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Short communication

Is intuitive eating related to resting state vagal activity?

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ABSTRACT

Efferent and afferent fibers of the vagus nerve are involved in regulating hunger and satiety. Vagally-mediated heart rate variability (vmHRV) reflects vagal activity. Previously no study addressed a potential association between resting state vagal activity and intuitive eating. Self-reports on intuitive eating and measures of resting state vmHRV were obtained in 39 students (16 female, mean age: 19.64 ± 1.44 years). Hierarchical multiple regression models showed that, after controlling for gender, age, and body mass index, resting vagal activity was inversely related to the Unconditional Permission to Eat subscale of the Intuitive Eating scale. Individuals with higher resting vagal activity tend to be less willing to eat desired foods and are more likely to label certain foods as forbidden. Future studies should include measures of self-regulation and eating disorder symptomatology to identify potential mediators or moderators when attempting to replicate these preliminary findings in larger samples.

1. Introduction

The gastrointestinal tract is innervated by the vagus nerve (Berthoud, 2008), signifying its importance to eating behavior. Specifically, both vagal efferent (motor) and afferent (sensory) fibers are involved in regulating hunger and satiety. On the one hand, the activation of vagal efferents in the cephalic phase, when the anticipation of food entering the stomach prepares the body for digestion, leads to the release of ghrelin (Feldman and Richardson, 1986). On the other hand, the activation of vagal afferents subsequent to food ingestion initiates feedback processes that induce satiety and eventually encourage the termination of a meal (Berthoud, 2008).

The vagus nerve modulates heart rate variability (HRV). The heart is dually innervated by the parasympathetic and the sympathetic nervous system with the parasympathetic branch decelerating, and the sympathetic branch accelerating, heart rate. HRV is the resulting variation of the inter-beat-intervals. Vagally-mediated HRV (vmHRV) reflects parasympathetic modulation of the heart rate (Levy, 1997), and provides a non-invasive, widely-used, surrogate measure for vagal activity (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, 1996). Empirical data show that individuals with high vagal activity at rest tend to score higher on positive affect and well-being, whereas those with low vagal activity trend toward heightened anxiety and depressed mood (Chalmers et al., 2014; Geisler et al., 2010; Kemp and Quintana, 2013; Kemp et al., 2010).

Alterations in vagal activity at rest have been reported in individuals with eating disorders. Paradoxically, the majority of studies on individuals with anorexia nervosa have found vmHRV to be increased in comparison to healthy controls (for a review, see Mazurak et al., 2011). Similarly, individuals with bulimia nervosa also seem to be characterized by increased vmHRV (Peschel et al., 2016a; Peschel et al., 2016b).

While vagal activity has been examined among those with eating disorders, no study has examined associations between vagal activity and adaptive eating behavior.

Intuitive eating (IE) entails focusing on internal sensations of hunger and satiety rather than external (e.g., eating because food is readily available) or emotional (e.g., negative affect) cues when determining when, what, and how much to eat. Because those who eat intuitively are aware of their physiological hunger and satiety signals and regulate their eating behavior accordingly, they do not engage in dieting practices, including calorie restriction, avoiding certain foods, or eating only at particular times during the day (Tribole and Resch,

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1995).

In the present study, we examined a possible link between vagal activity and intuitive eating. Given that IE is negatively associated with eating disorder symptomatology (Tylka and Kroon Van Diest, 2013) and eating disorders are characterized by higher vagal activity, we hypothesized that IE would be inversely related to vagal activity indexed by vmHRV.

2. Materials and methods

2.1. Participants and procedures

Forty-five participants were recruited from a large Midwestern University's Psychology Research Experience Program, whereby students complete research tasks for partial course credit. We asked all participants not to smoke, undergo vigorous physical activity, or drink caffeine 6-h prior to the experiment. Six participants were excluded due to equipment failure, leaving a sample of 39 students for the final analysis.

After participants signed informed consent, measurements of height and weight were obtained to calculate body mass index (BMI; kg/m^2). Participants were subsequently seated in a quiet room without natural light and completed the Intuitive Eating Scale-2 (IES-2; Tylka and Kroon Van Diest, 2013). The experimenter left the room, but communication continued to be enabled through a dual microphone speaker. A non-recording camera allowed for additional supervision to ensure safety. After completing the IES-2, the experimenter entered the room and prepared the physiological recordings. Table 1 includes age and BMI data.

2.2. Measures

2.2.1. Resting state vagal activity

Once electrodes were in place, participants completed a 5-minute baseline-resting period, while they sat in a comfortable chair placed in a room without natural light, and viewed a blank, gray screen, and were instructed not to move or fall asleep while spontaneously breathing. Heart rate was continuously recorded with a 3-lead electrocardiogram attached to a 16-channel bioamplifier (NeXus 16). BioTrace+ software was used to collect and store physiological data. Inter-beat-intervals were exported to Kubios software (Tarvainen et al., 2014) for artifact correction and HRV analyses. The first and last minute of recordings were excluded to rule out potential effects of adaption. We calculated the root mean square of successive differences (RMSSD) as an index of resting vagal activity. As such, we report vmHRV results using RMSSD. RMSSD values were natural log transformed (ln) to fit assumptions of linear analyses (Ellis et al., 2008). Mean (3.83) and standard deviation (0.46) values for lnRMSSD in the current study are comparable to average values and standard deviations reported elsewhere (Nunan et al., 2010).

Table 1
Sample characteristics.

N (female)	39 (16)
Age, mean years (*SD*)	19.64 (1.44)
BMI[a], mean kg/m^2 (*SD*)	25.16 (5.08)
IES-2, mean (SD)	
Total	3.52 (0.44)
UPE	3.39 (0.75)
EPR	3.62 (0.74)
RHSC	3.54 (0.66)
B-FCC	3.44 (0.95)
RMSSD, mean ms log (*SD*)	3.83 (0.46)

RVT = resting state vagal activity; RMSSD = root mean square of successive differences as a proxy for resting state vagal activity (log transformed); IES-2: Intuitive Eating Scale–2; EPR: Eating for Physical Rather Than Emotional Reasons; UPE: Unconditional Permission to Eat; RHSC: Reliance on Hunger and Satiety Cues; B-FCC: Body–Food Choice Congruence.

[a] Recordings from four individuals on BMI were missing.

2.2.2. Intuitive Eating Scale

The 23-item self-report IES-2 (Tylka and Kroon Van Diest, 2013) contains four subscales: Unconditional Permission to Eat (UPE; six items, e.g., “If I am craving a certain food, I allow myself to have it”), Eating for Physical Rather Than Emotional Reasons (EPR; eight items, e.g., “When I am lonely, I do NOT turn to food for comfort”), Reliance on Hunger and Satiety Cues (RHSC; six items, e.g., “I trust my body to tell me how much to eat”), and Body-Food Choice Congruence (B-FCC; three items, e.g., “I mostly eat foods that give my body energy and stamina”). Items are rated on a 5-point scale (1 = *strongly disagree*; 5 = *strongly agree*) and averaged to generate total IES-2-score and subscale scores, with higher values indicating greater intuitive eating.

2.3. Data analysis

All statistical tests were conducted using SPSS v. 22. Hierarchical multiple regression analyses examined the relationships between lnRMSSD (resting vmHRV) as a continuous variable and IES-2 total and subscale scores controlling for age, gender, and BMI. All tests were two-tailed and analyzed using $p < 0.05$.

3. Results

Hierarchical multiple regression models showed that, after controlling for gender, age, and BMI, resting vagal activity (lnRMSSD) was inversely associated with UPE (see Table 2). No associations between resting vagal activity and IES-2 total or other subscale scores were significant. However, the positive association between resting vagal activity and the B-FCC-subscale approached statistical significance (see Table 2).

Table 2
Hierarchical regression analyses for resting state vagal activity predicting IES-2 scores controlling for age, gender, and BMI*.

Criterion	Step	Predictor	β	*t*	R^2	ΔR^2	ΔF
IES-2: Total	1	Gender	− 0.069	− 0.397	0.005	0.005	0.157
	2	Age	− 0.084	− 0.466	0.011	0.007	0.218
	3	BMI	− 0.033	− 0.172	0.012	0.001	0.030
	4	RMSSD	− 0.240	− 1.067	0.049	0.036	1.140
IES-2: UPE	1	Gender	− 0.018	− 0.105	0.000	0.000	0.011
	2	Age	0.016	0.086	0.001	0.000	0.007
	3	BMI	− 0.147	− 0.760	0.019	0.018	0.578
	4	RMSSD	− 0.451	− 2.125	0.147	0.128	4.515*
IES-2: EPR	1	Gender	− 0.134	− 0.779	0.018	0.018	0.607
	2	Age	− 0.140	− 0.789	0.037	0.019	0.622
	3	BMI	− 0.123	− 0.647	0.050	0.013	0.418
	4	RMSSD	− 0.075	− 0.334	0.053	0.004	0.111
IES-2: RHSC	1	Gender	0.087	0.503	0.008	0.008	0.253
	2	Age	− 0.115	− 0.647	0.020	0.013	0.419
	3	BMI	0.179	0.941	0.048	0.027	0.886
	4	RMSSD	− 0.235	− 1.068	0.082	0.035	1.140
IES-2: B-FCC	1	Gender	− 0.060	− 0.346	0.004	0.004	0.120
	2	Age	0.123	0.687	0.018	0.014	0.472
	3	BMI	0.127	0.663	0.032	0.014	0.439
	4	RMSSD	0.347	1.597	0.108	0.076	2.550

Note. RMSSD = root mean square of successive differences (log transformed) as a proxy for resting state vagal activity; IES-2: Intuitive Eating Scale-2; EPR: Eating for Physical Rather Than Emotional Reasons; UPE: Unconditional Permission to Eat; RHSC: Reliance on Hunger and Satiety Cues; B-FCC: Body–Food Choice Congruence; BMI = body mass index.

* Recordings from four individuals on BMI were missing. $p < 0.05$.