# The Relationship between Performance of Attention Task and Suicidal Ideation in Korean Patients with Mood Disorders

**Soo In Kim**[1] ✉ **and Kyoung Ae Kong**[2]

[1]Department of Psychiatry, Ewha Womans University College of Medicine, Seoul, Republic of Korea
[2]Department of Preventive Medicine, Ewha Womans University College of Medicine, Seoul, Republic of Korea

**Objective**   We examined the performance of attention tests related to suicidal ideation in mood disorder patients and to explain the difference of attention test performance in relation to suicidal ideation after controlling clinical and psychological variables of mood disorder patients.

**Methods**   Seventy-three in- and outpatients with major depressive disorder (n=41) or bipolar disorder (n=32) completed a self-rating questionnaire assessing socio-demographic characteristics, and clinical and psychological variables. Comprehensive Attention Test (CAT) also was conducted.

**Results**   Thirty-three patients were the high-suicidal ideation (SI) group, and forty patients were the low-SI group. The errors of commission (CEs) of visual sustained attention in the high-SI group was 6.3 times higher on average than that of the low-SI group. After controlling for sex, age, and diagnosis, a higher number of CEs on visual sustained attention tasks predicted higher SI score. However, after controlling for sex, age, diagnosis, and depressive mood, this predictive ability was no longer observed.

**Conclusion**   This study showed that CE on the visual sustained attention task seems to influence suicidal ideation as a result of interaction with depressive symptoms.                           **Psychiatry Investig 2020;17(4):374-381**

**Key Words**   Mood disorder, Suicidal ideation, Sustained attention.

## INTRODUCTION

Korea had the highest suicide rate among Organization for Economic Cooperation and Development (OECD) countries in 2016, and the mortality rate from suicide per 100,000 population in Korea was 25.6.[1] This is lower than the rate of 28.5 per 100,000 population in 2013 but is still a high suicide rate.[2] The suicide rate has been decreasing somewhat as a result of social interest, support, and policy for suicide prevention in Korea. However, there is continuing need for interventions to alleviate suicidal risk factors to lower suicide rates.

Suicidal behavior (SB) refers to all intentional acts of suicide and can be conceptualized in the phenotypic spectrum as ranging from suicidal ideation (SI) and preparatory acts

toward imminent SB to suicide attempts (SA) and completed suicide. SB is associated with mental illness, particularly depression. Additionally, patients with bipolar disorders and those with depressive disorder have lifetime suicide rates of 15−20% and 15%, respectively.[3] Cognitive deficits are well-known symptoms in mood disorders. Most cognitive functions seem to be affected, and these broad deficits are present regardless of mood symptoms other than acute state.[4] Research on cognitive characteristics associated with SB has been conducted steadily. Cognitively, SB is thought to have inherent characteristics independent of mood disorders.

Executive functions are a set of cognitive process that are necessary for the cognitive control of behavior, such as selecting and successfully monitoring behaviors that facilitate the attainment of chosen goals. These include basic cognitive processes such as attentional control, cognitive inhibition, inhibitory control, working memory, and cognitive flexibility.[5-7] Cognitive flexibility defined as an individual's ability to modify thinking and generated solutions in respond to changing environmental factors.[8] Persons with suicidality are often considered to have cognitive inflexibility. One study reported that depressed indi-

viduals with suicidal ideation performed significantly worse on several measures of executive function compared with depressed, non-suicidal individuals after controlling demographic and clinical factors and displayed decreased cognitive flexibility. The executive functions have been seen as regulated by the prefrontal regions of the frontal lobes. Therefore, the results showed a pattern of mental inflexibility associated with frontal lobe dysfunction and mental inflexibility may underlie suicidal thinking and the executive decision to commit suicide.[9] These findings were supported by a meta-analysis of neuropsychological findings that indicated an association between susceptibility to SB and impairments in cognitive control and decision-making.[10]

Among various cognitive functions, attention deficits are common in major depression and bipolar disorder and are associated with risk factors for suicidal behavior.[11,12] Various instruments have been used to analyze attention processes, such as the letter cancelation test, trail making test, stroop test, and continuous performance test (CPT). The CPT is a computer-based task that provides an objective method for assessing attention deficits. It is cited as the most frequently used test in both clinical and research contexts.[13] The subject is asked to click a button upon observation of a target stimulus on a computer screen. If observing a stimulus other than the target, the subject should not click the trigger. The computer automatically notes errors of omission (OEs), errors of commission (CEs), reaction time to stimuli (RT), and repeated clicking for one stimulus. OEs occur when the subject does not respond to the designated target and are considered a measure of inattention. CEs occur when the subject incorrectly responds to a non-target and are regarded as measures of impulsivity or disinhibition.[14] The CPT task has been used primarily to assess selective attention and sustained attention and is a measure of impulsivity.[15]

The CAT is a type of continuous performance test to quantify attention concentration and impulse control ability. It was developed by the Korean Academy of Child and Adolescent Psychiatry because the CPT is limited in comprehensively measuring neuropsychological abnormalities, predicting attention problems in children with high intellectual abilities or in older grades, and distinguishing ADHD from attention deficits or distractions observed in other psychiatric disorders such as depression and anxiety.[16] When applied to healthy Korean adolescents in one study, the CAT showed an association between attention deficits and increased suicidal ideation after controlling for depressed mood.[17] CAT is considered useful for distinguishing attention associated with mood disorders with suicidal ideation because it can evaluate subcategories of attention and impulse control ability.

Impulsivity is a tendency to act on a whim, displaying be-

havior characterized by little or no forethought, reflection, or consideration of the consequences.[18] The relationship of impulsivity with RT and CEs in CPT tests is well established.[19] Many studies have reported that impulsivity is associated with suicidal behavior.[20-23] One study showed that greater self-reported impulsivity was associated with more self-reported thoughts of suicide and self-harm.[24] Recently, one study reported that local atrophy of the left hippocampus, right caudate, and right pallidum had a positive correlation with impulsivity among major depressive disorder patients with suicidal ideation in comparison between MDD with suicidal ideation and without. They mainly investigated whether specific structural differences were present in MDD patients with and without suicidal ideation and identified biological features related to suicidal risk.[25] These biological features might be the basis for demonstrating that cognitive function may also be affected in mood disorder patients with suicidal ideation.

In this study, we intended to examine the performance of attention tests related to suicidal ideation in mood disorder patients and to explain the difference of attention test performance reflecting impulsivity in relation to suicidal ideation after controlling clinical and psychological variables of mood disorder patients.

## METHODS

### Participants

Study participants comprised 73 in- and outpatients [41 with depressive disorder and 32 with bipolar disorder (BPD)] between 18−65 years old who visited the Psychiatry Department at Ewha Womans University Mokdong Hospital in Korea, from July 2012 to January 2016, and completed the CAT. Depressive disorder and bipolar disorder were diagnosed according to the DSM-IV-TR diagnostic criteria by a psychiatrist. Exclusion criteria were severe medical problem or neurological disorder, history of comorbid Axis I or II disorder according to the DSM-IV-TR criteria, and mental retardation (IQ<70). This study was approved by the Institutional Review Board of Ewha Womans University Mokdong Hospital (ECT13-20A-15) and conformed to the tenets of the Declaration of Helsinki. All patients provided written informed consent after receiving information on the purpose of the study.

### Assessment of clinical variables

#### Sociodemographic and clinical variables

For all participants, sociodemographic (i.e., age, sex, educational level, marital status, and occupation) and clinical variables (i.e., diagnosis, history of alcohol consumption,

current smoking, and family history of psychiatric disorders and suicide) were obtained through personal interview at the Psychiatry Department.

### Attention tasks

Visual sustained attention, and divided attention were tested using the CAT. This tool was designed to evaluate the attention of children and adolescents in a comprehensive manner. The test-retest reliability and validity of the CAT were acceptable. The mean correlation coefficient for the test-retest scores was 0.715, and results from the factor analyses explained 51.7% of the cumulative variance.[16] The test results are presented as four indexes of OEs, CEs, mean RT for correct response, and standard deviation (SD) of RT. Visual sustained attention is the ability to maintain attention continuously and to suppress impulsivity. A visual ellipse, rhombus, cross, or X is presented every 2 s for 10 min, and participants are instructed to respond to all given stimuli except the X. Divided attention is the ability to process two or more stimuli and assess the high level of attentiveness to the presentation and process of visual and auditory stimuli simultaneously.

### Suicidal behavior

We used the Beck scale for suicidal ideation (BSI), a self-reporting version originally developed for the interviewer-administered scale to assess SI.[26] The BSI is a 19-item tool for measuring the current intensity of specific patient thoughts, behaviors, and plans to commit suicide during the past week. The 19 items are rated on a 3-point scale ranging from 0–2 according to intensity of suicidal intention. These ratings are summed for a total score of 0–38. Individual items indicating the wish to die, frequency and duration of SI, desire to perform a passive or active SA, sense of control over SA, and amount of actual preparation for SA are evaluated. The Korean version of the BSI translated by Shin et al.[27] was used in this study. Although there is no strict cut-off value for classifying patients on the basis of BSI, a score of 9 was used as the criterion in this study, given that a greater incidence of SI has been reported in patients with BSI score of 9 or higher[27-29] and among Korean adults.[30] Therefore, participants were divided into two groups: patients with BSI score of 9 or above were classified as the high-SI group, and those with BSI score less than 9 were classified as the low-SI group.

### Psychological assessment

To assess the psychological variables, participants were evaluated in a psychiatric interview by psychiatrists and self-rating questionnaires. Depressive symptoms were evaluated using the beck depression inventory (BDI) with the Korean translation by Lee and Song.[31] The BDI comprises a 21-item self-reported scale of depressive symptoms and is a useful measure of severity of depressive symptoms.

Anxiety symptoms were evaluated using the state-trait anxiety inventory (STAI),[32] which evaluates the severity of two types of anxiety. State anxiety describes the anxiety symptoms an individual is currently experiencing, and trait anxiety assesses general anxiety symptoms. This study used the Korean translation by Kim.[33]

The Barratt impulsiveness scale (BIS) was used to assess impulsivity with the Korean translation by Lee.[34] It consists of 30 self-reported questionnaires including 11 reverse scoring questions, each of which is rated on a 4-point Likert scale. The score of each item is summed up considering inverse scoring items, and the higher the total score, the higher the impulsiveness. BIS consists of three factors: attentional impulsiveness, motor impulsiveness, and non-planning impulsiveness. Attentional impulsiveness involved making quick cognitive decisions. It assesses the degree of focus on what you are trying to do. Motor impulsiveness was defined acting without thinking. It assesses the degree of impulsive behavior. Non-planning impulsiveness was characterized as a present orientation or a lack of futuring. It measures the degree of deliberation or planning.[35,36]

### Statistical analysis

Sociodemographic characteristics, suicidal ideation and other psychological assessments were compared between the high-SI group and low-SI group using the chi-square test for dichotomous variables and the independent-samples t-test for continuous variables. Subject performance on attention tasks between the high-SI group and low-SI group was compared using the general linear model with adjustment for sex and age. To examine the relationship between SI score and performance on attention tasks, three multiple linear regression models controlling for sex and age; sex, age, and diagnosis, or sex, age, diagnosis, and depressive symptoms were applied for each index of attention performance. The association between SI score and depressive symptoms was also assessed with the models after the same adjustments. Partial correlation analyses adjusting for sex and age were performed to examine the relationships between CAT score and depressive symptoms, state anxiety, trait anxiety, and impulsivity.

All statistical analyses were performed using SAS software (version 9.4, SAS Institute, Cary, NC, USA), and p<0.05 was considered statistically significant.

## RESULTS

A total of 73 participants was enrolled in the study. Based on BSI score 9, 33 patients were the high-SI group, and 40

**Table 1.** Comparison of socio-demographic characteristics and diagnosis between high suicidal ideation group and low suicidal ideation group

| Sociodemographic characteristics, N (%) | Low SI group (BIS<9) (N=40) | High SI group (BIS≥9) (N=33) | p |
|---|---|---|---|
| Sex | | | 0.1554 |
| Male | 26 (65) | 16 (38.1) | |
| Female | 14 (35) | 17 (54.8) | |
| Age (years) | | | 0.1400 |
| <40 | 9 (22.5) | 14 (42.4) | |
| 40−49 | 15 (37.5) | 7 (21.2) | |
| ≥50 | 16 (40.0) | 12 (36.4) | |
| Education | | | 0.5566 |
| Less than high school | 11 (27.5) | 11 (33.3) | |
| High school | 16 (40.0) | 15 (45.5) | |
| College | 13 (32.5) | 7 (21.2) | |
| Marital status | | | 0.879 |
| Married | 15 (-37.5) | 11 (33.3) | |
| Single | 16 (40.0) | 13 (39.4) | |
| Divorced/separated/ widowed | 9 (22.5) | 9 (27.3) | |
| Job | | | 0.5552 |
| Unemployed | 16 (40.0) | 11 (33.3) | |
| Housewife/student | 4 (10.0) | 8 (24.2) | |
| Labor worker | 14 (35.0) | 11 (33.3) | |
| Office worker | 5 (12.5) | 2 (6.0) | |
| Professional | 1 (2.5) | 1 (3.0) | |
| Diagnosis | | | 0.2425 |
| Depression | 20 (50.0) | 21 (63.6) | |
| Bipolar disorder | 20 (50.0) | 12 (36.4) | |

BIS: Barratt Impulsiveness Scale

**Table 2.** Comparison of scores on beck scale for SI and psychological assessments and performance on attention tasks between high SI group and low SI group

| | Low SI group (N=40) | High SI group (N=33) | p |
|---|---|---|---|
| | Mean±SD | Mean±SD | |
| BSI score | 2.9±2.7 | 16.1±6.2 | <0.001*** |
| BDI score | 13.9±10.6 | 28.5±12.4 | <0.001*** |
| BIS score | 62.2±14.0 | 71.5±12.3 | 0.0083** |
| Trait anxiety | 44.7±9.5 | 57.5±10.7 | <0.001*** |
| State anxiety | 43.1±9.6 | 58.8±12.5 | <0.001*** |
| Visual sustained attention[†] | | | |
| OE | 27.7±45.9 | 32.2±55.5 | 0.9512 |
| CE | 8.9±8.0 | 15.2±14.7 | 0.0122* |
| RT (ms) | 63.6±149.9 | 488.5±158.4 | 0.0823 |
| SD of RT | 172.6±80.0 | 166.2±89.0 | 0.9220 |
| Divided attention[†] | | | |
| OE | 20.3±10.6 | 19.7±13.3 | 0.6245 |
| CE | 8.9±8.0 | 9.3±11.0 | 0.6429 |
| RT (ms) | 792.3±183.3 | 724.8±257.0 | 0.1919 |
| SD of RT | 290.9±90.2 | 263.9±107.3 | 0.3111 |

Independent t-test, *p<0.05, **p<0.01, ***p<0.001, [†]general linear model adjusting for sex and age. BSI: Beck Scale for Suicide Ideation, BDI: Beck Depression Inventory, BIS: Barratt Impulsiveness Scale, SI: suicidal ideation, OE: omission error, CE: commission error, RT: reaction time, SD: standard deviation

patients were the low-SI group. The numbers of male and female patients were as follows: high-SI group (M: 16, F: 17) and low-SI group (M: 26, F: 14). The high-SI group did not differ from the low-SI group in terms of sex, age, education, marital status, job, or diagnosis. Sociodemographic characteristics and diagnoses of these groups are shown in Table 1.

In comparing scores of BSI and psychological assessment including BDI, BIS, and STAI by SI group, the high-SI group showed significant higher scores on all scales than the low-SI group. In the performance of visual sustained attention test and divided attention test on CAT, the CEs of visual sustained attention in the high-SI group was 6.3 times higher on average than that of the low-SI group (15.2 vs. 8.9, p=0.0122). The other performance index scores were not different (Table 2).

In the multiple linear regression analysis to assess the associations between suicidal ideation and performance on atten-

tion tasks and psychological variables after adjusting for sex, age, and diagnosis, the higher the CE on the visual sustained attention tasks, the higher the SI score [β=0.28 (SE=0.07), p=0.0002, $R^2$=21.8%]. Other performance indexes of CAT showed no significant association with suicidal ideation. After additionally controlling for depressive symptoms, higher CEs on visual sustained attention tasks was not significant [β=0.13 (SE=0.07), p=0.0630, $R^2$=49.3%] (Table 3). Similarly, impulsivity showed a positive association with SI score after controlling for sex, age, and diagnosis, but when depressive symptoms were further controlled, the association was not significant [β=0.11 (SE=0.06), p=0.0581, $R^2$=49.4%]. Table 4 shows the correlation coefficients for the attention performance scores and psychological variables after controlling sex and age. Among indexes of sub-tests in CAT, CEs for stimulus showed a positive correlation with impulsivity, and CEs of sustained attention was moderately correlated with not only impulsivity measured by BIS (r=0.38), but also psychological variables of depressive symptoms (r=0.42), trait anxiety (r=0.49), state anxiety (r=0.37), and suicidal ideation (r=0.42). Impulsivity was positively correlated with SI score (r=0.42) and depressive symptoms (r=0.39), similar to CEs in the sustained attention test, and more strongly correlated with trait

**Table 3.** Associations between suicidal ideation and performance on attention tasks and psychological variables for all participants (N=73)

| | Sex and age adjusted | | | Sex, age, diagnosis, and depressive symptoms adjusted | | |
|---|---|---|---|---|---|---|
| | Beta | SE | RSquare (%) | Beta | SE | RSquare (%) |
| Visual sustained attention | | | | | | |
| OE | 0.01 | (0.02) | 5.3 | 0.00 | (0.02) | 46.6 |
| CE | 0.28* | (0.07) | 21.8 | 0.13** | (0.07) | 49.3 |
| RT (ms) | -0.01 | (0.01) | 7.9 | -0.01 | (0.00) | 48.5 |
| SD of RT | 0.01 | (0.01) | 6.3 | 0.00 | (0.01) | 46.6 |
| Divided attention | | | | | | |
| OE | -0.03 | (0.08) | 5.2 | 0.00 | (0.06) | 46.6 |
| CE | 0.05 | (0.10) | 5.3 | -0.04 | (0.08) | 46.8 |
| RT (ms) | -0.01 | (0.00) | 7.2 | 0.00 | (0.00) | 46.9 |
| SD of RT | 0.00 | (0.01) | 5.3 | -0.01 | (0.01) | 47.2 |
| BIS | 0.24* | (0.06) | 21.9 | 0.11** | (0.06) | 49.4 |
| BDI | 0.38* | (0.05) | 45.9 | | | |

*p<0.001, **p<0.065. General linear model adjusting for sex, age, diagnosis, and depressive symptoms. OE: omission error, CE: commission error, RT: reaction time, SD: standard deviation, BIS: Barratt Impulsiveness Scale, BDI: Beck Depression Inventory

**Table 4.** Pearson's correlations between suicidal ideation and performance on attention tasks and psychological variables for all participants (N=73)

| | Suicidal ideation | Depressive symptoms | Impulsivity | Trait anxiety | State anxiety |
|---|---|---|---|---|---|
| Suicidal ideation | 1.00 | 0.66** | 0.42* | 0.62** | 0.70** |
| Depressive symptoms | 0.66** | 1.00 | 0.39* | 0.68** | 0.65** |
| Impulsivity | 0.42* | 0.39* | 1.00 | 0.66** | 0.67** |
| Trait anxiety | 0.62** | 0.68** | 0.66** | 1.00 | 0.81** |
| State anxiety | 0.70** | 0.65** | 0.67** | 0.81** | 1.00 |
| Visual sustained attention | | | | | |
| OE | 0.06 | 0.05 | -0.01 | 0.04 | 0.11 |
| CE | 0.42* | 0.42* | 0.38* | 0.49** | 0.37* |
| RT (ms) | -0.18 | -0.05 | -0.12 | -0.09 | -0.09 |
| SD of RT | 0.12 | 0.17 | 0.17 | 0.23 | 0.23 |
| Divided attention | | | | | |
| OE | -0.05 | -0.06 | 0.07 | -0.11 | -0.04 |
| CE | 0.06 | 0.16 | 0.10 | 0.08 | 0.15 |
| RT 0 (ms) | -0.15 | -0.13 | 0.09 | -0.03 | -0.04 |
| SD of RT | -0.06 | 0.02 | 0.17 | 0.05 | 0.12 |

*p<0.01, **p<0.001. OE: omission error, CE: commission error, RT: reaction times, SD: standard deviation

and state anxiety (r=0.66, 0.67).

## DISCUSSION

We hypothesized that suicidal ideation in mood disorder patients was associated with poor performance on visual sustained attention tasks. The high-SI group showed a significant higher CEs for such a task. Meanwhile, after controlling for depressive symptoms, the association between suicidal ideation and poor performance on visual sustained attention task was not statistically significant. This finding is inconsistent with previous reports that showed an association between greater CEs of visual sustained attention and increased suicidal ideation in adolescents after controlling for depressive symptoms.[17] This inconsistency may be attributable to the different target group and our small sample size. We targeted mood disorder patients, whereas the other study targeted general adolescents. Therefore, the results of our study might

be influenced by the fact that the subjects had underlying cognitive deficits by mood disorder. Additionally, they compared 2,298 low-SI group and 164 high-SI group, while we compared 40 low-SI group and 33 high-SI group. Our subjects had higher BDI scores and variability than those of the other study. The mean score of BDI in our study was 5 points higher in the low-SI group (13.9±10.6 vs. 8.9±5.1) and 10 points higher in the high-SI group (28.5±12.4 vs. 18.8±8.0) than Kim et al.'s study. Larger model R squared value supported the contribution of depressive symptoms to much of the suicidal ideation in mood disorder patients in our study.

Sustained attention was the most significant sub-test associated with suicidal ideation and psychological variables of depressive symptoms, impulsivity, and anxiety symptoms in our study. Sustained attention is the ability to maintain attention continuously and to suppress impulsivity. It is known that the role of the brain's noradrenergic (NA) neurons in sustained attention is important. One study tested how NMDA receptor dependent activity of NA neurons in performance of sustained attention and showed the loss of NMDA receptors associated with decreased sustained attention cognitively and increased impulsivity at the level of behavior.[37] Sustained attention deficits are frequently reported in psychiatric and physical conditions. Esterman et al.[38] reported that failure of inhibition on the sustained attention test was higher in patients with PTSD and substance use disorder. Wooten et al.[39] showed a relationship between sustained attention ability and presence of multiple vascular risk factors in middle-age to older adults. This finding means that metabolic syndrome, the presence of three or more cardiovascular risk factors, has been associated with subtle and diffuse neural compromise and sustained attention is sensitive to the potentially negative effects of metabolic syndrome on subtle aspects of neurocognitive functioning. Several studies have reported that individuals with poor sleep quality, mild obstructive sleep apnea, or daytime sleepiness showed a decrease in sustained attention.[40-42] They supposed that poor sleep quality causes increased emotionality and it can affect prefrontal cortex dependent sustained attention tasks negatively.

In studies examining the association between neuroticism and CPT results, neuroticism increased error rates and decreased RT to target and non-target stimuli in healthy young adults[43] and was associated with error-prone behavioral performance on a CPT, suggesting that a propensity to experience negative emotions may manifest as impulsivity and hyperactivity on performance-based measures of executive function.[44] Therefore, psychiatric and physical conditions affecting the anatomical positions of the brain, which are important for sustained attention and emotional control, are thought to associate with sustained attention deficit and impulsivity.

In our study, suicidal ideation was correlated with psycho-logical variables of depressive symptoms, impulsivity, anxiety symptoms, and CEs on the visual sustained attention task. CEs on the visual sustained attention task and impulsivity accounted similarly for suicidal ideation, even after controlling for depressive symptoms. CEs on the visual sustained attention task was an attention item that well reflects impulsivity in our study. Considering that impulsivity is defined as the inability to resist a drive or irritation,[45] sustained attention is the test that most reflects impulsivity. Additionally, many researchers have suggested elevated frequencies of CEs as independent indicative of impulsivity in CPT.[20,46] Therefore, the significant higher CEs on the visual sustained attention task in high-SI group is somewhat predictable. This result showed that sustained attention task can be considered to be an additional way of evaluating impulsivity. BIS presents some weaknesses in terms of validity by cultural influence and reliability because of self-report questionnaire.[47] In that respect, the sustained attention task of CAT could be a simple, objective, and accurate measurement to assess impulsivity.

Although not statistically significant, probably due to the small sample size, the beta of CEs in sustained attention in the model adjusted for sex, age, and depressive symptoms (i.e., the increase of BSI per unit of increase of CEs) was significantly approximately three times higher than the beta of CEs in sustained attention. Several studies have shown that depression is related to reductions in many cognitive domains, including attention, processing speed, executive function, and memory.[48,49] Attention deficits in depressed patients have been identified in many studies, and many other cognitive dysfunctions are thought to be due to attention deficit. However, based on the finding that cognitive deficits in depression persist after attention impairment has been restored, it is believed that cognitive deficits in depression may be fundamental rather than secondary to the disturbance of attention.[50,51] In BD, neurocognitive impairment can appear practically in all cognitive domains, the most noticeable of which is executive function, which is known to be affected by attention. In one study of BD individuals who were re-tested according to episode status, attention and processing speed deficits appeared stable as manic and depressive symptoms fluctuated.[12]

There are many factors that contribute to suicidality, and the main area of concern in this regard is impulsivity.[52] Higher emotion-related impulsivity has been found to relate to greater suicidality and aggression among those with remitted Bipolar I disorder. Emotion-related impulsivity relates to decreased functional outcome, greater aggression, and stronger suicidality in BD. However, Horesh[53] suggested that impulsivity significantly predicted the presence of suicidal thoughts, although this effect became non-significant when mood instability was included. In our study, impulsivity showed a positive association with SI

score after controlling for sex, age, and diagnosis, but the association was not significant when depressive symptoms were further corrected [$\beta$=0.11 (SE=0.06), p=0.0581, $R^2$=49.4%]. Therefore, suicidality in patients with mood disorders is more affected by depressive symptoms than impulsivity or attention deficits.

This study has several limitations. First, the participants were recruited from a single center; therefore, the sample population reflected regional characteristics. Second, the study was cross-sectional, with no control group and a small sample size. Finally, the medication used by the cohort was not evaluated. Although no significant results were obtained, our study is meaningful in that it is the first study to assess the relationship between performance to an attention task and suicidal ideation in Korean patients with mood disorders.

In conclusion, the findings of this study indicate an association between higher CEs on the visual sustained attention task and increase in suicidal ideation in mood disorder patients before controlling for depressive symptoms. These associations were not significant after controlling for depressive symptoms. This study showed that CEs on the visual sustained attention task reflect impulsivity and seems to influence suicidal ideation as a result of interaction with depressive symptoms.

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## Conflicts of Interest
The authors have no potential conflicts of interest to disclose.

## Author Contributions
Conceptualization: Soo In Kim. Data curation: Soo In Kim, Kyoung Ae Kong. Formal analysis: Kyoung Ae Kong. Funding acquisition: Soo In Kim. Investigation: Soo In Kim, Kyoung Ae Kong. Methodology: Soo In Kim, Kyoung Ae Kong. Project administration: Soo In Kim. Resources: Soo In Kim. Software: Soo In Kim, Kyoung Ae Kong. Supervision: Soo In Kim. Validation: Soo In Kim. Visualization: Soo In Kim, Kyoung Ae Kong. Writing—original draft: Soo In Kim. Writing—review & editing: Soo In Kim.

## ORCID iDs
Soo In Kim          https://orcid.org/0000-0001-6909-5034
Kyoung Ae Kong          https://orcid.org/0000-0003-1658-3282

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