

# The Effect of Sleep and Bully on the Superior Frontal Gyrus

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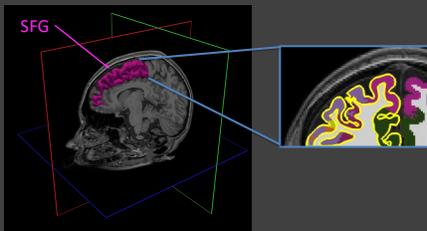
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## I. Background

- The superior frontal gyrus (SFG) is a broad cortical area involved in various psychological processes, including working memory<sup>1</sup>, emotional processing<sup>2</sup>, and aggression<sup>3</sup>, of which some may play a key role in individual's tendency to bully other people.
- Previous findings show that the prefrontal cortex is vulnerable to sleep deprivation<sup>4</sup>.
- The present study hypothesized that the structure of SFG would be correlated with bully, depending on sleep habits.

## II. Methods

- 50 college students (26 females and 24 males) completed the following:
  - MRI scan (3T Siemens Skyra, with 32ch brain array coil): T1-weighted anatomical image (MP-RAGE, voxel=1.0×1.0×1.0mm<sup>3</sup>).
  - Demographic assessments.
  - Adolescent Peer Relations Instrument (modified for the present study): Higher score on bully/victim subscale indicates more frequent bullying/victimization in the past.
  - Four sleep-related question items from the Quick Inventory of Depressive Symptomatology: Higher score indicates more sleep problems.
- Image preprocessing was performed by FreeSurfer:
  - Estimated intracranial volume (eTIV), global cortical thickness (gCT), bilateral volumes and cortical thickness of the SFG.
  - Pink in the below figure indicates the SFG:
    - The volume of SFG was parcellated by FreeSurfer;
    - The thickness of the SFG was assessed by measuring the distance between the pial surface and the white matter boundary (both outlined by yellow in the below figure) within the SFG.



## III. Statistical Strategy

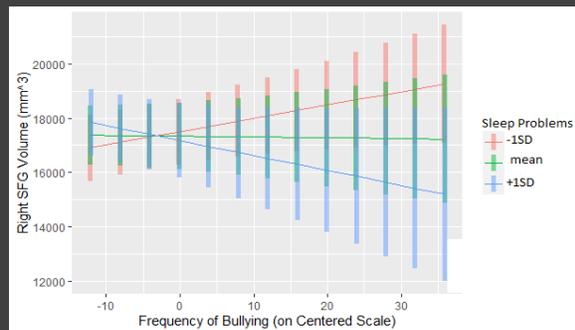
- Bully score and sleep score were centered, and the cross product of these variables were computed.
- 4 regression models were tested:
  - $\hat{Y}_1 = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5$
  - $\hat{Y}_2 = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5$
  - $\hat{Y}_3 = a + b_6X_6 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5$
  - $\hat{Y}_4 = a + b_6X_6 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5$
- $\hat{Y}_1$  = Left SFG volume;
- $\hat{Y}_2$  = Right SFG volume;
- $\hat{Y}_3$  = Left SFG thickness;
- $\hat{Y}_4$  = Right SFG thickness
- $X_1$  = eTIV;  $X_2$  = victim score;  $X_3$  = bully score;  $X_4$  = sleep problem;  $X_5$  = bully score × sleep problem;  $X_6$  = gCT
- b = unstandardized regression coefficient
- a = constant

## IV. Results

Variable		Bully		Sleep Problems		Bully × Sleep Problems	
		$\beta$	$t$	$\beta$	$t$	$\beta$	$t$
SFG Volume	Left	0.01	0.04	-0.15	-1.04	-0.30	-2.21*
	Right	0.12	0.92	-0.05	-0.41	-0.31	-3.02*
SFG Thickness	Left	0.17	0.14	-0.14	-1.25	0.93	0.87
	Right	0.01	0.06	-0.07	-0.75	0.16	1.86

\* $p < 0.05$

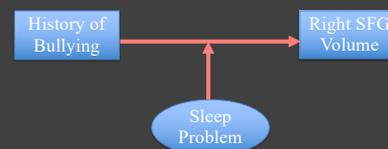
- Only the right volume survived ( $p = 0.005$ ) at the Bonferroni-adjusted significance level



- The upper figure visualizes the relationships between the frequency of bullying and right SFG volume, depending on three levels of sleep problems (mean & mean ± 1 standard deviation).
- The right SFG volume (1) decreased as participants exhibited more serious sleep problem and more frequent bullying behavior and (2) increased as participants exhibited less serious sleep problem and more frequent bullying behavior.

## V. Discussion

- Poor sleep quality moderates the relationship between SFG volume and bully perpetration experiences.
  - Right SFG volume decreased as the frequency of bullying and sleep problems increased.
  - Right SFG volume decreased as the frequency of bullying increased but sleep problems decreased.
  - Sleep may be important to preserve individuals with frequent bullying behavior from having smaller right SFG volume. This assumption might be addressed in future studies.



<sup>1</sup>Boisgueheneuc, F.D., Levy, R., Volle, E., et al. (2006). 'Functions of the left superior frontal gyrus in humans: A lesion study', *Brain*, vol. 129, no. 12, pp. 3315-3328.

<sup>2</sup>An, S., Han, X., Wu, B., et al. (2018). 'Neural activation in response to the two sides of emotion', *Neuroscience Letters*, vol. 684, pp. 140-144.

<sup>3</sup>Zhu, X., Wang, K., Cao, A., Zhang, Y., & Qiu, J. (2020). 'Personality traits and negative affect mediate the relationship between cortical thickness of superior frontal cortex and aggressive behavior', *Neuroscience Letters*, vol. 718, pp. 134728.

<sup>4</sup>Muzur, A., Pace-Schott, E.F., & Hobson, J.A. (2002). 'The prefrontal cortex in sleep', *Trends in Cognitive Sciences*, vol. 6, no. 11, pp. 475-481.