



High frequency heart rate variability: Evidence for a transdiagnostic association with suicide ideation

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ABSTRACT

Low levels of high frequency heart rate variability (HF-HRV) have been shown to be associated with suicidal ideation and behavior in students and depressed patients. The goal of the present study was to examine associations between suicide ideation and resting HF-HRV as well as HF-HRV reactivity in a diagnostically heterogeneous sample of adult outpatients with or without concurrent suicide ideation. Participants were $N = 85$ outpatients (67.1% female; age: $M = 38.8$, $SD = 13.72$). HF-HRV reactivity was assessed using a sad film induction method. Associations between resting HF-HRV, HF-HRV reactivity and suicide ideation were analyzed using linear regression modeling – controlling for depression, anxiety and stress. HF-HRV reactivity towards the sad film, but not low resting HF-HRV baseline, was predictive of higher scores on suicidal ideation within the whole sample. In women, lower resting as well as perturbed HF-HRV reactivity was associated with higher scores on suicidal ideation. Results suggest that suicide ideators have a reduced capacity to regulate their response to stress.

1. Introduction

High frequency-heart rate variability (HF-HRV) is a marker of vagal tone and has been conceptualized as a transdiagnostic biomarker of self-regulation, cognitive control and psychopathology in general (Beauchaine & Thayer, 2015; Beauchaine, 2015). On a neuronal level, HF-HRV indexes activity within a cortico-limbic control system, enabling the flexible regulation of cardiac output, a mechanism putatively disturbed in psychopathology (Thayer, Hansen, Saus-Rose, & Johnson, 2009). There is evidence that HF-HRV is correlated with prefrontal cortex activity and performance on executive function tasks (Thayer et al., 2009), reflecting its influence on cognitive control capacity. Importantly, low resting HF-HRV (rHF-HRV) and large reductions in HF-HRV in response to emotional stressors, are associated with symptoms of both internalizing and externalizing psychopathology (Beauchaine, 2015; Thayer et al., 2009). Thus, high HF-HRV reflects activity of a healthy regulation system that is able to respond quickly to environmental demands, whereas a low HF-HRV is an indicator of autonomic and cognitive inflexibility broadly associated with general psychopathology.

Interestingly, besides other facets of psychopathology, also suicidal ideation shows marked associations with vagally mediated cardiovascular functioning. For example, studies found that students with

lifetime suicide ideation (Forkmann et al., 2016) as well as patients suffering from major depression or a lifetime history of major depression with suicide ideation (Chang, Tzeng, Kao, Yeh, & Chang, 2017; Rottenberg, Wilhelm, Gross, & Gotlib, 2002; Wilson et al., 2016) exhibited lower rHF-HRV than non-suicidal controls. Another study found differences in resting respiratory sinus arrhythmia, which is indexed by rHF-HRV, in a diagnostically heterogeneous sample of women with and without a lifetime history of suicide attempts (Tsypes et al., 2017). These results point to the possibility that reduced cognitive control capacity indicated by HF-HRV constitutes a risk factor for suicide ideation and behavior.

Most studies by now have focused on differences in rHF-HRV between participants with or without suicide ideation or behaviour, whereas HF-HRV reactivity (Δ HF-HRV), that is, the response to environmental demands, has rarely been studied in suicidal individuals. This is surprising, as it has been shown that both rHF-HRV, as well as Δ HF-HRV contribute uniquely to physical, as well as mental health outcomes (e.g., Salomon, 2005; Yaroslavsky, Rottenberg, & Kovacs, 2014). Porges (1995) proposes within the Polyvagal Theory, that the vagal pathway works to “brake” energy-expenditure, whenever there are no demanding environmental conditions. However, this vagal brake can be withdrawn when environmental conditions become more demanding (vagal withdrawal). The functionality of this mechanism is

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thought to be highly adaptive (Rottenberg, 2007). Consistent with this formulation, greater Δ HF-HRV (i.e., lower HF-HRV during a stressor as compared to the resting baseline recording, indicating larger vagal withdrawal towards the stressor) is associated with lowered psychopathology (e.g., Rottenberg, Salomon, Gross, & Gotlib, 2005; Yaroslavsky, Rottenberg, & Kovacs, 2013). With regard to suicidal individuals, Wilson et al. (2016) found blunted Δ HF-HRV during a laboratory stress-induction task in depressed women with a lifetime history of suicide attempts versus those without a lifetime history of suicide attempts.

So far, most studies on HF-HRV and suicide ideation/suicide attempts have solely focused on samples of healthy controls or patients suffering from major depressive disorders. Indeed, this approach is problematic because it fails to identify risk factors that are common across disorders. This problem could be addressed by considering diagnostically heterogeneous samples (for a comparable line of arguments see Tsypes et al., 2017). As outlined above, both general psychopathology as well as suicide ideation show largely overlapping associations with HF-HRV. Moreover, deficits in executive functioning, including cognitive control, cognitive flexibility, or emotion regulation are associated with most forms of psychopathology (see reviews in Aldao, Nolen-Hoeksema, & Schweizer, 2010; Snyder, Miyake, & Hankin, 2015) as well as with suicide ideation (Westheide et al., 2008; Marzuk, Hartwell, Leon, & Portera, 2005; Miranda, Gallagher, Bauchner, Vaysman, & Morroquin, 2012; Rajappa, Gallagher, & Miranda, 2012; Neasciu, Fang, Rodriguez, & Rosenthal, 2018). Taken together, this suggests that cognitive impairment, as indexed by low HF-HRV, might be a superordinate risk factor for both general psychopathology (see Beauchaine & Thayer, 2015) as well as suicide ideation. Previous work has shown that the association between executive functions and suicide ideation/behavior is independent of current symptomatology (Bredemeier & Miller, 2015; Richard-Devantory, Berlin, & Jollant, 2014). It is thus likely that low HF-HRV, as an index of executive functioning, is of transdiagnostic relevance for suicide ideation.

Thus, seeking to both replicate and extend previous research, the first aim of the present study was to investigate the usefulness of HF-HRV as a biomarker for suicidal ideation in an unselected, diagnostically heterogeneous patient sample including men and women. In line with previous research, we predicted that regardless of mental disorder, suicidal ideation should be associated with lower rHF-HRV. Moreover, if HF-HRV constitutes a transdiagnostically relevant biomarker for suicidal ideation, this effect should be independent of current symptomatology. Therefore, we aimed to test for the unique contribution of rHF-HRV to suicide ideation by controlling for current depression, anxiety, and general distress.

The second aim of the present study was to investigate the association between Δ HF-HRV and suicide ideation. Therefore, participants were shown a sadness-inducing film clip, a task that has previously been shown to successfully induce Δ HF-HRV in depression- (Rottenberg et al., 2005) and emotion-research (Kreibig, 2010). In line with the literature, we hypothesized that enhanced suicidal ideation is predictive of blunted Δ HF-HRV in response to a sad film.

Finally, in an exploratory set of analyses, we assessed the usefulness of combining indices of rHF-HRV and Δ HF-HRV to assess differences in suicidal ideation. Indeed, rHF-HRV and Δ HF-HRV have been shown to contribute uniquely to psychopathology (Yaroslavsky et al., 2014). Moreover, first evidence shows that a combination of Δ HF-HRV and resting rHF-HRV lead to a better prediction of depression risk than either factor alone, and that patients with a combination of low rHF-HRV and blunted Δ HF-HRV towards a sad movie showed more severe symptoms of depression than patients showing a rather normative HF-HRV pattern with high rHF-HRV and large Δ HF-HRV toward the movie (i.e., see Yaroslavsky et al., 2013, 2014). Within the present work, we aimed to determine whether these combined indices are also useful in research on suicide ideation.

2. Method

2.1. Participants

Participants in this study were individuals starting treatment at an outpatient university clinic in Bochum, Germany. All patients were informed that the clinic regularly conducts research and provided informed consent prior to participation. In order to assure a standard of quality, all clients seeking help at the clinic are asked to fill out questionnaires and take part in a short laboratory assessment (see below) prior to their intake. No compensation is given to participants for doing so. This study-design was reviewed and approved by the local Ethics Committee.

A total of $N = 190$ ($n = 74$ male) patients, aged 18–73 ($M = 37.0$, $SD = 13.4$) took part in the laboratory assessment. Of those, $n = 85$ answered questions on suicide ideation and were included in the current analyses. Patients who took part in the suicide ideation assessment did not differ from non-participating individuals in age, $t_{(188)} = 1.70$, n.s., sex, $\chi^2_{(1)} = 2.50$, n.s., diagnosis, $\chi^2_{(1)} = 0.54$, n.s., as well as their scores on the DASS depression, $t_{(186)} = 1.24$, n.s., anxiety $t_{(188)} = 1.00$, n.s., and stress subscales, $t_{(186)} = 1.57$, n.s. Due to equipment failure ECG data were lost for two of these $N = 85$ participants.

Fifty-seven participants (67.1%) of those who took part in the risk screening were female, 28 participants (32.9%) were male. Ages ranged from 19 to 66, with an average age of $M = 38.8$ ($SD = 13.72$). The most common diagnoses were affective disorders (43.5%), as well as neurotic, stress-related and somatoform disorders (38.8%), followed by behavioral syndromes associated with physiological disturbances and physical factors (9.4%), personality disorders (5.9%) and other disorders (2.4%). All diagnosis were derived by Masters-level clinicians via a semistructured clinical interview (Diagnostisches Interview Psychischer Störungen, DIPS; Schneider & Margraf, 2006). All participants were Caucasian. As in previous studies within the outpatient clinic (Teismann et al., 2018; Teismann, Glaesmer, von Brachel, Siegmann, & Forkmann, 2017), approximately half of the sample (51.8%; $n = 44$) reported some level of suicide ideation (i.e., DSISS scores > 0) within the last two weeks. Suicide ideators did not differ from non-ideators, regarding age, $t(83) = -1.24$, $p = .218$, and sex, $\chi^2 = 0.05$, $df = 1$, $p = .815$. However, suicide ideators and non-ideators differed in primary diagnosis, $\chi^2 = 8.124$, $df = 1$, $p = .004$: suicide ideators suffered more often from a depressive disorder (59.1% vs. 26.8%), whereas non-ideators suffered more often from an anxiety disorder (53.7% vs. 22.7%).

All participants received therapeutic help. Therefore, participants were informed to turn to the respective therapist in charge in case of suicidal thoughts or impulses.

2.2. Measures

2.2.1. Depressive symptom inventory – suicidality subscale (DSI-SS; Joiner, Pfaff, & Acres, 2002)

The DSI-SS is a 4-item self-report questionnaire designed to assess the frequency and intensity of suicidal ideation and impulses in the past two weeks (“I am having thoughts about suicide and have formulated a definite plan”; “I always have thoughts of killing myself”; “In some situations I have impulses to kill myself”; “I am having thoughts about suicide and I am considering possible ways of doing it”). Scores on each item range from 0 to 3, with higher scores indicating greater severity of suicidal ideation. The first validation study of the German version of the DSI-SS (Von Glischinski, Teismann, Prinz, Gebauer, & Hirschfeld, 2016) found good internal consistency (Cronbachs $\alpha = .90$) for the scale. In accordance, internal consistency was good in the current sample, $\alpha = .93$.

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