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Capability for suicide interacts with states of heightened arousal to predict death by suicide beyond the effects of depression and hopelessness

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Abstract

Background—States of heightened arousal (e.g., agitation, sleep disturbance) have been repeatedly linked to suicidal thoughts and behaviors, including attempts and death. Studies have further indicated that these states may be particularly pernicious among individuals who evidence high suicidal capability. The objective of this study was to examine the interactive effects of heightened arousal and the capability for suicide in the prospective prediction of death by suicide. We examine this relation beyond the effects of robust predictors of suicide, namely depression and hopelessness.

Methods—Participants were drawn from a larger study of undergraduates who completed baseline assessments during their freshman year and were then followed to time of death. The sample in this study only included individuals who had died by suicide ($n=96$) or other causes ($n=542$). Proxy measures to assess predictor variables were constructed using items from the MMPI, which was administered at baseline. An independent sample of clinical outpatients ($n=$ was used to evaluate the construct validity of the proxy measures).

Results—Results were in line with expectation: heightened arousal interacted with capability for suicide to prospectively predict death by suicide, such that, as severity of heightened arousal symptoms increased, the likelihood of death by suicide increased among individuals high but not low on capability for suicide.

Limitations—Limitations include the use of proxy measures, the extended length of follow-up, and the homogeneity of the sample (i.e., primarily White males).

Conclusion—These findings add to an emerging literature that supports the moderating influence of capability for suicide on the relationship between states of heightened arousal on the likelihood of death by suicide.

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Keywords

Suicide; Arousal; Capability for suicide; Agitation; Sleep; Longitudinal

1. Introduction

Suicide claims the lives of over one million individuals annually (World Health Organization, 2012). Despite continued efforts to prevent death by suicide, suicide rates have continued to increase (Centers for Disease Control and Prevention, 2014). With few exceptions, research has primarily focused on identifying associated correlates and risk factors of suicidal thoughts and behaviors. Across studies identifying risk factors for suicide, states of increased arousal are often cited (Fawcett et al., 1990; Rudd et al., 2006). Suicide decedents, in the days prior to their deaths, are often characterized as psychologically and physiologically over-aroused (Robins, 1981; Busch et al., 2003). Specifically, evidence has accrued indicating that sleep disturbance as well as states of agitation may be particularly relevant to suicide.

Despite their importance, efforts focused exclusively on identifying correlates or risk factors for suicide are limited in their potential for identifying the causal mechanisms underlying suicidal behavior – theory-driven research may be a more fruitful means to meet this end. Yet, theoretically-driven research examining the relation between states of heightened arousal and suicidal behavior remains scant. The present paper draws from a leading theoretical model of suicide (i.e., interpersonal-psychological theory of suicide; Joiner, 2005; Van Orden et al., 2010), which argues that engaging in potentially lethal suicidal behavior requires both the desire to die and the capability to do so. As such, we suggest that heightened arousal states will only result in death by suicide among individuals evidencing the capability for suicide.

Suicide involves direct exposure to threats to survival; therefore, attempting suicide will naturally evoke a defensive or avoidant response from most individuals. Consistent with this, suicidal behavior is extremely rare, even among individuals who desire to die (Nock et al., 2008). Suicidal desire, therefore, has been proposed as insufficient in the prediction of near-lethal or lethal suicide attempts – individuals must also possess the capability for suicide (Joiner, 2005; Van Orden et al., 2010). Conceptually, capability for suicide is distinct from suicidal desire – that is, its nature, development, and role in suicide is distinct from that of the factors resulting in the desire for death (Ribeiro et al., 2014a, 2014b, 2014c). It is conceptualized as the result of overcoming the obstacles that prevent many individuals from engaging in suicidal behavior. Some of the primary obstacles to engaging in lethal suicidal behavior involve the fear and pain necessarily involved in inflicting harm. Therefore, it has been suggested that the capability for suicide will be reflected primarily in an individual's sense of fearlessness about pain, injury and death as well as an individual's level of physical pain tolerance (Joiner, 2005; Ribeiro et al., 2014a, 2014b, 2014c; Van Orden et al., 2010). Alone, however, capability for suicide should not result in suicidal behavior, as an individual must also evidence requisite levels of the desire to die.

As noted above, states characterized by heightened arousal symptoms have been shown to confer risk of serious suicidal behavior. Expert clinical consensus and a burgeoning literature highlight the importance of heightened arousal, such as sleep disturbance and agitation, in the prediction of suicide risk (Rudd et al., 2006; Ribeiro et al., 2014a, 2014b, 2014c). For instance, in a psychological autopsy study of suicide decedents in the days before their deaths, across a range of psychological disorders, insomnia symptoms and agitation (i.e., “tension,” “nervousness”) emerged among the most frequently reported symptoms observed in suicide decedents in the time preceding their deaths (Robins, 1981). Similarly, in a prospective study examining predictors of death by suicide in mood disorder patients, only insomnia and agitation (i.e., “psychic anxiety”) emerged as significant predictors at one-year follow-up (Fawcett et al., 1990).

Expert clinical consensus and a growing empirical literature have underscored the clinical importance of agitation, particularly when present in individuals at high risk of suicide (Rudd et al., 2006). Empirical evidence draws largely from retrospective studies of suicide decedents and suicide attempt survivors. Particularly in the time period shortly preceding suicide, decedents are often described as behaviorally and psychologically agitated (Busch et al., 2003). Some studies have documented agitation being present in close to 90% of suicide decedents in the weeks before their deaths (Busch et al., 2003). Agitation has also been linked with non-lethal suicide attempts (Hall et al., 1999).

Sleep disturbances have emerged as robust predictors of suicidal thoughts and behaviors as well (Bernert and Joiner, 2007). Despite associations with depression, which also confers risk of suicide, sleep disturbances appear to independently increase risk (Pigeon et al., 2012). Poor sleep quality in general appears to be a substantial risk factor for serious suicidal behavior. For instance, in a recent study, poor sleep quality at baseline independently predicted death by suicide at 10-year follow-up, and these effects held even beyond the effects of depressive symptoms (Bernert et al., 2014). Insomnia symptoms and nightmares appear to be particularly salient, according to a recent meta-analysis examining the effects of sleep on suicidal thoughts and behaviors (Pigeon et al., 2012). With respect to insomnia, symptoms have been associated with suicide attempts (Barbe et al., 2005; Liu, 2004; Wojnar et al., 2009; Agargun et al., 2007; Nrugham et al., 2008; Wong et al., 2011; Sjöström et al., 2007) and death (Goldstein et al., 2008; Bjorngaard et al., 2011; Fujino et al., 2005; McGirr et al., 2007). Insomnia symptoms have also been found to predict future suicide attempts at one month follow up, even after accounting for depression, hopelessness, and a range of other robust predictors of suicide (Ribeiro et al., 2012).

Nightmares, though having received less systematic empirical attention, have also been identified as salient suicide risk factors. The presence and frequency of nightmares have been shown to significantly increase risk of suicide death, with evidence indicating that occasional nightmare sufferers were at 57% greater risk of death by suicide whereas frequent nightmare sufferers were at 107% greater risk (Tanskanen et al., 2001). Similarly, Li et al. (2010) reported that suffering from frequent nightmares was associated with an eight-fold increase in the likelihood of attempting suicide within a year. When insomnia and nightmares co-occur, risk of suicidal behavior is greater still (Li et al., 2010).

Recent research has suggested that the effects of heightened states of arousal, such as agitation and sleep disturbance, on serious suicidal behavior may be influenced by capability for suicide (Ribeiro et al., 2015, Ribeiro et al., 2014a, 2014b, 2014c). As described above, the prospect of engaging in serious suicidal behavior is innately frightening for most individuals. Among individuals who are low on capability for suicide – that is, among individuals who remain fearful of pain, injury, and death – heightened arousal states may serve to promote further avoidance of the potentially lethal stimuli involved in engaging in serious suicidal behavior. However, among individuals evidencing high levels of capability for suicide (i.e., individuals who are fearless about pain, injury, and death), the increased arousal symptoms may provide them with necessary arousal to approach the potentially lethal stimuli required to engage in serious suicidal behavior. Emerging evidence supports this proposition. In a study of active-duty soldiers, Ribeiro et al. (2015) reported that capability for suicide ratings interacted with ratings of subjective agitation to predict greater suicide risk, even after controlling for documented risk factors of suicidal ideation. Heightened arousal, as indexed by the combination of insomnia symptoms, nightmares, and agitation, were also found to interact with capability for suicide in the prediction of suicidal symptom severity, controlling for symptoms of anxiety and depression, in a large sample of clinical outpatients (Ribeiro et al., 2014a, 2014b, 2014c).

Although there is research supporting the moderating role of capability in the relationship between heightened arousal and suicide, the existing research has two critical limitations: first, all research in this domain has been cross-sectional, which precludes temporal inference and second, none of the studies has directly examined the outcome of suicide death. To this end, the present project is designed as a longitudinal evaluation of the interactive effects of heightened arousal symptoms and the capability for suicide in the prediction of death by suicide versus other causes of death. We examine these effects beyond the effects of depression and hopelessness. As proxy measures were developed to assess each predictor of interest, we also used an independent sample of clinical outpatients to evaluate the construct validity of the proxy scales. Given the prospective design, our findings will further clarify the enduring effects of baseline symptoms on later death by suicide. We expect that capability for suicide will moderate the effect of heightened arousal on death by suicide, such that the likelihood of death by suicide will increase as a function of greater baseline heightened arousal among individuals high on capability for suicide at baseline. We expect that there will be no significant effect of heightened arousal on likelihood of death by suicide among those low on capability for suicide.

2. Methods

2.1. Participants

Individuals studied in this study come from the data archive of an ongoing longitudinal study population of 7007 college students who had completed the Minnesota Multiphasic Personality Inventory (MMPI; Hathaway and McKinley, 1949) at college registration (1964–1966). This group had been followed for mortality through January 21, 2014 when the data set was made. Enrollment in the longitudinal study began on May 7, 1987. Importantly, individuals did not need to enroll in the study to be followed for mortality. Of

the 737 individuals in this study, 355 never enrolled in the longitudinal study (dates of death December 22, 1965–June 26, 2013) and 382 joined the longitudinal study. There were no significant differences between those decedents who did versus did not enroll in the study. Cause of death was verified by death certificate (and coded by a trained nosologist). Study procedures were fully approved by institutional review boards.

At the time of the present study analysis, a total of 737 participants were identified as deceased; however, data on method of death (i.e., suicide versus not) was missing for 99 participants of 737, resulting in a total of 638 participants included in the present study. On average, participants were about 19.87 years of age at time of MMPI completion (standard deviation [sd]=5.35; range: 16–49). The average age at time of death was 49.98 (sd=12.87; range: 18–84). The sample was predominately male (88.60%) and White (98.60%). See Table 1.

2.2. Deceased by suicide group

Of the 638, 15.00% ($n=96$)¹ were verified to have died by suicide. Data available on confirmed suicide decedents includes MMPI profiles and information available on the decedents' death certificates, which typically specified date and place of death, age, occupation, and marital status at time of death, as well as method used to complete suicide. The average age at the time of MMPI administration of the suicide decedent group was 19.04 (sd=3.14; range=17–35); the average age at time of death was 41.35 (sd=12.88; range=19–68). Only 8.30% ($n=8$) of the sample was female, which is comparable to the proportion of females in the entire sample.

2.3. Control deceased group

A total of 542 participants were included in the control deceased group, which consisted of those individuals who had died by causes other than suicide. MMPI profiles as well as data obtained from the death certificate were available. The average age of participants at time of MMPI administration in the control deceased group was 20.02 (sd=6.34; range=16–49); average age at time of death was 51.51 (sd=12.21; range=19–84). About 12.00% of the control deceased group was female and 98.70% identified as White.

2.4. Measures

MMPI items were selected to create proxy scales of suicidal capability and heightened arousal. Although limitations are inherent to this approach, extensive efforts were taken to ensure the construct validity of the scales. First, study authors (J.R.; S.Y.) reviewed the MMPI items and selected items that appeared, on face validity, to assess constructs of interest. Retained items were reviewed by an expert on the constructs of interest (T.J.) to ensure the items were consistent with the constructs of interest. Once proxy scales were developed, the psychometric properties and construct validity of the proxy scales were examined in an independent sample that included the MMPI items selected for the derived

¹Of note, this proportion is higher than the national average of risk of death by suicide (Centers for Disease Control and Prevention, 2014); however, this proportion is likely attributable to the nature of the sample that included decedents who died at a young age who were also primarily White males – a group that is associated with higher risk of death by suicide (Centers for Disease Control and Prevention, 2014).

proxy scales of heightened arousal, capability for suicide, and depression as well as published scales used to examine these constructs.

The independent sample used to test the construct validity of the proxy scales consisted of 527 psychiatric outpatients seeking services at a community mental health clinic. Participants' ages ranged from 18 to 65 years old ($M=27.70$ years, $sd=10.67$); 59.2% were female. The sample was primarily White Non-Hispanic (71.2%) and approximately 12.9% of the sample endorsed being Black, 10.4% Hispanic, 1.7% Asian/Pacific Islander, and 1.5% Native American. To examine the appropriateness and construct validity of the derived proxy scales, bivariate correlations between the total scores on the proxy measures and published scales were examined. Results of these analyses are discussed below.

2.5. Capability for suicide

Capability for suicide was assessed using a scale comprised of 9 MMPI items (item numbers: 36, 128, 131, 218, 287, 354, 367, 522, 532) that assessed a sense of fearlessness about pain, injury or death and increased pain tolerance. Higher total scores correspond to greater capability for suicide. The scale demonstrated an alpha of 0.60, indicating acceptable internal consistency. Total scores of the derived capability scale demonstrated a moderate correlation ($r=0.40$) with scores on the Acquired Capability for Suicide Scale-Fearlessness about Death (ACSS-FAD; Ribeiro et al., 2014a, 2014b, 2014c) in the psychiatric outpatient sample. The correlation therefore falls in the low-moderate range, which though a limitation, is more likely to spuriously prevent our finding effects than to spuriously enable us to find effects. The attenuated correlation may also be an artifact of the fact that the proxy scale includes one item assessing pain tolerance whereas the ACSS-FAD only measures fearlessness about death.

2.6. Heightened arousal

Heightened arousal was assessed using 11 MMPI items (item numbers: 3, 31, 43, 52, 62, 72, 238, 242, 337, 543, 559) that assessed different features of heightened arousal, including sleep disturbance and behavioral and psychological agitation. Higher total scores on the scale were indicative of greater severity of heightened arousal symptoms. Internal reliability of the scale was acceptable with an alpha of 0.70. Total scores on the derived heightened arousal scale were compared to published scales designed to measure agitation (Brief Agitation Measure [BAM], Ribeiro et al., 2011), insomnia symptoms (Insomnia Severity Index [ISI], Bastien et al., 2001), and nightmares (Disturbing Dreams and Nightmare Severity Index [DDNSI], Krakow et al., 2002). Correlations were all significant and moderate to strong in magnitude: BAM: $r=0.66$; ISI: $r=0.50$; DDNSI: $r=0.52$. Although the correlations are stronger for heightened arousal symptoms, as above, this limitation likely will increase the difficulty in finding the hypothesized effect.

2.7. Depression

The proxy scale developed for depression comprised 10 items (item numbers: 8, 24, 41, 76, 107, 152, 236, 259, 301, 339) rated using a true or false scale. Total scores on the scale were indicative of depressive symptoms with higher scores indicating greater depression severity. Internal consistency of the proxy scale was good as indicated by alpha of 0.80. Associations

between the depression proxy scale and total scores on the Beck Depression Inventory (BDI-2; Beck et al., 1996) were significant and strong in magnitude ($r=0.76$).

2.8. Hopelessness

A total of three items (item numbers: 84, 88, 526) was used to assess severity of hopelessness. Items were rated using a true-false response scale. Greater severity of hopelessness symptoms was evidenced by higher total scores on the proxy scale. The internal consistency of the scale was acceptable, evidencing an alpha of 0.70. Although a direct measure of hopelessness was not available in the outpatient clinical sample, associations with relevant constructs provided some evidence of construct validity. Specifically, associations between the hopelessness proxy scale and total scores on the BDI-2 ($r=0.35$, $p<0.001$), pessimism item of the BDI-2 ($r=0.54$, $p<0.001$), and total scores on the Beck Scale for Suicide Ideation (Beck et al., 1997; $r=0.50$, $p<0.001$) were moderate-to-strong in magnitude.

2.9. Data analytic plan

Logistic regression was used to test the effects of arousal and capability for suicide on the odds of dying by suicide controlling for hopelessness and depressive symptoms. Scores on the depression and hopelessness proxy scales were entered as covariates, followed by scores on the arousal and capability for suicide proxy scales, and the interaction of arousal and capability for suicide scores. We then probed the interaction by testing the simple slope of heightened arousal at high (+1 standard deviation) and low (−1 standard deviation) levels of capability for suicide.

3. Results

Means, standard deviations, and inter-correlations are displayed in Table 2. Prior to examining the main hypotheses of the present study, groups were statistically compared with respect to demographic variables. As expected, the groups were not significantly different on the basis of age at baseline, race, or sex. Not surprisingly, age at time of death was statistically different between groups ($F(1, 635)= 55.06$, $p < 0.001$) with suicide decedents at a significantly younger age at time of death than non-suicide decedents.

Logistic regression was used to prospectively predict death by suicide (death by suicide was coded as 1; other causes of death were coded as 0) using the independent and interactive effects of capability and arousal, controlling for depressive symptoms and hopelessness at baseline. Control variables (i.e., depressive symptoms; hopelessness) were entered followed by the main effects of heightened arousal and capability. This was followed by the two-way interaction of arousal and capability in the final step of the model.

The full model was statistically significant ($\chi^2[5]=32.36$, $p < 0.001$), indicating the model was able to discriminate between decedents who died by suicide versus those who died by other means. As a whole, it explained 16.0% of the variance in death outcome and accurately predicted 87.9% of cases (Nagelkerke R^2). The statistical interaction of arousal and capability was a significant predictor of death by suicide (Wald=4.52, $p=0.03$, OR=1.10,

95% CI: [1.01, 1.19]), beyond the effects of depression, hopelessness, and main effects of heightened arousal and capability for suicide. Refer to Table 3.

To follow up on the two-way interaction, we tested the simple slope of heightened arousal at high (1 SD above the mean) and low (1 SD below the mean) levels of capability. Among individuals evidencing high capability, as arousal scores increased, the likelihood of death by suicide also increased (Wald=10.74, $p<0.01$, OR=1.54; 95% CI: [1.19, 1.99]), controlling for depressive symptoms and hopelessness; however, among individuals low on capability, the statistical interaction of capability and heightened arousal was not significant, beyond the effects of covariates and main effects (Wald=0.88, $p=0.35$). See Fig. 1.

Of note, to ensure that hypothesized effects were not driven by the inclusion of the robust covariates, we examined the predictive power of arousal and capability excluding the covariates of depression and hopelessness. As anticipated, in the absence of depression and hopelessness effects, the model as a whole ($\chi^2[3]=26.62$, $p<0.001$) as well as the interaction of heightened arousal and capability (Wald=5.11, $p=0.02$, OR=1.10; 95% CI: [1.01, 1.19]) remained significant.

4. Discussion

As a growing literature makes clear, heightened arousal states confer substantial risk for suicidal thoughts and behaviors. Despite consistent evidence supporting the relation, little theoretically-driven research has been conducted to further refine our understanding of the nature of the relationship. Some emerging evidence indicates that these states may be particularly dangerous among individuals who evidence a sense of fearlessness about pain, injury, and death – that is, who evidence a high capability for suicide. Although preliminary evidence is promising, studies have suffered from notable limitations, including the use of cross-sectional designs and examination of the effect on suicidal symptoms instead of death by suicide. The present paper was designed to replicate and extend existing research by addressing these limitations. We did so by prospectively examining the interactive effects of heightened arousal and capability for suicide in the prediction of death by suicide, beyond the effects of depression and hopelessness. Although findings were in line with a priori hypotheses, we emphasize the need for additional studies that improve upon our methods and aim to replicate these findings.

In the present study, capability for suicide emerged as a significant moderator of the relationship between heightened arousal symptoms and death by suicide, even after controlling for the effects of depression and hopelessness. Among individuals scoring high on capability for suicide, the likelihood of death by suicide increased as a function of higher scores on heightened arousal. By contrast, we failed to find a significant relationship between heightened arousal symptoms and death by suicide among individuals low on capability for suicide. Together, these findings indicate that heightened arousal is a significant predictor of death by suicide among individuals high but not low on capability for suicide.

These findings square well with the interpersonal-psychological theory of suicide (Joiner, 2005; Van Orden et al., 2010) that suggests that capability is a necessary (though not

sufficient) predictor of death by suicide; however, they are less compatible with escape-based models of suicide (e.g., Escape Theory (Baumeister, 1990), Psychache Theory (Shneidman, 1993); Cry of Pain (Williams, 1997)). From the perspective of escape-based models, as heightened arousal symptoms become more distressing, the likelihood of death by suicide should also increase. Therefore, escape-based models would predict that heightened arousal alone should be sufficient predictors of death by suicide. In the present study, however, we provide evidence that capability moderates the effects of heightened arousal. Specifically, results indicate that the likelihood of death by suicide only increases as a function of increasing heightened arousal symptoms among individuals evidencing *high* capability for suicide. The effects of heightened arousal were not significant for individuals low on capability for suicide.

Before discussing the implications of these findings for research and practice, the limitations of the present study should be noted. First, the use of proxy scales may raise construct validity concerns. Preliminary analyses demonstrating moderate-to-strong correlations between the proxies and published measures provide some support for the appropriateness of the proxy measures, however. Relatedly, concerns regarding the reliability of the proxy measures may be raised. Though most of the proxy measures used demonstrated adequate psychometric properties, the alpha level associated with the capability for suicide proxy in particular fell on the lower limit of acceptability (i.e., 0.60). It is important to note, however, that other evidence – in particular, the moderate-to-strong correlations with the published scales measuring the same constructs – suggests the proxy scales may be more reliable than alpha levels suggest. Although the correlations did not indicate a redundancy in the proxy and published scales (which would be ideal), the attenuated correlations would be expected to make it more (not less) difficult to find the hypothesized effects. Further, particularly in the case of the measure of capability, coefficient alpha may not provide the best index of reliability, given that alpha is designed an index of item homogeneity (Cortina, 1993; Schmitt, 1996) and the capability scale is designed to measure a heterogeneous construct comprised of two factors (pain tolerance and fearlessness about death). Regardless, future studies should look to include self-report indices designed to assess the measures of interest. Future studies would also benefit from using multiple methods of measurement to assess the constructs of interest, including more objective measures, such as physiological measures of arousal and/or behavioral indices of fearlessness about death.

Second, the interval between baseline and time of death was highly variable, with some deaths occurring decades after baseline; yet, clinicians are more often faced with imminent risk decisions – that is, clinicians are tasked with determining whether a patient is at risk of death by suicide within the following days or weeks. Therefore, future studies designed to examine the role of capability and heightened arousal states in the near-term would potentially be more informative. More broadly, we also recognize that the nature of this relationship may be more complex than currently tested. We look forward to additional studies further refine our hypotheses about the nature of this interaction and how it relates to suicide prediction. Third, the sample was limited to predominantly White males who were college freshmen at baseline. Although this demographic represents a high risk group (Centers for Disease Control and Prevention, 2014), questions remain about the

generalizability of these findings outside this group. Prioritizing similar research in demographic groups not well represented in the present study – for instance, females, races other than White, individuals who are not students – is necessary. Further, although a strength of this study was the inclusion of a stringent control group, additional information can be gathered by including an additional healthy living comparison group in order to further understand the generalizability of the present findings.

Limitations notwithstanding, the present findings offer directions for future research and practice. When considered in the context of the broader literature, the findings from the current project square well with previous research (e.g., Ribeiro et al., 2014a, 2014b, 2014c, 2015). Beyond replicating existing research, the current project extends our knowledge in several important ways. First, the prospective nature of the current study design as well as the stringent covariates included in the present analyses allow for stronger inferences regarding the temporal precedence. Our findings indicate that heightened arousal and capability for suicide may represent causal risk factors in the prediction of death by suicide. Establishing temporal precedence of the relationship is crucial in discriminating between factors that are simply correlates of suicidal behavior versus causal mechanisms that underlie suicidal behavior. Understanding the causal mechanisms of suicidal behavior is crucial to developing effective prevention and intervention strategies.

Secondly, beyond establishing temporal precedence, the findings of the present study also highlight the potential importance of exhibiting enduring predispositions to heightened arousal states as well as capability for suicide. The design of the present study involved a lengthy follow-up period. On average, participants died approximately ten years after completing baseline assessments. Although the lengthy follow up period may be viewed as a potential limitation of the current work, we note here that the follow up time is consistent with many other past prospective studies of death by suicide (e.g., Bernert et al., 2014). Moreover, the lengthy follow up period provides insight into possible distal effects of conditions measured at baseline. In the current study, we found evidence indicating baseline levels of heightened arousal and capability interacting to predict death by suicide roughly a decade later (on average) – these findings suggest that these states may have enduring influences on subsequent suicide risk.

The mechanisms accounting for the distal effects, however, remain unclear. We suggest that heightened arousal represents a more dynamic risk factor that may be particularly salient in imminent risk states. Specifically, among individuals high on capability, states of heightened arousal may serve to further amplify the ability to approach potentially lethal means. Among individuals low on capability, these states may serve to further potentiate avoidance. Although the findings from the present study would be consistent with this conceptualization, the study design precludes a direct evaluation of this hypothesis. We suggest that one possible explanation accounting for the significant effects over such a long follow-up period is that individuals evidencing elevated heightened arousal symptoms at baseline may be more vulnerable to experiencing these states throughout life. Consequently, these states may be present during periods of high suicidal desire. Among individuals high on capability for suicide who are also more vulnerable to experiencing greater heightened arousal symptoms, heightened arousal symptoms in periods of acute risk may also serve to

facilitate approaching potentially lethal means. Future studies examining the nature of heightened arousal and capability for suicide during acute risk periods (i.e., days and weeks preceding serious suicidal behavior) are necessary to further evaluate this hypothesis.

Third, the present project predicts the ultimate behavior of interest: death by suicide. Although suicide research serves the purpose of understanding the nature or prevention of suicide, few studies directly examine the outcome of suicide death. This is in part due to the difficulty in studying such a low base rate phenomenon. Although inferences can be drawn from research examining less severe forms of suicidality, differences between suicide decedents, attempters, and ideators have been documented (Klonsky and May, 2013; Nock et al., 2012, 2013); as such, research examining death by suicide specifically is necessary to most accurately inform intervention and prevention efforts.

Fourth, the present findings have implications for our understanding of the relationships between death by suicide and hopelessness as well as depressive symptoms. In the current project, the main effects of depression and hopelessness were not significant when considered in the context of the main and interactive effects of capability for suicide and heightened arousal symptoms. Other longitudinal studies of suicidal behavior have documented comparable results, documenting non-significant effects of hopelessness and depression when considered in the context of other arousal-related variables (e.g., Ribeiro et al., 2012, Sani et al., 2011). There is also evidence to suggest that depression effects may be particularly salient as dynamic time-varying predictors – that is, depressive states may have greater predictive validity of depressive traits in the prediction of serious suicidal behavior (Yen et al., 2003). Additional research evaluating the relative predictive validity of hopelessness and depression beyond the effects of the joint effects of heightened arousal symptoms and capability for suicide in the prediction of serious suicidal behavior would likely be useful.

With respect to clinical implications, results from the present study suggest that considering both capability for suicide and symptoms of heightened arousal may be informative. Integrating assessments about heightened arousal symptoms and capability for suicide may further inform suicide risk assessments. Future research examining the incremental validity of assessments that include heightened arousal and capability for suicide may prove fruitful in enhancing our accuracy in the prediction of death by suicide. Interventions focused on mitigating arousal symptoms and/or reducing capability for suicide may be helpful, though future research is needed to examine the effects on reducing suicide risk. In considering whether to target capability for suicide or arousal symptoms, the relative stability of the factors are worth considering. Capability for suicide has been characterized as a more enduring, relatively stable characteristic (Van Orden et al., 2010) whereas heightened arousal states are more dynamic and short-lived (Fawcett et al., 1990). Despite theoretical contentions, very little empirical evidence exists evaluating these propositions. As such, additional research examining the malleability of each construct is needed.

In sum, the present project adds to a growing literature examining the effects of heightened arousal symptoms and the capability for suicide on death by suicide. Based on the preliminary findings of the present study, heightened arousal symptoms appear to be

particularly pernicious among individuals who evidence high levels of capability for suicide, as reflected in a sense of fearlessness about pain, injury, and death. Findings also indicate that these effects exist even after accounting for powerful predictors of suicide, including hopelessness and depression. In light of this project's limitations, caution is warranted in the interpretation and implications of the findings. Additional studies are needed to replicate and extend these findings. Prioritizing studies that improve upon the assessment strategy, sample diversity, and follow-up timeline would be most useful. Further refining our understanding of the causal mechanisms that produce and exacerbate risk of death by suicide is crucial to making significant inroads in the prevention of serious suicidal behavior.

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Fig. 1. Logistic regression examining the interaction of heightened arousal and capability for suicide in the prediction of death by suicide, controlling for baseline depression and hopelessness.

Table 1

Demographics across groups.

	Suicide (<i>n</i> =96)	Control (<i>n</i> =542)	Total (<i>n</i> =638)
Age			
Baseline	19.04 (3.14)	20.02 (6.34)	19.87 (3.14)
Time of death	41.35 (12.88)	51.51 (12.21)	49.98 (12.88)
Sex			
Male	88 (91.7%)	477 (88.0%)	565 (88.6%)
Female	8 (8.3%)	65 (12.0%)	73 (11.4%)
Race			
White	94 (97.9%)	535 (98.7%)	629 (98.6%)
Black	1 (1.0%)	5 (0.9%)	6 (0.9%)
Other	1 (1.0%)	2 (0.4%)	3 (0.5%)

Table 2

Means, standard deviations and intercorrelations.

	1	2	3	4	5	Mean	SD	Skew	Kurtosis
1. Heightened arousal	1.00**					2.77	2.22	0.84	0.23
2. Capability for suicide	-0.34**	1.00**				5.50	1.75	-0.60	0.06
3. Depression	0.64**	-0.25**	1.00**			1.97	2.17	1.41	1.59
4. Hopelessness	0.42**	-0.14**	0.57**	1.00**		0.44	0.69	1.77	3.32
5. Suicide death	0.20**	< -0.01	0.15**	0.15**	1.00**	0.15	0.36	1.96	1.85

Note: SD=Standard Deviation
**

P<0.001.

Table 3

Logistic regression of over-arousal symptoms and capability for suicide controlling for depression and hopelessness.

	<i>B</i>	<i>SE</i>	<i>Wald</i>	<i>P</i>	<i>Exp(B)</i>	<i>95% CI</i>
<i>Constant</i>	−1.74	1.13	2.34	0.13	0.18	
Depression	0.13	0.10	1.83	0.18	1.14	(0.94, 1.39)
Hopelessness	0.10	0.25	0.15	0.70	1.10	(0.67, 1.81)
Heightened arousal	−0.27	0.09	7.65	0.03	1.31	(1.08, 1.59)
Capability	−0.001	0.11	<0.001	0.20	1.00	(0.80, 1.25)
Arousal*capability	0.09	0.04	4.52	0.03	1.10	(1.01, 1.20)