1985, 1985-1994, 1995-2004, etc.).

The magnitude of the risk factors reported by Franklin et al. (2017; *OR* range = 2.2-4.2) are considered small to medium, and equivalent to *Cohen's d* (Cohen, 1988) effect sizes of 0.2 to 0.5 (Chen et al., 2010). More importantly, they initially appear to meaningfully increase the odds of predicting who will attempt and die by suicide. However, accurate prediction depends on the prevalence (i.e., how common) of the outcome being predicted. For example, predicting a relatively prevalent health condition such as diabetes (13.5% of the U.S. population; Virani et al., 2020), one's odds of correctly predicting that a person will develop diabetes are (13.5 [number of people with diabetes per 100 individual]/86.5 [number of people without diabetes per 100 individuals]=) 0.16, or 16% per 100 people. A risk factor of similar magnitude to those identified by Franklin et al. (2017; e.g., *OR*=3.0) will increase our odds of accurately predicting diabetes from 0.16 to ([13.5x3]/86.5) 0.47, or 47 per 100 people, a meaningful increase. However, the

same risk factors do not meaningfully increase the prediction of fatal suicide attempts because these outcomes are *much less prevalent*. Specifically, the annual prevalence of fatal suicide attempts in the United States is estimated as 13.0 per 100,000 population (Centers for Disease Control and Prevention, 2016), which can be calculated as (13/100,000) 0.00013% of the population. Therefore, the baseline odds of predicting who will die by suicide are (13 [number of people who die by suicide]/99,987 [number of people who do not die by suicide]) 0.00013, or 0.013 per 100 people. Given the low prevalence of fatal suicide attempts, even the strongest risk factor for fatal suicide attempts identified by Franklin et al. (2017; psychiatric hospitalization [*OR*=3.5]) will only increase the odds to (0.00013x3.5) 0.00046, or 0.046 per 100 people.

In the same meta-analysis, Franklin et al. (2017) calculated the predictive properties of the risk factors identified. Specifically, Franklin et al. (2017) used the weighted Area Under the Curve (*wAUC*) statistic, a metric that plots the relative trade-off between a risk factor's ability to correctly categorize individuals at risk for suicide attempts (i.e., the true positive rate, or sensitivity) and incorrectly categorize individuals at risk for suicide attempts (i.e., the false-positive rate, or 1 - specificity). Perfect categorization (i.e., all people at risk for suicide correctly categorized as being at risk for suicide and all people not at risk for suicide categorized as not being at risk for suicide) results in a *wAUC* of 1.0 (true positive rate=1, false-positive rate=0). Chance prediction (i.e., number of people correctly categorized as being at risk for suicide equals the number of people incorrectly categorized as being at risk for suicide) would result in a *wAUC* of 0.50 (true positive rate = false-positive rate). Statistical guidelines suggest that *wAUC* values above 0.90 indicate excellent prediction, values between 0.80-0.89 indicate good prediction, values between 0.70-0.79 indicate fair prediction, values between 0.60-0.69 indicate poor prediction, and values between 0.50-0.59 indicate very poor prediction (Šimundić, 2008).

Combining data from the longitudinal studies identified in their meta-analysis, Franklin et al. (2017) reported that knowledge of the longstanding risk factors for suicide increased the field's ability to predict fatal and nonfatal suicide attempts by 7% (*wAUC*=0.57) and 8% (*wAUC*=0.58) better than chance (i.e., *wAUC*=0.50), respectively. These results remained largely unchanged when examined across levels of suicide intent (i.e., clear suicide intent [*wAUC*=0.57], inferred suicide intent [*wAUC*=0.59], unclear/unstated suicide intent [*wAUC*=0.59]) as well as whether the individual had previously attempted suicide (*wAUC*=0.60), never attempted suicide (*wAUC*=0.57), and when this information was unavailable (*wAUC*=0.65). Similarly, there was little difference in the results according to the method used to determine whether the death constituted a suicide (i.e., by relying on legal/medical documents [*wAUC*=0.55], family reports [*wAUC*=0.31], unclear assessment strategy [*wAUC*=0.62]) as well as the degree of certainty involved in classifying the death as a suicide (i.e., unambiguous suicide [*wAUC*=0.55], ambiguous suicide [*wAUC*=0.56], unclear/unstated suicide [*wAUC*=0.62]).

Additional evidence for the field's relatively poor ability to predict suicide attempts can be found in meta-analytic studies examining the predictive properties of longstanding suicide risk assessment instruments. For example, a meta-analysis (Runeson et al., 2017) of five suicide risk assessment instruments observed that none of the instruments met criteria for sufficient diagnostic accuracy (predefined in the study as sensitivity ≥0.80 and specificity ≥050). Similarly, analyses from a second recent meta-analysis (Carter et al., 2017) of 70 studies and more than 65 risk assessment instruments found that suicide risk assessment instruments poorly predicted suicide deaths. Specifically, Carter et al. (2017) calculated the instruments' positive predictive values (*PPVs*), defined as the probability that a person identified as being at risk for an outcome (in this case, suicide attempts) will experience the predicted outcome (Šimundić, 2008). *PPV* is

calculated by dividing the number of correct categorizations (e.g., individuals correctly categorized as being at risk for suicide) by the sum of people correctly and incorrectly categorized as being at risk for suicide. Carter et al.'s (2017) analyses revealed that suicide risk assessment instruments correctly categorized people as being at risk for dying by suicide less than 6% of the time (*PPV*=5.5%, .95CI[3.9-7.9%]). Independently examining psychological instruments resulted in even lower predicted values (*PPV*=3.7%, .95CI[2.5-5.4%]). Similar results were obtained in a separate meta-analysis of 39 longitudinal studies (Large et al., 2016) that compared the accuracy of suicide risk assessment instruments in individuals categorized as high (*PPV*=5.5%; .95CI[3.5-8.5%]) and low (*PPV*=0.9%; .95CI[0.5-1.7%]) risk for suicide. A separate meta-analysis (Chan et al., 2016) examining the predictive properties of three of the most frequently used suicide risk assessment instruments (the Beck Hopelessness Scale [BHS; Beck, Weissman, Lester, & Trexler, 1974], Suicide Intent Scale [Beck, Schuyler, & Herman, 1974], and Scale for Suicide Ideation [SSI; Beck, Kovacs, & Weissman, 1979]) in samples of individuals who recently self-harmed revealed similar results (*PPV* range=1.3-16.7%).

The poor predictive properties of risk factors and suicide risk assessment instruments have resulted in government organizations issuing explicit recommendations to avoid relying on suicide risk assessment instruments for predicting suicide risk. For example, Canada's Centre for Addiction and Mental Health cautioned that "such [suicide risk assessment] tools have low predictive ability and yield high false-positive and false negative rates (Centre for Addiction and Mental Health, 2015, p. 15). Similarly, in reviewing the research on suicide risk assessment instruments, the United States' Department of Veteran Affairs concluded that there is "insufficient evidence overall to recommend screening with these [suicide] risk assessment tools based on this evidence" (O'Neil et al., 2012, p. 35). Perhaps most definitive, the United

Kingdom's National Institute for Health and Care Excellence recommends that clinicians "…not use risk assessment tools and scales to predict future suicide or repetition of self-harm" (National Institute for Health and Care Excellence, 2011, p. 8).

Taken together, these findings suggest that the past half-century of suicide research has identified a large number of risk factors for fatal and nonfatal suicide attempts. The relationship of these risk factors to fatal and nonfatal suicide attempts has been replicated in a large number of studies using different samples of participants and research methodologies. Despite these robust findings, the same risk factors do not meaningfully contribute to predicting fatal and nonfatal suicide attempts, primarily because such events are relatively infrequent. This pattern remains largely unchanged, even when using specialized suicide risk assessment instruments designed to measure the factors that most strongly predict suicide attempts (e.g., psychiatric diagnoses, hopelessness, impulsivity).

1.3 Differentiating Suicide Ideators from Suicide Attempters

One possible explanation for the limited progress in suicide prediction and prevention is the assumption that the development of suicidal thoughts involves the same risk factors, mechanisms, and pathways as the development of suicidal acts. For example, empirical approaches to identifying risk factors for suicide have primarily relied on research designs comparing individuals with a history of suicide attempts to individuals without a history of suicide attempts, or individuals who died by suicide to those who have not. While intuitive, such approaches do not account for the presence of suicide ideation, and thereby ignore the possibility that important differences may exist between individuals with a history of suicide ideation but no history of attempts (suicide ideators) and individuals with a history of suicide attempts (suicide attempters). Similarly, theoretical approaches to understanding suicide risk often conceptualize a

linear relationship between risk factors for suicide (e.g., hopelessness, escape, psychache), the development of suicide ideation, and the progression from suicide ideation to suicide attempts (e.g., moderate hopelessness leads to ideation, whereas strong hopelessness leads to attempts). However, this assumption is being increasingly questioned by a growing number of studies, which suggest that the development of suicide ideation may involve different risk factors, mechanisms, and pathways than the progression from suicide ideation to suicide. This relatively recent literature will be reviewed in two separate sections focusing on (1) the empirical findings and (2) the theoretical developments that, taken together, highlight the need to differentiate suicide ideators from suicide attempters.

1.3.1 Empirical Approaches

Kessler, Borges and Walters (1999) were the first to examine differences between suicide ideators and suicide attempters in a large nationally-representative sample of participants. Specifically, using data from the National Comorbidity Survey, a sample of over 5,800 participants from the United States, Kessler et al. (1999) examined the likelihood that suicide ideators and suicide attempters would be diagnosed with a range of psychiatric disorders (e.g., mood, anxiety, substance use) over their lifetime. Consistent with previous studies, Kessler et al. (1999) found that psychiatric disorders were more common in both suicide ideators and suicide attempters, relative to individuals with no history of either suicide ideation or suicide attempts (nonsuicidal individuals). For example, in comparing suicide ideators to nonsuicidal individuals, Kessler et al. (1999) observed that suicide ideators had almost eleven times the odds (*OR*=10.7) of being diagnosed with a mood disorder at some point in their lifetime. Similarly, Kessler et al. (1999) observed that suicide attempters had almost 13 times the odds (*OR*=12.9) of being diagnosed with a mood disorder at some point in their lifetime, compared with nonsuicidal

individuals. Much like previous studies, Kessler et al. (1999) interpreted these findings to suggest that being diagnosed with a psychiatric disorder represents an important risk factor for the development of suicide ideation and suicide attempts.

However, unlike previous studies, Kessler et al. (1999) also examined whether the same psychiatric diagnoses would differentiate between suicide ideators and suicide attempters. In contrast to the large differences previously observed, Kessler et al. (1999) found that the magnitude of the difference in the odds of being diagnosed with a psychiatric disorder was dramatically reduced between suicide ideators and suicide attempters. Specifically, while both suicide ideators and attempters had more than ten times the odds of being diagnosed with a mood disorder compared with nonsuicidal individuals, suicide attempters had only twice the odds (*OR*=2.0) of being diagnosed with a mood disorder compared with suicide ideators. The same pattern was observed for other psychiatric diagnoses including having any anxiety disorder (*OR*=1.0), substance use disorders (*OR*=1.4), personality disorders (*OR*=1.1), and even being diagnosed with three or more psychiatric disorders (*OR*=1.1). This pattern led Kessler et al. (1999, p.617) to conclude that: "All significant risk factors… were more strongly related to ideation than to progression from ideation to a plan or an attempt".

The findings observed by Kessler et al. (1999) have since been replicated in several large epidemiological studies, including by Nock et al. (2008) who used data from over 84,000 participants and 17 countries collected by the World Health Organization World Mental Health Survey Initiative (Demyttenaere et al., 2004). Consistent with previous research, Nock et al. (2008) found that suicide ideators had greater odds of being diagnosed with mood, anxiety, impulse-control, and substance use disorders than nonsuicidal individuals (*OR* range=2.8-4.7). Similarly, Nock et al. (2008) also found that suicide attempters had greater odds of being

diagnosed with the same psychiatric disorders compared to nonsuicidal individuals (*OR* range=3.5-6.3). However, mood, anxiety, impulse-control, and substance use disorders did not appear to meaningfully differentiate suicide ideators and suicide attempters (*OR* range=1.2-2.3) as well as the number of psychiatric diagnoses an individual obtained during their lifetime (*OR* range=1.0-1.8). A similar pattern was also observed in a second study using the same dataset by Borges et al. (2010), who examined the relationship of psychiatric diagnoses to suicide ideation and suicide attempts occurring in the past twelve months. Similar to the findings reported by Nock et al. (2008), Borges et al. (2010) observed that recent suicide ideators did not meaningfully differ from recent suicide attempters on a range of psychiatric diagnoses, including mood disorders (*OR*=1.1-1.6), anxiety disorders (*OR* range=1.1-1.8), or impulse control disorders (*OR*=1.3-1.6). These findings were further replicated in a third study conducted by Nock, Borges, and Ono (2012), which used a different set of analyses to report that psychiatric diagnoses accounted for over 60% of the variance in predicting suicide ideation, but only slightly more than 7% of the variance in predicting suicide attempts among individuals with a history of suicide ideation.

Since the publication of these epidemiological findings, an increasing number of individual studies have also observed that many of the longstanding risk factors for suicide do not differentiate between suicide ideators and suicide attempters. For example, findings from cross-sectional studies suggest that hopelessness does not differentiate suicide ideators from suicide attempters, a result that has been replicated in samples of individuals diagnosed with mood disorders (Rudd et al., 1996), depression (Apter et al., 2001; Vuorilehto et al., 2006), bipolar disorder (Acosta et al., 2012), as well as children and young adults treated in a psychiatric inpatient facility (Nock & Kazdin, 2002). Furthermore, a prospective study (Qiu et

al., 2017) of psychiatric outpatients found that hopelessness did not distinguish outpatients who would develop suicide ideation from those who would attempt suicide over a 10-year period. Similarly, the role of impulsivity in increasing risk for attempting suicide, over and above suicide ideation, is also being increasingly questioned. For example, Klonsky and May (2010) examined differences in impulsivity between suicide ideators and suicide attempters in three distinct samples (military recruits, college students, and high school students) using factor-analytically derived measures of impulsivity (the Schedule for Nonadaptive and Adaptive Personality; Clark, Simms, Wu, & Casillas, 1993; The UPPS Impulsivity Scale; Whiteside & Lynam, 2001). Across all three samples, suicide ideators reported similar levels of impulsivity to suicide. A significant difference between suicide ideators and suicide attempters was obtained on one subscale (lack of Premeditation) on the UPPS in the combined student samples, though the magnitude of the difference in scores is considered small (*Cohen's d*=0.27)

The importance of distinguishing risk factors for suicide ideation from risk factors for suicide attempts was further emphasized by the meta-analytic findings reported by May and Klonsky (2016). Specifically, May and Klonsky (2016) were the first to *systematically* examine whether oft-cited risk factors for suicide (e.g., psychiatric diagnoses, hopelessness) are more closely associated with suicide ideation or suicide attempts. Across the risk factors identified, large differences were observed comparing suicide ideators to nonsuicidal individuals on measures of depression severity, depression diagnosis, and feelings of hopelessness (*d* range=0.55-0.90). However, the same risk factors did not appear to meaningfully differentiate between suicide ideators and suicide attempters (*d* range=-0.05-0.24). Furthermore, no large effect size differences (defined as *Cohen's d* values ≥0.80) were observed between suicide ideators and suicide attempters on *any* of the risk factors examined. These results led May and

Klonsky (2016, p. 9) to conclude that: "These meta-analytic results are consistent with… the World Health Organization's World Mental Health Survey… in that demographic factors, psychiatric diagnoses, and life history variables are much less powerful in distinguishing attempters from ideators than they are at separating those with a history of suicide ideation from those without."

1.3.2 Theoretical Approaches

Similar to the empirical literature, traditional theories of suicide have viewed suicide as a single phenomenon requiring a single explanation. For example, suicide was thought to occur as a result of loneliness (Durkheim, 1897), psychological pain (i.e., psychache; Shneidman, 1993), and aversive self-awareness (Baumeister, 1990), among others. However, more recent theories of suicide offer distinct explanations for the development of suicide ideation and the development of suicide attempts. Below we will first describe the traditional theories of suicide, followed by Thomas Joiner's Interpersonal-Psychological Theory of Suicide (IPTS; Joiner, 2005; Van Orden et al., 2010), the first theory to provide separate explanations for the development of suicide ideation and the progression from suicide ideation to suicide attempts.

1.3.2.1 Traditional Theories of Suicide

Perhaps the first theoretical framework to understand suicide, the French sociologist Émile Durkheim (1897) proposed that two constructs – social integration (the extent to which a person feels connected to others) and social regulation (the extent to which a person's environment is structured) – explain suicide ideation and suicide attempts. Specifically, Durkheim proposed that suicide ideation and suicide attempts emerge when individuals experience either too much or too little social integration or social regulation. Durkheim used these constructs to classify four types of suicides: (1) Egoistic, (2) Altruistic, (3) Anomic, and (4)

Fatalistic. According to Durkheim (1897), Egoistic suicide is thought to occur due to loneliness (i.e., low social integration). In contrast, Altruistic suicide occurs when an individual places society's wellbeing ahead of their own (i.e., high social integration). Anomic suicide is thought to occur when a person has little moral structure in their life (i.e., low social regulation), which results in them experiencing a sense of aimlessness and despair. In contrast, Fatalistic suicide occurs when a person's life is thought to be overly structured (i.e., high social regulation), and results in them feeling over-controlled and hopeless about their future. Although the four types of suicide defined by Durkheim (1897) are conceptually distinct from one another, they share a common framework; namely, that having either too much or too little of either social integration or social regulation results in suicide ideation and, at greater extremes, in suicide attempts.

A similar framework was used by Edwin Shneidman. For example, Edwin Shneidman (1993) suggested that suicide results from individuals experiencing psychache, a construct Shneidman defined as "… referring to the hurt, anguish, soreness, aching, *psychological pain* in the psyche, the mind." (Shneidman, 1993, p. 145). According to Shneidman (1993), psychache is thought to emerge when a person's psychological needs (e.g., achievement, affiliation, autonomy) are thwarted. The inability to satisfy important psychological needs will result in greater psychache, which, in turn, will result in the person viewing suicide as an acceptable method for reducing their psychological pain, thereby developing suicide ideation. Shneidman (1993) suggests that different people are capable of tolerating differing amounts of psychological pain. However, once psychache exceeds a person's threshold for tolerating psychological pain, Shneidman (1993) suggests that the person will attempt suicide to eliminate the psychological pain they experience. A similar framework was used by Roy Baumeister (1990), who suggested that suicide ideation and suicide attempts occur as a result of aversive self-awareness.

Specifically, Baumeister (1990) proposed that individuals hold expectations of themselves and, when the outcome of events fails to meet their expectations, individuals will tend to internalize the responsibility for the outcomes and blame themselves for the result. In turn, Baumeister suggested that people will experience the process of being self-aware as painful since it involves confronting their shortcomings and inadequacies. Baumeister (1990) proposed that individuals will therefore try to escape the pain elicited by their self-awareness using a variety of maladaptive cognitive and behavioural strategies. When these are unsuccessful, Baumeister (1990) suggested that individuals become increasingly irrational, disinhibited, and impulsive, which predisposes them to think about suicide (i.e., developing suicide ideation) as a method of escaping their pain and, with greater intensity, results in them attempting suicide.

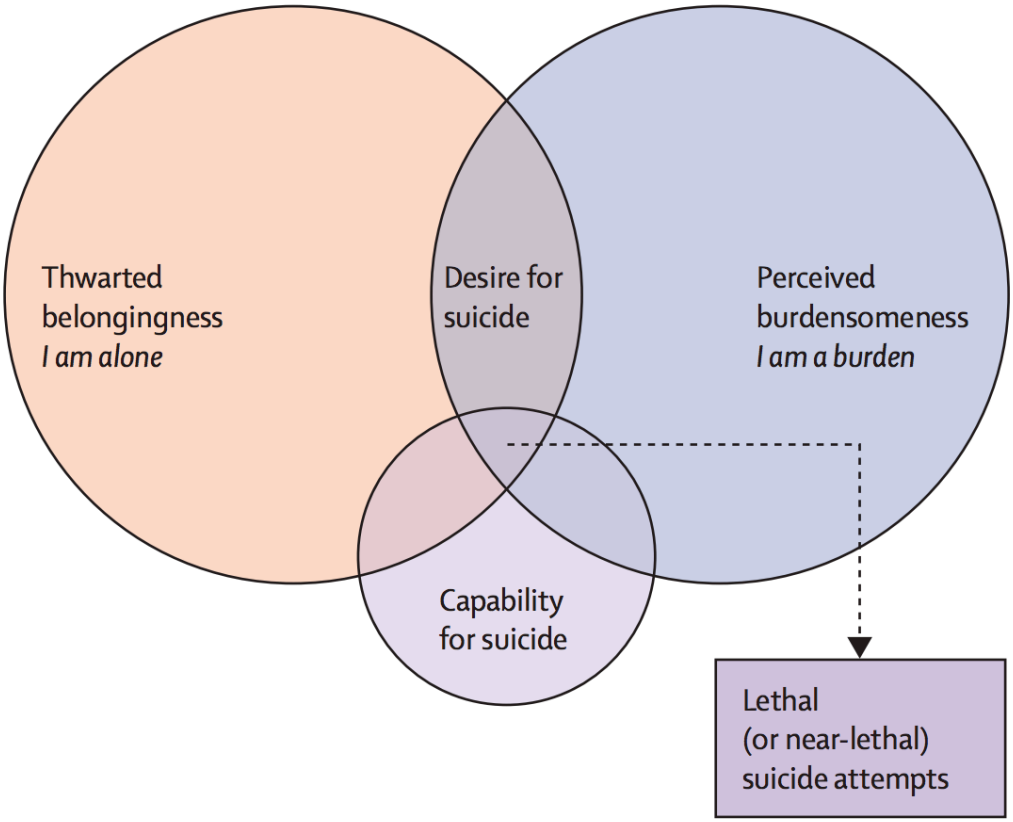
The conceptualization of risk factors equally contributing to the emergence of suicide ideation and suicide attempts is maintained even in theories of suicide that include more than one risk factor. For example, Wenzel and Beck's (2008) Cognitive Model of Suicidal Behaviour posits that suicide attempts result from the interaction of four broad categories, each composed of a large number of risk factors. Specifically, using a diathesis-stress model, Wenzel and Beck (2008) proposed that dispositional factors (e.g., impulsivity, problem-solving deficits, over-general memory, maladaptive cognitive patterns, and personality) interact with life stressors to produce distorted cognitive processes commonly observed in psychiatric diagnoses (e.g., negative bias) and cognitive processes associated with suicide attempts (e.g., hopelessness). According to Wenzel and Beck (2008), the interaction of dispositional factors with life stressors and distorted thinking patterns results in increasing a person's hopelessness which, in turn, acts as the primary risk factor for attempting suicide. A suicide attempt, therefore, "… results when a person can no longer tolerate the despair that results from this cognitive-emotional state…"

(Wenzel & Beck, 2008, p. 196). Thus, although Wenzel and Beck's (2008) model incorporates a large number of risk factors, no distinction is made between risk factors that contribute to the development of suicide ideation and risk factors that contribute to the progression from suicide ideation to suicide attempts. In other words, the underlying assumption of the model is that risk factors equally contribute to the development of suicide ideation, and, when the intensity of suicide ideation crosses a theoretical threshold, a suicide attempt will occur.

1.3.2.2 The Interpersonal-Psychological Theory of Suicide

Thomas Joiner's Interpersonal-Psychological Theory of Suicide (IPTS; Joiner, 2005; Van Orden et al., 2010) stands out as the first theory to distinguish between risk factors for suicide ideation and risk factors for suicide attempts. Perhaps most consistent with Durkheim's constructs of social integration and social regulation, Joiner's IPTS posits that suicide ideation emerges when an individual feels (a) disconnected from others (a construct Joiner [2005] defines as thwarted belongingness [TB]) and (b) that their existence represents a burden to others (a construct Joiner [2005] defines as Perceived Burdensomeness [PB]). However, unlike previous theories of suicide, Joiner's IPTS is unique in suggesting that the factors that cause suicide ideation (i.e., TB and PB) are not sufficient to bring about suicide attempts (see Figure 1).

Figure 1. The Interpersonal-Psychological Theory of Suicide (IPTS)



In order to attempt suicide, Joiner (2005) suggests that a person must overcome the fear inherent in attempting suicide (e.g., fear of the pain one might experience when attempting suicide, fear of the consequences of a nonfatal attempt, fear of dying), which Joiner (2005) collectively refers to as the acquired capability to attempt suicide. Acquired capability, is thought to develop when an individual is exposed to painful and provocative experiences, such as child maltreatment, combat exposure, and engaging in self-harming behaviours. Such experiences are thought to cause habituation to fear of pain and death, thereby making it easier to attempt suicide. Joiner's IPTS therefore suggests that suicide ideation results from experiencing severe TB and PB, but that risk for attempting suicide is elevated only when a person also has high acquired capability to attempt suicide (Joiner, 2005; Van Orden et al., 2010).

Since its initial publication, Joiner's IPTS has been empirically examined in a large number of studies, which have been summarized in two meta-analyses (Chu et al., 2017; Ma et al., 2016). However, findings from these studies provide mixed support for the hypothesized relationships of the IPTS constructs and their relationship to suicide ideation and suicide attempts. Although some details of the IPTS may not have been borne out by research, Joiner's IPTS stands-out as the first theory of suicide to provide separate explanations for the emergence of suicide ideation and suicide attempts, thereby representing an important landmark in advancing suicide theory.

1.4 The Ideation-to-Action Framework

In response to the growing empirical and theoretical literature highlighting differences in the development of suicide ideation and the progression to suicide attempts, Klonsky and May (2014) proposed that an ideation-to-action framework should guide all suicide theory and research. The ideation-to-action framework views (a) the development of suicide ideation and (b) the progression from suicide ideation to suicide attempts as separate processes with distinct risk factors, pathways, and mechanisms.

Adopting an ideation-to-action framework has several important implications for suicide research, theory, and clinical practice. First, the ideation-to-action framework encourages researchers to examine whether risk factors for suicide predict suicide attempts over and above their relationship with suicide ideation. For example, researchers are encouraged to directly compare differences between suicide attempters and suicide ideators, rather than suicide attempters and non-attempters. Second, theorists are encouraged to integrate empirical findings into theoretical models that provide separate explanations for the development of suicide ideation and suicide attempts. Although recent theories of suicide since Joiner's IPTS (2005) have been

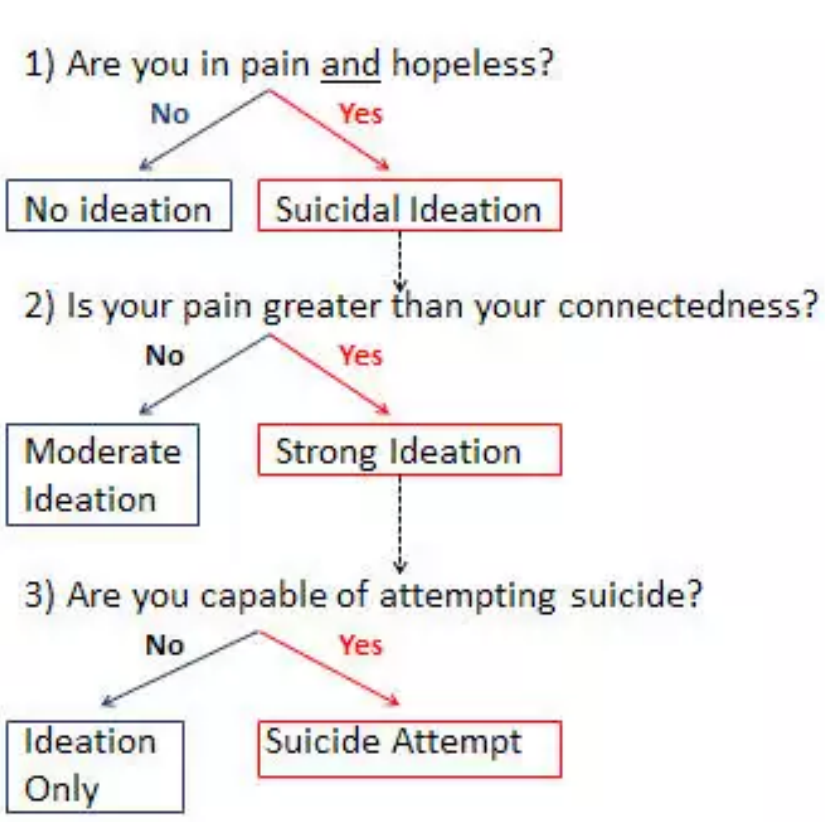
grounded in the ideation-to-action perspective (e.g., O'Connor's Integrated Motivational-Volitional Model of Suicide Behaviour [IMV; 2011], Klonsky & May's Three-Step Theory [3ST; 2015]), previous theories of suicide (e.g., Wenzel and Beck's Cognitive Model of Suicidal Behaviour [2008], Shneidman's Psychache Theory [1993], and Baumeister's Aversive-Self Awareness Theory [1990]) have yet to provide separate explanations for the development of suicide ideation and the progression from suicide ideation to suicide attempts. Third, lists of risk factors should distinguish between factors that increase the risk for suicide ideation and those that increase the risk for progression from suicide ideation to suicide attempts. Fourth, intervention and prevention programs should specify and distinguish among mechanisms designed to reduce the intensity of suicide ideation, the progression from suicide ideation to suicide attempts, or both.

Since the publication of Joiner's (2005) theory, other perspectives have been published that offer separate explanations for suicide ideation and suicide attempts. Two recent ideation-to-action perspectives are the Three-Step Theory (3ST; Klonsky & May, 2015) and the Neurocognitive Model of Suicidal Behaviour (NCM; Jollant, Lawrence, Olié, Guillaume, & Courtet, 2011). Both approaches provide separate explanations for the development of suicidal ideation and the progression from suicidal ideation to suicide attempts and are informed by the latest research. However, these were developed in parallel, highlight different factors, and the extent to which the two perspectives complement or contradict one another has yet to be empirically examined. The following sections review these two perspectives separately, which comprise the focus of this dissertation.

1.5 The Three Step Theory (3ST)

Klonsky and May's Three-Step Theory (3ST; 2015) is positioned within the ideation-to-action framework and provides separate explanations for (1) the development of suicidal ideation, (2) the intensification of suicidal ideation, and (3) the progression from strong suicidal ideation to suicide attempts. The 3ST explains the development of each of these steps by incorporating contributions from four longstanding theoretical variables for suicide: (a) pain, (b) hopelessness, (c) connectedness, and (d) suicide capability. The relationships of these variables to suicide ideation and suicide attempts are outlined in Figure 2 and discussed in detail in the paragraphs below.

Figure 2. The Three-Step Theory of Suicide (3ST)



The first step of the 3ST addresses development of suicide ideation. The 3ST suggests that suicide ideation emerges only when a person experiences *both* pain and hopelessness. Pain is broadly defined by the 3ST and can refer to a variety of emotional and physical factors (e.g., loneliness [Koivumaa-Honkanen et al., 2001], defeat and entrapment [O'Connor, 2011], and medical illness [Juurlink, Herrmann, Szalai, Kopp, & Redelmeier, 2004]) which are experienced as aversive. Consistent with the principles of behavioural conditioning, the 3ST posits that individuals experiencing pain are likely to search for ways to diminish their pain. Individuals experiencing pain who believe that their situation is likely to improve are *unlikely* to experience suicide ideation, presumably because they have hope their situation will improve. However, individuals experiencing pain plus hopelessness about the possibility of reducing their pain are likely to experience suicide ideation. The 3ST therefore hypothesizes that the *combination* of pain and hopelessness is required for the development of suicide ideation.

The second step of the 3ST addresses the intensification of suicide ideation. Specifically, once suicide ideation has developed, the 3ST posits that the intensity of suicide ideation depends on the extent to which an individual's sense of connectedness counterbalances their pain. In short, pain (when combined with hopelessness) causes the desire to die, whereas connectedness causes desire to live. Connectedness can refer to a variety of factors, including an individual's attachment to others in their life, a role, project, interest, or any aspect of their life that provides them with a sense of meaning and purpose. The 3ST therefore uses a broad definition of connectedness that would include constructs posited by other theories of suicide (e.g., IPTS [Joiner, 2005]: [high] belongingness and [low] burdensomeness, IMV [O'Connor, 2011]: social support) and suggests that connectedness prevents suicide ideation from intensifying to strong suicide ideation, *as long as connectedness outweighs pain*. An example of this might be an

individual whose day-to-day experience is both painful and unrelenting, but who is also invested in their relationship with their partner and finds that it provides them with a sense of meaning. As long as the individual's connection and sense of meaning exceeds their pain, the 3ST posits that their suicide ideation would remain largely passive and not intensify beyond a moderate desire to die. However, if the individual's pain exceeds or overwhelms their sense of connection to their partner, the 3ST posits that the individual's suicide ideation would intensify, representing a strong desire to die.

The third step of the 3ST addresses the progression of strong suicide ideation to suicide attempts. Consistent with Joiner's IPTS (2005), the 3ST assumes that people are biologically predisposed to avoid pain, injury, and death, and are therefore fearful of attempting suicide. The 3ST also posits that the key determinant of whether an individual will attempt suicide is whether they have the capability to attempt suicide, which is subdivided by the 3ST into three categories of factors: acquired, dispositional, and practical. *Acquired* factors refer to the same variables subsumed under Joiner's (2005) acquired capability construct (Van Orden et al., 2010). Specifically, acquired capability suggests that fear of suicide can be reduced through exposure to painful and provocative experiences (e.g., child maltreatment, combat exposure) as well as by engaging in self-harming behaviours (e.g., NSSI, attempting suicide). These "acquired" experiences are thought to habituate the individual to the fear of attempting suicide and are therefore thought to increase an individual's capability for attempting suicide. *Dispositional* factors refer to variables that are largely determined by genetics, such as pain sensitivity (Young et al., 2012) and blood phobia (Czajkowski et al., 2011) that either increase or decrease a person's fear of attempting suicide. For example, an individual with low pain sensitivity is likely to be less fearful of experiencing the pain involved in attempting suicide. In contrast, an

individual who is fearful of blood is likely to be more fearful of attempting suicide if the method of suicide involves the possibility of being exposed to blood. The 3ST would therefore categorize these individuals as having a greater and diminished capability for suicide, respectively, based on the presence of these dispositional factors. *Practical* factors refer to variables that make attempting suicide easier than it would otherwise be. These can include knowledge about acquiring and using lethal means as well as reducing the pain anticipated in attempting suicide. For example, someone with knowledge about potentially lethal medications (e.g., type, dosage, interactions) is thought to have greater practical capability for attempting suicide than someone who lacks this specialized knowledge. Similarly, someone with immediate and easy access to potentially lethal means (e.g., a firearm) is thought to be at greater risk for attempting suicide compared with someone without access to lethal means. A central assumption of the 3ST, therefore, is that active thoughts of suicide are likely to result in a suicide attempt only when the fear of attempting suicide has been reduced to an acceptable threshold for an individual, a process determined by the presence of dispositional, acquired, and practical factors.

1.5.1 Support for the 3ST

To date, several studies have provided support for the predictions made by the 3ST. For example, findings from studies examining people's motivations for attempting suicide (May, 2016; May & Klonsky, 2013; May, O'Brien, Liu, & Klonsky, 2016) suggest that psychological pain (i.e., psychache) and hopelessness are the most frequently endorsed motivations for attempting suicide among suicide attempters. Specifically, psychache and hopelessness were rated as important motivations for suicide by at least 90% of participants across five samples, including undergraduate students (*n*=66), psychiatric inpatients (*n*=59), psychiatric outpatients (*n*=53), adolescents (*n*=50), and online participants (*n*=222; May, 2016; May & Klonsky, 2013;

May, O'Brien, Liu, & Klonsky, 2016). Furthermore, support for these findings was obtained in a study conducted by Wintersteen (2014), who examined the factors that were different in the days, hours, and minutes prior to fatal and nonfatal suicide attempts. Of the 42 variables examined, Wintersteen (2014) observed that psychological psychache and hopelessness were the most commonly endorsed factors across both samples.

In addition to the aforementioned studies, the specific hypotheses made by the 3ST have been directly tested in four samples: 910 participants in the United States recruited from Amazon's Mechanical Turk (MTurk; Klonsky & May, 2015), 665 undergraduate university students from the United Kingdom (Dhingra et al., 2019), 1,097 university students from China (Yang et al., 2019), 190 psychiatric inpatients from western Canada (Tsai et al., 2020), and 487 community adults (Pachkowski et al., 2021). As previously stated, step 1 of the 3ST states that suicide ideation emerges as a result of experiencing *both* psychache and hopelessness. Results from these five studies (presented in chronological order: Klonsky & May, 2015, Dhingra et al., 2019, Yang et al., 2019, Tsai et al., 2020, and Pachkowski et al., 2021, respectively) indicate that suicide desire was strongly correlated with both psychache (r=.55, r=.64, r=.33, r=.77, r=.64) and hopelessness (r=.57, r=.67, r=.30, r=.77, r=.63). When entered into the same model, psychache and hopelessness accounted for 11-64% of the variance in suicide desire and, importantly, their interaction accounted for an additional 1-4% of the variance not accounted for by the individual predictors. Subsequent analyses indicate that interaction between psychache and hopelessness remained reliable in samples restricted to men and women (Dhingra et al., 2019; Klonsky & May, 2015; Tsai et al., 2020; Yang et al., 2019), and within different age ranges (i.e., 18-25, 26-35, and 36-70 years of age [Klonsky & May, 2015], participants above

and below the age of 35 [Dhingra et al., 2019], and participants 18-32 and 33-73 years of age [Tsai et al., 2020]).

Four of the aforementioned studies (Dhingra et al., 2019; Klonsky & May, 2015; Tsai et al., 2020; Yang et al., 2019) also sought to evaluate whether the interactions of the constructs proposed by Joiner's IPTS (2005; i.e., thwarted belongingness [TB] and perceived burdensomeness [PB]) better predicted the development of suicide desire than the interaction between psychache and hopelessness proposed by the 3ST. In these studies, TB and PB interacted significantly to predict between 12-62% of the variance of suicide ideation. However, the variance accounted for by these factors ranged between 0-11% *less* than the amount of variance accounted for by the interaction of psychache and hopelessness (Dhingra et al., 2019; Klonsky & May, 2015; Tsai et al., 2020; Yang et al., 2019), suggesting that psychache and hopelessness might represent better predictors of suicide desire.

Tsai et al. (2020) and Pachkowski et al. (2021) further examined the longitudinal relationship of psychache and hopelessness to suicide desire. Their results indicate psychache predicted suicide desire at 4 weeks (r=.53; Tsai et al., 2020), 3 months (r=.51; Tsai et al., 2020) and 6 months (r=.51; Pachkowski et al., 2021), even when controlling for baseline suicide ideation (4 weeks: $r_{partial}$=.29; 3 months: $r_{partial}$=.38; and 6 months : $r_{partial}$=.20). Similar results were obtained for hopelessness at 4 weeks (r=.61), 3 months (r=.44), and 6 months (r=.56), including when controlling for baseline suicide ideation (4 weeks: $r_{partial}$=.44; 3 months: $r_{partial}$=.26; and 6 months : $r_{partial}$=.27). However, the interaction of psychache and hopelessness did not predict suicide ideation at 4 weeks (Tsai et al., 2020), 3 months (Tsai et al., 2020), or 6 months (Pachkowski et al., 2021).

The second hypothesis of the 3ST, namely that connectedness is protective against the escalation of suicide desire in individuals with high psychache and high hopelessness, was also examined. The same studies reported a modest-strong relationship between connectedness and suicidal ideation in the subgroup of participants with both high psychache and high hopelessness (r=-36, r=-.34, r=-.28, r=-.52, r=-.47 [among participants at Time 1] and r=.-44 [among participants at Time 2]). Connectedness scores were also found to predict suicide desire at 4 weeks (r=.42; Tsai et al., 2020), 3 months (r=.47; Tsai et al., 2020), and 6 months (r=-.50; Pachkowski et al., 2021).

To more directly test the conceptual claim of Step 2 of the 3ST and examine the extent to which a person's sense of connectedness outweighs their psychological pain (i.e., psychache), the five studies standardized participants' scores on measures assessing both these constructs and subtracted the standard scores for connectedness from the standard scores for psychache. Positive scores therefore indicate that a person's standardized psychache score exceeds their standardized connectedness score. Conversely, a negative score indicates that a person's standardized connectedness score exceeds their standardized psychache score. Across studies, the psychache-connectedness difference score was moderately-strongly correlated to suicide desire in those with high pain and high hopelessness (r=.47, r=.46, r=.34, r=.64, r=.58 [among participants at Time 1] and r=.62 [among participants at Time 2]). The pain-connectedness difference score was also observed to predict suicide desire at 4 weeks (r=.51; Tsai et al., 2020), 3 months (r=.52; Tsai et al., 2020), and 6 months (r=.54; Pachkowski et al., 2021).

Four of the aforementioned studies (Dhingra et al., 2019; Klonsky & May, 2015; Tsai et al., 2020; Yang et al., 2019) tested the third hypothesis of the 3ST, namely whether capability for suicide distinguishes between individuals with a lifetime history of suicide attempts (suicide

attempters) from individuals with a lifetime history of suicide ideation but no history of attempts (suicide ideators). Across studies, total scores on a six-item measure of capability for suicide (the Suicide Capacity Scale [SCS-3; Klonsky & May, 2015]) differentiated suicide attempters from suicide ideators, with small-moderate effect sizes reported (*d*=0.42, Klonsky & May, 2015; *d*=0.72, Dhingra et al. 2019; *d*=0.52, Yang et al., 2019; and *d*=0.47, Tsai et al. 2020). Subsequent analyses in three of the four studies (Dhingra et al., 2019; Klonsky & May, 2015; Yang et al., 2019) examined the extent to which subscale scores on three facets of capability for suicide (i.e., acquired, dispositional, and practical capabilities, all measured using the SCS-3) differentiated suicide attempters from suicide ideators. Results from these analyses suggest that effect size differences on these measures ranged from negligible to large: acquired (*d*=0.38, Klonsky & May, 2015; *d*=0.48, Dhingra et al., 2019; reported as nonsignificant, Yang et al., 2019), dispositional (*d*=0.29, Klonsky & May, 2015; *d*=0.29, Dhingra et al., 2019; reported as nonsignificant, Yang et al., 2019), practical (*d*=0.23, Klonsky & May, 2015; *d*=0.87, Dhingra et al., 2019; *d*=0.56, Yang et al., 2019). A series of logistic regression and point-biserial correlational analyses revealed that capability for suicide remained predictive of lifetime history of suicide attempts vs. lifetime history of suicide ideation, even after controlling for current suicide desire, in two studies (Klonsky & May, 2015; Dhingra et al., 2019) but not in one study (Yang et al. 2019). Furthermore, while Klonsky and May (2015) reported that all facets of capability predicted lifetime suicide attempts over and above current suicide desire, Dhingra et al., (2019) reported that only acquired and practical capability predicted lifetime history of suicide attempts. Yang et al., (2019) reported that only practical capability predicted lifetime history of suicide attempts over and above current suicide desire, as did Tsai et al. (2020) who reported that only practical capability significantly predicted lifetime history of suicide attempts

(vs. no history of suicide attempts), even after separately controlling for the presence of lifetime suicide ideation and recent suicide desire. Taken together, the findings from these studies provide support for the hypotheses generated by the 3ST.

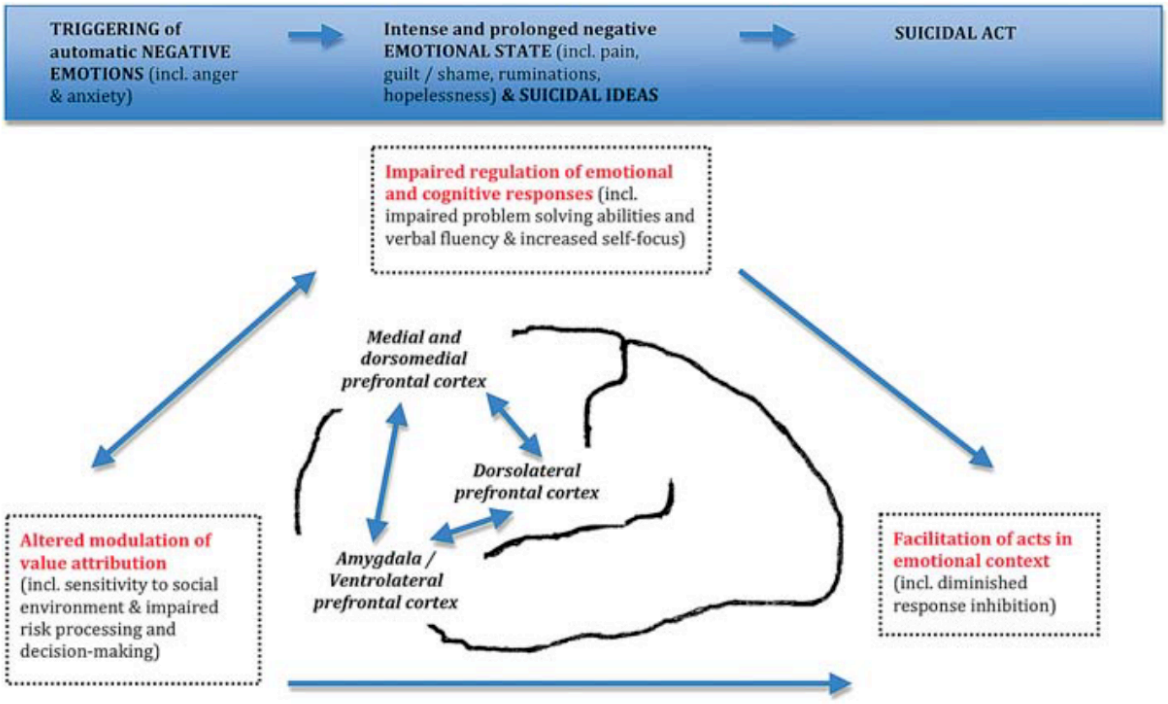
1.6 The Neurocognitive Model of Suicidal Behaviour (NCM)

Neurocognitive abilities represent an umbrella term for cognitive functions that support the production of perception, thought, action, and emotion, and are thought to be closely related to specific neural pathways and networks in the brain (Lichtenberger & Kaufman, 2009). Results from early neurocognitive studies observed that individuals with "high suicidality" exhibited distorted cognitions (Shneidman, 1961), rigid and dichotomous thinking patterns (Neuringer, 1961, 1964), and impaired problem-solving abilities (Levenson & Neuringer, 1971). Support for these findings was later provided by results obtained from more recent neuroimaging studies, suggesting that suicide attempters exhibit alterations in neural functioning within cortical regions implicated in maintaining the aforementioned neurocognitive abilities, particularly within the ventrolateral, orbitofrontal, dorsomedial, and dorsolateral regions of the prefrontal cortex (PFC; Jollant et al., 2008, 2010). Indeed, a review of the neurocognitive and neuroimaging studies states that: "These studies support the concept of alterations in suicidal behaviour distinct from those of comorbid disorders" (Jollant et al., 2011, p. 319).

In reviewing the results from neurocognitive and neuroimaging studies conducted with suicidal populations, Jollant et al. (2011) were the first to develop a neurocognitive theory to explain suicidal behaviour, which they titled the Neurocognitive Model of Suicidal Behaviour (NCM). According to Jollant et al. (2011), the goal of the model is to synthesize information from individual neurocognitive and neuroimaging studies to explain (1) the emergence of automatic negative emotions, (2) the intensifying of negative emotions to produce suicidal

ideation, and (3) the facilitation of suicidal acts among those with increased suicidal ideation. The NCM therefore incorporates the ideation-to-action framework in providing separate explanations for the development of suicidal ideation and the progression from suicidal thoughts to suicidal acts. The central tenets of the NCM are presented in Figure 3 and will be reviewed in the paragraphs below.

Figure 3. The Neurocognitive Model of Suicidal Behaviour (NCM)



The first hypothesis made by the NCM is that suicide attempters exhibit altered neural functioning in several regions of the PFC, which results in them paying more attention to signs of social rejection, making poorer decisions, and experiencing more negative emotions, such as depression, anxiety, and stress (Jollant et al., 2011). This hypothesis is based primarily on results from neuroimaging and neurocognitive studies suggesting that (1) suicide attempters exhibit greater neural activation within the ventrolateral PFC when presented with angry, but not happy,

faces (Jollant et al., 2008) and (2) that suicide attempters appear to pay more attention to words evoking defeat on a modified version of the Stroop task compared with non-attempters (Becker et al., 1999). Similarly, results from other studies have suggested that suicide attempters demonstrate a deficit in neural activation in the lateral orbitofrontal cortex when presented with risky vs. safe decision-making scenarios (Jollant et al., 2010), the same cortical regions that differed most among suicide decedents compared to individuals who did not die by suicide (Mann et al., 2000). The NCM posits that some of these alterations in neural functioning might represent trait-like characteristics that negatively interact with the environment to predispose suicide attempters to experience negative emotions.

The second hypothesis made by the NCM is that suicide attempters experience greater difficulty regulating emotional and cognitive processes, which results in intense and active suicidal ideation. Since no neuroimaging or neuroscientific study has directly examined differences in emotion regulation among suicide attempters and non-attempters, the NCM relies on indirect findings from studies suggesting that polymorphisms associated with suicidal behaviour (Pezawas et al., 2005) are implicated in the mediodorsal and anterior cingulate cortex; cortical regions implicated in emotional regulation (Phillips, Ladouceur, & Drevets, 2008) and in experiencing psychological pain (Mee et al., 2006). In contrast, differences in cognitive processes have been directly examined in suicidal populations, and results from these studies suggest that suicide attempters exhibit more impaired problem-solving abilities, particularly in emotional situations (Pollock & Williams, 2004), and that difficulties problem solving mediate the relationship between stress and suicidal ideation (Grover et al., 2009). The NCM therefore assumes that individuals experiencing difficulties regulating their emotions and solving problems

will be more likely to think of suicide as a solution to their problems, thereby intensifying thoughts of suicide.

The third hypothesis made by the NCM is that poor impulse control and impulsivity facilitate suicide attempts among individuals with heightened suicidal ideation. The NCM recognizes the important distinction between suicidal thoughts and suicidal acts but acknowledges that, to date, no neuroimaging studies have directly examined differences in impulsivity between these two populations. Rather, support for this hypothesis comes from indirect results documenting higher suicide attempt rates in individuals diagnosed with disorders characterized by poor impulse control (e.g., bipolar disorders, substance use disorders; Nock, Hwang, Sampson, & Kessler, 2010). The NCM therefore calls for further research to test this hypothesis and encourages neuroimaging studies to compare differences in impulsivity between suicide attempters and suicide ideators.

1.6.1 Support for the NCM

To date, no study has directly examined the hypotheses made by the NCM . However, numerous studies have examined differences in neurocognitive abilities between suicide attempters and non-attempters. For example, Richard-Devantoy, Berlim, and Jollant (2014) conducted a meta-analysis examining differences in executive functions, neurocognitive abilities responsible for purposeful and goal-directed behaviours (Strauss et al., 2006), between suicide attempters and non-attempters (i.e., patient- and healthy-controls). In reviewing results from 25 studies, Richard-Devantoy et al. (2014) reported that suicide attempters exhibited worse performance than both patient- and healthy-controls on several measures of executive functions, including the Iowa Gambling Task (IGT; Hedges' g=-0.47 and g=-0.65, respectively), Categorical Verbal Fluency (Animals; g=-0.32 and g=-0.67, respectively), and the Stroop task

(*g*=0.37 and *g*=0.91, respectively). In contrast, negligible differences were observed between suicide attempters and patient controls on the Trail Making Test, Part B (TMT_B; *g*=-0.13), Phonemic Verbal Fluency (FAS; *g*=-0.10), the Wisconsin Card Sorting Test (WCST; *g*=0.02), and the Continuous Performance Task (CPT; *g*=0.14). A more recent meta-analysis of 21 studies examining differences on the IGT reported a small effect size difference between suicide attempters and patient controls (*g*=-0.28, .95CI[-0.44 to -0.12]) and suicide attempters and healthy controls (*g*=-0.54, .95CI[-0.83 to -0.25]). Similarly, a systematic qualitative review of 43 studies (Bredemeier & Miller, 2015) concluded that impairments in executive functions were associated with a history of suicide attempts, and that these deficits are not fully accounted for by psychiatric disorders and psychological distress.

Results from meta-analytic studies examining neurocognitive abilities other than executive functions (e.g., memory, attention) appear mixed and largely inconclusive. For example, Richard-Devantoy et al. (2015) conducted a meta-analysis of studies comparing memory differences between suicide attempters, patient-, and healthy controls. In reviewing data from 24 individual studies, Richard-Devantoy et al. (2015) reported that suicide attempters performed worse than healthy controls on measures of short-term (*g*=-0.30), long term (*g*=-0.40), and working memory (*g*=-0.40). However, minimal differences were obtained comparing suicide attempters to patient controls, with suicide attempters performing equally on measures of short-term (*g*=0.09) and long-term memory (*g*=-0.07), and *better* on measures of working memory (*g*=0.20). Similarly, a separate meta-analysis of a small number of studies (*n*=4) conducted by Richard-Devantoy et al. (2016) examined attentional differences between suicide attempters and patient-controls. The meta-analysis obtained a small and negligible effect size difference (*g*=0.22

and *g*=0.06, respectively) comparing attempters to patient controls on attention spent on suicide and negatively valenced words, respectively.

Taken together, these meta-analytic findings suggest that some measures of executive functions (i.e., the IGT, Animals, and Stroop) appear to consistently differentiate suicide attempters from patient controls, while others (e.g., TMT_B, FAS, WCST, and CPT) do not (Richard-Devantoy, Berlim, et al., 2014). Conversely, differences in memory appear to be more closely related to a history of psychopathology rather than a history of suicide attempts (Richard-Devantoy et al., 2015) and results from a small number of studies suggest that suicide attempters may pay more attention to suicide-specific words but not to negatively-valenced words (Richard-Devantoy et al., 2016). Overall, these findings encourage further research, but their contribution to the existing literature is limited since they do not directly compare neurocognitive differences between suicide attempters and suicide ideators. As a result, any observable differences between suicide attempters and non-attempters could be the result of a history of suicide ideation, suicide attempts, or both.

To address this need, Saffer and Klonsky (2018) systematically reviewed all the studies examining any neurocognitive differences between suicide ideators and suicide attempters. Although a total of 159 studies were identified as using one or more neurocognitive measures with individuals with a history of suicide attempts, only 14 studies directly compared suicide attempters to suicide ideators. Combining the results from these studies revealed mostly negligible to small effect sizes differences across a range of neurocognitive abilities, including attention (median *Hedges' g*=-0.17), memory (*g*=-0.19), processing speed (*g*=0.20), intelligence (*g*=-0.02), and global cognitive functioning (*g*=-0.14). In contrast, medium effect size differences were observed between suicide attempters and suicide ideators on two subcomponents of

executive functions, namely inhibition (*g*=-0.50) and decision making (*g*=-0.49), suggesting that these abilities might be implicated in the progression from suicidal thoughts to suicidal acts. These findings provide initial support to the conclusions made by Jollant et al. (2011), and suggest that executive functions might be uniquely implicated in differentiating suicide ideators from suicide attempters. However, these findings should be considered tentative, given the small number of studies identified and the individual limitations of the studies included in the systematic review.

1.7 The Present Study

Despite a century of scientific inquiry, suicide remains a global public health problem. Developments in suicide research and theory over the past 15 years have emphasized the need for using an ideation-to-action framework to better understand the development of suicidal thoughts and the progression from suicidal thoughts to suicidal acts. An increasing number of studies have implemented an ideation-to-action framework in their research, included to test the predictions made by recent theories of suicide (e.g., Joiner's IPTS). However, the majority of these studies examine the predictions made by a single theory, with few, if any, studies comparing predictions across theories. Furthermore, despite their differences, the aforementioned theories of suicide focus exclusively on psychological factors (e.g., thwarted belongingness, hopelessness, loneliness, sense of entrapment, defeat) to explain the development of suicide ideation and the progression to suicide attempts. To our knowledge, no research has directly examined the extent to which the psychological factors included in these theories compare with non-psychological factors associated with suicide (Turecki, 2014; Turecki et al., 2012), such as genetic polymorphisms (Voracek & Loibl, 2007), brain abnormalities (Grangeon et al., 2010), or neurocognitive abilities (Jollant et al., 2011). The purpose of the present study was therefore to empirically test the predictions made by two ideation-to-action perspectives; one focused on psychological variables (i.e., Klonsky and May's [2015] Three-Step Theory [3ST]) and one incorporating neurocognitive variables (i.e., Jollant et al.'s [2011] Neurocognitive Model of Suicidal Behaviour [NCM]). The present study was designed to test the individual hypotheses made by each perspective as well as compare the factors posited by each theory against one another in predicting the development of suicide ideation and the progression to suicide attempts.

Chapter 2: Methods

2.1 Participants

A total of 1,154 participants were recruited for the present study between January 2016 and April 2019. To ensure the accuracy of participant responses, the study embedded a total of 13 attention-checking questions (e.g., "I have won more than two Nobel prizes") in the study questionnaires. A total of 110 participants incorrectly answered one or more attention checking questions (*M*=1.45, *SD*=1.37, *range* = 1-9). Participants with one or more invalid responses were removed from analyses. Furthermore, scores on the Behaviour Rating Inventory of Executive Functions – Adult (BRIEF-A) Infrequency and Inconsistency validity scales were also used to identify invalid responses. The BRIEF-A Infrequency scale is designed to measure the extent to which participants endorse rarely endorsed items (e.g., "I often forget my name", "I often have trouble counting to three"), even in clinical samples with severe cognitive impairments. The BRIEF-A Inconsistency scale is designed to measure the extent to which participants inconsistently endorse similar items (e.g., "I make careless errors when completing tasks" and "I make careless mistakes"). An additional 30 participants were identified by the BRIEF-A Infrequency and Inconsistency validity scales and were removed from further analyses. After removing all participants with invalid responses, a total of 1,014 participants were included in the analyses.

2.1.1 Demographic Characteristics

Demographic characteristics for the 1,014 participants included in the study analyses are outlined in Table 1.

Table 1. Demographic Characteristics (*n*=1,014)

	Mean (SD)
Age	20.95 (2.96)
	n (% sample)
Sex	
Female	798 (78.7%)
Male	206 (20.3%)
Other	10 (1.0%)
Ethnicity	
African	9 (0.9%)
East Asian	484 (48.6%)
European (Caucasian)	284 (28.0%)
Indian-South Asian	97 (9.6%)
Latin American-Hispanic	19 (1.9%)
Middle Eastern	33 (3.3%)
Native American	3 (0.3%)
Other	85 (8.4%)
English as a primary language	661 (65.2%)
Sexual orientation	
Straight (Heterosexual)	840 (82.8%)
Bisexual	94 (9.3%)
Gay (Homosexual)	28 (2.8%)
Questioning	32 (3.2%)
Other	20 (2.0%)
Marital status	
Single	923 (91.0%)
Married/Common-law	40 (3.9%)
Divorced/Separated	5 (0.5%)
Other	46 (4.5%)
Educational attainment	
Some high school	7 (0.7%)
High school graduate/GED	138 (13.6%)
Some college or university	782 (77.1%)
College or university graduate	77 (7.6%)
Some graduate or professional school after college	3 (0.3%)
Master's degree	7 (0.7%)

	n (% sample)
Work hours (outside of university)	
1 - 9 hours	194 (39.6%)
10 - 19 hours	220 (21.7%)
20 - 29 hours	56 (5.5%)
30 - 39 hours	15 (1.5%)
40 - 49 hours	4 (0.4%)
More than 80 hours	1 (0.1%)
Household net income (annual)	
Less than $5,000	121 (19.1%)
$5,000 - $9,999	49 (4.8%)
$10,000 - $19,999	58 (5.7%)
$20,000 - $29,999	50 (4.9%)
$30,000 - $39,999	33 (3.3%)
$40,000 - $49,999	43 (4.2%)
$50,000 - $59,000	58 (5.7%)
$60,000 - $74,999	83 (8.2%)
$75,000 - $99,999	86 (8.5%)
More than $100,000	176 (17.4%)
Do not wish to answer	257 (25.3%)

Participants were approximately 21 years of age (M_{age}=20.95, *SD*=2.96), female (78.7%), and primarily of East-Asian (48.6%) European/Caucasian (28.0%), and Indian/South-Asian (9.6%) descent. More than half the participants reported English as their primary language (65.2%), identified their sexual orientation as heterosexual (82.8%), and their marital status as single (91.0%). Most participants reported having completed some college or university as their highest educational attainment (77.1%) and working 1-9 and 10-19 hours per week outside of their education (39.6% and 21.7%), respectively. A quarter of participants declined reporting their annual household income (25.3%). Of the remaining participants, most reported a household income of either less than $5,000 (19.1%) or more than $100,000 (17.4%).

2.1.2 History of Suicide Ideation and Suicide Attempts

Participants were categorized according to lifetime histories of suicide ideation and suicide attempts. Of the 1,014 participants, 485 (47.8%) reported no lifetime history of suicide ideation or suicide attempts (nonsuicidal participants), 379 (37.4%) reported a history of suicide ideation but no history of suicide attempts (suicide ideators), and 150 (14.8%) reported a history of suicide ideation and suicide attempts (suicide attempters). The present study intentionally oversampled for participants with a history of suicide ideation and suicide attempts (described in the Procedure section), which resulted in a greater proportion of both suicide ideators and suicide attempters that are found in typical samples of university students (28.4% lifetime ideators and 4.3% lifetime attempters; Bruffaerts et al., 2019).

2.2 Measures

Study measures are organized in four categories: (1) Demographic Information, (2) Suicide Measures, (3) 3ST Measures, and (4) NCM Measures. Measures are listed alphabetically within each category. Table 2 outlines the measure and scores used to assess each construct.

Table 2. Measures Used to Assess Study Constructs

Perspective / Outcome	Construct	Measure
Suicide Ideation and Attempts	Current suicide ideation	Beck Scale for Suicidal Ideation – 5 Item Version (BSS-5)
	Lifetime suicide ideation	Youth Risk Behaviour Survey (YRBS) – Question 1
	Lifetime suicide attempts	Youth Risk Behaviour Survey (YRBS) – Question 3
Three-Step Theory (3ST)	Hopelessness (Step 1)	Beck Hopelessness Scale – Short Form (BHS-SF)
	Pain (Step 1 and 2)	Unbearable Psychache Scale (UP3)
	Connectedness (Step 2)	Interpersonal Needs Questionnaire – Thwarted Belongingness Subscale (INQ-TB) – Reverse scored
	Capability for suicide (Step 3)	Suicide Capacity Scale (SCS-3)
Neurocognitive Model of Suicidal Behaviours (NCM)	Decision Making (Step 1)	Iowa Gambling Task (IGT)
	Negative Affect (Step 1 and 2)	Depression Anxiety and Stress Scale – 21 Item Version (DASS-21)
	Perceived social rejection (Step 1)	Brief Fear of Negative Evaluation (BFNES)
		Interpersonal Needs Questionnaire – Thwarted Belongingness Subscale (INQ-TB)
	Emotion Dysregulation (Step 2)	Difficulties in Emotion Regulation Scale – 18 Item Version (DERS-18)

Problem Solving (Step 2)	Tower of London Task (TOL)
Impulsivity (Step 3)	Behaviour Rating-Inventory of Executive Function – Adult (BRIEF-A) – Inhibition Subscale
	Difficulties in Emotion Regulation Scale – 18 Item Version (DERS-18) – Impulse Subscale
	Flanker Task (FT)
	Frontal Systems Behaviour Scale (FrSBe) – Disinhibition Subscale
	UPPS Impulsive Behaviour Scale – 16 Item Version (UPPS-16)
	Victoria Stroop Task (VST)

2.2.1 Demographic Information

Demographic information was collected using a questionnaire developed by our lab (the Personality, Emotion, and Behaviour Laboratory). The questionnaire includes a total of 12 items and asks participant to report their age, gender, ethnicity, primary language, sexual orientation, and marital status. The questionnaire also includes items asking participants to report their highest level of education, occupation, yearly household income, occupation, weekly working hours, and number of people residing in the participant's household.

2.2.2 Suicide Measures

2.2.2.1 Beck Scale for Suicidal Ideation – 5 Item Version (BSS-5)

Suicide ideation was measured using the Beck Scale for Suicidal Ideation (BSS; Beck et al., 1988; Beck & Steer, 1991), a 19-item self-report measure adapted from the Scale for Suicidal Ideation (SSI; Beck, Kovacs, & Weissman, 1979). To complete the BSS, participants are asked to select the statement that best describes how they've been feeling. For example, Item 1 of the BSS presents participants with three statements: (0) "I have no desire to kill myself", (1) "I have a weak desire to kill myself" or (2) "I have a moderate to strong desire to kill myself". A total composite score is calculated by summing the numeric values of the endorsed statements. Total scores on the BSS range from 0 to 38, with greater scores indicating greater suicide ideation.

Studies using the BSS have reported that the internal consistency reliability of the BSS ranged from α=.84-.97 in samples of university students (Holden & DeLisle, 2005; Witte et al., 2006) as well as psychiatric inpatients and outpatients (Beck et al., 1988; Pinninti et al., 2002; Steer et al., 1993). Test-retest reliability of the computer-administered version of the BSS was reported as r=.54 (Steer & Beck, 1989) and scores on the BSS have been reported to correlate with measures assessing pessimism and suicide ideation (Beck Depression Inventory [BDI]

items 2 and 9; *r*=.52; Steer, Rissmiller, et al., 1993), hopelessness (BHS; *r*=.63; Steer, Rissmiller, et al., 1993), and suicide intent (*r*=.54; Holden & DeLisle, 2005).

For this study, suicide desire (as opposed to other forms of suicide ideation) was measured using the first five items of the BSS (i.e., the BSS-5). A score of 0 on the BSS-5 was assigned to participants who reported no lifetime history of suicide ideation (using item 1 of the YRBS) since they were not administered the BSS, as per the study protocol. Results from factor analytic studies (Beck et al., 1979, 1997; Dhingra et al., 2019) suggest that the BSS is composed of separate factors, and has consistently distinguished a suicide desire factor from other forms of suicide ideation (e.g., courage to attempt suicide, suicide plans and preparations) that are relevant to Step 3 of the 3ST. The BSS-5 items measure a participant's wish to live, wish to die, their reasons for living and dying, desire to attempt suicide, and passive suicide desire. Studies using the BSS-5 (Shahnaz et al., 2018) reported high internal consistency reliability (α=.86).

In this study, the internal consistency reliability of the BSS was α=.85.

2.2.2.2 Youth Risk Behaviour Survey (YRBS) Suicide Screening Questionnaire

History of suicide ideation and suicide attempts was measured using 10 questions from the Youth Risk Behaviour Survey (YRBS; Grunbaum et al., 2002; Kolbe, Kann, & Collins, 1993), a large-scale survey administered in the United States by the Centre for Disease Control (CDC). The YRBS is administered semi-annually to adolescents in grades 9-12 in the U.S. and measures 6 categories of health risk behaviours: (1) Behaviours that contribute to unintentional injuries, (2) Behaviours that contribute to violence, (3) Tobacco use, (4) Alcohol and other drug use, (5) Sexual behaviours that contribute to unintended pregnancy and sexually-transmitted diseases, and (6) Sadness, suicide ideation, and suicide attempts.

History of lifetime suicide ideation and suicide attempts was measured using the items: "Have you ever seriously thought about killing yourself" (item 1) and "Have you ever tried to kill yourself" (item 3), respectively. Participants respond to each item by selecting either "Yes" or "No". Recent history of suicide ideation and suicide attempts was measured using the items: "During the past 12-months, did you ever seriously consider attempting suicide?" (item 7) and "During the past 12-months, how many times did you actually attempt suicide?" (item 9), respectively. Participants select either "Yes" or No" for the recent suicide ideation question and use a scale ranging from 1 (*0 times*) to 5 (*6 or more times*) to indicate the number of recent suicide attempts for the recent suicide attempt question. Additional items include two items assessing lifetime and recent histories of suicide plans (starting with "Have you ever…" and "During the past 12 months, did you…" followed by "…made/make a plan about how you would kill yourself?"), two items assessing the medical severity of the suicide attempt (starting with "If you ever attempted suicide…" and "If you attempted suicide during the past 12 months,…" followed by "… did any attempt result in an injury, poisoning, or overdose that had to be treated by a doctor or nurse?"), a question assessing the lifetime frequency of suicide attempts ("How many times have you actually tried to kill yourself?"), and a question about the impulsivity of the attempt ("During your most recent suicide attempt, how much time passed between the time you decided to attempt suicide and when you actually attempted?"). Response options include selecting "Yes" or "No" for the questions asking about suicide plans and the medical severity of the suicide attempt. A Likert scale ranging from 1 (*0 times*) to 5 (*6 or more times*) is used to respond to the question asking about lifetime suicide attempts, and a similar Likert scale ranging from 1 (*Less than five minutes*) to 4 (*More than one day*) is used to respond to the question about the perceived impulsiveness of the attempt.

Studies examining the psychometric properties of the YRBS items have reported Kappa values (statistical values indicating level of agreement that would occur after correcting for chance) of 74.3% for recent suicide attempts, 66.6% for recent suicide plans, 72.7% for ≥1 recent suicide attempts, and 52.3% for medically severe suicide attempts (Brener et al., 2002). Furthermore, YRBS questions for lifetime and recent suicide ideation and suicide attempts have been reported to correlate with conceptually similar questions included in other self-report measures (e.g., the Patient Health Questionnaire for Adolescents [Kroenke & Spitzer, 2002] and the McLean Screening Instrument for Borderline Personality Disorder [MSI-BPD; Zanarini et al., 2003]) assessing suicide ideation and self-harming behaviours (*r* range=0.44-0.71; May & Klonsky, 2011).

2.2.3 3ST Measures

2.2.3.1 Beck Hopelessness Scale-Short Form (BHS-SF)

Hopelessness was measured using the 4-item Beck Hopelessness Scale-Short Form (BHS-SF; Aish, Wasserman, & Renberg, 2001), an abbreviated version of the Beck Hopelessness Scale (BHS; Beck, Weissman, et al., 1974). The BHS-SF asks participants to report their perceived levels of hopelessness during the past week by rating each item as either "True" or "False". "True" responses are scored as 1 and "False" responses are scored as 0. Items 1 and 4 are reverse-worded and therefore need to be reverse-scored. A total score ranging from 1 to 4 is calculated from summing all four items, with greater scores indicating greater hopelessness.

The BHS-SF was factor-analtically derived (Aish et al., 2001) and scores on the BHS-SF have been reported to correlate with scores on the full 20-item BHS (*r*=.88; Yip & Cheung, 2006). Scores on the BHS-SF have been reported to closely resemble those obtained using the

20-item BHS in predicting suicide ideation (BHS-SF Area Under the Curve [*AUC*]=.70 and BHS *AUC*=.77) and suicide attempts (BHS-SF *AUC*=.72 and BHS *AUC*=.75).

In this study, the internal consistency reliability of the BHS-SF was α=.77.

2.2.3.2 Interpersonal Needs Questionnaire (INQ-10)

The 10-item version of the Interpersonal Needs Questionnaire (INQ; Bryan, 2011; Hill et al., 2015; Van Orden et al., 2008) was used to assess participants' sense perceived burdensomeness (PB; the degree to which individuals believe they are a burden to others) and thwarted belongingness (TB; the degree to which individuals feel connected to others). Participants answer each item using a 7-point Likert scale ranging from 1 (*Not at all true for me*) to 7 (*Very true for me*). Scores on the 10 items are summed separately to create two composite scores, one for TB (using 5 items) and another for PB (using the remaining 5 items). Consistent with Klonsky and May's (2015) 3ST publication, the TB composite scores were used to measure participant's sense of connectedness.

Studies examining the psychometric properties of the 10-item version of the INQ have replicated its two-factor structure in four samples, and that the internal consistency reliability of the two factors ranged from α=.80-.86 for TB and from α=.81-.93 for PB (Bryan, 2011; Hill et al., 2015; Van Orden et al., 2008). The same studies also reported that the two factors are moderately correlated with one another (*r* range=.44-.57), consistent with conceptualization of the factors representing separate facets of a superordinate construct (suicidal desire).

In this study, the internal consistency reliability of the INQ PB and TB composite scores was α=.94 and α=.84, respectively.

2.2.3.3 Suicide Capacity Scale (SCS-3)

The Suicide Capacity Scale (SCS-3) is a 6-item measure designed to assess the three theoretically derived facets of suicide capacity (i.e., acquired, dispositional, and practical), as posited by the 3ST (Klonsky & May, 2015). For each item, participants rate the extent to which they agree with each item using a 7-point Likert scale ranging from 0 (*Strongly Disagree*) to 6 (*Strongly Agree*). Total scores for each of the three facets of suicide capacity can be calculated by summing the values for each of the two questions measuring, with scores ranging from 0 to 14. Furthermore, a total score ranging can be calculated for the SCS-3 by summing the values for each of the 6 questions, which ranges from 0-36.

The SCS-3 was developed by Klonsky and May (2015) and first used in a sample of 910 individuals recruited from Amazon's Mechanical Turk (MTurk). The SCS-3 total score was reported to correlate highly with scores obtained on the ACSS (r=.69), a conceptually similar measure of suicide capacity. Similarly, the scores on each of the three SCS-3 subscales were reported to also correlated with the scores obtained on the ACSS (acquired r=.59, dispositional r=.61, and practical r=.39). The SCS-3 has since also been used in a second study (Dhingra et al., 2019) using a sample of over 600 undergraduate students. The study reported that the internal consistency reliability of the SCS-3 was α=.72, and that scores on the SCS-3 correlated with measures of suicidal desire (r=.39), suicide attempt (r=.33), as well as psychache (r=.33).

In this study, the internal consistency reliability of the SCS total score was α=.75. The correlation between the two items for each of the SCS subscales was r=.57 (acquired), r=.52 (dispositional), and r=.91 (practical).

2.2.3.4 Unbearable Psychache Scale (UP3)

The Unbearable Psychache Scale (UP3; Pachkowski et al., 2019) is an abbreviated 3-item measure designed to measure psychological pain. The UP3 is created using 3-items from the 13-item Scale of Psychache measure developed by Holden, Mehta, Cunningham, and McLeod (2001). Specifically, items 10 ("I can't take the pain anymore"), 11 ("Because of my pain, my situation is impossible"), and 12 ("My pain is making me fall apart") from the Scale of Psychache (Holden et al., 2001) are used to create the UP3. For each item, participants rate the intensity of their psychache using a 5-point Likert scale ranging from 1 (*"Strongly disagree"*) to 5 (*"Strongly agree"*). A total score is calculating by summing the answers for each of the items. Higher scores indicate greater psychache.

Studies examining the psychometric properties of the UP3 (Pachkowski et al., 2019) reported high internal consistency reliability (α=.93) for the UP3 across a large sample of online participants (n>1,000) and a sample of psychiatric inpatients (n=190). The same study reported that cores on the UP3 correlated highly with scores obtained on the 13-item Scale of Psychache (r=.90), as well with scores on measures assessing suicide ideation (BSI-5; r=.73), hopelessness (BHS-SF; r=.75), perceived burdensomeness (r=.73), and thwarted belongingness (r=.69).

In this study, the internal consistency reliability of the UP3 was α=.92.

2.2.4 NCM Measures

To measures the NCM constructs, the present study used several self-report and behavioural measures. For the behavioural measures, the Psychology Experiment Building Language (PEBL; Mueller, 2017; Mueller & Piper, 2014) was used. PEBL is an open-source programming language designed for electronically constructing, administering, and scoring psychological experiments. PEBL is compatible with Windows, OSX, and Linux operating

systems and is available to download free of charge from the developer's website (http://pebl.sourceforge.net/download.html). Since its development in 2004, PEBL has been downloaded more than 100,000 times and published in over 150 publications (Mueller & Piper, 2014).

The PEBL software comes pre-installed with the ability to administer over 80 cognitive tasks. Each task was designed using information from the published peer-reviewed articles originally describing the development and validation of the task (for a full list of the tasks and their references, see Table 1 in Mueller & Piper, 2014). Studies have examined the reliability and validity of the PEBL tests (Piper et al., 2012, 2015, 2016) and found that the PEBL tests demonstrate moderate-to-high test-retest reliability (Piper et al., 2015) and correlate highly with scores obtained from traditional face-to-face versions of the same tasks (Piper et al., 2012, 2016; Scarpina et al., 2020). Similarly, results obtained using the PEBL tasks have replicated longstanding findings of cognitive differences across the lifespan obtained (Piper et al., 2012; Scarpina et al., 2020).

The four behavioural tasks administered in the present study (i.e., the Flanker Task, Iowa Gambling Task, Victoria Stroop Test, and Tower of London) were selected based on (1) the neurocognitive abilities they purport to measure (e.g., decision making, inhibition, switching), (2) the overlap of these neurocognitive abilities with the assumptions made by the NCM, (3) and the overlap of these measures with previous neurocognitive studies conducted with suicidal individuals.

2.2.4.1 Behaviour Rating-Inventory of Executive Function – Adult (BRIEF-A)

The Behaviour Rating Inventory of Executive Function – Adult version (BRIEF-A; Roth, Isquith, & Gioia, 2005) is a 75-item self-report inventory used to measure perceived executive functions. Participants complete the measure by reporting the frequency with which they engage in behaviours that indicate impaired executive functions using a 3-point Likert scale ranging from 1 (*Never*) to 3 (*Often*). Participants' responses are combined to create nine individual subscales scores representing non-overlapping facets of executive functions: (1) Inhibit, (2) Shift, (3) Emotional Control, (4) Self-Monitor, (5) Initiate, (6) Working Memory, (7) Plan/Organize, (8) Task Monitor, and (9) Organization of Materials. Scores from the first four subscales are combined to create the Behavioural Regulation Index (BRI) and scores from the last five subscales are combined to create the Metacognition Index (MI), two clinical indices designed to reflect broader aspects executive functions. The BRI and MI scores are also combined to create a single composite score for the BRIEF-A, the Global Executive Composite (GEC). Higher scores on these scales and indices indicate greater perceived difficulties with executive functions, and therefore suggest greater impairment. Scores on the BRIEF-A can also be converted to age-based normative scores. The BRIEF-A also includes three validity scales intended to measure infrequent (Infrequency Scale), inconsistent (Inconsistency Scale), and unusually negative (Negativity Scale) reporting styles. Cut-off scores for these scales were developed using samples of individuals with and without cognitive difficulties.

The BRIEF-A has been used in a large number of studies and demonstrates robust psychometric properties. Internal consistency reliability was reported to range from α=.73-.94 for the nine subscale scores, α=.93-.98 for the two index scores, and α=.96-.98 for the composite score in studies with samples of healthy adults, adults with psychiatric diagnoses, and adults with

a history of traumatic brain injury (Ciszewski, Francis, Mendella, Bissada, & Tasca, 2014; Roth et al., 2005; Waid-Ebbs, Wen, Heaton, Donovan, & Velozo, 2012). Test-retest reliability has been reported to range from *r*=.82-.93 for the nine subscale scores, *r*=.93-.94 for the two index scores, and *r*=.94 for the composite score over a one-month period (Roth et al., 2005). Studies examining the convergent validity of the BRIEF-A scores (Roth et al., 2005) report that the BRIEF-A index and composite scores correlated highly with scores obtained from other self-report measures of executive functions, including the Frontal Systems Behaviour Scale (FrSBe; Grace & Malloy, 2002; *r* range=.63-.67), the Dysexecutive Questionnaire (Wilson, Alderman, Burgess, Emslie, & Evans, 1996; *r* range=.73-.84), and the Cognitive Failures Questionnaire (CFQ; Broadbent, Cooper, FitzGerald, & Parkes, 1982, *r* range=.64-.84). Scores on the BRIEF-A have also been reported to significantly differentiate adults diagnosed with ADHD from those undiagnosed with ADHD (Roth et al., 2013) as well as older adults diagnosed with mild cognitive impairment (MCI) from those undiagnosed with MCI (Rabin et al., 2006).

In this study, the internal consistency reliability of the nine BRIEF subscales was α=.73 (Inhibit), α=.70 (Shift), α=.90 (Emotional Control), α=.73 (Self-Monitor), α=.80 (Initiate), α=.81 (Working Memory), α=.83 (Plan/Organize), and α=.77 (Task Monitor). Internal consistency reliability was α=.91 for the BRI, α=.94 MI, and α=.96 for the GEC.

2.2.4.2 Brief Fear of Negative Evaluation Scale (BFNES)

The Brief Fear of Negative Evaluation Scale (BFNES; Leary, 1983) is a 12-item measure designed to measure people's apprehension about being negatively evaluated, a core feature of social anxiety disorder. Participants are instructed to indicate how characteristic each item is of them by using a 5-point Likert scale ranging from 1 (*Not at all characteristic of me*) to 5 (*Extremely characteristic of me*). Four items (2, 4, 7, and 10) are reverse-worded and therefore

need to be reverse scored. Once reverse scored, a total score is calculated by summing all the values from the individual items. Higher scores indicate greater fear of negative evaluation.

As its name suggests, the BFNES is a shorter measure of negative evaluation than the Fear of Negative Evaluation Scale (FNES; Watson & Friend, 1969), which contains 30 items. The items for the BFNES were selected according to the magnitude of their correlation (set as $r \geq .50$) with the total score on the FNES. In the development of the BFNES, scores on the BFNES were found to have high internal consistency reliability ($\alpha = .90$), test-retest reliability ($r = .75$ over a four week period), and correlate highly ($r = .96$) with the total score on the FNE (Leary, 1983). More recent studies have examined the psychometric properties of the BFNES (Carleton et al., 2006, 2011; Rodebaugh et al., 2004; Weeks et al., 2005) and suggest that a two-factor structure composed of (1) positive- and (2) reverse-worded items. Furthermore, research comparing the revised versions of the BFNES (Carleton et al., 2011) suggest that the eight positively worded BFNES items either match or exceed the psychometric properties of the 12-item BFNES.

In this study, the internal consistency reliability of the 12-item BFNES was $\alpha = .92$.

2.2.4.3 Depression Anxiety Stress Scale – 21 Item Version (DASS-21)

For this study, symptoms of depression, anxiety, and stress were measured using an abbreviated 21-item version of the original 42-item version of the Depression Anxiety Stress Scale (DASS-21; Antony, Bieling, Cox, Enns, & Swinson, 1998; DASS; Lovibond & Lovibond, 1995). For each item, participants rate the extent to which the item applied to them during the past week using a 4-point Likert scale ranging from 0 (*Did not apply to me at all – NEVER*) to 3 (*Applied to me very much, most of the time – ALMOST ALWAYS*). Subscale scores for depression, anxiety, and stress are calculated by summing the scores from seven separate items

per scale. A total composite score can also be calculated by summing all the individual items. Higher scores indicate more of the domain being measured. Cut-scores indicating Normal, Mild, Moderate, Severe, and Extremely Severe scores have also been developed for the original 42-item version of the DASS (Lovibond & Lovibond, 1995) and can calculated for the DASS-21 by multiplying each of the subscales scores by two (Gomez, 2002).

The DASS-21 was factor-analytically derived (Antony et al., 1998) and it's factor structure has been replicated in several studies (Henry & Crawford, 2005; Szabó, 2010) using large samples of participants (e.g., n>1,700; Henry & Crawford, 2005) and participants of different ethnic backgrounds (e.g., African-American, Asian, Caucasian, and Hispanic/Latino participants; P. J. Norton, 2007). Studies examining the psychometric properties of the DASS-21 have reported that internal consistency reliabilities of the individual subscales ranged from α=.78-.93 and were similar to the original 42-item version of the DASS (DASS-21 depression α range=.83-.94 [DASS depression α=.97]; DASS-21 anxiety α range=.78-.87 [DASS anxiety α=.92]; DASS-21 stress α range=.83-.91 [DASS stress α=.95]; Antony et al., 1998; Henry & Crawford, 2005; P. J. Norton, 2007; Szabó, 2010), including for DASS-21the composite score (α=.93; Henry & Crawford, 2005). DASS-21 subscale scores have also been reported to correlate with one another (depression and anxiety r=.46, depression and stress r=.57, anxiety and stress r=.72; Antony et al., 1998), consistent with the conceptualization of these subscales representing separate dimensions of a superordinate construct, namely psychological distress, which has subsequently received factor-analytic validation (Henry & Crawford, 2005; Szabó, 2010). The DASS-21 subscale scores have been found to correlate with longstanding measures of depression and anxiety (DASS-21 depression and Beck Depression Inventory [BDI] r=.79, DASS-21 anxiety and Beck Anxiety Inventory [BAI] r=.85, DASS-21 anxiety and State-Trait

Anxiety Inventory [STAI] r=.55) to a similar extent as scores obtained on the original 42-item version of the DASS (DASS-42 depression and BDI r=.77, DASS anxiety and BAI r=.84, DASS anxiety and STAI r=.42; Antony et al., 1998).

In this study, the internal consistency reliability of the DASS-21 subscales were α=.81 (anxiety), α=.92 (depression), α=.85 (stress), and α=.94 for the DASS-21 total score.

2.2.4.4 Difficulties in Emotion Regulation Scale – 18 Item Version (DERS-18)

Emotion dysregulation was measured using an abbreviated 18-item version of the original 36-item version of the Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004; DERS-18; Victor & Klonsky, 2016). For each item, participants rate the frequency they experience the statements described in each item using a 5-point scale ranging from 1 (*Almost never [0-10%]*) to 5 (*Almost always [91-100%]*). Three items are reverse-keyed (Items 1, 4, and 6) and require reverse-scoring prior to calculating subscale and composite scores. Once reverse-scored, scores on the DERS-18 are summed to calculate six subscale scores, each using 3 items. The DERS -18 subscales are: (1) Lack of Emotional Awareness (Aware), (2) Lack of Emotional Clarity (Clarity), (3) Difficulties Engaging Goal-Directed Behaviours (Goals), (4) Impulse Control Difficulties (Impulse), (5) Nonacceptance of Emotional Responses [NonAccept], and (6) Limited Access to Emotion Regulation Strategies (Strategies). A composite score for the DERS-18 can also be calculated by summing all the individual items. Higher scores on the DERS-18 scales indicate greater difficulty regulating emotions.

The DERS-18 was factor analytically derived in five samples composed of high school students, adolescent psychiatric inpatients, undergraduate university students, adult participants recruited online, and adult participants recruited from the community (n>1600, Victor & Klonsky, 2016). Internal consistency reliabilities for the DERS-18 subscales ranged from α=.77-

.91 and was α=.91 for the DERS-18 composite score (Victor & Klonsky, 2016). Correlations between the DERS-18 subscales and the subscales calculated using the original 36-item version of the DERS ranged from *r*=.92-.97 and item-total correlations ranged from *r*=.53-.85 (Victor & Klonsky, 2016), which is largely similar to the item-total correlations range (*r* range=.45-.81) reported by 36-item version of the DERS (Gratz & Roemer, 2004). Scores on the DERS-18 were reported to correlate with longstanding measures of Borderline Personality Disorder (BPD) including the McLean Screening Instrument for Borderline Personality Disorder (MSI-BPD; Zanarini et al., 2003; *r* range=.49-.67) and the Structured interview for DSM-IV Personality (Pfohl, Blum, & Zimmerman, 1997; *r* range=.63-.66).

In this study, the internal consistency reliability of the DERS-18 subscales was α=.80 (Aware), α=.85 (Clarity), α=.92 (Goals), α=.90 (Impulse), α=.92 (NonAccept), and α=.83 (Strategies). The internal reliability consistency for the DERS-18 total score was α=.91.

2.2.4.5 Flanker Task (FT)

The Flanker Task (Eriksen & Eriksen, 1974) is a neurocognitive test designed to measure cognitive control, particularly individuals' ability to purposefully inhibit certain information in making decisions. To complete the task, participants are first instructed to focus their attention on the direction of the arrow presented in the middle of the screen and indicate the direction of the arrow by pressing either the left or right shift key (indicating the arrow is pointing to the left or right of the screen, respectively). Participants are also told that there are four conditions to the task, whereby the centre arrow will be presented (1) presented on its own, (2) with two dashed lines to the left and right of it, (3) with two arrows to the left and right of the centre arrow pointing in the same direction as the centre arrow, and (4) with the two arrows to the left and right of the centre arrow pointing in the opposite direction of the centre arrow. Trials in which

the surrounding arrows point in the same direction as the centre arrow are referred to as congruent trials. Trials in which the surrounding arrows point in the opposite direction of the centre arrow are referred to as incongruent trials.

Studies using the Flanker Task have repeatedly reported that individuals' reaction time is slower when responding to incongruent vs. congruent trials (Eriksen & Eriksen, 1974; Stins et al., 2007; Verbruggen et al., 2004). This is thought to result from the greater cognitive difficulty experienced by individuals trying to inhibit the contradictory information (i.e., arrows pointing in different directions) presented in the incongruent trials. Although few studies have reported information on the reliability of the Flanker Task, studies have reported that the Flanker Task appears to measures aspects of cognitive control that are similar to those measured by other neurocognitive measures requiring cognitive control, including the Spatial Conflict Task (Stins et al., 2007) and the Stroop Task (Verbruggen et al., 2004).

For this study, participants first completed 16 practice trials composed of an equal number of each of the four conditions and administered in random order. Next, participants completed a total of 320 trials composed of 80 trials of each of the four condition, also administered in random order. For all trials, a fixation cross appeared on the screen for 500 milliseconds before the stimulus was presented. Once presented, participants were provided with 800 milliseconds to respond. Participants were provided with feedback for each response (i.e., "Correct" or "Incorrect") as well as with their response time provided in square brackets (e.g., "Correct [679]"). The delay between trials was set to 1000 milliseconds (or 1 second).

2.2.4.6 Frontal Systems Behaviour Scale (FrSBe)

The Frontal Systems Behaviour Scale (FrSBe; Grace & Malloy, 2001) is a 46-item self-report scale designed to assess the frequency of behaviours associated with experiencing damage to the frontal lobes. Participants report the frequency with which they engage in each behaviour by using a 5-point Likert scale ranging from 1 (*Almost Never*) to 5 (*Almost Always*). Items 1-32 outline behaviours associated with damage to the frontal lobes and items 33-46 are reverse-keyed and include 'healthy' behaviours unrelated to frontal lobe damage. After reverse-scoring items 33-46, scores are summed to create three subscale scores: (1) Apathy, (2) Disinhibition, and (3) Executive Functions. A composite score can also be calculated by adding the scores of all the FrSBe items. Higher scores indicate greater endorsement of activities associated with frontal lobe damage, and therefore suggest greater frontal lobe impairment. Scores on each subscales can be converted to gender-, age-, and education-based normative scores using the FrSBe's normative sample (Grace & Malloy, 2001).

The FrSBe has been used in numerous studies and its psychometric properties have been repeatedly evaluated. For example, the internal consistency reliability of the three subscales has been reported to range from α=.72-.90 and from α=.88-.93 for the composite FrSBe score (Carvalho et al., 2013; Grace & Malloy, 2001; Lane-Brown & Tate, 2009; Niemeier et al., 2013). Test-retest reliabilities for the three subscales have been reported to range from r=.42-.57 and r=.54 for the composite FrSBE score (Niemeier et al., 2013). Studies have also confirmed the factor structure of the FrSBe subscales using both exploratory (Stout et al., 2003) and confirmatory factor analyses (Carvalho et al., 2013), though some studies have failed to replicate the subscales' factor structure (Niemeier et al., 2013). Scores on the FrSBe subscales have been reported to correlate with other self-report measures of frontal lobe damage including the

BRIEF-A (Roth et al., 2005; *r* range=.63-.67) and the Neuropsychiatric Inventory (Cummings et al., 1994; Norton, Malloy, & Salloway, 2001; *r* range=.62-.64). Scores on the FrSBe have been shown to meaningfully differentiate individuals with frontal temporal dementia from individuals with Alzheimer's disease (Mendez, Licht, & Saul, 2008) as well as predict instrumental activities of daily living (Norton et al., 2001) and community integration (Reid-Arndt et al., 2007) over and above other self-report and neurocognitive behavioural measures of intelligence and executive functioning.

In this study, the internal consistency reliability of the FrSBe subscales was α=.81 (Apathy), α=.78 (Disinhibition), α=.83 (Executive Functions), and α=.91 for the FrSBe total score.

2.2.4.7 Iowa Gambling Task (IGT)

The Iowa Gambling Task (IGT) is a neurocognitive test designed to measure real-world decision making abilities (Bechara et al., 1994). Participants begin the task by being 'loaned' $2,000 of play money. Next, participants are instructed to use the money by selecting from one of four decks of cards. Each bet results in participants 'winning' a certain amount of money. However, the amount of money gained by participants varies by deck, and some decks result in participants incurring penalties, thereby 'losing' money. Specifically, placing bets on two of the four decks of cards results in participants obtaining large 'winnings' but also incurring large 'losses'. These decks are referred to as the 'disadvantageous' decks and will result in a net loss of money over time. In contrast, the other two decks result in participants obtaining small 'winnings' but incurring even smaller 'losses'. These are referred to as the 'advantageous' decks since placing bets on these decks will result in a net increase of money over time. Succeeding on

the IGT therefore requires that participants learn the overall net 'payout' of each of the four decks and forego short-term gain in favor of long-term, albeit modest, profit.

Studies using the IGT have reported that most adults are able to learn the net 'payout' of the four decks and use this information to maximize gains and minimize losses (van den Bos et al., 2013). Difficulty completing the IGT has been associated with damage to prefrontal cortical regions in general (for a review, see: Lawrence, Jollant, O'Daly, Zelaya, & Phillips, 2009), and the ventromedial prefrontal cortex in particular (Bechara et al., 1994, 1996). A review of studies using the IGT (Buelow & Suhr, 2009) reported that scores on the IGT meaningfully differentiated individuals diagnosed with substance use, pathological gambling, obsessive-compulsive disorder (OCD), schizophrenia, ADHD, and psychopathy from healthy controls. However, the same review (Buelow & Suhr, 2009) identified several limitations of the IGT, including large practice effects, which questions the repeated use of the IGT within the same population.

For this study, none of the parameters of the IGT were modified; participants were provided with $2,000 of starting money and completed 100 trials. Consistent with (Bechara et al., 1994), decks A and B were assigned as the 'disadvantageous' decks and decks C and D were assigned as the 'advantageous' decks. Feedback about each choice was provided for 2.5 seconds. Participants also incurred a penalty if they didn't select a deck of cards after 2.5 seconds.

2.2.4.8 Stroop Task (the Victoria Stroop Test [VST] version)

The Stroop Task (Stroop, 1935) is one of the earliest neurocognitive tests developed. It was designed to measure cognitive control, and the paradigm used for the task dates back to Raymond B. Cattell's work in the late 1800s (Strauss et al., 2006). To complete the task, participants are first presented with a page that has patches of colour on it. Participants are then

instructed to name the colours aloud as quickly as they can. Next, participants are presented with colour words (e.g., “Blue”, “Red”) printed in black ink and are instructed to read the words aloud as quickly as they can. The last condition involves presenting the participants with colour words that have been printed in ink colours that do not match the printed colour word (e.g., the word “Red” printed in blue ink). The participant is then instructed to identify the colour of the ink the words are printed in, and not read the word. The “Stroop effect” describes the phenomenon whereby most people take longer to name the colour of the ink a word is presented than either naming a patch of colour or reading colour words printed in black ink.

For this study, we used the Victoria-version of the Stroop Test (the Victoria Stroop Test [VST]; Regard, 1981). The VST has been shown to require less administration time, produce smaller practice effects, generate scores that are independent of cognitive speed (e.g., an interference ratio that corrects generalized slowing), has several normative datasets to select from, and is in the public domain (Strauss et al., 2006). For the VST, participants are first presented with four rows, each containing six patches of colour per row. Participants are then instructed to name the colours aloud as quickly as possible. Next, participants are presented with four rows, each containing six non-colour words (e.g., “Over”) that are printed in coloured ink (e.g., blue). Participants are instructed to identify the colour of the ink the words are printed in as quickly as possible. The last condition mirrors that of the original Stroop task in that participants are presented with four rows, each containing six colour words (e.g., “Blue”) printed in ink colours that do not match the printed colour word (e.g., yellow). Consistent with the original Stroop task, participants are instructed to identify the colour of the ink the words are printed in.

The test-retest reliability of the VST conditions have been found to range from r=.83-.91 (Strauss et al., 2006), consistent with other versions of the Stroop task (Delis et al., 2001; Stroop,

1935). Studies have reported that scores on the VST correlated with other measures of attention, including the CPT (Weinstein, Nader, Silverstein, & Turnbull, 1999, R^2=.31) and the Paced Auditory Serial Addition Test (Macleod & Prior, 1996; *r*=.43). Other studies have found that the interference score on the Stroop test correlated with other inhibition measures, including stopping probability (*r*=.33) and time (*r*=.56) on the stop-signal task (Friedman & Miyake, 2004; C. P. May & Hasher, 1998). Scores on the Stroop have been found to differentiate individuals with depressive (Epp, Dobson, Dozois, & Frewen, 2012; *g*=0.86) bipolar disorders (Bora, Yucel, & Pantelis, 2009; *d*=0.76), ADHD (Lansbergen, Kenemans, & van Engeland, 2007, *d*=0.28) from individuals not diagnosed with mood disorders, as well between relatives of individuals with and without schizophrenia (Sitskoorn, Aleman, Ebisch, Appels, & Kahn, 2004, *d*=0.28).

2.2.4.9 Tower of London Task (TOL)

The Tower of London Task (TOL; Shallice, 1982) is a neurocognitive test designed to measure planning abilities. To complete the task, participants are asked to re-arrange three desks organized on three pegs to match the configuration depicted in a target image. Each disk has a different colour (blue, red, and green) and each peg has a different height to accommodate a different number of pegs (one, two, and three). Participants are instructed to move one disk at a time and are provided with both a limited number of moves and a limited amount of time within which to complete each trial. The number of moves required to complete each trial increases as the trials progress.

Studies examining the reliability of the TOL have reported that the internal consistency reliabilities of the TOL items ranges from α=.69-.90 with split-test reliability ranging from *r*=.72-.90 (Humes et al., 1997; Kaller et al., 2012; Schnirman et al., 1998). Test-retest reliability

has been reported as *r*=.70 (Schnirman et al., 1998). Scores on the TOL were correlated with a similar version of the TOL, the Tower of Hanoi test (Humes, Welsh, Retzlaff, & Cookson, 1997; Welsh, Satterlee-Cartmell, & Stine, 1999; *r* range=.37-.39), as well as similar measures of planning and working memory (Welsh et al., 1999) including, Stroop (*r* range=.32-.40), Visual Memory Span (*r* range=.41-.49), and Spatial Working Memory (*r* range=.45-.61).

For this study, participants completed a total of 12 trials according to the parameters outlined in Shallice (1982). Participants were provided a total of 120 seconds to complete each trial.

2.2.4.10 UPPS Impulsive Behaviour Scale – 16 Item Version (UPPS-16)

This study used an abbreviated 16-item version of the UPPS Impulsive Behaviour Scale (UPPS-16; Whiteside & Lynam, 2001). The UPPS is a factor-analytically derived measure assessing four facets of impulsivity including (1) Urgency: a person's tendency to experience strong impulses and perform behaviours in the presence of negative affect, (2) Premeditation: a person's ability to think through series of actions and their possible consequences prior to engaging in actions, (3) Perseverance: a person's ability to remain focused on a task, and (4) Sensation seeking: a person's tendency to seek-out and engage in behaviours that are exciting, new, and potentially dangerous. The UPPS-16 was developed by selecting the four items that had the highest item-total correlations for each factor in the original development study of the UPPS (Whiteside & Lynam, 2001). For each item, participants indicate the extent they agree with the item using a 4-point Likert scale ranging from 1 (*Agree Strongly*) to 4 (*Disagree Strongly*). To score the UPPS-16, the 4 items for the Urgency and Sensation Seeking scales must first be reverse scored. Then, a total score is calculated for each subscale by summing the individual

item response values. A total score for the UPPS-16 can also be calculated by summing the all the individual item response values, and ranges from 16 to 64.

Studies using the UPPS-16 have reported that the internal consistency reliability of the individual subscales ranged from α=.76-.85 in four large samples (*n* range=700-5,000) composed primarily of college students (Glenn & Klonsky, 2010, 2011; Klonsky & May, 2010). Factor scores using the UPPS-16 were also reported to correlate highly with factor scores obtained using the original 45-item version of the UPPS (Glenn & Klonsky, 2010; Urgency *r*=.89, Premeditation *r*=.88, Perseverance *r*=.88, and Sensation seeking *r*=.91). Scores on the UPPS-16 have also been reported to differentiate individuals with a history of NSSI from those without a history of NSSI (*d*=0.57, Glenn & Klonsky, 2010; *d*=0.52, Glenn & Klonsky, 2011) and individuals currently engaged in NSSI from those with a past history of NSSI (*d*=0.54; Glenn & Klonsky, 2010).

In this study, the internal consistency reliability of the UPPS-16 subscales was α=.74 (Urgency), α=.77 (Premeditation), α=.80 (Perseverance), and α=.79 (Sensation Seeking). The internal consistency reliability of the UPPS-16 total score was α=.78.

2.3 Procedure

The study began recruiting participants in January 2016. Participants were recruited using the Department of Psychology's Human Subject Pool (HSP). HSP is an online platform that allows students at the University of British Columbia (UBC) to participate in psychological research in exchange for course credit and/or financial compensation. Prior to participating in research, students were required to complete a screening questionnaire composed of questions submitted by the individual laboratories conducting research in the Department of Psychology at UBC. For this study, two questions assessing lifetime histories of suicide ideation and suicide

attempts (questions 1 and 3 on the YRBS, previously described) were included in the screening questionnaire and used to categorize individuals as nonsuicidal (i.e., no lifetime history of suicide ideation or attempts), suicide ideators (i.e., lifetime history of suicide ideation, no lifetime history of suicide attempts), or suicide attempters (i.e., lifetime history of suicide ideation and suicide attempts). This categorization was used to oversample the recruitment of suicide ideators and suicide attempters.

After completing the HSP screening questionnaire, participants were presented with an advertisement to participate in the present research study. All three groups of participants (i.e., nonsuicidal, suicide ideators, and suicide attempters) were presented with identical versions of the advertisement. The advertisement described the study as examining the relationship between personality, emotion, and attention. Participants were informed that the study will require them to complete computerized tasks measuring facets of attention as well as self-report questionnaires assessing their views of themselves, their mental health, and cognitive functioning. The advertisement stated that the study is estimated to require up to two hours of participants' time and that, in exchange for their participation, participants will be reimbursed 2 HSP credits, consistent with the HSP guidelines (whereby 1 hour of participation = 1 HSP credit). Participants who receive HSP credits can assign these to any undergraduate psychology course at UBC in order to increase their final grade in that course. For reference, 1 HSP credit is equivalent to a 1 percentage point increase in the participant's final grade.

Participants who registered for the study and presented to the lab for their study timeslot were met by a trained Research Assistant (RA) who greeted them and confirmed their participation in the study. The RA also provided the participant with a copy of the study consent form and verbally reviewed the consent form with the participant. Participants were informed

that they can decide to withdraw from the study at any point and that doing so will not impact their eligibility to receive the HSP credits for the study. Upon obtaining the participant's informed consent, the RA administered the study measures electronically using a personal computer that was connected to an external 24-inch monitor (resolution set to 1920x1080), keyboard, and mouse, which the participant used to complete the study. The RA sat at a 90-degree angle to the participant and was therefore unable to see the participant's responses.

Self-report measures were administered using Qualtrics, a large online survey platform provided by UBC. The neurocognitive tasks were administered using the PEBL platform, previously described. The study measures were administered in three sections. First, participants completed measures designed to obtain demographic and non-clinical information. This included the PEBL demographics questionnaire, UPPS-16, BRIEF-A, and FrSBe. Next, the neurocognitive tasks were administered. These included the FT, IGT, VST, and TOL. For each neurocognitive task, RAs observed the participant's behaviour and rated the extent to which they appeared to experience difficulties completing the task on five domains, including (1) Cognition, (2) Motor, (3), Emotion, (4) Sensory, and (5) Fatigue. For each domain, a scale ranging from 0 ("*No problems"*) to 3 ("*Test invalidated"*) was used. RAs also provided descriptions of the behaviours they observed and explained the rationale for their ratings. Behavioural scores and observations were subsequently used to identify and remove invalid neurocognitive data.

Once the neurocognitive tasks were completed, participants were administered clinical questionnaires. These included the BFNES, DAST-10, DERS-18, DASS-21, BHS-SF, INQ, SCS-3, Scale of Psychache, and YRBS. Note that the YRBS (the measure used to screen participants into the study groups from HSP) was readministered to verify participants' lifetime

history of suicide ideation and suicide attempts. Participants who endorsed a lifetime history of suicide ideation also completed the BSI.

Before completing the study, participants were asked to rank their top 5 strengths and values and to list all the positive coping strategies they use when they are stressed. These questions were used to remind participants of their personal strengths, values, and coping resources in the event they experience distress in completing the study measures. All participants were also provided with an extensive list of mental health resources before being debriefed by the RA about the purpose of the study.

Ethical approval for this study was obtained from the Behavioural Research Ethics Board at UBC (Study BREB Number: H14-01171). The study completed recruiting participants in April 2019. Statistical Analyses

2.3.1 Power Analyses

A series of post-hoc power analyses were conducted using the pwr R package (Champely, 2020) to determine the study's ability to detect large (*Cohen's d*=0.8), moderate (*d*=0.5), and small (*d*=0.2) effect size differences between two independent groups (Cohen, 1988). All analyses were two-tailed and the probability of error (i.e., alpha [α]) was set to 0.05.

Power analyses were conducted comparing groups categorized according to lifetime history of suicide ideation and suicide attempts. Results of these analyses suggest that the present study has 1.00, 0.99, and 0.83 power for detecting large, medium, and small effect size differences, respectively, between nonsuicidal participants and suicide ideators. Power was 1.00, 0.99, 0.57 for detecting large, medium, and small effect size differences, respectively, between nonsuicidal participants and suicide attempters and 1.00, 0.99, and 0.54, respectively, for comparing suicide ideators and lifetime suicide attempters.

2.3.2 Statistical Assumptions

Prior to conducting statistical analyses, we examined whether the distribution of the 3ST and NCM variables resembled a parametric distribution. Specifically, we calculated z-scores for skew and kurtosis (Field, 2009), as well as the Kolmogorov-Smirnov (Massey, 1951) and Shapiro-Wilk (Shapiro & Wilk, 1965) tests of normality. The results of these analyses suggested that majority of the variables were not normally distributed. However, given the large sample used in this study (n>1,000 participants), these results are to be expected, as even in parametric distributions with very small deviations from normality (Field, 2009; Field et al., 2012). We therefore decided to take a cautious and statistically conservative approach to our analyses in using Spearman's rank correlation coefficient (Spearman, 1910) for correlational analyses.

In addition to testing whether the data met the assumption of normality, we also tested whether the data met other statistical assumptions. For linear regression analyses we examined whether residuals are normally and linearly distributed by visually inspecting (1) the distribution of the standardized residuals, (2) the residuals vs. fits plots (i.e., residuals plotted against predicted values), and (3) the Q-Q plots (i.e., standardized residuals vs. theoretical quintiles). We also examined the residuals vs. leverage plots to identify outliers that might be unduly influencing our models. For logistic regression models, the linearity of the relationship between the predictors and outcomes was examined by calculating whether the interaction between the predictor and a log-transformed version of the predictors was statistically reliable, as recommended by Field (2012). Across both linear and logistic regression models, the assumption of the independence of residuals was examined by calculating the Durbin-Watson test. Values closer to 2 indicate uncorrelated residuals with values below 1 or greater than 3 are indicating possibly correlated residuals (Field, 2012). Multicollinearity was examined by calculating the

Variance Inflation Factor (VIF), tolerance (i.e., 1/VIF), and mean VIF values, with values greater than 10, below 0.2, and greater than 1 indicating possible collinearity (Field, 2018). Results from these analyses indicate that the analyses conducted for this study met the aforementioned assumptions. (These analyses were not included in the dissertation for brevity but are available upon request.)

2.3.3 P-values

Consistent with recommendations made by the American Statistical Association (Wasserstein & Lazar, 2016) and increasing scientific consensus (Amrhein et al., 2019), we treat p-values as a dimensional indicator of the reliability of the effect being reported. Thus, we present p-values throughout the manuscript so that readers can have access to them, and because p-values provide one metric of the reliability of the findings. In contrast, we do not use p-values to make categorical decisions about whether an effect is 'real' or statistically significant. Whether p-values fall above or below any particular threshold (e.g., <.05, <.01, <.001) does not, in and of itself, result in us making any categorical decisions regarding which effects are "real" or "not real", and therefore do not require adjustment for categorical decisions. Because we are not using the logic of t-tests for categorical decisions about 'significant' results, we do not adjust p-values for multiple comparisons.

2.3.4 Statistical Software and Packages

All statistical analyses were conducted using the RStudio environment (version 1.4.673; RStudio Team, 2020) for the R language for statistical computing (version 4.0.2; R Core Team, 2017). The beta version of the PROCESS macro (Hayes, 2018) for R was used alongside the following R packages: AER (Kleiber & Zeileis, 2008), apa (Gromer, 2020), bestNormalize (Peterson & Cavanaugh, 2019), car (Fox & Weisberg, 2019), corrplot (Wei & Simko, 2017),

DescTools (Signorell, 2020), foreign (R Core Team, 2020a), gmodels (Warnes et al., 2018), GPArotation (Bernaards & Jennrich, 2005), hmisc (Harrell, 2020), InformationValue (Prabhakaran, 2016), lavaan (Russeel, 2012), lmtest (Zeileis & Hothorn, 2002), MASS (Venables & Ripley, 2002), moments (Komsta & Novometsky, 2015), parameters (Lüdecke, Ben-Shachar, et al., 2020), pastecs (Grosjean & Ibanez, 2018), performance (Lüdecke, Makowski, et al., 2020), pscl (Zeileis & Kleiber, 2008), psych (Revelle, 2020), psycho (Makowski, 2018), pwr (Champely, 2020), QuantPsych (Fletcher, 2012), rcompanion (Mangiafico, 2020), readxl (Wickam & Bryan, 2019), reshape2 (Wickham, 2007), ResourceSelection (Lele et al., 2019), Rmisc (Hope, 2013), semTools (Jorgensen et al., 2020), sjmisc (Lüdecke, 2018), sjPlot (Lüdecke, 2020), stats (R Core Team, 2020b), sur (Harel, 2020), and tidyverse (Wickham et al., 2019).

Chapter 3: Results

Descriptive statistics for measures and scores used for all analyses are presented in Table 3 according to lifetime history of suicide ideation and suicide attempts.

Table 3. Descriptive Statistics by Lifetime History of Suicide Ideation and Suicide Attempts

Perspective / Outcome	Measure / Score	Nonsuicidal			Ideators			Attempters		
		n	Mean	SD	*n*	Mean	SD	*n*	Mean	SD
Suicide Ideation	BSS-5	485	0.00	0.00	379	1.58	1.97	150	2.15	2.33
3ST	BHS-SF	363	0.47	0.96	284	1.07	1.26	126	1.28	1.52
	INQ-TB	362	26.37	6.18	284	22.21	7.12	126	21.04	7.28
	SCS-3	362	15.22	6.93	284	20.07	6.86	126	22.09	7.24
	SCS-3-A	362	6.29	2.81	284	7.38	2.59	126	7.61	2.92
	SCS-3-D	362	5.69	2.75	284	6.50	2.93	126	6.59	2.96
	SCS-3-P	362	3.24	3.59	284	6.19	4.03	126	7.89	3.75
NCM	BFNES	201	39.04	9.39	131	42.27	10.51	43	46.58	11.20
	BRIEF-A-Inh.	485	12.50	2.84	379	13.32	3.06	150	14.35	3.18
	DASS-21	476	11.90	10.39	379	19.04	12.62	150	22.92	13.23
	DERS-18	476	38.54	10.72	379	45.40	12.63	150	48.85	14.30
	DERS-18 Imp.	476	4.90	2.41	379	5.75	2.81	150	6.35	3.23
	Flanker-Con.	463	57.38	21.12	371	56.87	21.91	143	57.99	19.70
	Flanker-Err.	463	18.39	37.46	371	16.13	31.42	143	13.66	12.25
	FrSBe Dis.	484	29.85	6.78	379	32.34	6.56	150	34.25	7.85
	IGT-Cha.	462	15.13	12.13	370	15.89	11.23	144	13.43	12.23
	IGT-Net	462	25.87	32.46	370	31.76	32.17	144	25.06	34.18
	INQ-TB	362	13.63	6.18	284	17.79	7.12	126	18.96	7.28
	TOL	462	24.50	6.22	370	25.18	6.23	144	24.44	6.01
	UPPS-16-Urg.	484	9.53	2.52	379	9.96	2.62	150	10.55	2.59
	UPPS-16-Pers.	484	7.25	2.08	379	7.65	2.35	150	7.78	2.52
	UPPS-16-Prem.	484	7.39	2.05	379	7.37	2.07	150	7.74	2.42
	UPPS-16-Sen.	484	10.32	2.90	379	10.16	3.15	150	10.89	3.15
	VST-Eff.	458	1.06	0.26	371	1.07	0.25	145	1.07	0.22
	VST-Err.	458	0.96	1.44	371	1.05	1.39	145	0.97	1.29

Note. 3ST=Three-Step Theory; BFNES = Brief Fear of Negative Evaluation Scale; BHS-SF = Beck Hopelessness Scale – Short Form; BRIEF-A-Inh. = Behaviour Rating Inventory of Executive Functions – Adult-Inhibition subscale; BSS-5 = Beck Scale of Suicide Ideation – 5 Item Version; DASS-21 = Depression, Anxiety, and Stress Scale – 21 Item Version; DERS-18 = Difficulties in Emotion Regulation Scale – 18 Item Version; DERS-18-Imp. = Difficulties in Emotion Regulation Scale – 18 Item Version, Impulse subscale; Flanker-Con. = Flanker Conflict Cost; Flanker-Err. = Flanker Errors; FrSBe-Dis. = Frontal Systems Behaviour Scale – Disinhibition subscale; IGT-Cha. = Iowa Gambling Task Change Score; IGT-Net = Iowa Gambling Task Net Score; INQ-TB = Interpersonal Needs Questionnaire – Thwarted Belongingness subscale; N/A = Not Applicable; NCM = Neurocognitive Model of Suicidal Behaviour; SCS-3 = Suicide Capability Scale; SCS-3-A = Suicide Capability Scale – Acquired Capability subscale; SCS-3-D = Suicide Capability Scale – Dispositional Capability subscale; SCS-3-P = Suicide Capability Scale – Practical Capability subscale; SD = Standard Deviation; TOL = Tower of London; UP3 = Unbearable Psychache Scale; UPPS-16-Urg. = UPPS Impulsivity Scale – 16-Item Version, Negative Urgency subscale; UPPS-16-Pers. = UPPS Impulsivity Scale – 16-Item Version, Lack of Perseverance subscale; UPPS-16-Prem. = UPPS Impulsivity Scale – 16-Item Version, Lack of Premeditation subscale; UPPS-16-Sen. = UPPS Impulsivity Scale – 16-Item Version, Sensation Seeking subscale; VST-Eff. = Victoria Stroop Task Efficiency; VST-Err. = Victoria Stroop Task Errors.

3.1 Testing the 3ST Hypotheses

Descriptive statistics and internal consistency reliabilities for the 3ST variables are presented in Table 4.

Table 4. Descriptive Statistics and Internal Consistency Reliability for the Three-Step Theory (3ST) Variables

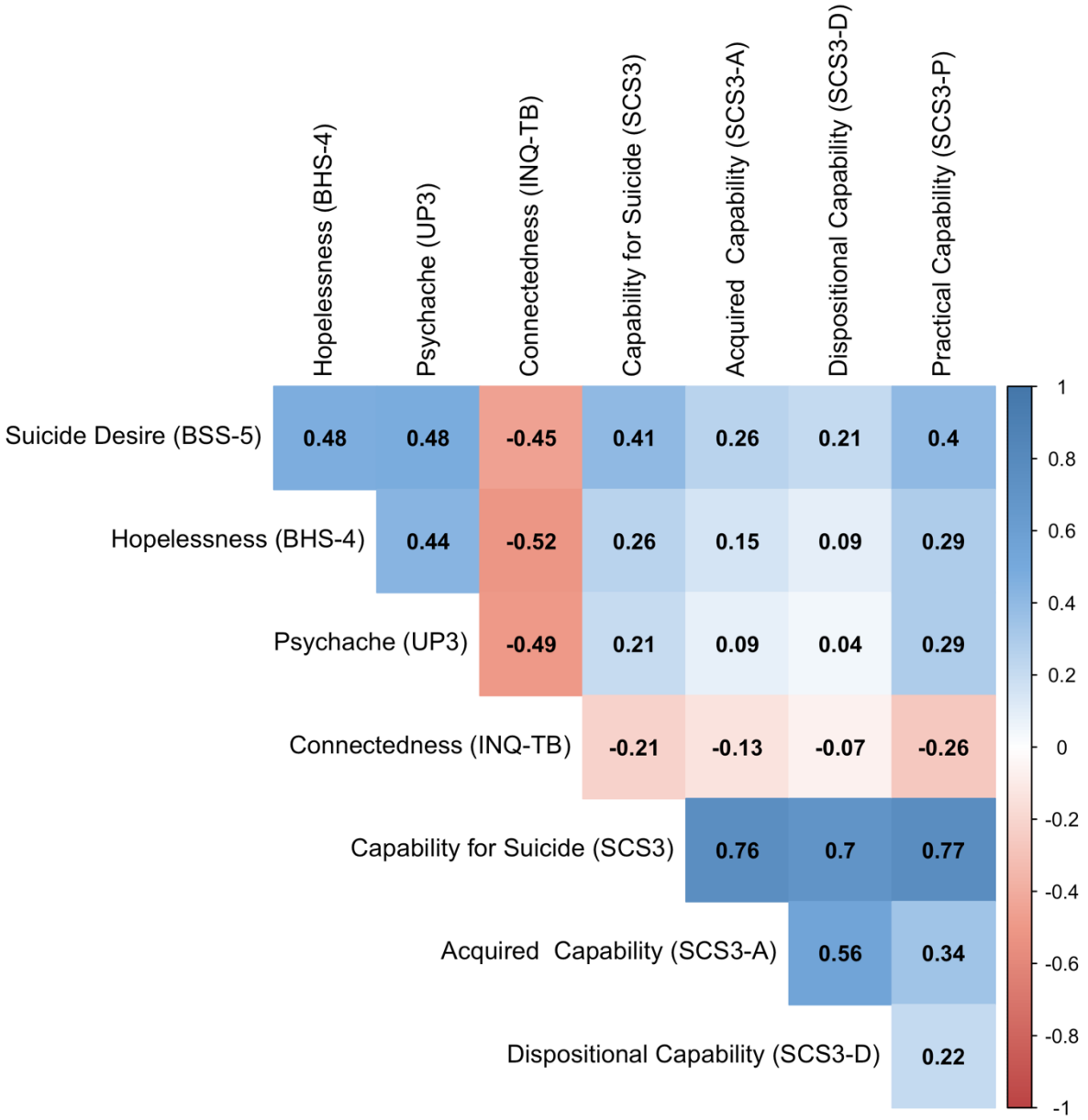
3ST Step	Construct	Measure	*n*	Mean	SD	Skew	Kurtosis	α
Step 1	Suicide Desire	BSS-5	1,014	0.92	1.75	2.18	4.26	.81
	Hopelessness	BHS-SF	773	0.82	1.23	1.41	0.82	.77
	Psychache	UP3	772	5.85	5.85	0.82	-0.14	.92
Step 2	Connectedness	INQ-TB[a]	772	23.97	7.09	-0.42	-0.51	.88
Step 3	Capability for Suicide	SCS-3	772	18.12	7.50	0.00	-0.53	.75
	Acquired	SCS-3-A	772	6.91	2.81	-0.35	-0.38	.57
	Dispositional	SCS-3-D	772	6.13	2.88	-0.04	-0.69	.52
	Practical	SCS-3-P	772	5.08	4.20	0.18	-1.37	.91

Note. α = Cronbach's Alpha; 3ST=Three-Step Theory; BHS-SF = Beck Hopelessness Scale – Short Form; BSS-5 = Beck Scale of Suicide Ideation – 5 Item Version; INQ-TB = Interpersonal Needs Questionnaire – Thwarted Belongingness subscale; SCS-3 = Suicide Capability Scale; SCS-3-A = Suicide Capability Scale – Acquired Capability subscale; SCS-3-D = Suicide Capability Scale – Dispositional Capability subscale; SCS-3-P = Suicide Capability Scale – Practical Capability subscale; SD = Standard Deviation; UP3 = Unbearable Psychache Scale.

[a]INQ-TB items were rescored so that greater scores represent greater connectedness

The intercorrelation of all the 3ST variables is outlined in Figure 4.

Figure 4. Intercorrelation Matrix of the Three-Step Theory (3ST) Variables



Note. 3ST = Three-Step Theory; BHS-SF = Beck Hopelessness Scale – Short Form; BSS-5 = Beck Scale of Suicide Ideation – 5 Item Version; INQ-TB = Interpersonal Needs Questionnaire – Thwarted Belongingness subscale; SCS-3 = Suicide Capability Scale; SCS-3-A = Suicide Capability Scale – Acquired Capability subscale; SCS-3-D = Suicide Capability Scale – Dispositional Capability subscale; SCS-3-P = Suicide Capability Scale – Practical Capability subscale; UP3 = Unbearable Psychache Scale.

Absolute correlation values equal to .09 and >.09 are statistically significant at $p<.05$ and $p<.001$, respectively.

[a]INQ-TB items were rescored so that greater scores represent greater connectedness

3.1.1 Step 1: The Combination of Pain and Hopelessness Predicts Suicide Desire

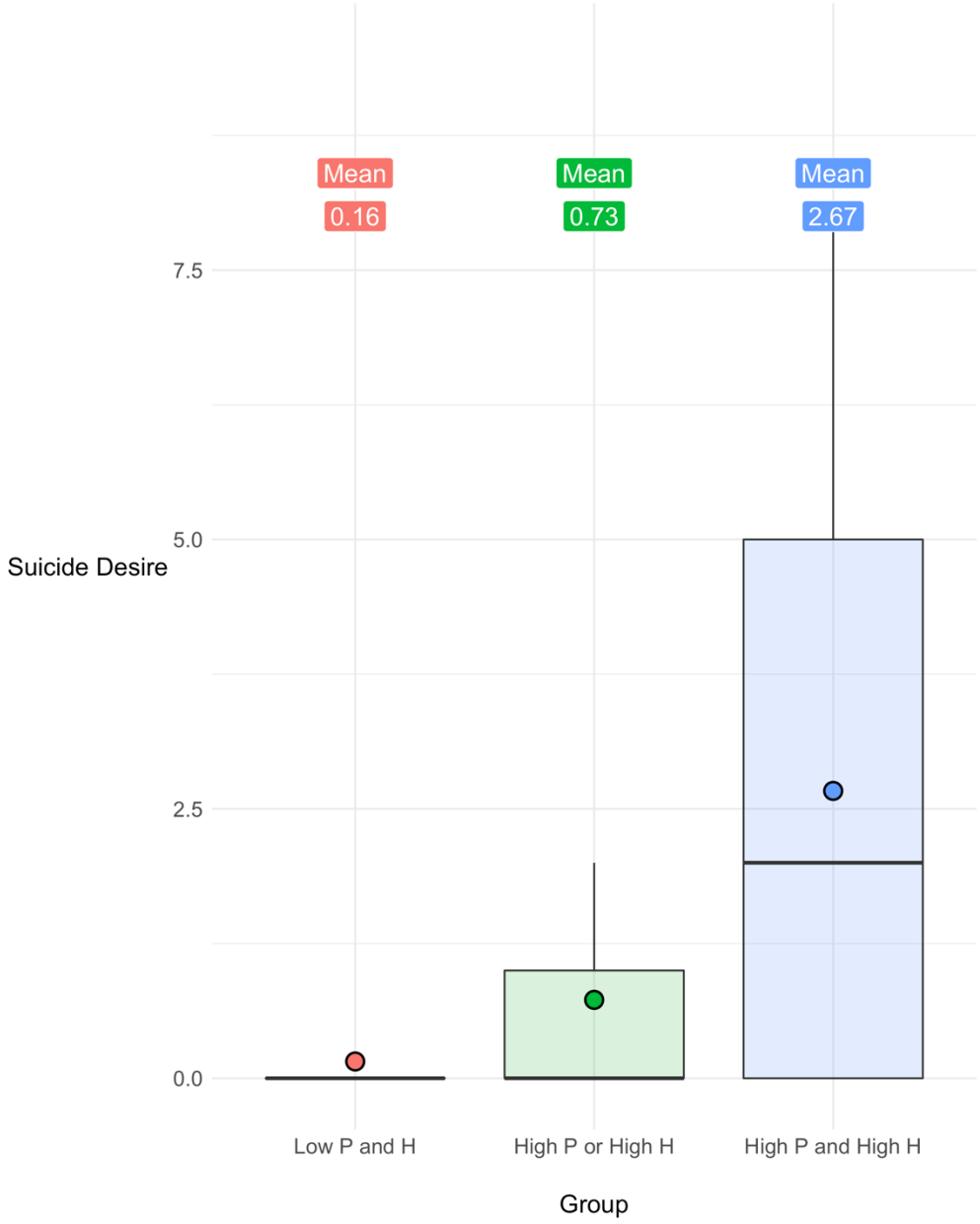
Step 1 of the 3ST proposes that psychache and hopelessness interact to predict suicide desire. Psychache was measured using the total score on the UP3 and hopelessness was measured using the total score on the BHS-SF. Suicide desire was measured using the total score on the BSS-5. First, we conducted preliminary analyses to examine the independent relationship of each of the 3ST step 1 variables to suicide desire using Spearman's rank correlation coefficients. As outlined in n Figure 4.

Figure 4 moderate positive correlations were observed between psychache and suicide desire (UP3 and BSS-5), r_s=.48, p<.001, hopelessness and suicide desire (BHS-SF and BSS-5), r_s=.48, p<.001, as well as between psychache and hopelessness (UP3 and BHS-SF), r_s=.44, p<.001.

Next, we used linear regression analyses to test whether psychache and hopelessness predicted suicide desire when entered into the same model. Results indicated that suicide desire was predicted by both psychache, b=0.22, t(769)=11.71, p<.001, and hopelessness, b=0.51, t(769)=11.55, p<.001, together accounting for 39.9% of the variance, F(2, 769)=255.6, p<.001. We then entered the interaction of psychache and hopelessness into the linear regression model along with the independent predictors. The interaction term of psychache and hopelessness, b=0.07, t(768)=5.92, p<.001, accounted for an additional 2.62% of the variance in suicide desire F(3, 768)=189.6, p<.001, a statistically reliable increase compared to the model without the interaction term. Furthermore, the interaction of psychache and hopelessness remained reliable across models restricted to demographic subgroups, including in males, t(155)=2.76, p<.007, females, t(592)=5.10, p<.001, individuals aged 18-21, t(577)=3.16, p<.001, 22-49, t(179)=3.65, p<.001, Caucasians, t(206)=4.82, p<.001, and East Asians, t(364)=2.02, p=.04.

To visually illustrate the importance of the psychache and hopelessness interaction, median splits were used to create high and low subgroups for psychache and hopelessness. As can be seen in Figure 5, suicide desire is negligible in the (a) low psychache and low hopelessness group as well as the (b) high psychache or high hopelessness group, compared with the (c) high psychache and high pain group.

Figure 5. Interactive Effects of Psychache (P) and Hopelessness (H) on Suicide Desire



Note. Circles indicate mean values; black lines indicate median values;

3.1.2 Step 2: Connectedness Protects Against the Escalation of Suicide Desire in Those with High Psychache and High Hopelessness

Step 2 of the 3ST states that, individuals experiencing high psychache and high hopelessness, connectedness protects against experiencing severe suicide desire when it outweighs the amount of pain an individual experiences. Consistent with step 1, psychache was measured using the UP3 total score and suicide desire was measured using the BSS-5 total score. Connectedness was measured by reverse scoring the items on the INQ-TB (a measure of thwarted belongingness) so that greater scores reflect greater connectedness.

To test whether connectedness is protective against the escalation of suicide desire in a manner consistent with the 3ST, we standardized the connectedness and psychache scores and subtracted the connectedness scores from the psychache scores. Positive scores therefore indicate that one's psychache scores exceed their connectedness scores. Conversely, negative scores indicate that one's connectedness scores exceeds their psychache scores. The correlation of the psychache-connectedness difference score with suicide desire was moderate, r_s=.42, p<.001. We also examined the relationship of connectedness to suicide desire and observed a moderate negative relationship, r_s=-.37, p<.001.

3.1.3 Step 3: Capability for Suicide Facilitates the Transition from Suicidal Ideation to Suicide Attempts

The third step of the 3ST states that suicide attempts are more likely to occur in individuals who have greater capability for suicide. Capability for suicide was measured using the total score on the SCS-3. Three facets of capability (i.e., acquired, dispositional, practical) were measured using the three SCS-3 subscale scores. Responses to question 1 and 3 on the YRBS ("Have you every seriously thought about killing yourself, and "Have you ever tried to

kill yourself?", respectively) was used to differentiate lifetime suicide ideators from suicide attempters

To test whether the capability for suicide facilitates the transition from suicide ideation to suicide attempts, Cohen's *d* effect size differences were calculated comparing lifetime suicide ideators and lifetime suicide attempters. A small effect size difference was obtained on the SCS-3 total score, *d*=0.29, .95CI (0.08 to 0.50), with suicide attempters reporting greater capability for suicide. Examining the three separate facets of capability (i.e., dispositional, acquired, and practical, all measured using the SCS-3 subscales) revealed a small effect size difference on practical capability, *d*=0.43, .95CI(0.22 to 0.64), and negligible effect size differences on dispositional, *d*=0.03, .95CI(-0.18 to 0.24), and acquired, *d*=0.08, .95CI(-0.13 to 0.29), capability. Entering the total and separate facets of capability into individual logistic regression models controlling for current suicide desire (BSS-5) revealed that total, acquired, and dispositional capability scores did not reliably predict lifetime history of suicide attempts, *OR* range=0.99-1.03, *p* range=.06-.90. However, practical capability appeared to reliably predict a lifetime history of suicide attempts, over and above suicide desire, *OR*=1.10, *p*=.001, accounting for between *Psuedo* R^2=.02 (*McFadden*) to *Psuedo* R^2=.04 (*Nagelkerke/Cragg and Uhler*) of the model's predictive ability.

3.2 Testing the NCM Hypotheses

Descriptive statistics for the NCM variables are outlined in Table 5.

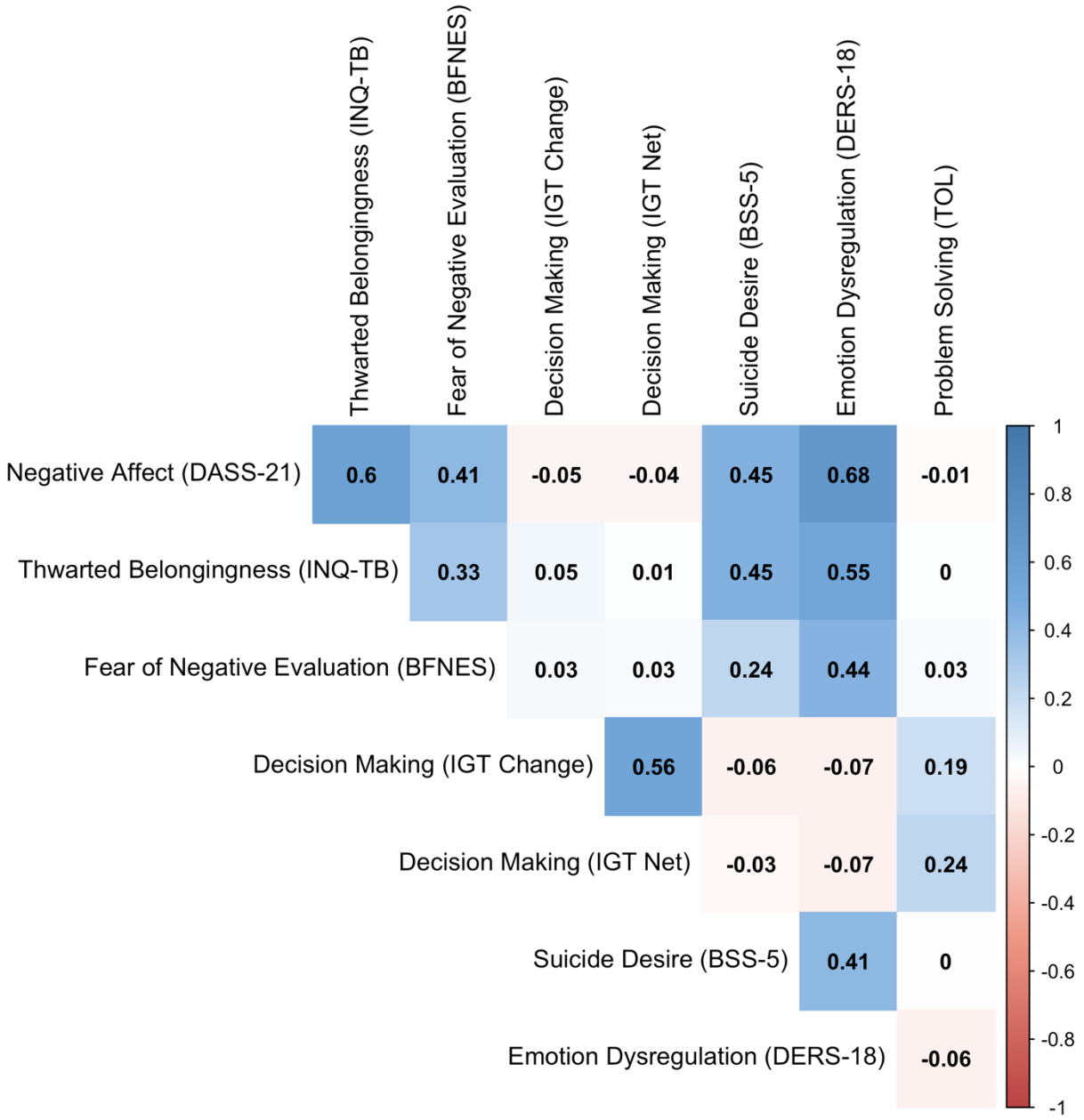
Table 5. Descriptive Statistics and Internal Consistency Reliability for the Neurocognitive Model (NCM)Variables

NCM Step	Construct	Measure	*n*	Mean	SD	Skew	Kurtosis	α
Step 1	Negative Affect	DASS-21	1,005	16.24	12.47	0.84	0.04	.94
	Thwarted Belongingness	INQ-TB	772	16.03	7.09	0.42	-0.51	.88
	Fear of Negative Evaluation	BFNES	375	41.03	10.29	-0.20	-0.60	.92
	Decision Making	IGT-Cha.	976	15.17	11.83	-0.46	-0.20	N/A
		IGT-Net	976	27.99	32.71	-0.48	-0.37	N/A
Step 2	Suicide Desire	BSS-5	1,014	0.92	1.75	2.18	4.26	.85
	Emotion Dysregulation	DERS-18	1,005	42.67	12.71	0.55	-0.15	.91
	Problem Solving	TOL	976	24.75	6.20	-0.35	-0.03	N/A
Step 3	Impulsivity	BRIEF-A-Inh.	1,014	13.08	3.04	0.54	-0.08	.73
		DERS-18-Imp.	1,005	5.44	2.75	1.31	1.40	.90
		FrSBe Dis.	1,013	31.43	7.05	0.25	-0.02	.78
		UPPS-16-Urg.	1,013	9.84	2.59	0.06	-0.34	.74
		UPPS-16-Pers.	1,013	7.48	2.26	0.33	-0.11	.80
		UPPS-16-Prem.	1,013	1.43	2.12	0.31	0.03	.77
		UPPS-16-Sen.	1,013	10.34	3.04	-0.16	-0.77	.79
		Flanker-Con.	976	57.27	21.22	0.32	1.68	N/A
		Flanker-Err.	976	16.84	32.62	7.56	67.83	N/A
		VST-Eff.	972	1.06	0.25	1.10	2.66	N/A
		VST-Err.	972	0.99	1.40	2.60	13.34	N/A

Note. α = Cronbach's Alpha; BFNES = Brief Fear of Negative Evaluation Scale; BRIEF-A-Inh. = Behaviour Rating Inventory of Executive Functions – Adult-Inhibition subscale; BSS-5 = Beck Scale of Suicide Ideation – 5 Item Version; DASS-21 = Depression, Anxiety, and Stress Scale – 21 Item Version; DERS-18 = Difficulties in Emotion Regulation Scale – 18 Item Version; DERS-18-Imp. = Difficulties in Emotion Regulation Scale – 18 Item Version, Impulse subscale; Flanker-Con. = Flanker Conflict Cost; Flanker-Err. = Flanker Errors; FrSBe-Dis. = Frontal Systems Behaviour Scale – Disinhibition subscale; IGT-Cha. = Iowa Gambling Task Change Score; IGT-Net = Iowa Gambling Task Net Score; INQ-TB = Interpersonal Needs Questionnaire – Thwarted Belongingness subscale; N/A = Not Applicable; SD = Standard Deviation; TOL = Tower of London; UPPS-16-Urg. = UPPS Impulsivity Scale – 16-Item Version, Negative Urgency subscale; UPPS-16-Pers. = UPPS Impulsivity Scale – 16-Item Version, Lack of Perseverance subscale; UPPS-16-Prem. = UPPS Impulsivity Scale – 16-Item Version, Lack of Premeditation subscale; UPPS-16-Sen. = UPPS Impulsivity Scale – 16-Item Version, Sensation Seeking subscale; VST-Eff. = Victoria Stroop Task Efficiency; VST-Err. = Victoria Stroop Task Errors.

The intercorrelation matrix for Step 1 and 2 NCM variables is presented in Figure 6.

Figure 6. Intercorrelation Matrix of the Neurocognitive Model of Suicidal Behaviour (NCM) Step 1 and 2 Variables

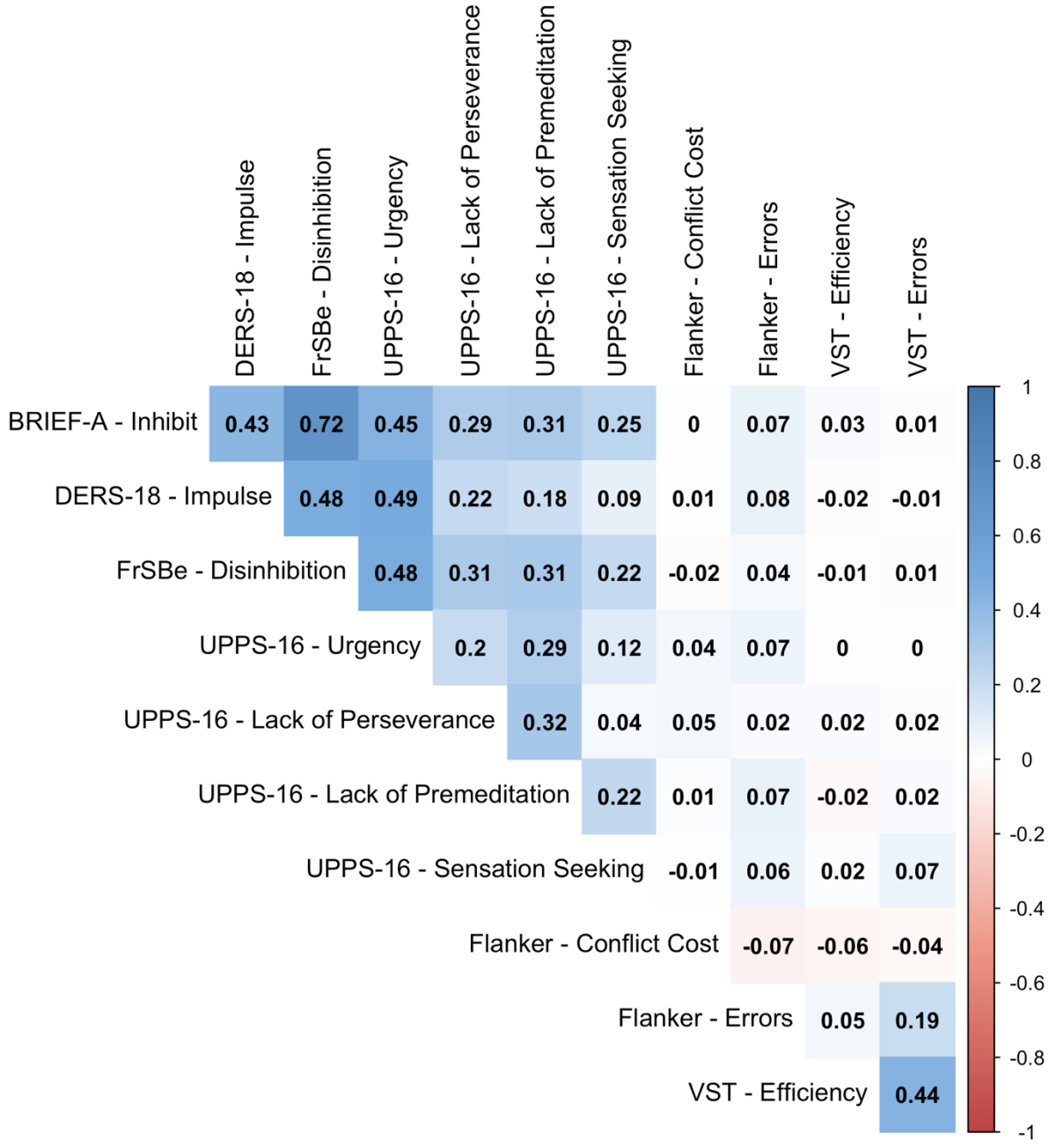


Note. BFNES = Brief Fear of Negative Evaluation Scale; BSS-5 = Beck Scale of Suicide Ideation – 5 Item Version; DASS-21 = Depression, Anxiety, and Stress Scale – 21 Item Version; DERS-18 = Difficulties in Emotion Regulation Scale – 18 Item Version; IGT-Cha. = Iowa Gambling Task Change Score; IGT-Net = Iowa Gambling Task Net Score; INQ-TB = Interpersonal Needs Questionnaire – Thwarted Belongingness subscale; TOL = Tower of London.

Absolute correlation values ≥.06 and ≥.12 are statistically significant at $p<.05$ and $p<.001$

The Intercorrelation matrix for Step 3 NCM variables is presented in Figure 7.

Figure 7. Intercorrelation Matrix of the Neurocognitive Model of Suicidal Behaviour (NCM) Step 3 Variables



Note. BRIEF-A - Inhibit. = Behaviour Rating Inventory of Executive Functions – Adult-Inhibition subscale; DERS-18 - Impulse = Difficulties in Emotion Regulation Scale – 18 Item Version, Impulse subscale; FrSBe – Disinhibition = Frontal Systems Behaviour Scale-Disinhibition subscale; UPPS-16 - Urgency. = UPPS Impulsivity Scale – 16-Item Version, Negative Urgency subscale; UPPS-16 – Lack of Perseverance. = UPPS Impulsivity Scale – 16-Item Version, Lack of Perseverance subscale; UPPS-16 - Premeditation. = UPPS Impulsivity Scale – 16-Item Version, Lack of Premeditation subscale; UPPS-16 – Sensation Seeking. = UPPS Impulsivity Scale – 16-Item Version,

Sensation Seeking subscale; VST - Efficiency = Victoria Stroop Task Efficiency; VST - Errors. = Victoria Stroop Task Errors.

Absolute correlation values ≥.08 and ≥.12 are statistically significant at $p<.05$ and $p<.001$, respectively.

3.2.1 Step 1: History of Suicide Attempt Moderates the Relationship of Social Rejection and Decision-Making to Negative Affect

Step 1 of the NCM proposes that the impact of social rejection and decision-making difficulties result in suicide attempters experiencing greater negative affect than nonattempters. To test this hypothesis, negative affect was measured using the total score on the DASS-21 (which is composed of the depression, anxiety, and stress subscale scores). Social rejection was measured using two scores: (1) the total score of the INQ-TB (a measure of thwarted belongingness) and (2) the total score on the BFNES (a measure of fear of negative evaluation). Because these measures were moderately, but not strongly related (r_s=.33, $p<.001$), we used them as separate measures rather than aggregating them into a single indicator. Similarly, decision making was measured using two related scores (r_s=.56, $p<.001$) from the IGT: (1) IGT Net score (calculated as the sum of choices made from advantageous decks minus choices made from disadvantageous decks) and (2) IGT Change score (the net score obtained on trials 81-100 minus the net score obtained on trials 1-20). Greater IGT Net scores indicate more selections from advantageous decks relative to disadvantageous decks, thereby implying better decision making. Similarly, greater scores on the IGT Change score suggests improved decision making between the first 20 and last 20 IGT trials. Responses to question 3 on the YRBS ("Have you ever tried to kill yourself?") was used to differentiate suicide attempters from never attempters.

First, we examined the interrelationship of the NCM step 1 variables. As outlined in Figure 6, negative affect scores were strongly and moderately correlated with thwarted belongingness scores (DASS-21 and INQ-TB), r_s=.60, $p<.001$, and fear of negative evaluation

scores (DASS-21 and BFNES), r_s=.41, p<.001, which, in turn, were moderately intercorrelated (INQ-TB and BFNES), r_s=.33, p<.001. The two decision making scores (IGT Net and IGT Change) were strongly correlated strongly with one another, r_s =.56, p<.001, but not correlated with negative affect, thwarted belongingness, or fear of negative evaluation scores, r_s *range*=-.05 to .05, *p values*>.05. Next, we examined the extent to which suicide attempters differed on these measures from never attempters. Results revealed moderate effect size differences, with suicide attempters reporting greater negative affect, *d*=0.65, .95CI(0.47 to 0.82), thwarted belongingness, *d*=0.50, .95CI(0.31 to 0.70), and fear of negative evaluation, *d*=0.62, .95CI(0.30 to 0.94). In contrast, negligible effect size differences were obtained on both decision-making scores, *d*=-0.11, .95CI(-0.28 to 0.07; IGT Net) and *d*=-0.17, .95CI(-0.35 to 0.00; IGT Change).

To directly test the hypotheses made by step 1 of the NCM, we conducted a series of linear regression analyses to examine whether the relationship of social rejection (measured using thwarted belongingness and fear of negative evaluation scores) to negative affect is moderated by history of suicide attempts. Specifically, thwarted belongingness scores and fear of negative evaluation scores were entered as individual predictors into separate multivariate linear regression models along with attempter vs. never attempter status to predict negative affect score. Results across both models suggest that all variables significantly predicted negative affect scores, including thwarted belongingness, *b*=1.02, t(769)=20.01, *p*<.001, fear of negative evaluation, *b*=0.49, *t*(769)=8.31, *p*<.001, and attempter vs. never attempter status *b*=4.47, *t*(769)=4.56, *p*<.001 (thwarted belongingness model) and *b*=10.06, *t*(769)=5.35, *p*<.001 (fear of negative evaluation model). The thwarted belongingness model accounted for 38.0% of the variance in negative affect, *F*(2, 769)=235.2, *p*<.001, while the fear of negative evaluation model accounted for 24.3% of the variance, *F*(1,768)=59.64, *p*<.001. However, contrary to the

NCM's step 1 hypotheses, entering the interaction terms into their respective models revealed that both terms were unreliable, b=-0.06, t(768)=-0.46, p=.65 (thwarted belongingness model) and b=0.23, t(370)=1.35, p=.18 (fear of negative evaluation model), and did not explain a further proportion of the variance not already accounted for by the individual predictors, R^2 *Change* <.001, F(1,768)=0.21, p=.65 (thwarted belongingness model) and R^2 *Change* =.004, F(1,370)=1.83, p=.18 (fear of negative evaluation model).

The same series of analyses were used to examine the relationship of decision-making scores to negative affect scores. Results across both models revealed that attempter vs. never attempter status reliably predicted negative affect scores, b=7.85, t(972)=7.16, p<.001 (IGT Net model) and b=7.79, t(972)=7.10, p<.001 (IGT Change model). IGT Net appeared to be slightly less of a reliable predictor of negative affect, b=-0.02, t(972)=-1.83, p=.07, than IGT Change, b=-0.07, t(972)=-2.09, p=.04. Both models accounted for approximately 5.5% of the variance in negative affect, R^2=.054, F(2,972)=27.86, p<.001 (IGT Net model) and R^2=.055, F(2,972)=28.40, p<.001 (IGT Change model). However, and contrary to hypotheses made by the NCM, entering the interaction terms into their respective models revealed that these terms were largely unreliable, b=0.00, t(971)=-0.07, p=.95 (IGT Net) and b=-0.03, t(971)=-0.31, p=.76 (IGT Change), and did not explain a further proportion of the variance not already accounted for by the individual predictors, R^2 *Change*<.001, F(1,971)=0.004, p=.95, (IGT Net model) and R^2 *Change*<.001, F(1,971)=0.09, p=.76 (IGT Change model).

3.2.2 Step 2: Emotion Dysregulation and Planning Difficulties Moderate the Relationship of Negative Affect to Suicide Ideation

Step 2 of the NCM states that suicide ideation emerges as a result of emotion dysregulation and poor problem-solving abilities in the presence of negative affect. To test this

hypothesis, measured suicide ideation using two scores: (1) the BSS-5 total score to measure recent suicide desire and (2) question 1 on the YRBS ("Have you ever seriously thought about killing yourself?) to measure lifetime history of suicide ideation. Emotion dysregulation and problem-solving abilities were measured using the DERS-18 total score and TOL total score, respectively. Consistent with step 1 of the NCM, negative affect was measured using the DASS-21 total score.

Prior to testing NCM step 2 hypothesis, we first examined the interrelationship of the NCM step 2 variables. As outlined in Figure 6 suicide desire scores were moderately correlated with emotion dysregulation scores (BSS-5 and DERS-18), r_s=.41, p<.001, and negative affect scores (BSS-5 and DASS-21), r_s=.45, p<.001, while emotion dysregulation scores and negative affect scores were strongly correlated (DERS-18 and DASS-21), r_s=.68, p<.001. Problem solving (TOL) scores were largely uncorrelated with suicide desire, emotion dysregulation, or negative affect scores (r_s *range*=-.06 to .00, *p range*=.01 to .92). Next, we examined differences according to lifetime history of suicide ideation by comparing lifetime suicide ideators to nonsuicidal participants. Results revealed that suicide ideators obtained greater scores on emotion dysregulation, d=0.59, .95CI(0.45 to 0.73), and negative affect (DASS-21), d=0.62, .95CI(0.48 to 0.77), than nonsuicidal participants . Similarly, negligible differences in problem solving (TOL) were observed between individuals with a lifetime history of suicide ideation and never ideators, d=0.11, .95CI(-0.03 to 0.25).

To directly test the NCM's step 2 hypothesis, emotion dysregulation scores and problem-solving scores were entered into separate logistic regression models along with negative affect to predict lifetime suicide ideation. Across both models, negative affect reliably predicted suicide desire, b=0.05, t(999)=10.03, p<.001 (emotion dysregulation model) and b=0.07, t(969)=18.32,

p<.001 (problem solving model). Emotion dysregulation also predicted suicide desire, b=0.03, t(999)=5.04, p<.001, while problem-solving did not, b=0.01, t(969)=0.79, p=.43. The emotion regulation and problem-solving models accounted for 27.1%, F(2,1002)=186.0, p<.001, and 25.7%, F(2,972)=167.8, p<.001, of the variance in suicide desire, respectively. Entering the interaction terms into their respective models revealed that the interaction of emotion regulation and negative affect was reliable, b=0.00, t(1001)=3.94, p<.001, and explained an additional 1.1% of the variance in suicide desire, F(1,1001)=15.50, p<.001. Similarly, the interaction of problem-solving and negative affect was reliable, b=0.00, t(971)=2.15, p=.03, and explained an additional 0.4% of the variance, F(1,971)=4.61, p=.03.

Next, we tested whether the aforementioned variables would predict lifetime history of suicide ideation. Across both models, negative affect reliably predicted lifetime history of suicide ideation, OR=1.03, p<.001 (emotion dysregulation model) and OR=1.05, p<.001 (problem solving model), as did emotion dysregulation, OR=1.02, p<.001. However, problem solving was not predictive of lifetime suicide ideation, OR=1.00, p=82. The emotion regulation model's predictive ability ranged from *Psuedo* R^2=.06 (*McFadden*) and *Psuedo* R^2=.09 (*Nagelkerke/Cragg and Uhler*) while the problem-solving model's predictive ability ranged from *Psuedo* R^2=.09 (*McFadden*) to *Psuedo* R^2=.13 (*Nagelkerke/Cragg and Uhler*). Both models' predictive ability remained unchanged, even after entering the interaction terms of emotion regulation and negative affect, OR=1.00, p=.24, *Psuedo* R^2 *range*=.07 (*McFadden*) to .10 (*Nagelkerke/Cragg and Uhler*), and problem solving and negative affect, OR=1.00, p>.85, *Psuedo* R^2 *range*=.09 (*McFadden*) to .13 (*Nagelkerke/Cragg and Uhler*) into their respective models.

3.2.3 Step 3: Impulsivity Facilitates the Transition From Suicidal Suicide Ideation to Suicide Attempts

Step 3 of the NCM states that impulsivity predicts the transition from suicidal thoughts to suicide attempts. In the present study, impulsivity was measured using several self-report scores including the BRIEF-A Inhibition subscale, FrSBe Disinhibition subscale, DERS-16 Impulse subscale, the four UPPS impulsivity subscales (i.e., negative urgency, lack of premeditation, lack of perseverance, sensation seeking). Impulsivity was also measured using behavioural measures including the Flanker Task and Victoria Stroop Task (VST). Specifically, greater scores on the Flanker Conflict Cost (the difference in reaction time between conditions when the surrounding arrows are either pointing in the same or opposite direction of the central arrows), Flanker Errors (number of errors in identifying the direction of the central arrows), VST Efficiency (the ratio of time needed to complete the incongruent VST condition divided by the time required to complete the congruent text and colour conditions), and VST Errors (number of errors obtained while completing the entire VST) are thought to indicate greater impulsivity. Rather than selecting a subset of the aforementioned self-report and behavioural scores for analyses, we decided to include all scores in our analyses so as to provide a more comprehensive understanding of the structure of impulsivity as well as its relationship to lifetime histories of suicide ideation and suicide attempts.

We first conducted preliminary analyses on the impulsivity scores obtained from the self-report and behavioural measures of impulsivity. As outlined in Figure 7 examining the interrelationship of the impulsivity variables indicated moderate to strong relationships between the BRIEF-A Inhibit, DERS-18 Impulse, FrSBe Disinhibition, and UPPS-16 Urgency subscales, r_s range=.45 to .72, *all p values*<.001. Negligible to small correlations were observed between

the aforementioned variables and the remaining UPPS-16 subscales, as well as the intercorrelation of the UPPS-16 subscales, r_s range=.04 to .32, *p values range*=.20 to <.001. With the exception of the correlation between the two VST scores (VST efficiency and VST errors, r_s=.44, p<.001) none of the correlations for the behavioural measures exceeded r_s=.08. Next, we examined mean differences in impulsivity scores between lifetime suicide ideators and lifetime suicide attempters. The largest effect size differences were obtained on the BRIEF-A Inhibit scale, *d*=0.33, .95CI(0.14 to 0.52), FrSBe Disinhibition scale, *d*=0.28, .95CI(0.09 to 0.47), UPPS-16 Urgency and Sensation Seeking subscales, *d*=0.23, .95CI(0.04 to 0.42) and *d*=0.23, .95CI(0.04 to 0.42), respectively, with lifetime attempters obtaining greater scores than lifetime ideators on these measures. In contrast, negligible differences were observed on the behavioural measure (i.e., Flanker and VST) scores, *d range*=-.09 to .05. All effect size differences are outlined in Table 6.

Table 6. Cohen's d effect size differences between lifetime suicide ideators and lifetime suicide attempters on measures of impulsivity

Construct	Measure	Attempter vs. Ideator (*Cohen's d [.95CI]*)
Impulsivity	BRIEF-A-Inh.	0.33 (0.14 to 0.52)
	DERS-18-Imp.	0.20 (0.01 to 0.39)
	FrSBe Dis.	0.28 (0.09 to 0.47)
	UPPS-16-Urg.	0.23 (0.04 to 0.42)
	UPPS-16-Pers.	0.05 (-0.14 to 0.24)
	UPPS-16-Prem.	0.17 (-0.02 to 0.36)
	UPPS-16-Sen.	0.23 (0.04 to 0.42)
	Flanker-Con.	0.05 (-0.14 to 0.25)
	Flanker-Err.	-0.09 (-0.28 to 0.10)
	VST-Eff.	0.01 (-0.18 to 0.20)
	VST-Err.	-0.06 (-0.25 to 0.13)

Note. .95CI = 95% Confidence Interval; BRIEF-A-Inh. = Behaviour Rating Inventory of Executive Functions – Adult, Inhibition subscale; DERS-18-Imp. = Difficulties in Emotion Regulation Scale – 18 Item Version, Impulse subscale; Flanker-Con. = Flanker Conflict Cost; Flanker-Err. = Flanker Errors; FrSBe-Dis. = Frontal Systems Behaviour Scale-Disinhibition subscale; UPPS-16-Urg. = UPPS Impulsivity Scale – 16-Item Version, Negative Urgency subscale; UPPS-16-Pers. = UPPS Impulsivity Scale – 16-Item Version, Lack of Perseverance subscale; UPPS-16-Prem. = UPPS Impulsivity Scale – 16-Item Version, Lack of Premeditation subscale; UPPS-16-Sen. =

UPPS Impulsivity Scale – 16-Item Version, Sensation Seeking subscale; VST-Eff. = Victoria Stroop Task Efficiency; VST-Err. = Victoria Stroop Task Errors.

A series of factor analyses were conducted on the impulsivity scores reported by lifetime suicide ideators and suicide attempters to better understand the latent structure of impulsivity. First, we examined the extent to which the impulsivity scores were suitable for factor analysis. Calculating Bartlett's test of sphericity on the correlation matrix of the impulsivity items indicated that the correlations between the impulsivity items were sufficiently large for factor analysis, $\chi^2(55)=1219.76$, $p<.001$. The Keiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) verified the sampling adequacy for the analysis, KMO=.73 ("good", according to Field et al., 2012). However, examining the KMO values for the individual items revealed that while the KMO values for the self-report items ranged from .74 to .81 ("good" to "great", according to Field et al., 2012), KMO values for three of the four behavioural measures (Flanker Errors [KMO=.47], VST Efficiency [KMO=.48], and VST Errors [KMO=.48]) were below or equal to.50, suggesting that they are likely unsuitable for factor analysis (Dziuban & Shirkey, 1974; Kaiser, 1970; Kaiser & Rice, 1974). Removing these items resulted in further reduction in KMO for the fourth behavioural measure item (Flanker Conflict Cost [from KMO=.51 to KMO=.44]), while the KMO values for the other items remained unchanged. Given the exploratory nature of these analyses, it was decided to conduct separate factor analyses on (1) all the impulsivity items, regardless of individual item KMO scores, and (2) on the impulsivity items with KMO scores above .50 (i.e., the self-report items).

Entering all the impulsivity scores into a factor analysis using maximum likelihood factoring and oblimin rotation resulted in four eigenvalues >1: (1) 3.01, (2) 1.49, (3) 1.22, and (4) 1.03. Visual inspection of the scree plot indicated either a two- or four-factor structure.

Examining chi-square values suggested that a four-factor structure represented the best fit for the data since a five-factor structure resulted in a *p value* >.05. Parallel analyses on the complete and reduced correlation matrices identified three factors, as did results from applying the very simple structure criteria. The loadings of the impulsivity scores were next examined in models composed of 1-4 factors. A three-factor model was ultimately decided as the best fit for the data, in part because it was recommended by the two parallel analyses and very simple structure criterion (described above), and also because the factor solutions (described below) resulted in conceptually interpretable constructs.

Table 7 outlines factor loadings, factor intercorrelations, and fit indices for the three and one factor models.

Table 7. Impulsivity Factor Analysis Results

Construct	Measure	All Impulsivity Scores			Self-Report Impulsivity Scores
		Factor 1 (Inhibit)	Factor 2 (VST)	Factor 3 (Negative Affect Imp.)	Factor 1 (Self-Reported Impulsivity)
Impulsivity	BRIEF-A-Inh.	.919			.820
	DERS-18-Imp.			.623	.556
	FrSBe Dis.	.747		.134	.868
	UPPS-16-Urg.			.821	.625
	UPPS-16-Pers.	.241			.319
	UPPS-16-Prem.	.211		.234	.401
	UPPS-16-Sen.	.312			.305
	Flanker – Con.	-.200		.247	--
	Flanker – Err.			-.100	--
	Stroop – Eff.		.997		--
	Stroop – Err.		.480	.115	--
		Factor 1	Factor 2	Factor 3	Factor 1
Factor intercorrelation (r_s)	Factor 1		-.03	.77	.98
	Factor 2			-.05	-.04
	Factor 3				.84
		df	value	*p* value	(df), value, *p* value
Fit indices	Chi-square (χ^2)	44	83	<.001	(14)=116, *p*<.001
	RMSEA		.066		.117
	RMSA		.04		.07
	TLI		.89		.85

Note. BRIEF-A-Inh. = Behaviour Rating Inventory of Executive Functions – Adult-Inhibition subscale; DERS-18-Imp. = Difficulties in Emotion Regulation Scale – 18 Item Version, Impulse subscale; Flanker-Con. = Flanker Conflict Cost; Flanker-Err. = Flanker Errors; FrSBe-Dis. = Frontal Systems Behaviour Scale-Disinhibition subscale; Negative Affect Imp. = Negative Affect Impulsivity factor; RMSA = Root Mean Square of the Residuals; RMSEA = Root Mean Square Error of Approximation; Stroop-Eff. = Stroop Efficiency; TLI=Tucker Lewis Index of Factoring Reliability; UPPS-16-Urg. = UPPS Impulsivity Scale – 16-Item Version, Negative Urgency subscale; UPPS-16-Pers. = UPPS Impulsivity Scale – 16-Item Version, Lack of Perseverance subscale; UPPS-16-Prem. = UPPS Impulsivity Scale – 16-Item Version, Lack of Premeditation subscale; UPPS-16-Sen. = UPPS Impulsivity Scale – 16-Item Version, Sensation Seeking subscale; VST-Eff. = Victoria Stroop Task Efficiency; VST-Err. = Victoria Stroop Task Errors.

Absolute correlation values >.05 statistically significant at $p<.001$, respectively.

Examining the factor loadings revealed that the BRIEF-A Inhibition and FrSBe Disinhibition subscale scores appeared to load most strongly on factor 1 (.92 and .75, respectively; “Inhibition” factor). The two VST scores were the only items to load onto the factor 2 (“VST” factor), while the UPPS-16 Negative Urgency and DERS-18 Impulse subscales loaded strongly onto factor 3 (.63 and .56, respectively; “Negative Affect Impulsivity” factor). All other impulsivity scores (i.e.., the remaining UPPS-16 subscales and Flanker scores) did not load strongly (<.40) onto any of the factors. The Inhibition factor correlated, r_s=-.03, p=.52, with the VST factor and, r_s=.77, p<.001,with the Negative Affect Impulsivity factor, while the correlation between the VST and Negative Affect factors was, r_s=-.05, p=.23.

Entering all the self-report impulsivity items into a factor analysis using maximum likelihood factoring and oblimin rotation resulted in two eigenvalues greater than 1: [1] 3.02 and [2] 1.02. Parallel analyses on the complete and reduced correlation matrices identified one factor, as did visual inspection of the scree plot. As outlined in Table 7 with the exception of the UPPS-16 Lack of Perseverance and Sensation Seeking subscales, all self-report impulsivity items loaded strongly onto the single factor (i.e., loadings >.40; “Self-Reported Impulsivity”), with the greatest loadings obtained for the FrSBe Disinhibition and BRIEF-A Inhibition subscales (.87 and .82, respectively). The single Self-Reported Impulsivity factor correlated r_s=.98, p<.001, with the Inhibition factor, r_s=-.04, p=.35, with the VST factor, an r_s=.84, p<.001, with the Negative Affect Impulsivity factor.

Next, we examined the mean differences between lifetime ideators and attempters on the factors of impulsivity. Suicide attempters scored higher on three factors, including the Inhibition factor, d=0.32, .95CI(0.13 to 0.52), Negative Affect Impulsivity factor, d=0.30, .95CI(0.11 to 0.49), and Self-Reported Impulsivity factor, d=0.34, .95CI(0.15 to 0.53). Negligible differences

were obtained on the VST factor, *d*=0.02, .95CI(-0.18 to 0.21). To better understand the relationship of the impulsivity factors to lifetime suicide attempts, we entered these factors into separate logistic regression models along with recent suicide desire (BSS-5) as a covariate. Results from these models indicated that lifetime suicide attempter status (vs. lifetime suicide ideator status) was predicted by the Inhibit, *OR*=1.36, *p*=.005, Negative Affect, *OR*=1.35, *p*=.01, and Self-Report Impulsivity factors, *OR*=1.37, *p*=.003, over and above suicide desire. The VST factor was not predictive of lifetime suicide attempter status, *OR*=1.03, *p*=79, over and above suicide desire.

3.3 Testing Hypotheses Across Perspectives

3.3.1 Suicide Desire and Ideation

A linear regression model was created to better understand the association of the 3ST and NCM variables to suicide desire. Specifically, the interaction of psychache (UP3) and hopelessness (BHS-SF) was entered alongside the interaction of negative affect (DASS-21) and emotion dysregulation (DERS-18) and negative affect (DASS-21) and problem solving (TOL) to predict suicide desire (BSS-5). the model accounted for 40.6% of the variance in suicide desire, $F(3,722)=164.3$, $p<.001$. Examining the independent variables revealed that that the interaction of hopelessness and psychache, $b=0.07$, $t(722)=13.65$, $p<.001$, and negative affect and emotional dysregulation, $b=0.00$, $t(722)=3.58$, $p<.001$ were reliably associated with suicide desire. In contrast, the interaction of negative affect and problem solving was not, $b=0.00$, $t(722)=-0.29$, $p=.77$. Results of these analyses are outlined in Table 8.

Table 8. Linear Regression of 3ST and NCM Interaction Variables Predicting Suicide Desire (BSS-5)

Perspective	Construct	Measure/s	Estimate (*b*)	SE of *b*	*β*	*t* value	*p* value
	Intercept		-4.88	0.07		-65.20	<.001
3ST	Hopelessness by Psychache	BHS-SF x UP3	0.07	0.01	0.50	13.65	<.001
NCM	Negative affect by Emotion dysregulation	DASS-21 x DERS-18	0.00	0.00	0.21	3.58	<.001
NCM	Negative affect by Problem solving	DASS-21 x TOL	0.00	0.00	-0.02	-0.29	.77

Note. 3ST = Three-Step Theory; BHS-SF = Beck Hopelessness Scale – Short Form; BSS-5 = Beck Scale of Suicide Ideation – 5 Item Version; DASS-21 = Depression, Anxiety, and Stress Scale – 21 Item Version; DERS-18 = Difficulties in Emotion Regulation Scale – 18 Item Version; NCM = Neurocognitive Model; TOL = Tower of London task; UP3 = Unbearable Psychache Scale.

Next, to better understand the relationship of the 3ST and NCM variables to lifetime history of suicide ideation, a logistic regression model was created using the 3ST and NCM interaction terms. Examining the results revealed that only the interaction of psychache and hopelessness was reliably associated with lifetime history of suicide attempts, *OR*=1.04, *p*=0.003, with the predictive properties of the model ranging from *Pseudo* R^2=.35 (*McFadden*) to *Pseudo* R^2=.58 (*Nagelkerke/Cragg and Uhler*). Results of these analyses are outlined in Table 9.

Table 9. Logistic Regression of 3ST and NCM Interaction Variables Predicting Lifetime History of Suicide Ideation

Perspective	Construct	Measure/s	Estimate (*b*)	SE of *b*	*OR*	*p* value
	Intercept		-0.84	0.13		<.001
3ST	Hopelessness and Psychache	BHS4 x UP3	0.04	0.01	1.04	.003
NCM	Negative affect by Emotion dysregulation	DASS-21 x DERS-18	0.00	0.00	1.00	.25
NCM	Negative affect by Problem solving	DASS-21 x TOL	0.00	0.00	1.00	.15

Note. 3ST = Three-Step Theory; BHS-SF = Beck Hopelessness Scale – Short Form; BSS-5 = Beck Scale of Suicide Ideation – 5 Item Version; DASS-21 = Depression, Anxiety, and Stress Scale – 21 Item Version; DERS-18 = Difficulties in Emotion Regulation Scale – 18 Item Version; NCM = Neurocognitive Model; TOL = Tower of London task; UP3 = Unbearable Psychache Scal

3.3.2 Suicide Attempts

To test the association of the 3ST and NCM variables to lifetime history of suicide attempts, a logistic regression model was created. The three Capability for Suicide (SCS-3) subscales (acquired, dispositional, and practical) were entered alongside the three factor-analytically derived impulsivity factors (i.e., Inhibit, VST, Negative Affect) to predict lifetime suicide attempter status. The predictive properties of the model ranged from *Psuedo* R^2=.26 (*McFadden*) to *Psuedo* R^2=.43 (*Nagelkerke/Cragg and Uhler*). Examining the individual predictors in the model revealed that only the SCS-3 Practical capability subscale predicted lifetime history of suicide attempts, over and above suicide desire, *OR*=1.10, *p*=.003. Results remained unchanged even after entering the fourth factor-analytically derived impulsivity subscale (Self-Reported Impulsivity), *OR*=0.67, *p*=.73, into the logistic regression model, *Psuedo* R^2 *range*=.26 (*McFadden*) to .43 (*Nagelkerke/Cragg and Uhler*). The results of these analyses are outlined in Table 10.

Table 10. Logistic Regression of 3ST and NCM Variables in Predicting Lifetime Suicide Attempts

Perspective	Construct	Measure/s	Estimate (*b*)	SE of *b*	*OR*	*p* value
	Intercept		-1.43	0.38	0.25	<.001
	Suicide Desire	BSS-5	0.07	0.06	1.08	.20
3ST	Capability for Suicide – Acquired	SCS-3-A	-0.02	0.05	0.98	.62
3ST	Capability for Suicide – Dispositional	SCS-3-D	-0.01	0.04	0.99	.78
3ST	Capability for Suicide – Practical	SCS-P	0.10	0.03	1.10	.003
NCM	Impulsivity Factor – Inhibition	Inhibit factor	0.07	0.20	1.11	.61
NCM	Impulsivity Factor – VST	Stroop factor	0.05	0.11	1.05	.64
NCM	Impulsivity Factor – Negative Affect	Negative Affect	0.22	0.20	1.20	.38
	Impulsivity	Impulsivity factor				

Note. 3ST = Three-Step Theory; BSS-5 = Beck Scale of Suicide Ideation – 5 Item Version; NCM = Neurocognitive Model; SCS-3-A = Suicide Capability Scale – Acquired Capability subscale; SCS-3-D = Suicide Capability Scale – Dispositional Capability subscale; SCS-3-P = Suicide Capability Scale – Practical Capability subscale; VST = Victoria Stroop Ta

Chapter 4: Discussion

The present study empirically tested the hypotheses made by Klonsky and May's (2015) Three-Step Theory (3ST) and Jollant et al.'s (2011) Neurocognitive Model of Suicide Behaviour (NCM) in a large sample of university students (n=1,014). To our knowledge, this study represents the first to compare a psychological theory of suicide (i.e., the 3ST) with a model that integrates both psychological and neurocognitive factors (i.e., the NCM). Furthermore, this study is also the first study to test the hypotheses posited by the NCM and is the largest study to date examining the relationship of neurocognitive functioning to suicide ideation and attempts in university students. This study therefore addresses important gaps in the literature.

4.1 Support for the 3ST Hypotheses

The results of the present study support several of the hypotheses made by the 3ST. For example, the first step of the 3ST states that the *combination* of pain and hopelessness is required to produce suicide desire. Findings from the present study support this hypothesis. Specifically, the interaction of pain and hopelessness was found to reliably account for additional variance in suicide desire over and above the individual predictors. Furthermore, the interaction of psychache and hopelessness remained reliable when examined within gender, ethnicity, and specific age range subgroups. As illustrated in Figure 5, suicide desire appears to be present primarily in individuals with high psychache and high hopelessness, with negligible to no suicide desire being present in groups not high on both psychache and hopelessness.

The results from the present study also largely align with results reported by previous studies examining the 3ST hypotheses (Dhingra et al., 2019; Klonsky & May, 2015; Pachkowski et al., 2021; Tsai et al., 2020). This includes the proportion of variance accounted by the interaction of psychache and hopelessness (2.6% in this study vs. 1-4% in the aforementioned

studies), the entire model (42.5% vs. 12-68%), as well as the relationship of psychache (r_s=.48 [Spearman] or *r*=.54 [Pearson] vs. *r*=.33-.77 [Pearson]) and hopelessness (r_s=.48 [Spearman] or *r*=.54 [Pearson] vs. *r*=.30-.77 [Pearson]) with suicide desire. Of note, the magnitude of the variance accounted for by the interaction of pain and hopelessness (2.6%), as well as the independent relationship of psychache and hopelessness with suicide desire (*r*=54 and *r*=.54 [both Pearson], respectively), in the present study are consistently greater than those reported by Yang et al. (2019; 1% of variance, *r*=.33 and *r*=.30, respectively), roughly equal to those reported by Klonsky and May (2015; 3% of variance, *r*=.55 and *r*=.57, respectively), Dhingra et al. (2019; 3% of variance, *r*=.64 and *r*=.67, respectively), and Pachkowski et al. (2021; 3% of variance, *r*=.64 and *r*=.67, respectively) and consistently lower than the results reported by Tsai et al. (2020; 4% of variance, *r*=.71 and *r*=.77, respectively).

One potential explanation for this pattern might be the clinical severity of the samples recruited. For example, Yang et al. (2019) noted that: "the relatively small number of suicide attempters in the current study may contribute to the discrepancy in the explanatory power of the first step of 3ST on the suicide ideation" (p.656) as a possible explanation for the consistently smaller effects sizes reported in their study. Recruiting a sample composed largely of nonsuicidal and/or non-clinical participants is likely to lead to infrequent endorsement of the 3ST step 1 measures (e.g., hopelessness, psychache, suicide desire) which, in turn, could result in the attenuation of the inter-relationship between the 3ST step 1 measures (i.e., the "restricted range" problem; Salkind, 2012). Conversely, having a greater proportion of participants with a history of suicide attempts and/or psychopathology is likely to result in a greater range of scores being reported which, in turn, might result in observing stronger inter-relationships between the 3ST step 1 variables.

Indeed, across studies examining the hypothesis made by step 1 of the 3ST, the magnitude of results is consistently greatest in the study by Tsai et al. (2020), which recruited the most clinically severe sample. Specifically, Tsai et al. (2020) recruited 190 psychiatric inpatients diagnosed with schizophrenia spectrum disorders or psychosis (62%), bipolar affective disorders (21%), major depressive disorders (23%), and personality disorders (28%). Although none of the other studies reported the prevalence of psychiatric diagnoses in their samples, the same studies recruited participants from community and university samples, which have lower prevalence rates of psychiatric diagnoses compared with inpatient and outpatient psychiatric settings (Ellison et al., 2018). Furthermore, the sample recruited by Tsai et al. (2020) had the greatest proportion of suicide attempters (57%, *n*=108) compared to the other studies (14%, *n*=127, Klonsky & May, 2015; 24%, *n*=160, Dhingra et al., 2019; 3.83%, *n*=42, Yang et al., 2019; 14.8%, *n*=150, present study).

In addition to less restricted range of scores, the strong inter-relationship of the 3ST step 1 variables observed in Tsai et al. (2020) could result due to selection bias. Specifically, hopelessness and suicidal desire not only represent diagnostic criteria for common psychiatric conditions (e.g., major depressive disorder) but are also frequently assessed in acute psychiatric settings as predictors of future self-harm and suicide attempts. Individuals who report greater hopelessness or suicide desire are more likely to be admitted to psychiatric inpatient units, which might explain the larger effect sizes observed by Tsai et al. (2020). Relatedly, it is possible that the interrelationship of the 3ST variables depends on the presence of one or more "third-variables" (e.g., other symptoms of depression, such as loss of interest in pleasurable activities or difficulties sleeping) that may moderate the relationship of the 3ST step 1 variables to one another. For example, loss of interest in activities may moderate the relationship of hopelessness

to psychache, which in turn will influence the interaction of hopelessness and psychache to suicide desire. The presence of these third variables in more clinically severe samples may therefore explain the more pronounced results reported for the 3ST step 1 variables, as observed by Tsai et al. (2020).

A second interpretation of the 3ST step 1 results is that, to some extent, the strength of the association between the 3ST step 1 variables might be language and/or culture-specific. Specifically, the sample recruited by Yang et al. (2019) is unique in that it is the only non-Western and non-English speaking sample of the 3ST studies. It is therefore possible that the differences are due to cultural differences between China and Western countries, including a greater tendency for Chinese individuals to be more emotionally reserved, introverted, overly considerate, and self-restrained (Law & Liu, 2008). Greater levels of introversion and self-restraint could impact the reporting, and thereby the interrelationship, of the 3ST step 1 variables. Similarly, the high emphasis placed on personal honour – including the fear of 'losing face' – might represent a unique cultural contributor for the development of suicide ideation that is less present in Western cultures (Zhang et al., 2004). For example, 'losing face' may be associated with experiencing subsequent feelings of guilt and shame, which may be less related to either psychache or hopelessness, but still associated with developing suicide desire. Cultural differences might also account for the relatively smaller magnitude of findings reported by the present study when compared to those reported by Klonsky and May (2015), Dhingra et al. (2019) and Tsai et al. (2020) since, in the present study, the proportion of East Asian participants (n=484, 48.6%) is far greater than the proportion of East Asian participants recruited by Klonsky and May (2015; n=73, 8%), Dhingra et al. (2019; n=80, 12.1%), or Tsai et al. (2019; n=42, 22%). Similarly, the proportion of participants who endorsed English as their primary language

was 65.2% (n=661) in the present study, which was much lower than the 100% of participants who reported English as their first language in Tsai et al. (2020). Unfortunately, neither Klonsky and May (2015) nor Dhingra et al. (2019) report the proportion of English speakers in their samples.

The present study also found support for the hypothesis made by the second step of the 3ST, namely that connectedness is protective against intensifying suicide ideation when it outweighs the amount of psychache a person experiences. The magnitude of the effect observed in this study is (r_s=.42 or r=.47 [Pearson]) is largely comparable to the results obtained from previous studies (r=.47, Klonsky & May, 2015; r=46, Dhingra et al., 2019; r=.34, Yang et al., 2019; r=.64, Tsai et al., 2020; r=.58 [Time 1] and r=.62 [Time 2], Pachkowski et al., 2021). Examining the magnitude of the results across the 3ST studies suggests that pattern of results for step 2 is similar to the pattern of results observed for step 1 (i.e., smallest magnitude reported by Yang et al., 2019; largest magnitude reported by Tsai et al., 2020). Given the similarities, the same interpretations (i.e., clinical severity of sample, cultural differences) are offered to explain the differences in magnitude obtained across studies.

The results of the present study also appear to support the hypothesis made by step 3 of the 3ST, whereby capability for suicide is thought to facilitate the transition from suicidal thoughts to suicidal acts. Indeed, participants in the study with a lifetime history of suicide attempts reported having greater capability to attempt suicide than participants with a lifetime history of suicide ideation but no history of attempts (d=0.23). This difference appeared to be largely due to differences in practical (d=0.43), but not acquired (d=0.08) or dispositional (d=0.03), capability. Although capability for suicide was not associated with lifetime history of

suicide attempts after controlling for suicide desire, practical capability retained its relationship with lifetime history of suicide attempts even after controlling for suicide desire.

Some of the results from the present study align with those obtained from previous studies that examined step 3 of the 3ST (Dhingra et al., 2019; Klonsky & May, 2015; Tsai et al., 2020; Yang et al., 2019). For example, across the four studies, capability for suicide was observed to differentiate suicide attempters from suicide ideators, with small-moderate effect sizes (*d*=0.23, present study; *d*=0.42, Klonsky & May, 2015; *d*=0.72, Dhingra et al. 2019; *d*=0.52, Yang et al., 2019; and *d*=0.47, Tsai et al. 2020). Similarly, practical capability consistently differentiated suicide attempters from suicide ideators (*d*=0.43, present study; *d*=0.23, Klonsky & May, 2015; *d*=0.87, Dhingra et al., 2019; *d*=0.56, Yang et al., 2019) and remained associated with lifetime history of suicide attempts even after controlling for suicide desire (Dhingra et al., 2019; Klonsky & May, 2015; Yang et al., 2019).

In contrast, mixed results were observed examining the relationship of capability for suicide with lifetime suicide attempts after controlling for suicide desire. Specifically, two studies reported that capability for suicide continued to predict lifetime suicide attempts (Klonsky & May, 2015; Dhingra et al., 2019), while results from the present study and those reported by Yang et al. (2019) failed to replicate that finding. Similarly, mixed results were obtained for acquired (*d*=0.08, present study; *d*=0.38, Klonsky & May, 2015; *d*=0.48, Dhingra et al., 2019; reported as nonsignificant, Yang et al., 2019), and dispositional (*d*=0.03, present study; *d*=0.29, Klonsky & May, 2015; *d*=0.29, Dhingra et al., 2019; reported as nonsignificant, Yang et al., 2019) capability in differentiating lifetime suicide attempters from lifetime suicide ideators, with results from the present study aligning with those reported by Yang et al. (2019). Furthermore, the relationship of acquired and dispositional capability to lifetime history of

suicide attempts after controlling for the presence of suicide desire was found to be present for both by Klonsky and May (2015), just for acquired capability by Dhingra et al. (2019), and for neither by Yang et al. (2019), consistent with the results of the present study.

Unlike the previous studies, Tsai et al. (2020) examined differences in capability for suicide between lifetime suicide attempters and never attempters (not lifetime ideators). Their results therefore cannot be directly compared to the results obtained from the aforementioned studies. However, the study by Tsai et al. (2020) is notable because it is the only study to use a longitudinal design, and therefore the only study capable of examining the predictive properties of capability for suicide. The results reported by Tsai et al. (2020) indicate that capability for suicide at baseline differentiated inpatients who subsequently attempted suicide after 3 months from those who did not attempt suicide (d=.59), though that relationship appeared to be accounted for by concurrent suicide desire. Examining the specific facets of capability revealed that practical capability at baseline strongly differentiated inpatients who later attempted suicide from those that did not three months later (d=0.90). Furthermore, practical capability remained predictive of future suicide attempts even after controlling for the presence of suicide desire at baseline, and also predicted future suicide attempts when examined only among inpatients with a previous history of suicide attempts (d=0.75). In contrast, neither acquired nor dispositional capability predicted future suicide attempts after accounting for the presence of suicide desire (effect sizes not reported).

Taken together, the results from the present and previous 3ST studies provide support for the hypothesis made by step 3 of the 3ST, namely that capability for suicide facilitates the transition from suicidal thoughts to suicidal acts. Specifically, overall capability for suicide appears to differentiate suicide attempters from both suicide ideators and never attempters, with

suicide desire accounting for a proportion of this relationship. However, the results across all studies provide strong support for the role of practical capability in predicting suicide attempts. Unlike acquired or dispositional capability, practical capability not only differentiated suicide attempters from suicide ideators and never attempters cross-sectionally, but also predicted future suicide attempts 3 months later, over and above baseline suicide desire (Tsai et al., 2020). Furthermore, practical capability at baseline continued to predict future suicide attempts at 3 months even when restricted to participants with a history of suicide attempts. These results therefore emphasize the importance of practical capability to future suicide attempts.

More broadly, the results from the present and previous 3ST studies align with findings from other studies highlighting the close relationship of practical capability (i.e., knowledge about acquiring and using lethal means) to fatal and nonfatal suicide attempts. For example, in a large sample of National Guard service members (n=2,292), firearm ownership and increased firearm familiarity were associated with practical capability for suicide (d=0.47 and r=.25, respectively; Goldberg et al., 2019). Individuals with greater practical capability for suicide were more likely to store their firearms unsafely (i.e., loaded, in a non-secure location, without a locking device; Butterworth et al., 2018), which in turn was related to a greater likelihood of making a future suicide attempt (Anestis et al., 2020). Even among suicide attempt survivors, handgun ownership was found to moderate the relationship of past-week suicidal ideation and likelihood of attempting suicide, with a stronger relationship observed in individuals who own one or more handguns (Houtsma & Anestis, 2017). Finally, a recent cohort study of 26.3 million residents of California followed over 12 years indicated that male and female handgun owners had 3.34 and 7.16 times higher suicide rates by any method, respectively, than non-handgun owners (Studdert et al., 2020). The increased suicide rate was largely accounted for by handgun

ownership, with male and female handgun owners being far more likely (7.82 and 35.15 times, respectively) to die by suicide using a handgun than non-handgun owners, with no differences between handgun owners and no-handgun owners in suicide rates using other methods. Taken together, these results suggest that knowledge and access to lethal means (i.e., practical capability) is strongly associated with lifetime history of suicide attempts and is highly predictive of future suicide attempts.

4.2 Support for the NCM Hypotheses

Results from the present study provide mixed support for the hypotheses made by the NCM. For example, step 1 of the NCM posits that social rejection and impaired decision-making result in suicide attempters experiencing greater negative affect than non-attempters. Preliminary analyses conducted in the present study examining the NCM step 1 variables indicated moderate-large correlations between social rejection (measured separately as thwarted belongingness and fear of negative evaluation) and negative affect (r_s=.60 and r_s=.41, respectively), whereas impaired decision-making (measured using two scores from the Iowa Gambling Task [IGT]) appeared largely unrelated (r_s *range*= -.05 to .05). Examining differences on these variables by history of suicide attempts revealed that suicide attempters reported greater negative affect, thwarted belongingness, and fear of negative evaluation (*d* range=0.50 to 0.65) than never attempters, with negligible differences on measures of impaired decision making (*d* range=-0.17 to -0.11). In a direct test of the NCM step 1 hypothesis, history of suicide attempts did not moderate the relationship between social rejection or impaired decision-making and negative affect. The results of the present study therefore suggest that, while suicide attempters appear to differ from never attempters on several of the NCM step 1 variables, the relationship of social rejection and impaired decision making to negative affect does not appear to be influenced by

history of suicide attempts. It is therefore possible that suicide attempters and non-attempters experience approximately equal negative affect resulting from social rejection and impaired decision making.

Some of the results of the present study align with those reported in the research literature. For example, previous studies have reported that suicide attempters experience greater negative affect (Stein et al., 1998) and social rejection (Campos & Holden, 2015; Klein & Golub, 2016; Olié & Courtet, 2020) than never attempters. In contrast, the difference in decision making abilities between suicide attempters and never attempter reported in the present study (*d*=-0.11, .95CI[-0.28 to 0.07]) is smaller in magnitude than those reported by meta-analyses (Perrain et al., 2021; Richard-Devantoy, Berlim, et al., 2014) comparing suicide attempters to patient (Hedges' *g*=-0.28, .95CI[-0.44 to -0.12]; Perrain et al., 2021) and healthy controls (*g*=-0.54, .95CI[-0.83 to -0.25]; Perrain et al., 2021). Examining the range of scores obtained by the individual studies including in the Perrain et al. (2021) meta-analysis revealed that the effect size reported in the present study (*d*=0.11) falls within the 95% confidence interval reported for 12 of the 17 (71%) studies used to compare suicide attempters to patient controls and 8 of the 14 (57%) studies used to compare suicide attempters to healthy controls. This could suggest that the results from the present study fall largely within the range of scores observed by the individual studies included in the meta-analysis, and therefore do not appear to represent an outlier to the literature. In fact, given the large sample used in the present study, which is over 14 times larger than the average sample size of the individual studies included in the Perrain et al. (2021) meta-analysis, it's possible that the difference in results might be due to other factors, such as sample characteristics. Indeed, examining the 21 studies included in the meta-analysis revealed that, with the exception of one study, all studies recruited either inpatient or outpatient psychiatric

patients diagnosed primarily with a mood disorder. Given the literature on cognitive impairment in mood disorders (e.g., Latalova et al., 2011; Snyder, 2013), it is possible that the results reported by Perrain et al. (2021) are, in part, due to the presence and severity of participant's mood disorder. The results of the present study might therefore better speak to differences in decision-making abilities in less clinically severe samples, such as university students.

To our knowledge, no studies have examined the interactive effects of history of suicide attempts with social rejection or decision-making difficulties on negative affect, the primary hypothesis of step 1 of the NCM. As previously mentioned, the present study failed to find support for these interactions, suggesting that perhaps other factors might be better suited to explain the relationship of these variables to negative affect. Previous studies examining the relationship of social rejection to negative affect (Brodsky et al., 2006; Chapman et al., 2014) suggest that perhaps borderline personality disorder (BPD), a personality disorder characterized by emotional, behavioural, interpersonal, and cognitive dysregulation, might represent a better moderator between social rejection and negative affect. Specifically, experimental findings reported by Chapman et al. (2014) suggest that individuals with prominent traits of BPD experienced greater negative affect in response to social rejection than individuals with less prominent traits of BPD. Similar results were reported by (Gratz et al., 2013) who observed greater emotional distress in individuals diagnosed with BPD (relative to individuals without a diagnosis of BPD) after completing a social rejection task.

Step 2 of the NCM posits that suicide ideation emerges in response to experiencing emotion dysregulation and problem-solving difficulties in the presence of negative affect. Similar to the pattern of results observed for the NCM step 1 variables, moderate-strong relationships were observed between emotion dysregulation, negative affect, and suicide desire

scores (r_s range=.41 to .68), while problem-solving scores appeared to be largely uncorrelated with the same variables (r_s *range*=-.06 to .00). Similarly, examining differences between individuals with and without a history of suicide ideation revealed moderate differences in emotion dysregulation and negative affect (*d*=0.59 and *d*=0.62, respectively) and negligible difference on problem solving (*d*=0.11). However, unlike step 1 of the NCM, both the interactive terms of emotion dysregulation and problem-solving difficulties with negative affect appeared reliable, explaining an additional 1.1% and 0.4% of the variance in suicide desire, respectively. However, entering the interactive terms into logistic regression models predicting lifetime history of suicide ideation did not reliably improve the fit of the model over and above the individual predictors.

The hypotheses posited by step 2 of the NCM appear to be largely supported by the results of the present study. In particular, negative affect and emotion dysregulation appear to not only differentiate individuals with and without a history of suicide ideation but are also associated with concurrent suicide desire. These results appear to be consistent with results obtained by other studies examining the relationship of negative affect, emotion dysregulation, and problem-solving abilities to suicide desire and suicide ideation (e.g., Anestis et al., 201; for a review, see: Law et al., 2015). For example, the relationship reported in the present study between emotion dysregulation and suicide desire (r_s=.41) and emotion regulation and negative affect (r_s=.68) were fairly similar to those reported in other studies, such as by Weinberg and Klonsky (2009; *r*=.43, *r*=.65 [Depression] and *r*=.42 [Anxiety], respectively) in a large sample of adolescents (*n*=428). The independent relationships of negative affect and emotion dysregulation to suicide ideation was reported to be robust in a sample of community adults (Neacsiu et al., 2018), even when controlling for demographic and clinical variables, as well as to longitudinally

predict suicide ideation 2-3 years later in a sample of young adults (Miranda et al., 2013). Interestingly, studies examining problem solving differences using the Tower of London (TOL) task (which was used to measure problem solving in the present study) observed that TOL scores did not differentiate between suicide attempters, suicide ideators, depressed, and non-depressed older-adult participants (Dombrovski et al., 2010). These results are consistent with the results of the present study that did not observe a meaningful difference on the TOL scores between suicide ideators and nonsuicidal participants (d=0.11). To our knowledge, no studies apart from the present study have examined the interaction of TOL and emotion dysregulation in predicting suicide ideation. However, Dour et al. (2011) examined the interaction of TOL scores with emotion reactivity (not dysregulation) and found that the interaction was predictive of the likelihood of future suicide attempts. Unfortunately, Dour et al. (2011) did not examine whether the same interaction predicted suicide ideation. It's therefore unclear how to interpret the results from Dour et al. (2011) relative to predicting suicide ideation. Thus, although the results from the present study suggest that TOL and negative affect meaningfully interact to predict suicide desire, the proportion accounted for by this interaction was relatively small (0.4%) and requires replication.

The primary hypothesis posited by step 3 of the NCM is that impulsivity may facilitate the transition from suicidal thoughts to suicidal acts. The present study included a large number of both self-report and behavioural measures of impulsivity, which were factor analyzed to better understand their underlying structure. Results from two separate factor analyses indicated roughly equivalent differences between suicide attempters and suicide ideators on the three self-report impulsivity factors (d range=0.30 to 0.34), with negligible differences observed on the single behavioural impulsivity factor (d=0.02). Similarly, the self-report impulsivity factors were

found to predict history of suicide attempts, over and above concurrent suicide desire (*OR* range=1.35-1.37), while the behavioural impulsivity factor did not (*OR*=1.03).

Integrating the results from the present study into the empirical literature on impulsivity and suicide is challenging, primarily due to the largely confusing and contradictory results reported in the literature (e.g., for a review, see: Gvion et al., 2011). Briefly, discrepancies in this literature are largely due to studies using different conceptualizations of "impulsivity", measures used to assess these constructs, statistical analyses, as well as contrasting different groups of "suicidal" participants (e.g., comparing suicide attempters to never attempters, combining participants with a history of suicide attempts with participants with a history of non-suicidal self-injury, etc.). A study by Anestis et al. (2014) made a significant contribution to the literature by meta-analyzing the results from individual studies examining the relationship of trait impulsivity (measured using both self-report and behavioural measures) to suicidal behaviour. Small effect size differences were obtained from cross-sectional and psychological autopsy studies (*g*=0.37 and *g*=0.30) while negligible differences were obtained from longitudinal studies (*g*=0.09). This study advances our understanding of the relationship of trait impulsivity to suicidal behaviour, however, given that it did not compare suicide ideators to attempters, it is unclear the extent to which observed differences are the result of suicide ideation or suicide attempts.

A number of studies have adopted an ideation-to-action framework to examine the relationship of *self-reported* impulsivity to suicide ideation and attempts. For example, Klonsky and May (2010) used two factor-analytically derived measures of impulsivity to examine differences between suicide attempters and suicide ideators in three large samples of participants, including 2,111 military recruits, 1,296 college studies, and 399 high school students. The results

of their analyses indicate that impulsivity did not reliably differentiate between military recruits with a history of suicide ideation and suicide attempts (p=.76), with suicide ideators obtaining slightly greater impulsivity scores (M=6.3, SD=4.1) than suicide attempters (M=5.9, SD=3.6). Furthermore, suicide attempters obtain similar scores to suicide ideators across three facets of the UPPS impulsivity measure (Whiteside et al., 2005), when combining the college and high school samples. The only facet of impulsivity to distinguish suicide attempters from suicide ideators was Lack of Premeditation, with a small (d=0.26) effect size difference reported. The results of the present study align with those reported by Klonsky and May (2010). Specifically, the magnitude of the differences observed on the self-report impulsivity factors in the present study (d range=0.30 to 0.34) are slightly larger than the differences reported by Klonsky and May (2010) on the four facets of the UPPS (d range=0.05 to 0.23), with the 95% confidence interval for these effect sizes ranging from d=-0.14 to d=0.42. Taken together, these results suggest that self-reported impulsivity slightly differentiates suicide attempters from suicide ideators.

Results from studies using *behavioural measures* of impulsivity and contrasting suicide attempters and suicide ideators were recently summarized in a meta-analysis by Saffer and Klonsky (2018). Specifically, the meta-analysis identified three studies (Burton et al., 2011; Minzenberg et al., 2014; Richard-Devantoy, Szanto, et al., 2014) that examined differences between suicide attempters and suicide ideators on behavioural measures of disinhibition (including on the Stroop Task). The overall effect size was g=-0.50, .95CI(-0.78 to -0.25) with individual effect sizes ranging from g=-0.25 to g=-0.78, and 95% confidence intervals ranging from widely g=-1.72 to g=0.20. Although the results from the present study (VST efficiency, d=0.01, .95CI[-0.18 to 0.20], and VST errors, d=-0.06 .95CI[-0.25 to 0.13]) fit within the individual studies' confidence interval, they are much smaller than either the combined or

individual effect sizes observed in the individual studies. One potential explanation for these differences might be that differences in impulsivity between suicide attempters and suicide ideators are more pronounced in more clinically severe samples. Specifically, the samples recruited by Burton et al., (2011) Minzenberg et al., (2014) and Richard-Devantoy, Szanto, et al., (2014) were all psychiatric inpatients diagnosed primarily with either a mood disorder or recent-onset schizophrenia. In contrast, the present study recruited undergraduate students. As previously mentioned, severity of psychopathology may further excarbeate cognitive difficulties and therefore be uniquely associated with suicide attempts in psychiatric, but not university, populations. Another potential explanation might be the number of participants recruited in each study. Specifically, the present study recruited 1,014 participants, between 29 and 9 times the number of participants recruited by the aforementioned studies (*n*=35, Minzenberg et al., 2014; *n*=77, Burton et al., 2011; *n*=112, Stéphane Richard-Devantoy, Szanto, et al., 2014). The results of the present study might therefore be more reliable estimates of the difference (or lack therof) in impulsivity between suicide attempters and suicide ideators, as measured using a variation of the Stroop Task (i.e., the VST). Taken together, behavioural measures of impulsivity are unlikely to differentiate suicide attempers from suicide ideators, particularly in university samples.

4.3 Testing Hypotheses Across Perspectives

In addition to examining the hypotheses generated by the 3ST and NCM within their respective perspectives, hypotheses were also compared across perspectives in predicting suicide desire, lifetime history of suicide ideation, and lifetime history of suicide attempts. Entering the 3ST and NCM interaction terms into the same model revealed that = psychache and hopelessness (from the 3ST) and negative affect and emotion dysregulation (from the NCM) reliably predicted suicide desire, though the interaction of negative affect and problem solving did not. Of the three

interaction terms, only psychache and hopelessness reliably predicted history of lifetime suicide ideation, whereas neither of the NCM interactions did when entered into the same model. For lifetime history of suicide attempts, the three Capability for Suicide subscales (from the 3ST) were entered into a logistic regression model alongside the factor-analytically derived impulsivity factors (from the NCM). Results from these analyses suggest that only practical capability was associated with a lifetime history of suicide attempts. Taken together, the aforementioned results further highlight the importance of psychache, hopelessness, negative affect, and emotion regulation to the development of suicide desire. Similarly, of all the impulsivity factors and capability for suicide scores, results of the present study suggest that practical capability is uniquely associated with a lifetime history of suicide attempts, thereby replicating previous studies (Dhingra et al., 2019; Klonsky & May, 2015; Tsai et al., 2020; Yang et al., 2019).

4.4 Clinical Implications

The results from the present study have important implications for the mitigation of suicide ideation and prevention of suicide attempts. First, in order to reduce individuals' desire for suicide, interventions can focus on fostering hope or reducing psychological pain (psychache). As demonstrated by the results of the present study and others (Dhingra et al., 2019; Klonsky & May, 2015; Pachkowski et al., 2021; Tsai et al., 2020; Yang et al., 2019), suicide ideation is present in individuals who experience *both* hopelessness and psychache, suggesting that successfully addressing *either* variable is likely to result in meaningful decreases in suicide desire. Similarly, results from the present study also suggest that suicide desire is likely to lessen in intensity as a result of improving individuals' mood or strengthening their emotion regulation skills.

Several forms of psychotherapy appear to be well positioned to directly address these treatment targets to reduce suicidal ideation. For example, behavioural activation is a relatively straightforward treatment that encourages individuals to schedule and engage in activities they find pleasurable, meaningful, and/or provide them with a sense of mastery. Doing so is thought to increase the frequency of positive reinforcement an individual experiences, thereby decreasing negative affect (Veale, 2008). A large number of studies have examined the efficacy of behavioural activation, with meta-analytic results suggesting that behavioural activation represents an effective treatment for depression (Cuijpers et al., 2007; Ekers et al., 2008, 2014; Trevor et al., 2009) and improves overall wellbeing (Mazzucchelli et al., 2010). A second treatment option is Dialectical Behavioural Therapy (DBT; Linehan, 1993), which was specifically designed to assist individuals with borderline personality disorder understand and regulate their emotions to reduce suicide ideation and suicide attempts. Unlike behavioural activation, DBT is a relatively complex and intense form of psychotherapy in which clients attend weekly individual sessions as well as skills training classes. Skills training classes are designed to provide individuals with psychoeducation about the interrelationship of their thoughts, emotions, and behaviours, as well as introduce and practice distress tolerance and behavioural regulation skills (Linehan, 2015). Meta-analytic results of studies examining the efficacy of DBT suggest that DBT is an effective treatment reducing suicide desire and ideation (Cristea et al., 2017; DeCou et al., 2019; Kliem et al., 2010; Tarrier et al., 2008).

A second clinical implication of the present study is the importance of assessing and addressing practical capability for suicide in suicide risk assessments and treatment. Practical capability refers to one's knowledge about acquiring and using lethal means, and results from the present study indicate that practical capability was the only facet of capability that remained

associated with a history of suicide attempts, over and above concurrent suicide desire, and factor-analytically derived facets of impulsivity. A particularly effective example of decreasing a person's risk for suicide by addressing practical capability is means safety, i.e., restricting a person's access to lethal means. This can include restricting access to poisons, medications that are lethal when taken at certain dosages and/or combinations, as well as various weapons (e.g., firearms). Studies have reported meaningful decreases in suicide attempts resulting from means safety. For example Knipe et al. (2017) observed that restricting people's access to lethal pesticides in Sri Lanka results in a 21% decrease in suicide mortality rates between 2011 and 2015. Similarly, Nordentoft et al., (2007) observed a 55% decline in suicide mortality rates in Denmark associated with the reduction of availability of barbiturates, analgesics, carbon monoxide in vehicle exhaust, and household gas. In the United States, states that implement more handgun laws (e.g., waiting periods for purchasing handguns, universal background checks, gun locks, and open carrying regulations) saw larger reductions in suicide mortality rates compared with states who enacted fewer or no handgun laws (Anestis & Anestis, 2015). Given the importance of practical capability to suicide attempts, suicide risk assessment should thoroughly evaluate a person's knowledge of, and access to, lethal means and use this information to designate their risk for suicide. Furthermore, reducing a person's risk for suicide must include restricting their access to lethal means, even if temporarily, until the factors responsible for their suicidal ideation are properly addressed.

4.5 Strengths and Limitations

The present study has several strengths. First, it recruited a large sample (n=1,014), which was over sampled for participants with a lifetime history of suicide ideation (n=379) and lifetime suicide attempts (n=150). Having a large sample provided the study with ample

statistical power (>.80) to detect moderate (d=0.5) and large (d=0.8) effect size differences across suicide attempter, suicide ideator, and nonsuicidal groups. Furthermore, the oversampling of suicide ideators and suicide attempters is notable, given the prevalence of these groups in university students (28.4% lifetime ideators and 4.3% lifetime attempters; Bruffaerts et al., 2019). Second, the study administered the same measures (e.g., BSS-5, BHS-4, UP3, SCS-3) used in previous studies examining the hypotheses of the 3ST. Using the same measures facilitates the comparison of results between the present study and previous studies. Third, behavioural and self-report measures were administered, including to measure the same construct (e.g., impulsivity). Doing so allowed the study to examine the underlying structure of impulsivity in addition to the individual relationship of the measures to suicide attempts. Fourth, careful attention was paid to the order of measures administered in the study so as not to bias participants' results. Specifically, general measures of perceived cognitive functioning (i.e., the BRIEF-A, FrSBe) were administered prior to the administration of the behavioural neurocognitive tasks (i.e., the Flanker Task, IGT, TOL, VST), which preceded the clinical questionnaires (e.g., DASS-21, DERS-18) and measures of suicide ideation (BSS-5) and attempts (YRBS), which were administered last. This was done to avoid the potential bias participants might experience as a result completing the perceived cognitive functioning questionnaires after having completed the behavioural neurocognitive tasks as well as any bias that might be created by reflecting on one's history of suicide ideation and suicide attempts prior to completing clinical questionnaires.

In addition to the strengths of the study, several limitations are worth noting. First, the design of the study is cross-sectional. Despite statistical techniques designed to control for the influence of covariates, the study is unable to determine the temporal precedence of the variables

examined. For example, although the study found that practical capability was uniquely associated with history of suicide attempts, it is reasonable to assume that suicide attempters are likely to have greater practical capability for suicide as a result of their suicide attempt, or as a result of the preparing for their suicide attempt. Although these concerns are somewhat ameliorated in the case of practical capability, due to the longitudinal results reported by Tsai et al., (2020), this study is unable to determine the temporal precedence of variables, and is therefore incapable of making causal statements about the relationship of these variables.

A second notable limitation is the use of proxy measures to assess constructs of interest. For example, connectedness was measured by reverse-scoring the INQ-Thwarted Belongingness scale which, in turn, measures the extent to which one's effort to connect with others has been disrupted. However, the 3ST views connectedness more broadly as not only one's connection to others, but also their connection to their work, values, religions, and sports teams, among others. Similarly, the 3ST views pain as not only composed of psychological pain (psychache) but also as including physical pain. Yet the measure used to assess for pain (the UP3) focused on measuring psychological but not physical pain. The same limitation also applies to the behavioural measures used to assess the NCM constructs. Specifically, it's unclear whether the problem-solving abilities measured by the TOL, for example, correspond to the problem-solving abilities required to solve problems in the presence of strong negative affect, as specified by the NCM. In addition to these limitations, relying on proxy measures also limited the study's ability to measure the extent to which a person's sense of connection exceeded their pain, as specified by Step 2 of the 3ST. Specifically, while scores on the connectedness and psychache measures were standardized prior to their subtraction from one another, it is potentially misleading to state

that a person's connectedness exceeds their pain since connectedness and pain were not measured using the same scale.

A third limitation involves the reliability the behavioural measures used to assess the NCM constructs (e.g., the IGT for decision making, TOL for problem solving). Specifically, although all four of the behavioural tasks represent longstanding neurocognitive measures, more recent research (Hedge et al., 2018) has reported low test-retest reliability for the same measures (e.g., Interclass Correlations (ICC) range =.40-.57 for the reaction time score of the Flanker Task; ICC range=.44-.48 on the Stroop error scores). Hedge et al. (2018) attribute the low test-retest reliability of these measures to low between subject-variability, which attenuates the correlation of the scores obtained on the behavioural measures to other factors. It is therefore possible that low between-subject variability might explain the pattern of negligible correlations observed between behavioural measures as well as between behavioural measures and self-report measures. That said, the present study also conducted non-correlational analyses (e.g., mean differences) on scores obtained from behavioural measures between groups of participants (e.g., nonsuicidal, ideators, attempters) and observed largely negligible effect size differences between these groups, suggesting that low between-subject variability might not fully explain the lack of differences observed in study.

A fourth limitation is the limited empirical literature used to generate the NCM hypotheses. Specifically, the NCM was developed by Jollant et al., (2011) after carefully examining the existing neuroimaging, neurocognitive, and psychological literature on suicide ideation and suicide attempts. Considerable effort was made to distil the assumptions made by the model into testable hypotheses, including discussing the NCM hypotheses with Dr. Jollant. However, given the fields nascent understanding of brain-behaviour relationships, several of the

NCM hypotheses are based on findings from single studies, often with a relatively small number of participants. It is therefore possible that the NCM hypotheses were developed based on results from studies with low reliability. A related limitation is the reliance on neuroimaging findings for generating the NCM hypotheses, which the present study is unable to test. Similarly, given that 10 years have passed since the publication of the NCM, it is also possible that the NCM has changed in response to more recent research findings. To our knowledge, no update to the NCM has been published by Dr. Jollant or his colleagues, nor has any study formally tested any of the hypotheses posited by the NCM.

A fifth limitation is the possible lack of generalizability of our findings. Specifically, despite recruiting a large sample of participants, it is possible that the generalizability of the present findings is limited due to relying on university students. It's therefore unclear the extent to which the results of the study may apply to other populations, of varying clinical severity (e.g., psychiatric inpatients, community sample) and ages (e.g., children or adults 35 years of age and older). Furthermore, it possible that the results of the study are influenced by the unique combination of stressors experienced by many university students (e.g., moving to a new city, meeting new people, deciding on a major, taking exams, etc.) and therefore might not fully apply to other educational settings as well as clinical, domestic, or vocational settings.

4.6 Future Directions

Future researchers can further advance our understanding of the 3ST and NCM in important ways. For example, studies using a longitudinal design can help clarify the temporal relationship between variables, thereby providing important information about whether suicide ideation develops in response to, or as a result of, experiencing psychache and hopelessness. Similarly, the field would likely benefit from a temporal examination of impulsivity and suicide

attempts, particularly since the trait vs. state aspect of impulsivity is poorly understood. A further, and related, area of research involves using ecological momentary assessment (EMA) technologies to examine the intra-individual fluctuations of the 3ST and NCM variables over a designated period of time (e.g., a week). Doing so would allow for more nuanced intra-individual test if the 3ST and NCM hypotheses, which, in turn, would likely provide the field with valuable information to better understand a person's risk for attempting suicide.

To better understand the generalizability of results, studies are encouraged to recruit participants of varying clinical severity (e.g., inpatient and community samples), age (e.g., children, older adults), and ethnic backgrounds and compare results across these groups in the same study. Recruiting more diverse samples will allow for closer examination of the factors that influence the relationship of the 3ST and NCM variables. Doing so would also likely provide future studies with greater variability in the range of scores reported by participants, thereby avoiding obtaining attenuated results due to restricted ranges of scores.

A further exciting avenue of future research involves developing reliable and valid measures that better measure the constructs included in the 3ST and NCM. This is a promising area of research that is likely to provide the field with a more comprehensive understanding of the 3ST and NCM constructs, their interrelationship, relationship to one another, as well as to suicide ideation and suicide attempts. Creating these measures, and examining their predictive properties in longitudinal samples, is also likely to meaningfully benefit clinical work in providing clinicians with a more valid method for assessing key constructs for suicide ideation and suicide attempts, thereby informing risk assessment treatment outcomes.

In addition to the aforementioned recommendations, it is recommended that the hypotheses of the NCM be updated based on the latest research findings as well as clearly

stipulate the specific hypotheses posited in each step of the NCM, included the particular analyses that would test these hypotheses. Doing so likely to create renewed interest in the NCM, including in testing its hypotheses, which would be highly desirable given the absence of studies on the NCM. Further research would then, in turn, provide researchers with reference points for how best to interpret the results of their study as well as provide further recommendations for future research.

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