Response Inhibition in Emotional Contexts in Suicide Ideators and Attempters: Evidence From an Emotional Stop-Signal Task and Self-Report Measures

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Objective: Based on the ideation-to-action framework of suicidality, this study aimed to examine whether suicide attempters differ from suicide ideators or nonsuicidal controls in response inhibition under emotional context. *Method:* A total of 142 community adults with lifetime history of suicide ideation or attempt as well as nonsuicidal controls were recruited. All participants completed an emotional stop-signal task and self-report measures of impulsivity. *Results:* In the stop-signal task, suicide attempters did not differ from ideators in response inhibition under emotional context. Moreover, both attempters and ideators did not differ from nonsuicidal controls in response inhibition to negative emotions. Compared with nonsuicidal controls, suicide ideators and attempters exhibited poorer response inhibition to positive emotions in the threat context but not in the nonthreat context. Using self-report measures, it was found that only negative urgency differentiated suicide attempters from ideators or nonsuicidal controls. *Conclusions:* These results suggest that people who have thought about or attempted suicide have impaired response inhibition toward positive emotional stimuli in threat contexts but not toward negative emotional stimuli. However, suicide attempters perceived themselves as more impulsive when experiencing negative emotional states as compared with suicide ideators and nonsuicidal controls.

*Keywords:* response inhibition, impulsivity, stop-signal task, suicide attempt, suicide ideation

Thinking about suicide is a motivational state or impulse toward a conflicting action, as people are mostly ambivalent about committing suicide (Shneidman, 1996). When thinking about suicide, one is likely to experience cognitive conflicts of whether to act, and this motivational state tends to come with a mixture of negative emotions. In fact, most people who have suicidal ideation do not attempt suicide. The conditional prevalence of suicide attempt in the presence of suicidal ideation was only 9.7% among ideators without a plan and 32.8% among ideators with a suicide plan (Kessler, Berglund, Borges, Nock, & Wang, 2005). What distinguishes people who have suicidal thoughts but do not act on them from those who attempt suicide is still unclear, and this remains an important research question (Joiner, 2005; Klonsky & May, 2014; Nock, Kessler, & Franklin, 2016; O'Connor, 2011).

Considering that suicide attempts occur during negative emotional states and self-threatening circumstances, it is likely that suicide attempters have difficulty withholding an ongoing response in threatening and negative emotional states. Moreover, they may have difficulty initiating a response to positive emotional stimuli in the context of threatening emotional states. Difficulty responding to positive information and varying environmental demands during emotional distress are associated with delayed recovery from psychopathology (Coifman & Bonnano, 2010). Yet, the question of whether suicide attempters differ from suicide ideators in response inhibition in the emotional context has remained unanswered; thus, this study aimed to examine that question.

Theoretical models of suicidal behavior have suggested various moderating factors that lead people from suicide ideation to an attempt (Joiner, 2005; Klonsky & May, 2015; O'Connor, 2011). Impulsivity has been suggested as a moderating factor that leads to suicide attempt from ideation (O'Connor, 2011) or as a dispositional factor that may increase the capability for taking a suicidal

action (Joiner, 2005). Meta-analytic studies examining the association between impulsivity and suicidal behavior have yielded small-to-medium effects or mixed results (Anestis, Soberay, Gutierrez, Hernández, & Joiner, 2014; Hamza, Willoughby, & Heffer, 2015; Liu, Trout, Hernandez, Cheek, & Gerlus, 2017). These conflicting results may be because various types of impulsivity were treated as a unitary construct or measured differently across studies. Further, the role of impulsivity in the progression from suicide ideation to action is not clear.

Impulsivity is a heterogeneous, multidimensional construct with diverse operational definitions, and little overlap was examined between self-reported and task-based measures of impulsivity (Cyders & Coskunpinar, 2012; Roberts, Fillmore, & Milich, 2011; Strasser et al., 2016). Consistently, previous research suggests that only a certain type of impulsivity would be related to suicidal behavior. Negative urgency, a tendency to act rashly in negative emotional states, has been consistently related to suicidal behavior (Hamza et al., 2015). Moreover, a recent study reported that only negative urgency among various self-reported impulsivity differentiated suicide attempters from ideators (Millner et al., 2018). Negative urgency and certain subtypes of impulsivity, such as impulse control difficulties or difficulties engaging in goal-directed behavior, are conceptually relevant to the failure or disruption of inhibition of behavior. In cognitive psychology and related fields, voluntary inhibition of behavior (i.e., response inhibition) has been investigated with task-based measures (e.g., stop-signal task and go/no-go task).

Response Inhibition in Emotional Contexts and Suicidal Behavior

Response inhibition is the voluntary inhibition of behavior that is not relevant at a given time (Logan & Cowan, 1984). Meanwhile, a stop-signal task is a widely used task-based measure of response inhibition. In the stop-signal paradigm (Logan & Cowan, 1984), participants are asked to respond as fast as possible to a target stimulus (e.g., arrows), which is occasionally followed by a stop signal (e.g., auditory tone). If the stop signal is presented, participants are required to withhold the ongoing response. The stop signal is presented after a variable delay from the target onset; thereby, participants fail to cancel the ongoing response in some of the stop trials. Successfully inhibiting a response depends on a race between a stop process initiated by the stop signal and a go process initiated by the target stimulus. Based on the race assumption, the latency of the stopping process, which is called stop-signal reaction time (SSRT), is estimated to measure response inhibition.

Using the stop-signal task, some studies have examined whether people with suicidal behavior exhibit poor response inhibition. However, they found little evidence of impaired response inhibition among various groups. These included young adults with suicidal ideation or attempt (Chamberlain, Odlaug, Schreiber, & Grant, 2013), adolescents showing nonsuicidal self-injury along with suicide attempt (Dougherty et al., 2009), alcohol dependence patients with suicide attempt (Wojnar et al., 2009), self-injurers (Glenn & Klonsky, 2010), and suicide ideators or attempters (Millner et al., 2018). However, it should be noted that neutral stimuli (e.g., arrows), not emotional stimuli, were used in these studies. Considering that people generally attempt suicide in a negative emotional state, previous researchers using neutral stimuli may have failed to efficiently distinguish people with suicidal behavior from those without.

Previous studies have shown that emotional stimuli interfere with response inhibition, and the interference effect depends on the valence or the threat/arousal level of emotional stimuli. For example, the greater interference effect of emotional stimuli has been found when negative faces (i.e., anger) were used as a go stimulus than positive faces (i.e., joy; Rebetez, Rochat, Billieux, Gay, & Van der Linden, 2015). However, it is unclear whether the valence effect was owing to the negative valence or the threat level of emotional stimuli because angry faces are often used as threat stimuli (Gotlib, Krasnoperova, Yue, & Joormann, 2004). Pessoa, Padmala, Kenzer, and Bauer (2012) found that response inhibition was impaired when high-threat emotional stimuli were used as stop signals. Taken together, these findings in nonclinical populations suggest that threatening and/or negative emotional stimuli possibly impair response inhibition.

Goals and Hypotheses of the Study

The goal of this study was to investigate whether suicide attempters would have poor response inhibition under emotional contexts using a behavioral measure and self-reported questionnaires. To address this goal, we developed a block-wise emotional stop-signal task. Using emotional face stimuli, two blocks of threat and nonthreat contexts were alternatively presented to the participants. Simultaneously, self-report measures of impulsivity that are presumed to measure similar construct of response inhibition were administered to the participants. Specifically, this study examined the following research questions and hypotheses.

Research Question 1: On the stop-signal task, would suicide attempters display more impaired response inhibition in emotional contexts than ideators or nonsuicidal controls?

Hypothesis 1a: It was hypothesized that there would be a group difference in the valence effect (i.e., the interaction effect of group and valence). Compared with ideators or controls, attempters would have poorer response inhibition to negative than to positive emotional stimuli.

Hypothesis 1b: It was hypothesized that there would be a group difference in the context effect (i.e., the interaction effect of group and context). Compared with ideators or controls, attempters would have poorer response inhibition in the threat than in the nonthreat context.

Hypothesis 1c: It was hypothesized that there would be a group difference in the interaction of context and valence (i.e., the interaction effect of group, context, and valence). Compared with ideators or controls, attempters would have more difficulty responding to positive stimuli in the threat than in the nonthreat context.

Research Question 2: On self-report measures, would suicide attempters report more difficulty in response inhibition than ideators or nonsuicidal controls?

Hypothesis 2: It was hypothesized that compared with ideators or controls, attempters would have higher scores on negative urgency, difficulties in impulse control, and goal-directed actions.

Method

Participants

Community adults with a lifetime history of suicide ideation or attempt as well as those with no lifetime history were invited to participate in our study. We restricted the age range from 19 to 35 years because previous research indicated the existence of an age-related effect on response inhibition using the stop-signal task (Sebastian et al., 2013) and self-reported impulsivity (Steinberg et al., 2008). Moreover, related research involving middle-aged adults is rare, which makes it difficult to assume that they have similar patterns of response inhibition when compared with younger age groups. A total of 142 participated in this study. The mean age of the participants was 22.97 years ($SD = 3.21$), of which 50.7% ($n = 72$) were women.

Procedure

The same study protocol and procedure were implemented in two research sites. Participants were recruited through online postings (e.g., university or community online boards) and local flyers in two regions of South Korea, one in Seoul and the other in Cheongju, a midsized city in the Chungbuk province. Participants who were willing to participate in the study contacted one of our research assistants via telephone or text messaging, and then they were scheduled for a study session. After providing written informed consent, participants completed an emotional stop-signal experiment and self-report measures. In the last component of the study protocol, structured clinical interviews regarding suicidal behavior were conducted. All clinical interviews were conducted by master's-level research assistants and supervised by a doctoral-level licensed clinical psychologist. The study was approved by the institutional review boards of Korea University (KU-IRB-17–17-A-1) and Chungbuk National University (CBNU-201703-BMSBETC-427–01).

Emotional Stop-Signal Experiments

Stimulus and apparatus. A white ($R = 255$, $G = 255$, $B = 255$) fixation circle (approximately 0.24° visual angle in diameter) and target face stimulus (approximately 3.85° $\times$ 4.98°) were presented at the center of a display with gray ($R = 128$, $G = 128$, $B = 128$) background color. A 750-Hz pure tone auditory stop signal was played through a headphone for 50 ms. Visual stimuli were presented on a 22-in. LED monitor of a personal computer at about a 60-cm distance from the participants. The experiment was controlled by MATLAB software (R2015a), using Psychtoolbox 3.0.11.

The face stimuli were selected from the Korea University Facial Expression Collection (Kim et al., 2017), which is the Korean version of facial stimuli depicting basic emotions based on Ekman's Facial Action Coding System (Ekman & Friesen, 2003). For threat context blocks, a set of face pictures (10 males and 20 females) was selected for both angry and happy expressions. For nonthreat context blocks, another set of face pictures (10 males and 10 females) was selected for both sad and happy expressions. Thus, each face identity with angry expression was repeated with happy expression in the threat context, but it was not presented in the nonthreat context. In the same manner, the face identity of sad expression overlapped with that of happy expression in the nonthreat context, but it did not appear in the threat context. Based on the ratings reported in Kim et al.'s study, the arousal level in response to the 20 angry faces ($M = 4.89$, $SD = 0.36$) was significantly higher than the arousal level in response to the 20 sad faces ($M = 4.23$, $SD = 0.39$), $t(38) = 5.59$, $p < .001$, Cohen's $d = 1.77$.

Task procedure. Participants were first instructed in the experimental procedure. The midlines of the keyboard and participants were aligned with the center of the monitor. A practice block of 80 trials was followed by the main experiment consisting of 10 blocks of 80 trials. The stop signal was presented on the 25% trials of each block after a negative or positive target face was presented. Stop trials were randomly presented but never presented in successive trials. For each block, 50% of the target faces depicted a negative emotion, which was randomly selected, and the rest depicted a positive emotion. Threat (angry–happy face) and nonthreat contexts (sad–happy face) were distinguished in a block-wise manner and presented in an AABB order, with the order counterbalanced across the participants. A 30-s break was provided between blocks.

After the fixation circle was presented for 500 ms, the target face stimulus was displayed. The target face remained on the screen until response or for a maximum duration of 1,500 ms. Participants were asked to press the "F" key with their left index finger when responding to a negative face (i.e., angry or sad) and the "J" key with their right index finger to a positive face (i.e., happy) as accurately and rapidly as possible. They were not explicitly told that two different types of negative facial expressions would be presented. Participants were also instructed to withhold responding when a stop signal was presented.

In go trials, the target was followed by a blank display for 500 ms without a stop signal. In stop trials (25% of total trials), however, a stop signal was presented with a short delay after the target onset. Stop trials were randomly presented with equal probability after a negative or positive target face but never presented in successive trials. The stop-signal delay between the onsets of the target and the stop signal was adjusted dynamically for each experimental condition (i.e., negative and positive in the nonthreat context and negative and positive in the threat context). The delay increased by 50 ms after participants successfully stopped their response and decreased by 50 ms after they failed to inhibit response in the presence of the stop signal, leading to an approximately 50% overall successful stop rate regardless of the overall response time. The initial duration of the delay used in the practice block was 250 ms for all the experimental conditions. For each experimental condition, the delay obtained at the end of the practice block was used as the initial durations for stop-signal delay in the main experiment. To prevent participants from intentionally postponing responses with the anticipation of a stop signal, it was noted that making fast and correct responses in the go trials was as important as successfully stopping responses in the stop trials.

Three different types of feedbacks were provided after incorrect, slow, and unsuccessful stop trials by presenting the corresponding messages on the screen during practice, but not in the main experiment.

Self-Reported Measures of Impulsivity

Urgency, Premeditation, Perseverance, Sensation seeking, Positive Urgency. The Urgency, Premeditation, Perseverance, Sensation seeking, Positive Urgency (UPPS-P; Whiteside & Lynam, 2001) is a widely used self-report questionnaire assessing multifaceted aspects of impulsivity. The Korean version of the UPPS-P shows adequate psychometric properties (Lim & Lee, 2014). Among the five subfactors of the UPPS-P, only the Negative Urgency factor was used. The scale consists of 12 items that use a 4-point Likert scale ranging from 1 (*agree strongly*) to 4 (*disagree strongly*). The reliability coefficient of the negative urgency factor in this study was .90.

Difficulties in Emotion Regulation Scale. The Difficulties in Emotion Regulation Scale (Gratz & Roemer, 2004) is a self-report measure of emotion dysregulation with six factors. Among those factors, two factors relevant to the study purpose were used: a five-item scale of the impulse control difficulties (IMPULSE) and a three-item scale of the difficulties engaging in goal-directed behavior (GOALS). Participants were asked to rate each item using a 5-point Likert scale ranging from 1 (*almost never*) to 5 (*almost always*). The Korean version of the Difficulties in Emotion Regulation Scale had good reliability and validity (Cho, 2007). The reliability coefficients of the IMPULSE and GOALS in this study were .93 and .92, respectively.

Assessment of Demographic and Clinical Characteristics

Age, gender, education level, and income were assessed. Also, lifetime history of major depressive disorder was assessed using clinical interviews of the Korean version of the Structured Clinical Interview for *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* Axis I Disorders (First, Spitzer, Gibbon, & Williams, 1996; Han & Hong, 2000).

Assessment of Suicidal Behavior and Group Classification

The Columbia–Suicide Severity Rating Scale (C-SSRS; Posner et al., 2008, 2011) was used to determine group classification (i.e., attempters, ideators, or controls). The C-SSRS is a clinician interview for suicidal behavior that has been validated in the United States (Posner et al., 2011) and Korea (Jang et al., 2014). The Korean version of the C-SSRS provided on the C-SSRS official web site was used for this study. All interviewers completed the video training provided on the C-SSRS official web site and obtained the C-SSRS training certificate before the study.

Based on the C-SSRS interviews, participants were classified into three mutually exclusive groups. In this study, suicide attempt was defined as "a self-injurious act with some intent to die" and included actual, aborted (stopped by self), and interrupted (stopped by others) attempts. Participants who responded "yes" to at least one of the C-SSRS ideation severity Questions 2 to 5 and the question of lifetime history of suicide attempt were placed in the attempt group. Participants who responded "yes" to the questions regarding lifetime history of suicidal ideation using the same criteria described above but responded "no" to the question concerning lifetime suicide attempt history were placed in the ideation group. Participants who gave a positive response only to the C-SSRS "wish to be dead" question were included in the control group.

Data Analysis Plan

To detect the group difference in SSRT with a power $1-\beta = .95$ at $\alpha = .05$, a sample size was calculated using G*Power 3.1 (Faul, Erdfelder, Buchner, & Lang, 2009). An analysis of variance with three groups required a total of 51 participants, assuming the effect size of .58 based on a meta-analysis study of the stop-signal paradigm (Lijffijt, Kenemans, Verbaten, & van Engeland, 2005). In the present study, however, SSRTs of three groups were compared, and within-subject variables were included in the experiment. Given the possible differences in the effect-size estimation, a larger number of participants were recruited.

Before hypothesis testing, we conducted preliminary analyses for sociodemographic and clinical characteristics of the sample and provided statistics for group differences, if possible. Based on the preliminary analyses, lifetime history of major depressive disorder was entered as a covariate in the subsequent analyses. For the stop-signal task, SSRT was used as an index of response inhibition. To estimate stop-process latency, SSRT was calculated for each participant. Based on the integration method (Logan & Cowan, 1984), SSRTs were estimated by subtracting the mean stop-signal delay from the *n* percentile of RTs in go trials, where the *n* was the percentage of unsuccessful stopping in stop trials. To provide preliminary information, the mean correct RT and error rates in the go trials were also calculated. Three-way mixed analysis of covariance was conducted separately on RTs, error rates, and SSRTs with *valence* (positive vs. negative) and *context* (threat vs. nonthreat) as within-subject variables and *group* (controls vs. ideators vs. attempters) as a between-subjects variable. For the self-report measures of impulsivity, a series of analysis of covariance was conducted to examine group differences.

Results

Preliminary Analyses

Among the participants, 14 participants who reported a history of nonsuicidal self-injury and no suicide attempt history were excluded from the final analysis, and one additional participant was excluded from the analysis because of a high error rate on the go trials. Another five participants who yielded negative SSRTs were excluded because negative SSRT values reflect deliberately delayed go responses and are thus presumed to be invalid estimates (Congdon et al., 2012). After excluding the 20 participants as described earlier, the final sample included 41 attempters, 38 ideators, and 43 controls.

Sociodemographic and suicidal characteristics of the three groups, attempters, ideators, and controls, are presented in Table 1. The sociodemographic characteristics of age, gender ratio, and education levels did not differ significantly across the three groups. A significant group difference was found for the lifetime history of major depressive disorder, $\chi^2(2) = 38.24$, $p < .001$. Assessment of suicidal behavior using the C-SSRS indicated that attempters scored higher than ideators on suicidal ideation severity, $t(77) = 3.98$, $p < .001$. Among attempters, 58.5% reported a history of two or more attempts, 48.7% actual attempt, 19.5% interrupted attempts, 63.4% aborted attempts, and 31.7% nonsuicidal self-injury. Also, 43.9% of attempters and 18.2% of ideators reported some preparatory acts or behavior. For statistical analyses of correct RT and error rates on go trials, the trials with RT exceeding 2.5 SD away from the conditional mean for each individual participant were excluded from analyses (approximately 2.3% of the total trials).

Group Differences in Emotional Stop-Signal Experiment

Emotion identification performance. The RT data demonstrated a significant main effect of *valence*, $F(1, 118) = 34.78$, $p < .001$, $MSE = 1,317$, $\eta_p^2 = .228$. Negative emotion took longer to identify than did positive emotion. *Valence* interacted with *context*, $F(1, 118) = 10.96$, $p = .001$, $MSE = 352$, $\eta_p^2 = .085$, such that the RT difference between negative and positive emotions was larger in the threat context, $F(1, 118) = 43.13$, $p < .001$, $MSE = 884$, $\eta_p^2 = .268$, than in the nonthreat context, $F(1, 118) = 14.69$, $p < .001$, $MSE = 785$, $\eta_p^2 = .111$. No other main or interaction effects were significant, Fs < 3.21, ps $> .076$. The overall error rate was 4.32%. No main or interaction effects were significant in the error rate data, Fs < 3.46, ps $> .065$.

Response inhibition performance. It was hypothesized that there would be group differences in the valence effect (Hypothesis 1a) and context effect (Hypothesis 1b) on response inhibition as measured by SSRT. These hypotheses were not supported. There was no significant two-way interaction of *group* and *valence* as well as *group* and *context*, Fs $< .55$, ps $> .577$. Hypothesis 1c, which stated that there would be a group difference in the interaction of valence and context, was supported by a significant three-way interaction of *valence*, *context*, and *group*, $F(2, 118) = 6.02$, $p = .003$, $MSE = 1,071$, $\eta_p^2 = .093$ (Figure 1). Separate analyses for each context were conducted as a function of *group* and *valence*. The interaction between *group* and *valence* was significant only in the threat context, $F(2, 118) = 3.98$, $p = .021$, $MSE = 1,314$, $\eta_p^2 = .063$, but not in the nonthreat context, $F(2, 118) = 1.39$, $p = .253$. In the threat context, SSRT was significantly shorter in response to positive face targets than it was for negative ones among controls, $F(1, 41) = 6.34$, $p = .016$, $MSE = 1,498$, $\eta_p^2 = .134$, but not among attempters and ideators, Fs $<$

Table 1

Sociodemographic and Clinical Characteristics of the Sample

Variable	Controls (n = 43)		Ideators (n = 38)		Attempters (n = 41)		Statistics	p
	n	%	n	%	n	%		
Sociodemographics								
Age in years (*M, SD*)	22.12	2.68	23.03	3.14	23.46	3.70	F = 1.95	.147
Sex (% female)	21	48.8	18	47.4	24	58.5	χ^2 = 3.50	.477
Education	—	—	—	—	—	—	χ^2 = 5.99	.424
High school or below	0	0	3	7.9	2	4.9	—	—
University attending	36	83.7	26	68.4	27	65.9	—	—
University graduates	4	9.3	6	15.8	7	17.1	—	—
Graduate school and above	3	7.0	3	7.9	5	12.2	—	—
Lifetime history of MDD	2	4.7	20	52.6	28	68.3	χ^2 = 38.24	<.000
C-SSRS	—	—	—	—	—	—	—	—
Suicide ideation history	—	—	—	—	—	—	—	—
Wish to be dead	9	20.9	38	100	41	100	—	—
Active suicidal thoughts	—	—	38	100	41	100	—	—
Active ideation with any methods	—	—	35	92.1	39	95.1	—	—
Active ideation with intent	—	—	15	39.5	37	90.2	—	—
Active ideation with plan and intent	—	—	3	7.9	7	17.1	—	—
Suicide ideation severity (*M, SD*)[a]	—	—	3.39	0.76	4.02	0.65	t = 3.98	<.001
Suicide attempt history	—	—	—	—	—	—	—	—
Frequency	—	—	—	—	—	—	—	—
One	—	—	—	—	17	41.5	—	—
Two or more	—	—	—	—	24	58.5	—	—
Actual attempt	—	—	—	—	20	48.7	—	—
Interrupted attempt	—	—	—	—	8	19.5	—	—
Aborted attempt	—	—	—	—	26	63.4	—	—
Preparatory acts or behavior	—	—	4	18.2	18	43.9	—	—
NSSI history	—	—	—	—	13	31.7	—	—

Note. MDD = major depressive disorder; C-SSRS = Columbia Suicide Severity Rating Scale; NSSI = Non-suicidal self-injury.
[a] C-SSRS suicidal ideation severity ratings from 1 = wish to be dead, 2 = active suicidal thoughts, 3 = active suicidal thoughts with method, 4 = active suicidal thoughts with some intent, and 5 = active suicidal thoughts with intent and specific plan.
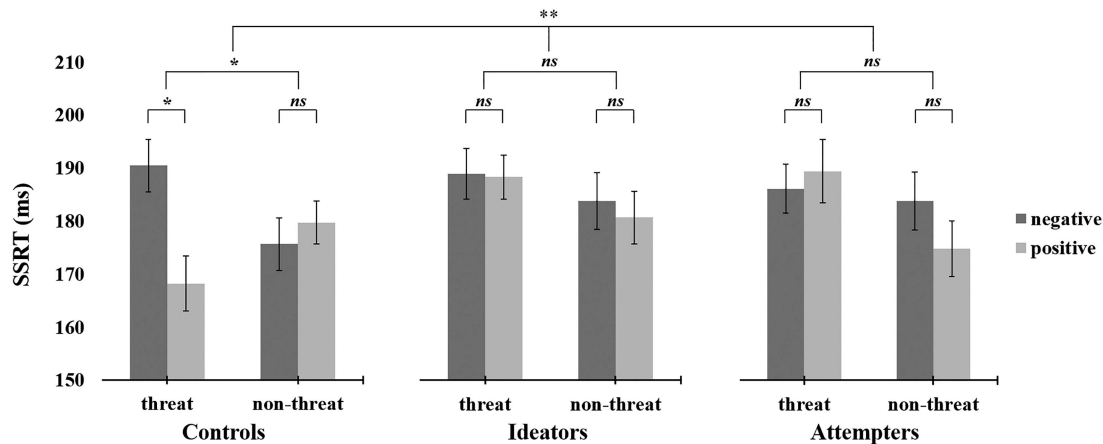
Figure 1. Stop-signal reaction time as a function of valence, context, and group. Error bars denote 95% confidence interval without individual variability (Loftus & Masson, 1994). *ns* = nonsignificant. * *p* value less than .05. ** *p* value less than .01.

1.25, *p*s > .270. However, in the nonthreat contexts, no such difference was found for attempters, ideators, and controls, *F*s < 1.51, *p*s > .227. SSRTs as a function of *context* and *valence* are presented in Table 2.

Group Differences in Self-Reported Measures of Impulsivity

Hypothesis 2, which states that attempters would have higher scores on negative urgency, difficulties in impulse control, and goal-directed actions compared with ideators or controls was partially supported. As seen in Table 3, after lifetime history of major depressive disorder was controlled, group differences all remained significant for negative urgency, impulse control difficulties, and difficulties engaging in goal-directed behavior. Post hoc Tukey's honestly significant difference tests showed that attempters had significantly higher scores for negative urgency than did ideators, whose scores were significantly higher than those of controls. However, attempters and ideators had significantly higher scores on impulse control difficulties and difficulties engaging in goal-

directed behavior than did controls. No group differences were found between attempters and ideators on these two subscales.

Correlations of Self-Reported Impulsivity and SSRT in the Stop-Signal Task

Overall, self-reported impulsivity and task-based response inhibition (i.e., SSRT) were not significantly correlated (Table 4). All three subscales of self-reported impulsivity were significantly correlated only with the difference scores of SSRT in response to positive emotional stimuli (threat vs. nonthreat context). All three subscales of self-reported measures of impulsivity were correlated to each other, *r*s > .52, *p*s < .001.

Discussion

The study examined the role of response inhibition under emotional contexts in suicidal behavior. In the stop-signal task, compared with nonsuicidal controls, attempters and ideators had impaired response inhibition in response to positive stimuli under the

Table 2
Group Differences in Task Performance in the Stop-Signal Task

SSRT (ms)	Controls (n = 43)		Ideators (n = 38)		Attempters (n = 41)		F	p	η_p^2	Post hoc Tukey
	M	SD	M	SD	M	SD				
Threat context	—	—	—	—	—	—	—	—	—	—
Negative valence	190.45	52.61	188.95	73.75	186.15	60.46	0.75	.472	.013	—
Positive valence	168.19	48.88	188.33	57.58	189.49	73.75	0.87	.421	.015	—
Nonthreat context	—	—	—	—	—	—	—	—	—	—
Negative valence	175.65	49.32	183.83	67.02	183.88	48.74	0.02	.985	.000	—
Positive valence	179.71	45.36	180.69	70.85	174.82	63.17	1.02	.354	.017	—
$Neg_{threat} - Neg_{nonthreat}$	14.80	41.88	5.11	51.88	2.27	48.90	1.27	.286	.021	—
$Pos_{threat} - Pos_{nonthreat}$	−11.53	48.30	7.64	44.05	14.66	57.42	4.61	.012	.072	C < I, A

Note. SSRT = stop-signal reaction time. All analyses were conducted after controlling for lifetime history of major depressive disorder; $Neg_{threat} - Pos_{threat}$ = difference in SSRT in response to negative and positive valence stimuli in the threat context; $Neg_{threat} - Neg_{nonthreat}$ = difference in SSRT in response to negative valence stimuli in the threat and nonthreat contexts; $Pos_{threat} - Pos_{nonthreat}$ = difference in SSRT in response to positive valence stimuli in the threat and nonthreat context. C = Controls; I = Ideators; A = Attempters.

Table 3
Group Differences in Self-Reported Impulsivity

Variable	Controls (n = 43)		Ideators (n = 38)		Attempters (n = 41)		F	p	η_p^2	Post hoc Tukey
	M	SD	M	SD	M	SD				
Negative urgency	22.12	5.86	27.58	6.73	31.85	6.68	14.70	<.001	.199	C < I < A
IMPULSE	6.77	2.92	11.37	4.99	12.76	4.80	9.22	<.001	.135	C < I, A
GOALS	6.16	2.53	9.55	2.86	10.32	2.84	10.37	<.001	.150	C < I, A

Note. All analyses were conducted after controlling for lifetime history of major depressive disorder; Negative Urgency = a subscale of the Urgency, Premeditation, Perseverance, Sensation seeking, Positive Urgency; IMPULSE = Impulse Control Difficulties subscale of the Difficulties in Emotion Regulation Scale; GOALS = difficulties engaging in Goal-Directed Behavior subscale of the Difficulties in Emotion Regulation Scale. C = Controls; I = Ideators; A = Attempters.

threat context, whereas no such group difference was found in the nonthreat context. Attempters and ideators had higher scores on all three self-report measures of impulsivity compared with controls. Based on the ideation-to-action framework, however, negative urgency was the only factor that differentiated attempters and ideators. No other self-reported or behavioral measures differentiated these two groups.

The results indicated that attempters and ideators did not differ in terms of how to act under emotional contexts, but they differed from nonsuicidal controls. The most unexpected finding was that attempters and ideators did not demonstrate impaired response inhibition to negative emotional stimuli compared with controls. What distinguished attempters and ideators from controls was their responses to positive emotional stimuli in a threat context compared with a nonthreat context. Attempters and ideators had difficulty attending to positive information under threatening circumstances.

Table 4
Correlations of Self-Reported Impulsivity and Stop-Signal Reaction Time in the Stop-Signal Task

Variable	Negative urgency	IMPULSE	GOALS
Self-reported impulsivity	—	—	—
Negative Urgency	—	—	—
IMPULSE	.64***	—	—
GOALS	.52***	.78***	—
SSRT (ms) in the stop-signal task	—	—	—
Threat context	—	—	—
Negative valence	.03	.02	−.01
Positive valence	.12	.10	.09
Nonthreat context	—	—	—
Negative valence	.14	.06	.02
Positive valence	−.09	−.19*	−.15
Neg$_{threat}$−Neg$_{nonthreat}$	−.12	−.04	−.04
Pos$_{threat}$−Pos$_{nonthreat}$	.23*	.33***	.27***

Note. SSRT = stop-signal reaction time; Negative Urgency = a subscale of the Urgency, Premeditation, Perseverance, Sensation Seeking, Positive Urgency; IMPULSE = Impulse Control Difficulties subscale of the Difficulties in Emotion Regulation Scale; GOALS = difficulties engaging in Goal-Directed Behavior subscale of the Difficulties in Emotion Regulation Scale; Neg$_{threat}$−Neg$_{nonthreat}$ = difference in SSRT in response to negative valence stimuli in the threat and nonthreat contexts; Pos$_{threat}$−Pos$_{nonthreat}$ = difference in SSRT in response to positive valence stimuli in the threat and nonthreat context.
* p < .05.   *** p < .001.

The mechanisms that underlie the current findings are yet unclear. One possibility is that attempters and ideators would have difficulty shifting or disengaging attention from threatening to positive emotion, similar to people with high trait anxiety (Fox, Russo, & Dutton, 2002; Yiend & Mathews, 2001). In other words, suicidal ideators or attempters would have difficulty processing positive emotional information when threatening emotional information captures their attention. Consistent with this idea, findings from a population-based longitudinal study indicated that anxiety disorders predicted suicidal ideation and attempt after other mental disorders were controlled. Furthermore, a comorbid condition of anxiety disorders in people with mood disorder increased the risk of suicide ideation and attempt (Sareen et al., 2005).

Negative urgency was the only significant factor in differentiating the attempt group from the ideation group. People with high negative urgency are likely to engage in maladaptive behavior owing to failed impulse control in response to distress to relieve negative emotions, often resulting in worsening consequences and regrets (Cyders & Smith, 2008). Based on the interpersonal psychological theory, Anestis and Joiner (2011) reported that negative urgency is an amplifier for suicide attempt among people with high suicide risk. They also noted that individuals with this disposition are likely to engage in risky behaviors, thus having more chances to develop the capability for suicidality. It requires further investigation if a third variable, such as the capability for suicidality, would mediate the relationship between negative urgency and suicidal behavior.

Consistent with previous studies (Cyders & Coskunpinar, 2012; Strasser et al., 2016), no significant correlations were found between self-reported impulsivity and response inhibition measured in the stop-signal task. However, self-reported impulsivity was significantly correlated with difference scores in response inhibition to positive emotional stimuli in the threat and nonthreat contexts. Roberts et al. (2011) suggested that only certain types of response inhibition and impulsivity are correlated. Along with the current findings, this suggests the need for further research focusing on context-dependent response inhibition in suicidal behavior by adopting various emotional contexts and its relationship with self-reported impulsivity.

Limitations

The results should be cautiously interpreted in light of our sample characteristics. As noted in the Results section, about half of the attempters who participated in this study were either interrupted or aborted attempters, which may reflect their capability for stopping even once they have initiated certain suicidal action.

Although recent studies have reported quite similar suicide risk characteristics among aborted, interrupted, and actual attempters (Burke, Hamilton, Ammerman, Stange, & Alloy, 2016; Rogers, Hom, Dougherty, Gallyer, & Joiner, 2018), further study examining group differences in attempt types will advance the field. Also, the sample was collected in two regional communities in South Korea with a limited age range; thus, replication studies in other settings (e.g., hospitals), other countries, and other age groups will be needed. In addition, we only considered lifetime history of major depressive disorder as a covariate. Given that suicidal behavior can occur in contexts of various psychiatric disorders, further study with psychiatric populations or individuals with more serious suicide attempts, whose action lead to hospitalization, is needed to confirm the current findings.

Research Implications

Consistent with the ideation-to-action framework, attempters reported a higher tendency to act rashly in negative emotional states than ideators in our self-reported measures, but attempters did not differ from ideators in their performance to inhibit responses in emotional contexts. Two possibilities can be considered to explain this conflicting result. First, subjective perception and objective performance are not necessarily consistent. Attempters did not differ from ideators in their performance in response inhibition, but it is possible that attempters perceived themselves more impulsive in negative emotional states than ideators. Second, negative emotional states can be interpreted in a range of meanings in self-report questionnaires, whereas only a limited emotional context was set for the behavioral tasks. In this study, only anger and sadness were used in the stop-signal task. Behavioral testing using other suicide-specific negative emotions, such as shame, guilt, or self-hate, would be necessary to expand these findings. In addition, attempters and ideators did not differ in impulse control difficulties and difficulties engaging in goal-directed behavior. This may be because these types of impulsivity occur in broad contexts, including nonemotional circumstances, and thus are associated with a range of problems related to executive functioning or attention.

A nonsignificant difference across groups in response inhibition to negative emotional stimuli was unexpected. What we observed instead was that compared with nonsuicidal people, suicidal people had impaired response inhibition to positive stimuli under a threat context. These results suggest an important research implication. Regardless of suicidal risk, people may respond similarly to negative emotional stimuli. However, suicidal people have difficulty effectively responding to positive emotional stimuli under a threat context. Further research is needed to investigate how the threat context influences people during a suicidal crisis and how suicidal people would react under such context.

Clinical and Policy Implications

This study suggests that clinicians working with suicidal people need to pay more attention to how they process positive information under threatening circumstances. When extremely stressed or threatened, people tend to have an attenuated attention span and difficulty disengaging attention from threatening information. Thus, it would be helpful if clinicians could help them recognize

and respond to a wider range of information or circumstances, either positive or negative. Another important implication is that an individual's perceived uncontrollability for action in negative emotional states is an important factor that increases suicide risk. Increasing one's self-efficacy in dealing with negative emotional states may prevent ideators from taking a suicidal action. Finally, this study raises the question of whether ideators are actually different from attempters in their potential to act when experiencing suicidal ideation. Nevertheless, compared with attempters, ideators have received little clinical attention and are often ignored in suicide prevention efforts. In Korea, for example, extensive suicide prevention efforts have been implemented for suicide attempters but relatively less for ideators. More prevention efforts and clinical attention are needed for ideators as well as attempters.

Conclusion

Overall, the results indicate that attempters and ideators, as compared with nonsuicidal people, differ not in their responses to negative or threatening stimuli but in their responses to positive stimuli under threatening circumstances. Moreover, the results indicate that what differentiates attempters from ideators is not objective performance but an individual's perceived ability to control their actions while experiencing negative emotional states.

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