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## Examining the Link Between Pain and Suicidal Capability Using Virtual Reality as the Translational Approach

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THE FLORIDA STATE UNIVERSITY

COLLEGE OF ARTS & SCIENCES

EXAMINING THE LINK BETWEEN PAIN AND  
SUICIDAL CAPABILITY USING VIRTUAL REALITY  
AS THE TRANSLATIONAL APPROACH

By

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The members of the Defense Committee approve the thesis of Jaylene Sosa defended on November 19<sup>th</sup>, 2020.

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## Abstract

In prior literature regarding suicide, physical pain has been long implicated as a risk factor for suicide. Popular view has suggested that individuals who are exposed to pain may have an increased capability of suicide. However, it is unclear *how* the experience of pain and the likelihood of engaging in suicide are linked to each other. One possibility, as proposed by several suicide theories, could be that people who have developed higher tolerance for pain (e.g., via repeated exposures to pain) may be at increased risk for suicide (e.g., Joiner 2005). Due to ethical and methodological constraints, there is a significant scarcity in research that examines the underlying processes linking pain and suicidal behaviors. Our study aimed to use a novel approach of virtual reality (VR) suicide scenarios and a lab-induced pain stimulation task to examine the link between pain and virtual reality suicide decision. Participants (N=164) went through: (1) pain calibration to assess their tolerable pain level (unless assigned to a neutral condition) and (2) virtual reality suicide scenarios where they were given the option to choose to engage in VR suicide or the alternative with mild pain manipulation applied. We aimed to examine whether the participants suicide decision in the VR scenario was related to pain manipulation, and if their pain threshold could potentially affect the virtual reality suicide decision (emergence of suicide). The difference among the groups was minor as the administration of pain did not cause any significant changes in the participants engagement in suicide compared to the control group ( $\chi^2 = 2.58, p = .108$ ).

## **Examining the Link Between Pain and Suicidal Capability**

### **Using Virtual Reality as the Translational Approach**

Suicide has been a significant matter in public health for an extensive period of time. According to the World Health Organization, close to 800,000 individuals die to suicide each and every year. In 2016, suicide was considered the second leading cause of death among those who are between 15 and 29 years old (2019). These statistics prove the importance of understanding which kind of risk factors should be considered when conferring to the matter of suicide. This topic is in urgent need of awareness, but unfortunately, primarily due to the lack of experimental designs, there has been a deficiency of research towards suicide. Previous literature has suggested that pain may play a role in the emergence of suicide. In fact, several suicide theories posit that individuals who are exposed to painful experiences may be at a higher risk for suicide (Baumeister, 1990; Joiner, 2005; Van Orden et al., 2010; Williams 1997). In order to draw a causal inference for these variables, a feasible experimental design is needed. Novel techniques, such as virtual reality, can advance our understanding of causal factors by allowing us to test various potential risk factors. This enables us the possibility to empirically test the relationship between pain and the emergence of suicide.

Virtual reality is a simulated experience that could replicate or completely transform the surrounding world we live in computationally. As mentioned previously, due to the lack of experimental designs, suicide is particularly challenging to study in a laboratory setting. Although, with the advancements in technology such as virtual reality, we may be able to simulate suicidal context in a safe and controlled environment. In fact, recent efforts in research suggests that virtual reality could indeed potentially assist with creating an experimental design to further study the causes and the possible preventions of suicide in a valuable manner. This was

formerly accomplished by the development of a laboratory approximation of suicide in which the new virtual reality technological advancements were utilized (Franklin, 2018). In this series of studies, participants were asked to partake in two different virtual reality scenarios that had been repurposed to simulate distinctive suicidal situations and behaviors; in these scenarios, the participants were given the option to select whether or not to engage in the suicide virtually. The results indicated that the virtual reality paradigm was safe, as well as rated by the participants to be realistic and suicide-relevant (Franklin, Huang, & Bastidas, 2018). This leads to the demonstration that virtual reality could possibly allow us to experimentally test out the causal role of previously proposed risk factors of suicide, such as exposure to pain, in a safe and plausible manner.

As it was briefly stated previously, prior research has implicated a link between pain and the emergence of suicide (Calati et al., 2015; Joiner, 2005; Van Orden et al., 2010). One meta-analysis applied this concept by examining distinctive study publications that compared rates of suicidal thoughts and behaviors in individuals with any sort of physical pain (e.g. back or neck ache, arthritis, medically unexplained pain, etc.). According to the meta-analysis by Calati et al (2015), individuals with physical pain were at increased risk for suicidal thoughts and or behaviors, as well as deaths by suicide. These results remain consistent with prominent suicide theories, thus driving attention towards a deeper exploration within this link. Another demonstration of this relationship could be noted within the notions of Dr. Thomas Joiner's Interpersonal-Psychological Theory of Suicidal Behavior (IPTS) (2005). Within this theory, it is suggested that painful and provocative events could potentially cause a desensitization to painful stimuli in those individuals affected by the events, thus increasing their likelihood to engage in suicidal behaviors which ultimately leads to an increase of their risk of suicide (Joiner, 2005;

Van Orden et al., 2010). In line with these theories, there are some additional cross-sectional studies that suggest that same potential link between physical pain and the emergence of suicide. The experimental pain induction utilized in the referenced study was the cold pressor task, used to demonstrate the association between self-harming behaviors. Following these methods, they measured when the participant would find the pain to be intolerable. Their results were in accord with those of other studies, notably demonstrating that pain tolerance was significantly correlated with the emergence of suicide in reference to their measures (Franklin et al., 2011). These studies have advanced our knowledge in regard to the potential link between pain and suicide; however, there still remains important questions regarding the causal role of pain in the development of suicide. The inability to combat unmeasured confounding variables could be problematic when attempting to infer causal links in cross-sectional studies. In order to draw a causal inference, an experimental design is needed. Using virtual reality allows us to test this correlation of pain and the emergence of suicide by successfully testing out the causal role of previously proposed risk factors of suicide.

In the present study, we tested the causal role of pain in giving rise to suicidal behaviors by randomizing participants into a pain manipulated group or a no pain group (control), and whether or not there is an effect due to the experimentally induced pain on suicide engagement in virtual reality. We hypothesize that there will be a significant correlation between those who received a manipulation of pain in opposition to those who did not. The findings of the present study will bear implications in regard to future theories and interventions of suicide.

## **Method**

### **Participants**

Participants were 164 undergraduate Florida State University students (114 females, 69.51%; 50 males, 30.49%) recruited from Psychology courses for research participation credit. The average age was 19.29 (SD = 1.62), and 95 participants self-identified as White/Caucasian (57.93%), 35 as Hispanic/Latino (21.34%), 22 as Black/African American (13.41%), 7 as Asian/Pacific Islander (4.26%), 4 as Mixed Ethnicities (2.44%), and 1 as Native American (0.61%). The inclusion criteria of the present study required that each participant (1) was at least 18 years old, (2) had normal or corrected vision, (3) could read and speak English, and (4) had no current pacemaker.

### **Procedure**

Eligible participants were assigned to a condition at random. Depending on which condition was assigned, the participant received either a mild manipulation of pain delivered through an electrotherapy OMRON device with electrodes, or no manipulation of pain (e.g. control condition). The participant went through two different virtual reality scenarios, repurposed to simulate distinctive suicidal situations and behaviors obtained from the Franklin, Huang, & Bastidas (2018) study, in which they will be able to decide whether or not they will virtually engage in suicide. If pain manipulation was necessitated due to the condition assigned, the pain calibration would be done prior to the pain application, allowing the threshold of subjective pain to be measured. Self-report questionnaires were given in the beginning of the study, as well as after each scenario. A positive mood induction task paired with a final survey was given prior to the debriefing and the end of the study (see Figure 1).



## Conditions

**Control condition.** In this condition, the participant received no pain manipulation at all, but was asked to choose between virtually engaging in suicide, or the alternative in the virtual reality scenarios.

**No Escape condition.** The participant went through the pain calibration prior to the first condition. During the scenarios, they had the option to either engage in suicide or the alternative. The pain manipulation remained on during the entire scenario.

## Scenarios

**Shooting scenario.** In this scenario, the participant was put into a virtual reality scenario where they were standing in a warehouse. The participant was given explicit instruction to pick up the gun in the VR stimulation, and practice pressing the remote trigger which was used for shooting. They were then given the option to either shoot themselves in the face, or to shoot at a neutral barrel.

**Plank Scenario.** In this scenario, the participant was put into a virtual reality scenario where they were outside of a building on the street. The participant was given explicit instructions to virtually go up the elevator that leads to the top of a building. Once the participant arrived to the top of the building, they were given the option to either walk off the elevator, causing them to fall to their death, or to press the button that leads back to the ground floor and return to the street in the elevator.

## Measures

The threshold of subjective pain of each participant was explicitly measured through the intensity level demonstrated on the OMRON device. The participant was instructed to inform the researcher of the pain level that they were feeling with each intensity level of pain on a scale

from 0, being no pain, to 10, being the worst imaginable pain. The threshold of subjective pain was measured once the participant stated their subjective pain of that intensity level was a 3 out of 10. The intensity level of pain established on the OMRON device was noted and documented.

The participant's decision on whether or not they choose to engage in suicide through the virtual reality scenario was also noted. The participant had 10 seconds to make their decision, both their decision and the amount of time taken to make the decision was documented.

### **Data Analysis**

**Primary Analysis.** First, the descriptive statistics of the variables were calculated. The main analysis was conducted by performing a Chi-squared test in order to determine whether two paralleled conditions, the pain manipulated group and the control group, significantly differ in their decision of whether or not they chose to engage in suicide through the virtual reality scenarios.

**Exploratory Analysis.** A secondary analysis was conducted by performing a Binary Logistic Regression to determine the relationship between the participants measured threshold of subjective pain (independent variable) and whether or not they chose the option to engage in suicide through the virtual reality scenarios (dependent variable).

## **Results**

### **Primary Analysis**

Across the conditions, 12.21% of participants chose to engage in the virtual reality suicide, while 87.80% chose not to engage. Administration of pain manipulation did not cause any significant changes in the participants engagement in suicide compared to the control group,  $\chi^2(1, N=164) = 2.58, p = .108$ . Full description of engagement in suicide is reported in Table 1 & Figure 2.

### **Exploratory Analysis**

A Binary Logistic Regression analysis was conducted to test our second hypothesis to determine the relationship between the participants self-reported threshold of subjective pain (0-10 Likert scale; continuous variable) and virtual reality suicide completion (yes or no; categorical variable). Calibrated pain level was weakly associated with the virtual reality suicide decision as evidenced by the small reduction of the ORs with a change in the level of calibrated pain (Table 2). ( $B = -.275, p = .080, OR = .760, 95\% CI [.558, 1.034]$ ).

## **Discussion**

The present study aimed to examine whether a pain manipulated group and a control group, differed in their decision to engage in suicide during virtual reality (VR) scenarios. In addition, an exploratory analysis was conducted to investigate the relationship between the participants' measured threshold of subjective pain and whether or not that was associated with suicide engagement. The results of both aims yielded insignificant findings, indicating that (1) there was no significant effect of the pain manipulation on the decision to engage in VR suicide, and (2) no association was found between the measured threshold of pain and the decision to engage in VR suicide.

The primary analysis conducted indicated that there was no effect of lab-induced pain on VR suicide engagement. As seen in Figure 2, there was about an 8% increase in those who engaged in VR suicide in the No Escape group that was administered pain manipulation, but not enough to be deemed as significant within the analysis. Consistent with this, our exploratory analysis showed that there was a weak association between the subjective pain threshold and the decision to engage in VR suicide, such that how much pain the individual perceived did not predict whether or not they chose the suicide option. Taken together, our findings suggest that pain plays a weak, if any, role in suicidal behaviors. The results are inconsistent with existing literature that explored a similar relationship between physical pain and suicide. These previous studies suggest that pain plays an important and consistent role as a risk factor for suicidal thoughts and behaviors (Calati et al, 2015; Franklin et al, 2011; Bahk et al 2011). Comparable studies also found significant associations between pain threshold and an individual's capability of suicide, which we failed to find in our study (Orbach et al. 1997).

There may be multiple explanations as to why our study found evidence that diverges from previous findings. First, most of the previous studies exploring pain and suicide gathered participants with chronic or symptomatic physical pain. As it is difficult to simulate chronic pain in an experimental design, our findings may not generalize to other types of pain other than the specific pain that was used in our study (i.e. short-term pain). Additional studies would be needed to determine if different kinds of pain offer different effects within suicidality. Second, within these studies it was found that pain was significantly correlated with various measures of suicidality, including self-report measures for an acquired capability of suicide, suicidal ideation, and suicide attempts. Since most of the previous studies focus on suicidal ideations or proxy constructs related to suicide (e.g. PPE) rather than actual suicidal behaviors, it is possible that the role of pain is dependent on the suicide outcomes. This variance in measures could also be a representation of why results differed in significance when compared to previous literature.

Although our study found compelling evidence that pain plays a weaker role in suicidal behavior than previously assumed, our study should be interpreted in light of several limitations. First, VR suicide scenarios are not the same as actual suicidal situations. Although it allows us to examine suicide in a safe and experimentally controlled setting, it is not an exact measure of suicide. Most research previously conducted has been limited to correlational studies, and the present study aimed to expand our knowledge on the topic by employing a novel approach to examine pain as a potential risk factor for suicidal behavior with an experimental design. This would be the only method that could be used to infer causality. In the future, another way to explore this link between pain and suicide may be to approach the question with different empirical measures, such as Ecological Momentary Assessments, which could examine whether fluctuations in pain are associated with the emergence of suicidality in real-time.

Another potential limitation may lie in our chosen method of pain induction. It may be possible that by using a different type of pain induction method or an increased intensity of the pain—within an ethical limit—may result in a greater impact on the emergence of suicide. The device used to induce the pain throughout the study was an OMRON therapy device that most subjects could have been familiar with prior to their participation in the study. Perhaps exploring different ways to induce pain, such as the widely used cold-pressor task, in future studies using virtual reality suicide may cause a change in the significance of the results.

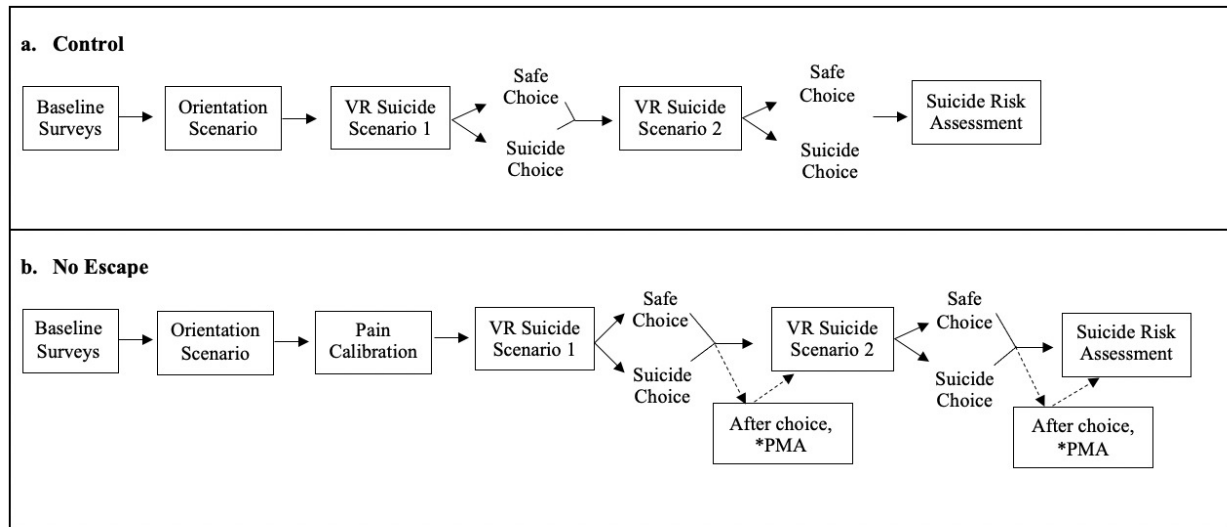
Lastly, given that most research examining pain and suicide included those who were chronically ill, the results may vary if the study was conducted with individuals other than those who were generally healthy and college aged. The uneven demographic measured within our study could also be a limitation, as the narrow pool of subjects from a convenience sample could compromise the generalization of the study. Further research should include a wider range of subjects that vary from mainly students, female, or White participants, which was the majority of subjects within in the present sample. Future research should consider a more diverse sample in a clinical setting, which in turn could shift the significance of the results.

Conclusively, although the analysis of the present study demonstrated a weak association between pain and the engagement of suicide, the limitations mentioned may have played a role in determining the causal effects of pain manipulation and its function as a proposed risk factor of suicide. Overall, many of these limitations should be addressed in future research to further explore the role of pain in the emergence of suicide.

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## Tables & Figures



\*Note. PMA = Pain Manipulation Administered

Figure 1. Study procedure flowchart.

Table 1  
Virtual Reality Suicide Decision by Condition

Virtual Reality Suicide Decision			
Condition	Engaged	Not Engaged	Total
Control (no pain manipulation)	7 (8.24%)	78 (91.76%)	85 (100%)
No Escape (pain manipulation)	13 (16.46%)	66 (83.54%)	79 (100%)
Total	20	144	164

$$\chi^2 (1, N=164) = 2.58, p = .108$$



Table 2

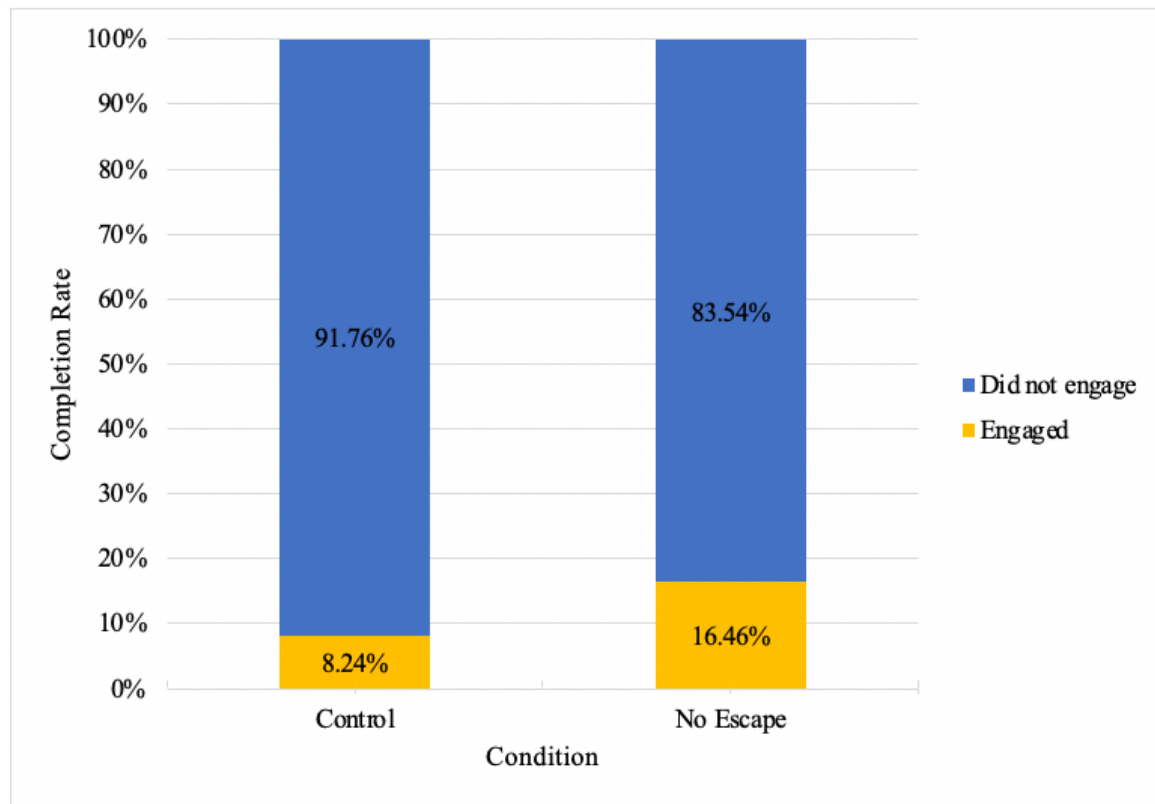
*Logistic Regression Analysis of Calibrated Pain Level (Pain Threshold) in Relation to VR Suicide Engagement*

Predictor	$\beta$	SE $\beta$	Wald's $\chi^2$	$df$	$p$	Odds Ratio	95% C.I. for Odds Ratio	
							Lower	Upper
Calibrated pain level	-.275	.157	3.055	1	.080	.760	.558	1.034
Constant	3.422	1.125	9.258	1	.002	30.643		

Table 3

*Calibrated Pain Level Descriptives*

Engagement in suicide during VR scenarios	Total Sample ( $N$ )	Calibrated Pain Level	
		Mean	S.D.
Engaged in VR suicide	13	7.08	1.71
Did not engage in VR suicide	66	6.02	1.98
Total	79	6.12	1.96



*Figure 2. Engagement in virtual reality suicide by condition.*

