Archival Report

Reward Responsiveness in Suicide Attempters: An Electroencephalography/Event-Related Potential Study

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ABSTRACT

BACKGROUND: The present study aimed to objectively examine the Research Domain Criteria (RDoC) subconstructs of reward anticipation and initial response to reward in adult suicide attempters, compared with nonattempters, using electroencephalography (EEG) and event-related potentials (ERPs) within the context of the RDoC–recommended experimental paradigms for these subconstructs.

METHODS: Participants had either a history of at least 1 suicide attempt ($n = 30$) or no history of attempting suicide ($n = 30$). They completed diagnostic interviews, self-report questionnaires, and 2 computer-based tasks—the monetary incentive delay task and the doors task—during which continuous EEG was recorded. Temporospatial principal component analysis was used to isolate each of the ERP components of interest from other temporally or spatially overlapping components. Exploratory time-frequency analyses were also conducted to supplement the ERP analyses.

RESULTS: Suicide attempters, compared with nonattempters, exhibited specific deficits in reward anticipation (i.e., blunted cue-P3 ERP during the monetary incentive delay task) and in initial response to reward (i.e., reduced feedback-related delta power in the gain condition of the doors task). These results were at least partially independent of current symptoms or diagnoses of depression and anxiety.

CONCLUSIONS: These findings constitute an important step in obtaining a more fine-grained understanding of the specific reward-related abnormalities that might contribute to suicide risk.

Suicide is the second leading cause of death for 10- to 34-year-olds in the United States, and rates of suicide increased by 24% between 1999 and 2014 (1). However, the field's ability to predict risk for death by suicide has not improved in the past 50 years (2). This suggests that existing research does not accurately capture the nature of suicide risk and signals the need for studies that overcome conceptual and methodological limitations of past research. The Research Domain Criteria (RDoC) project of the National Institute of Mental Health (3) has the potential to move the field of suicide research forward because this framework specifically allows for the identification of novel correlates and risk factors in a way that integrates data across multiple methodological approaches (4). Because prior suicidal behavior is one of the best single predictors of future deaths by suicide [e.g., (2,5,6)], it is particularly important to better understand factors that increase risk for suicide attempts (SAs). Indeed, SA survivors represent an extremely important source of information about factors that may increase risk of attempting and dying by suicide.

Despite the usefulness of the RDoC framework for advancing our understanding of suicide risk, few studies to date have examined correlates and predictors of suicidal thoughts and behaviors in a way that is consistent with the RDoC (7). Moreover, most of these studies have focused on the variables that fall under the Negative Valence Systems domain of the RDoC (7). In contrast, the Positive Valence Systems domain of the RDoC has been particularly understudied in relation to suicide risk (7). This is an important gap in knowledge because there is growing evidence that several reward processes are implicated in suicide risk. Indeed, research suggests that suicide attempters might exhibit deficits in reward-related decision making, including overvaluing their current emotional state and inaccurately estimating the anticipated value of actions and events [for a review, see (8)]. Thus, when in suicidal crisis, these processes might contribute toward the decision to forgo one's future, deemed to be hopeless, in favor of escaping from the current emotional state, deemed to be intolerable. Consequently, the ability to adaptively respond to in-the-moment experiences and to anticipate future incentives is directly relevant to how individuals react to the intense negative emotions generally experienced during suicidal crises. The identification of specific reward system disruptions in suicide attempters might provide important

information needed to improve intervention or prevention efforts with this specific, extremely high-risk population.

To date, the majority of past research on reward-related processes in suicide attempters has focused on self-reported levels of anhedonia (i.e., loss of interest or pleasure in previously enjoyable activities). To this end, although a number of studies have demonstrated higher levels of anhedonia in those with versus those without a history of SA (9–12), there are also studies that did not find elevations in self-reported anhedonia in suicide attempters [e.g., (13,14)]. This inconsistency is likely due to limitations inherent in the sole reliance on self-reports in assessing constructs that are complex, multifaceted, and difficult to accurately report on. For example, self-reports alone do not generally allow for a precise determination of which component(s) of reward-related processes are implicated (e.g., anticipatory pleasure, consummatory pleasure, or both). Yet, this is crucial, given the distinct nature and neural correlates of these two stages of reward processing (15). Indeed, reflecting this distinction, the RDoC construct of reward responsiveness separates the reward anticipation subconstruct from the initial response to reward subconstruct. However, most studies have focused on only one aspect of reward processing per sample, assessed at a single unit of analysis (e.g., self-report), which is inconsistent with the RDoC framework and slows the advancement of suicide research (4). Thus, an important next step in advancing the understanding of reward processing in relation to suicide risk is to examine reward responsiveness in a more objective manner through the use of multimethod approaches and RDoC paradigms specifically recommended for the assessment of the reward anticipation subconstruct versus the initial response to reward subconstruct.

Owing to their excellent temporal resolution, electroencephalography (EEG) and event-related-potential (ERP) approaches allow for a high degree of differentiation of these subconstructs. Although relatively underutilized in the field of suicidology, EEG/ERP research has the potential to improve the understanding of a large number of complex processes in individuals with suicidal thoughts and behaviors (16), including reward-related processes. Researchers have used a number of EEG/ERP indices to study reward-related processes [for a review, see (17)]. Several ERP components map onto the subconstruct of reward anticipation and can be elicited and accessed via the RDoC-recommended experimental paradigm for this subconstruct (i.e., the monetary incentive delay task [MIDT]) (18,19) adapted for use with ERPs (20,21). The cue-P3 (or P300) ERP component is a slow centroparietal positivity that emerges between 300 and 600 ms poststimulus onset and is thought to capture the allocation of attention toward reward-predicting stimuli that motivates subsequent reward-seeking behavior (17,20,21). The contingent negative variation ERP component is a slow negative potential that is maximal over frontocentral sites and is thought to capture the transition toward motivated approach behavior (17,20,21). The stimulus-preceding negativity ERP component is a slow cortical potential that manifests as sustained centroparietal negativity in the seconds leading up to the feedback and is thought to capture the period after the motor response during the anticipation of feedback delivery (17,21). Although there is some evidence from functional magnetic resonance imaging (fMRI) studies that self-injurious/suicidal behaviors might be associated with blunted reward anticipation–related activity [e.g., (22,23)], fMRI's poor temporal resolution does not allow for a greater delineation of the processes that comprise reward anticipation. Thus, it is currently unclear which specific subcomponents of reward anticipation might be impaired in suicide attempters.

In addition to the MIDT, the doors task (24,25) has been recommended as a method for assessing the subconstruct of initial response to reward (26). The primary ERP component elicited by the doors task is the reward positivity (ΔRewP) (also known as the feedback negativity (FN), feedback-related negativity, and medial frontal negativity). The ΔRewP is often quantified as the difference between neural responsiveness to monetary gains (RewP-Gain) versus losses (RewP-Loss). This component peaks around 300 ms after feedback presentation at frontocentral sites (17,20,21). Although no studies to date have objectively examined the ΔRewP in suicide attempters via a similar paradigm, preliminary ERP evidence from the doors task suggests the presence of reward responsiveness abnormalities in children of suicide attempters (27). More specifically, these abnormalities manifested via a heightened ΔFN/ΔRewP, which was primarily driven by these children's responsiveness to monetary losses specifically and is broadly consistent with evidence that suicide attempters might overvalue their negative emotional states (8). However, because children of suicide attempters are at risk for a broad range of negative outcomes, not just future suicidal behavior, it is important to examine the ΔRewP in suicide attempters.

To avoid the problem of the overlap among neighboring ERP components that has contributed to numerous mixed results in the reward processing literature (17), we used temporospatial principal component analysis to isolate each of the ERP components of interest from other temporally or spatially overlapping components. In addition to examining these ERPs, exploratory time-frequency analyses were also conducted. Particularly relevant for the current study, research demonstrates gain-related increases in the delta frequency band and loss-related increases in the theta frequency band (28), which indicates possibilities for a greater dissociation of gain- and loss-related neural activity. Feedback-related theta is maximal at frontal-midline sites from around 200 to 500 ms, whereas feedback-related delta is maximal at parietal sites from around 100 to 500 ms [for a review, see (17)]. Interestingly, there is some evidence that time-frequency–based indices might be predictive of psychopathology independent of the ERP components [e.g., reward feedback-related delta prospectively predicted depression onset independent of the ΔRewP; see (29)]. Thus, time-frequency decompositions provide an important tool, which is complementary to ERPs, for isolating and representing reward-related neural activity (30).

Taken together, the primary goal of the present study was to clarify the nature of reward-related abnormalities in suicide attempters in the RDoC-consistent manner. Thus, we used the RDoC-recommended experimental paradigms in combination with EEG/ERPs to conduct an objective examination of the subconstructs of reward anticipation and initial response to reward. Based on prior research [e.g., (22,23)], we hypothesized that suicide attempters would exhibit blunted reward anticipation. Owing to limited knowledge about the nature of these abnormalities, we did

Table 1. Descriptive Statistics for Participants in Each of the Two Groups

Measure	SA Group (n = 30)	No-SA Group (n = 30)	$r_{effect\ size}$
Demographics			
Age, years	23.23 ± 8.13	26.60 ± 12.36	−.16
Female	23 (76.7)	19 (63.3)	.15
Caucasian	16 (53.3)	23 (76.7)	−.25
Heterosexual	17 (56.7)	23 (76.7)	−.21
Diagnoses			
Current MDD	5 (16.7)	2 (6.7)	.16
Lifetime MDD	28 (93.3)	19 (63.3)	.36[a]
Current anxiety	10 (33.3)	8 (26.7)	.07
Lifetime anxiety	15 (50.0)	9 (30.0)	.20
Symptoms/Mood			
BDI-II	20.33 ± 15.06	14.63 ± 11.33	.21
BAI	36.53 ± 13.27	33.97 ± 10.10	.11

Values are mean ± SD or n (%).

BAI, Beck Anxiety Inventory; BDI-II, Beck Depression Inventory; MDD, major depressive disorder; SA, suicide attempt.

[a]p < .01.

not make specific predictions regarding whether these deficits would generalize to all three of the reward anticipation-related ERP components. Further, based on prior evidence for a larger ΔRewP in children of suicide attempters (27), as well as the findings highlighting the tendency of suicide attempters to overvalue current emotional states (8), we expected that suicide attempters, compared with nonattempters, would exhibit a larger ΔRewP to wins versus losses. Finally, we conducted exploratory time-frequency analyses to examine gain- and loss-related oscillatory neural activity in the delta and theta frequency bands. Although we sought to match the two groups on current depressive and/or anxious symptoms and diagnoses, for an even stronger test of the specificity of any obtained group differences to participants' history of SA, we also examined whether the group differences would be maintained after statistically controlling for the influence of these psychiatric variables.

METHODS AND MATERIALS

Participants

Participants for this study were a total of 60 adults recruited from the community based on either having a history of at least 1 prior SA (n = 30) or having never attempted suicide (n = 30). Exclusion criteria for both groups were 1) history of intellectual disabilities or traumatic brain injury with loss of consciousness for more than 60 minutes; 2) current (past 6 months) psychosis, mania, or substance (including alcohol) dependence; 3) an inability to read and understand the materials given to them; and 4) unclear SA history. The demographic and clinical characteristics of the two groups are presented in Table 1.

Measures

Suicide Attempt History and Characteristics. The Self-Injurious Thoughts and Behaviors Interview–Short Form (31) was used to assess for lifetime SA history and

its characteristics. Of those with a lifetime history of SA, 17 participants reported a history of multiple lifetime SAs (range, 2–30) and 13 participants reported a history of a single lifetime SA.

Diagnoses. The Mini International Neuropsychiatric Interview for DSM-5 (32) was used to assess for lifetime histories of DSM-5 major depressive disorder (MDD) and anxiety disorders and was used primarily to characterize the sample.

Depressive and Anxious Symptoms. The Beck Depression Inventory-II (33) and the Beck Anxiety Inventory (34) were used to assess the levels of depressive and anxious symptoms, respectively. Both scales exhibited excellent internal consistency (Beck Depression Inventory-II: α = .92; Beck Anxiety Inventory: α = .93).

Reward Responsiveness (Self-report). The Temporal Experience of Pleasure Scale (TEPS) (35) was used to assess perceived anticipatory and consummatory pleasure, with higher scores indicating stronger feelings of pleasure. In the present study, the internal consistency of the TEPS total score was 0.84.

Reward Responsiveness (Neural Activity). Participants completed a version of the MIDT adapted for use with ERPs (20,21) and completed the doors task (24,25). Owing to space considerations, a detailed description of the reward tasks and EEG data acquisition and processing steps is provided in the Supplement. See Table 2 for a description of the principal component analysis factor combinations selected for statistical analyses and their split-half reliability.

RESULTS

TEPS Self-report

Although overall the SA group (mean = 78.83 ± 15.30) reported slightly lower levels of pleasure on the TEPS total score,

Table 2. PCA Factor Combinations Selected for Statistical Analyses and Their Split-Half Reliability

PCA Factor	Corresponding ERP Component	Peak Latency (ms)	Peak Channel	Split-Half Reliability SA Group	Split-Half Reliability No-SA Group
TF3SF1	Cue-P3	580	CP2	Incentive: 0.80 Neutral: 0.62	Incentive: 0.70 Neutral: 0.69
TF1SF1	CNV	2998	CP2	Incentive: 0.79 Neutral: 0.26	Incentive: 0.56 Neutral: 0.32
TF1SF1	SPN	90	Cz	Incentive: 0.66 Neutral: 0.84	Incentive: 0.88 Neutral: 0.77
TF2SF1	RewP	375	Cz	Loss: 0.83 Gain: 0.80	Loss: 0.92 Gain: 0.88

CNV, contingent negative variation; ERP, event-related potential; PCA, principal component analysis; RewP, reward positivity; SA, suicide attempt; SPN, stimulus-preceding negativity.

in comparison with the no-SA group (mean = 80.23 ± 11.21), this difference was not statistically significant ($F_{1,58} = 0.16$, $p = .69$, $\eta_p^2 = .003$).

Monetary Incentive Delay Task

As expected, participants were faster in their button presses in response to the target across incentive, compared with neutral, trials ($\chi^2_1 = 193.27$, $p < .001$). We conducted three 2 group (SA, no SA) × 2 condition (neutral, incentive) repeated-measures analyses of variance with the cue-P3, contingent negative variation, and stimulus-preceding negativity amplitudes serving as the dependent variables. As can be seen in Table 3, the only significant group × condition interaction was for the cue-P3. Follow-up tests that focused on the cue-P3 difference score (see Figure 1) revealed that the SA group exhibited significantly less difference between the cue-P3 in the incentive compared with the neutral condition (mean = 0.17 ± 2.95 μV) than the no-SA group (mean = 2.38 ± 4.83 μV) ($F_{1,58} = 4.58$, $p = .04$, $\eta_p^2 = .07$). This between-group difference in the cue-P3 appeared to be driven by the SA group being more responsive than the no-SA group specifically in the neutral condition ($F_{1,58} = 4.55$, $p = .04$, $\eta_p^2 = .07$) but not in the incentive condition ($F_{1,58} < 0.01$, $p = .99$, $\eta_p^2 < .001$). The cue-P3 effect was maintained when we statistically controlled for the influence of participants' current diagnoses of MDD or any anxiety disorder, or current symptoms of depression, anhedonia, or anxiety (all ps < .05). Further, although the findings were reduced to a nonsignificant trend when we only included the participants from both groups with a lifetime history of MDD, the magnitude of the effect size was similar to that observed in the full sample, suggesting that the reduction in significance was likely due to reduced statistical power with the smaller sample ($F_{1,45} = 3.39$, $p = .07$, $\eta_p^2 = .07$).

Doors Task

We conducted three 2 group (SA, no SA) × 2 condition (gains, losses) repeated-measures analyses of variance with the RewP amplitude and feedback-related delta and theta power serving as the dependent variables. As can be seen in Table 4, the only significant group × condition interaction was for the delta power (see Figure 2), with the SA group exhibiting a negative difference score (mean = −0.33 ± 1.00 μV, reflecting larger responses to losses than gains), whereas the no-SA group exhibited a positive difference score (mean = 0.43 ±

1.32 μV, reflecting larger responses to gains than losses). This group difference in the delta power difference score was maintained when we statistically controlled for the influence of participants' current diagnoses of MDD or any anxiety disorder, or current symptoms of depression, anhedonia, or anxiety, and when we limited our analyses to participants with lifetime MDD (all ps < .05). This between-group difference in the delta power appeared to be driven by the SA group exhibiting significantly lower delta power than the no-SA group specifically in the gain condition ($F_{1,58} = 6.51$, $p = .01$, $\eta_p^2 = .10$) but not in the loss condition ($F_{1,58} = 0.65$, $p = .42$, $\eta_p^2 = .01$). For the theta power, the main effects of group ($F_{1,58} = 0.20$, $p = .66$, $\eta_p^2 = .003$), condition ($F_{1,58} = 0.25$, $p = .62$, $\eta_p^2 = .004$), and the group × condition interaction ($F_{1,58} = 0.43$, $p = .52$, $\eta_p^2 = .007$) were all nonsignificant.

DISCUSSION

The primary goal of this study was to conduct an objective investigation of anticipatory and consummatory reward-related abnormalities in suicide attempters, compared with non-attempters, using the RDoC framework. We found significant SA group differences in the cue-P3 amplitude but not in the other anticipatory ERPs (i.e., contingent negative variation, stimulus-preceding negativity). Specifically, the SA group exhibited significantly less difference between the cue-P3 in the incentive compared with the neutral condition than the no-SA group, suggesting that individuals in the SA group exhibit deficits in the ability to distinguish between reward-predicting and non–reward-predicting stimuli. These results are in line with the previous work demonstrating lower neural activity in reward-related brain regions during reward anticipation in the MIDT in adolescent self-injurious girls (23). At the same time,

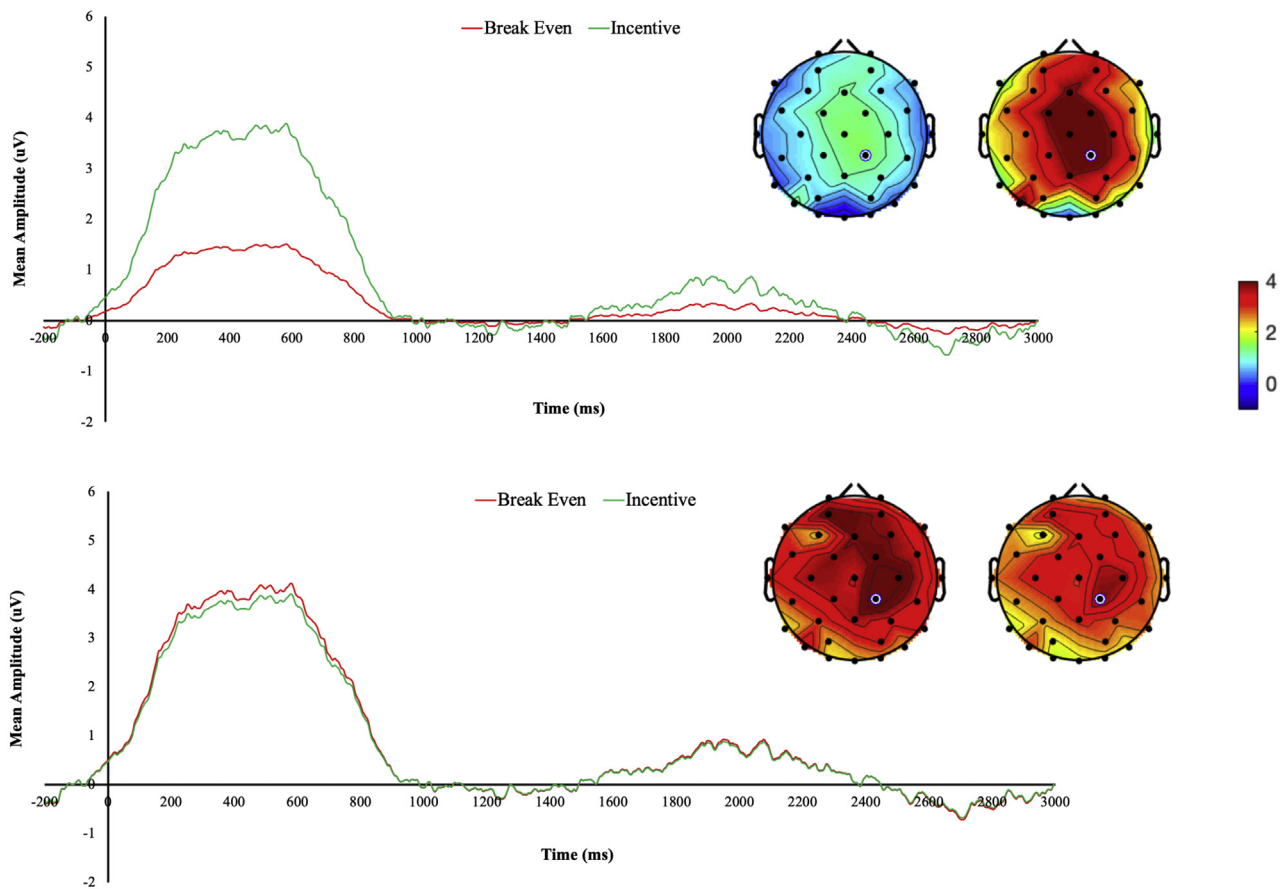**Table 3. Results of the Repeated-Measures Analyses of Variance (Monetary Incentive Delay Task)**

	Cue-P3 F	Cue-P3 η_p^2	CNV F	CNV η_p^2	SPN F	SPN η_p^2
SA Group	1.73	.03	1.01	.02	0.42	.01
Condition	6.11[a]	.10	0.26	.004	11.11[b]	.16
SA Group × Condition	4.58[a]	.07	0.63	.01	0.00	.00

CNV, contingent negative variation; SA, suicide attempt; SPN, stimulus-preceding negativity.
[a]$p < .05$.
[b]$p < .01$.

Figure 1. Principal component analysis–derived factor TF3SF1 that resembled the cue-P3 to the cues indicating an incentive or neutral (i.e., break-even) trial type in the no suicide attempt (SA) (top) and SA (bottom) groups at the peak channel CP2. Scalp maps show principal component analysis–derived TF3SF1 (neutral and incentive conditions, respectively).

the current findings build on this prior work by suggesting that blunted neural reward anticipation may generalize to suicide attempters (vs. a sample with combined suicidal and non-suicidal self-injury), adults (vs. adolescents), both sexes (vs. girls only), and ERPs (vs. fMRI). Owing to the high temporal resolution of the ERPs, we were able to differentiate between several components of reward anticipation-related neural activity, which provides preliminary evidence that SA-associated deficits in reward anticipation are specific to the allocation of attention toward reward-predicting stimuli, rather than to the other components of reward anticipation (i.e., motor preparation or feedback anticipation).

Although we did not find significant between-group differences in the ΔRewP amplitude, the SA group exhibited significantly lower feedback-related delta power in the gain versus loss condition than the no-SA group. This significant between-group difference in feedback-related delta power in the absence of group differences in the ΔRewP demonstrates the value of conducting the time-frequency analyses that are complementary to ERPs and suggests that suicide attempters might also exhibit a specific abnormality in feedback processing, in addition to the deficits in reward anticipation. Indeed, researchers have suggested that feedback-related delta power may be linked with reward-related processes by contributing to RewP-

Table 4. Results of the Repeated-Measures Analyses of Variance (Doors Task)

	RewP		Delta Power		Theta Power	
	F	η_p^2	F	η_p^2	F	η_p^2
SA Group	0.01	<.001	3.41	.06	0.20	.003
Condition	1.94	.03	0.11	.002	0.25	.004
SA Group × Condition	0.69	.01	6.47[a]	.10	0.43	.007

RewP, reward positivity; SA, suicide attempt.
[a]$p < .05$.
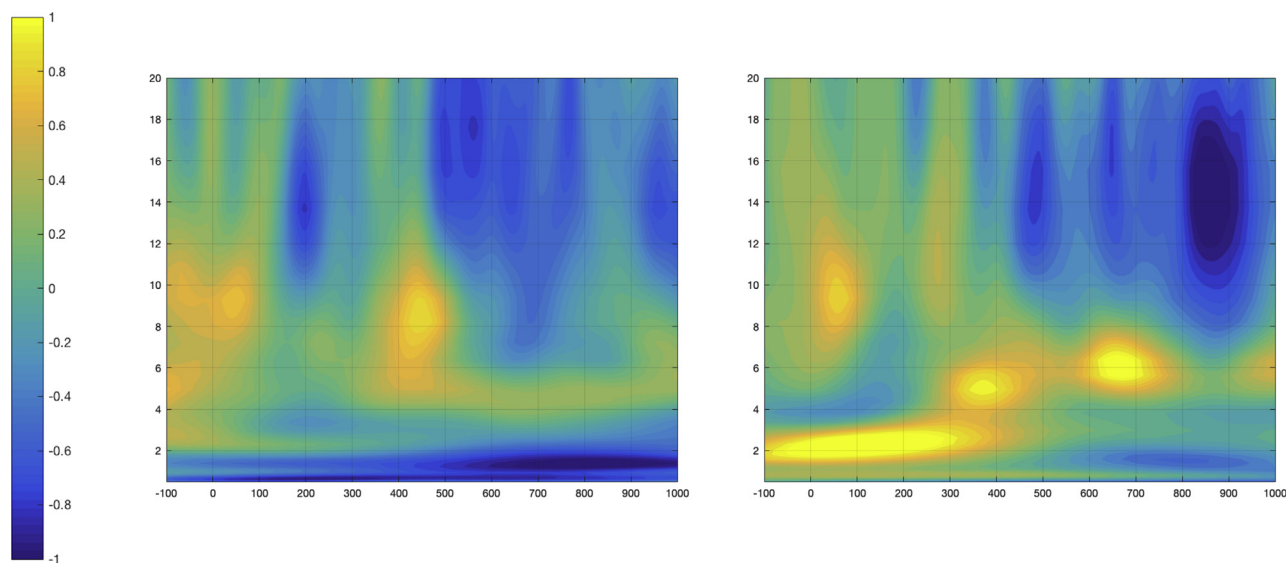
Figure 2. Time-frequency maps at Pz for the difference score between delta power in the loss condition and delta power in the gain condition of the doors task for the suicide attempt (SA) (left) and the no-SA (right) groups. Time is on the x-axis, frequency is on the y-axis.

Gain [for a review, see (17)]. This is consistent with our prior work suggesting the presence of suicidal thoughts and behavior-associated abnormalities in feedback processing in children of suicide attempters (27), children with a history of nonsuicidal self-injury (36), and children with recent suicidal ideation (37). Interestingly, we found that whereas parental history of prior SA (27) as well as personal history of nonsuicidal self-injury (36) were associated with a greater differentiation between gains versus losses in children, recent suicidal thoughts in children were associated with the opposite pattern of feedback responsiveness (37). Although more work remains to be done to understand the intricacies of reward processing in different forms of self-harm across development and any conclusions must remain tentative until such work is completed, our findings suggest that complementary time-frequency analyses might meaningfully contribute to answering these questions. This is consistent with a number of studies that demonstrate important links between psychopathology and feedback-related oscillatory activity, such as feedback-related delta and theta [e.g., (29,38,39)].

Interestingly, we did not find significant group differences in self-reported levels of anticipatory and consummatory pleasure. Although somewhat unexpected, the results of prior studies that examined self-reported levels of anhedonia in suicide attempters have also been mixed, with some studies demonstrating higher levels of anhedonia in suicide attempters compared with nonattempters [e.g., (8,10–12)] and other studies failing to find such an association [e.g., (13,14)]. Indeed, self-reports cannot provide a reliable differentiation between different stages of reward processing, and it might be difficult for the study participants, particularly those with current depressive symptoms, to objectively and accurately report on their ability to anticipate and experience pleasure. The present study suggests that EEG/ERP measures might be better suited for obtaining more objective reward processing-related information.

We should also highlight that the group differences in the cue-P3 amplitude and delta power appeared to be at least partially independent of any influences contributed by symptoms or diagnoses of depression or anxiety. Overall, the two groups were similar in their current depressive and anxious symptom levels, as well as in the rates of current MDD and anxiety disorder diagnoses. Further, the between-group differences in the cue-P3 amplitude during the MIDT and in the feedback-related delta power during the doors task were maintained when we statistically controlled for the influence of these psychiatric variables. Although replications will be important, the analyses suggest that these between-group reward-related deficits are at least partially independent of current symptoms. Because there was a significant group difference in lifetime MDD, as an additional test of robustness, we repeated these analyses after limiting the sample to only the participants in both groups with lifetime MDD and found that the between-group difference in the feedback-related delta power during the doors task was maintained, whereas the between-group difference in the cue-P3 amplitude during the MIDT was reduced to a nonsignificant trend ($p = .07$). However, it is important to note that the magnitude of the cue-P3 effect remained the same (i.e., $\eta_p^2 = .07$), suggesting that the group differences in delta power or cue-P3 are not simply due to differences in the rates of lifetime MDD between the groups.

The present study had several strengths and constitutes an important addition to the currently limited literature on reward processing in suicide attempters. Whereas most prior studies of suicide attempters have focused on only one aspect of reward processing per sample assessed via a single unit of analysis, the present investigation is the first, to our knowledge, to conduct a more objective and detailed examination of anticipatory and consummatory pleasure in this high-risk population. Further, the use of EEG/ERP approaches allowed us not only to investigate the broad components of reward-

related functioning (i.e., anticipatory and consummatory), but also to separately examine different subcomponents of anticipatory and consummatory pleasure afforded by the high temporal resolution of EEG/ERP. In addition, the similarity of the two groups in their current symptoms and diagnoses of depression and anxiety allowed for a stronger test of specificity of the reward-related findings to the SA history.

There were also limitations that provide important future research directions. First, although typical for the ERP studies, our sample size was relatively small. It will be important for future research to replicate our findings in larger samples. Further, it was not possible to examine all of the potentially relevant reward-related processes within a single study. It will be crucial for future work to examine additional constructs and subconstructs of reward-related functioning, as described in the Positive Valence Systems domain of the RDoC. Finally, owing to the cross-sectional nature of this study, future research should utilize longitudinal designs to establish whether reward-related impairments constitute an antecedent, a consequence, or merely a correlate of prior SA.

The present study contributes to the currently scarce literature on reward processing abnormalities in suicide attempters by suggesting that suicide attempters, compared with nonattempters, might exhibit deficient initial responses to reward, which might then disrupt their ability to accurately anticipate future rewards. This is in line with the evidence that suicide attempters might tend to inaccurately estimate the anticipated value of actions and events and to overvalue their current emotional state (8) and highlights the centrality of multiple reward-related processes as potential contributors to deciding whether to attempt suicide. Notably, our follow-up analyses suggest that these reward-related deficits appear to be at least partially independent of the influences of participants' symptoms and diagnoses of depression and anxiety. Overall, our findings constitute an important first step in obtaining a more detailed understanding of the specific reward-related abnormalities that might contribute to suicide risk.

ACKNOWLEDGMENTS AND DISCLOSURES

ARTICLE INFORMATION

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