The association between prefrontal cortical thickness and heart rate

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Introduction

Both animal studies and human functional neuroimaging studies have shown a network of brain regions including the prefrontal cortex (PFC) to be involved in the regulation of the autonomic nervous system (ANS).[1-2] However limited studies have focused on the structural brain correlates of the ANS in humans.[3-4] **The aim of the current study is to investigate the association between cortical thickness of the PFC (figure 1) and heart rate, as a measure of the ANS.**

Methods

Sample

Population	N	Mean age (SD)	% female	% psych*	Heart rate	Imaging
NESDA	297	37.73 (10.06)	66.7%	80%	ECG outside of scanner	Phillips 3T
AHAB-II	459	42.68 (7.34))	52.3%	0%	ECG outside of scanner	Phillips 3T
Total	756	40.74 (8.84)	57.9%	30.6%		

**Part of the sample derived from the Netherlands Study on Depression and Anxiety (NESDA) in which 80% of the participants has a diagnosis for a depressive or anxiety disorder. The data from the Adult Health and Behavior Study II (AHAB-II) consisted healthy participants only.*

Analysis

Cortical thickness of the regions of interest were obtained using **FreeSurfer** image analysis suite version 5.3

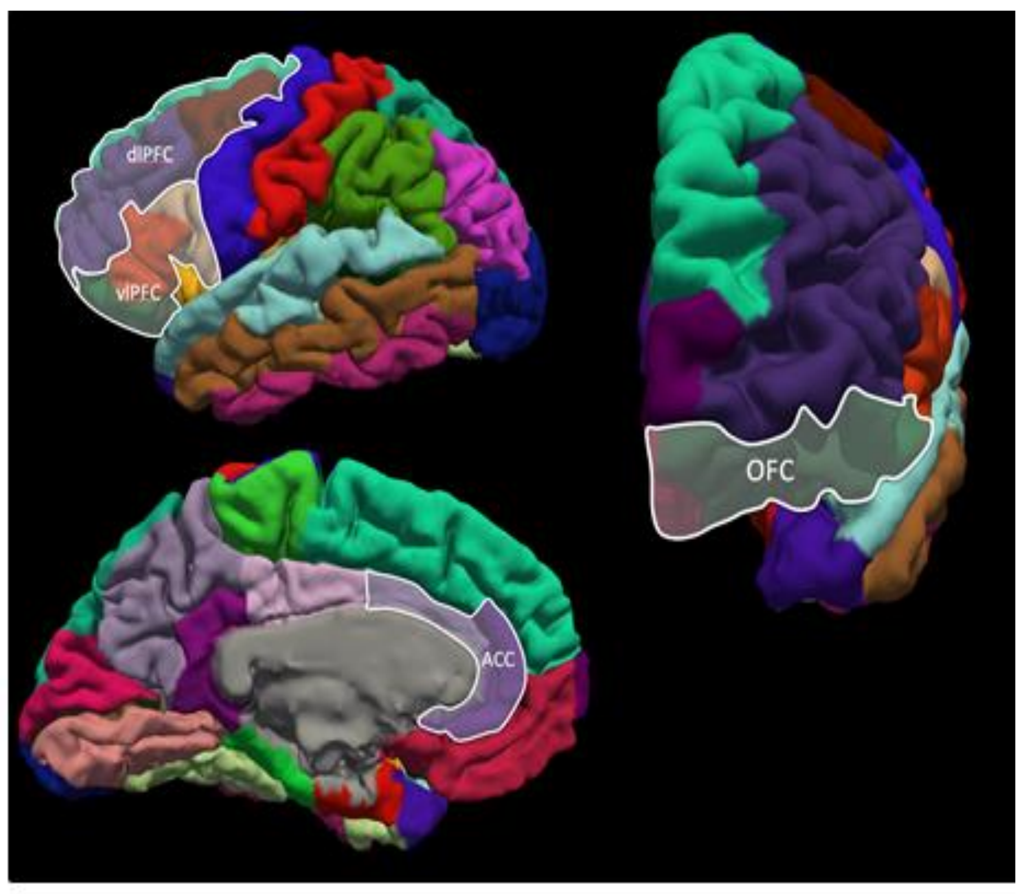

Figure1. Freesurfer image of the brain regions of interest. dlPFC= dorsolateral prefrontal cortex; vlPFC= ventrolateral prefrontal cortex; ACC= anterior cingulate cortex; OFC= orbitofrontal cortex.

Univariate ANOVA analysis was performed with SPSS version 23

- Pooled data of the NESDA & AHAB subsample
- Gender & hemisphere seperately[5-7]
- Corrected p-value for multiple testing was calculated using *matSpD* (p = .004)[8]
- Exploratory analysis for population if $p < .05$

Summary

→ Thinner left orbitofrontal cortex in females is associated with higher heart rate

Multiple testing significant
Similar direction of effect for both samples
Effect stronger in the NESDA sample

→ Thinner bilateral ventrolateral prefrontal cortex in females tends to be associated with higher heart rate

Not multiple testing significant; *but trend in NESDA*
Similar direction of effect for both samples
Effect stronger in the NESDA sample

Results

Table 1. The association between cortical thickness of the PFC regions of interest and heart rate in males and females.

	Males			Females		
	N	B (SE)	P	N	B (SE)	P
Right ACC	306	0.074 (0.062)	.233	416	-0.044 (0.047)	.344
Left ACC	307	-0.029 (0.064)	.647	413	-0.008 (0.046)	.863
Right OFC	305	-0.048 (0.066)	.465	414	-0.068 (0.049)	.165
Left OFC	308	-0.063 (0.070)	.365	417	-0.162 (0.051)	**.002**
Right dlPFC	306	0.039 (0.064)	.540	417	-0.024 (0.048)	.622
Left dlPFC	303	0.015 (0.066)	.228	418	-0.020 (0.048)	.673
Right vlPFC	307	0.024 (0.066)	.719	418	-0.117 (0.049)	***.019***
Left vlPFC	305	0.034 (0.065)	.602	417	-0.177 (0.052)	***.025***

Adjusted univariate ANOVA analysis corrected for age, the presence of a psychiatric disorder, SSRI use and scan site.

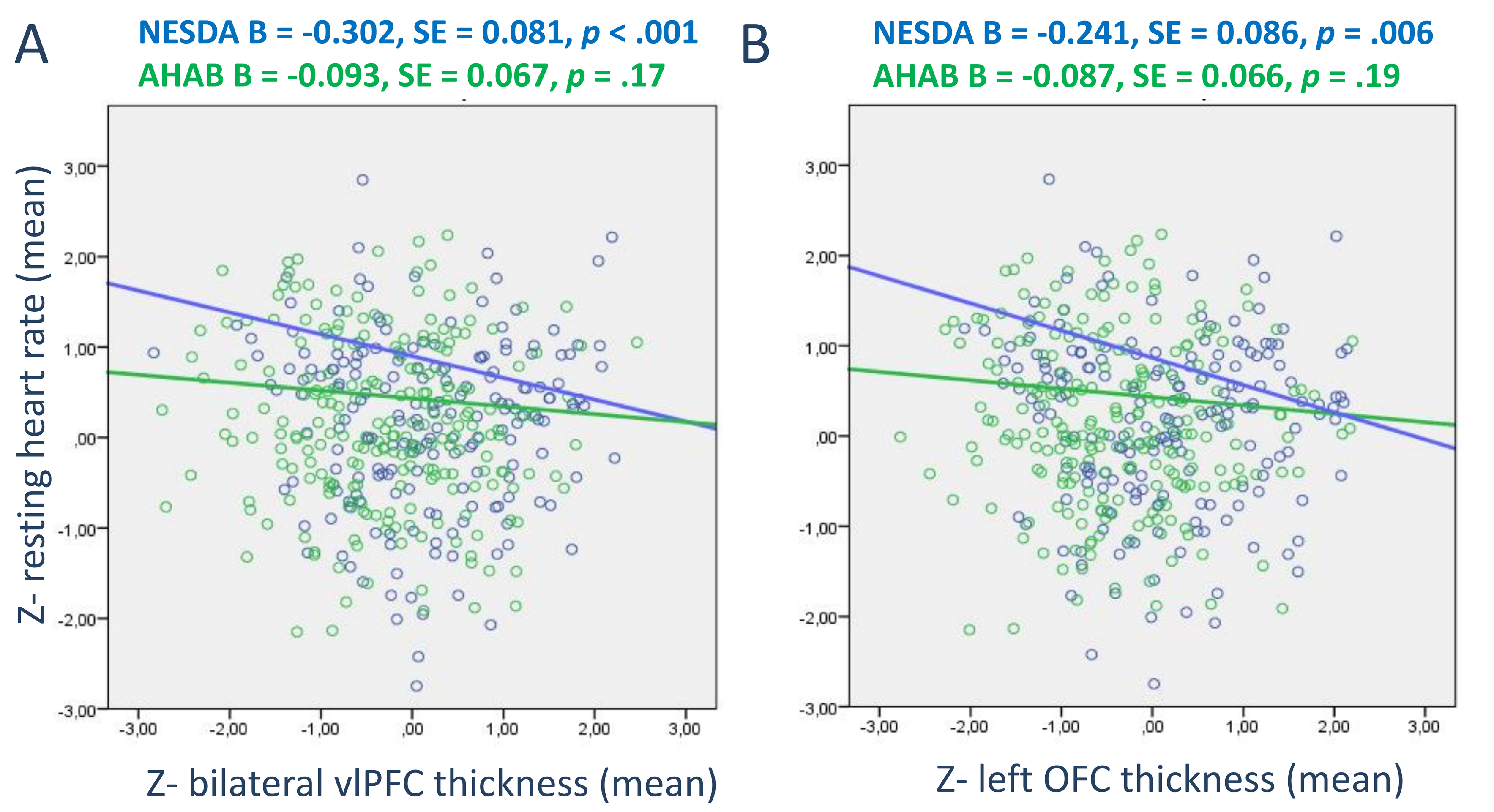

Figure 2. Scatterplots. A) Scatterplot of the difference between study population in the association of mean resting heart rate (z-score) with mean bilateral ventrolateral prefrontal cortical thickness (z-score) in women. B) Scatterplot of the difference between study population in the association of mean resting heart rate (Z-score) with mean left orbitofrontal cortical thickness (z-score) in women.

Discussion

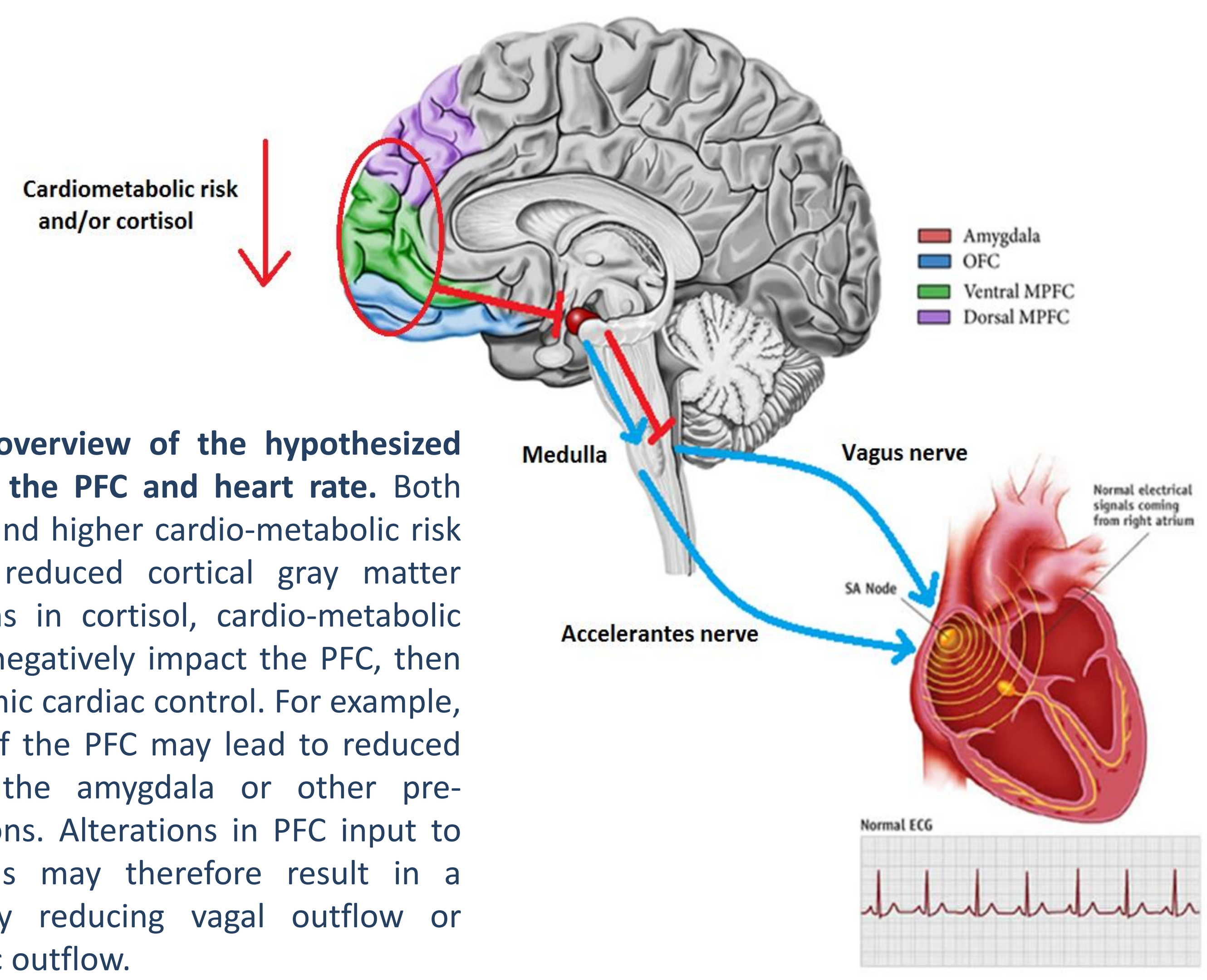

Figure 3. Schematic overview of the hypothesized relationship between the PFC and heart rate. Both higher cortisol levels and higher cardio-metabolic risk are associated with reduced cortical gray matter volume. [9] If elevations in cortisol, cardio-metabolic risk, or other factors negatively impact the PFC, then this may alter autonomic cardiac control. For example, a reduced thickness of the PFC may lead to reduced regulatory input to the amygdala or other pre-autonomic brain regions. Alterations in PFC input to pre-autonomic regions may therefore result in a higher heart rate by reducing vagal outflow or increasing sympathetic outflow.

In **females** a **lower thickness** of the **left OFC** is associated with a **higher heart rate**. This association might be due to **altered prefrontal control** over the ANS.

References
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