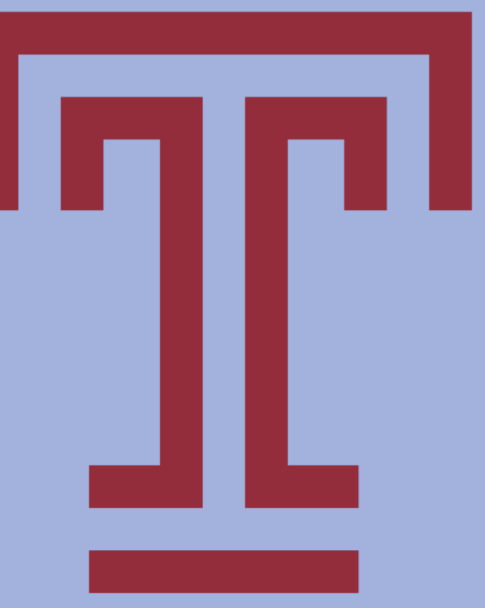


# Sex Differences in Associations between Socioeconomic Status, Pubertal Status and Cortical Thickness



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## Background

Previous studies have identified associations between socioeconomic status (SES) and prefrontal cortical thickness (CT) such that socioeconomically disadvantaged youth demonstrate reduced cortical thickness.<sup>1</sup> It has also been found that SES is positively associated with timing of puberty.<sup>2</sup> Additionally, research has shown that physical and hormonal markers of puberty relates to changes in cortical development across adolescence.<sup>3</sup> Little is known about how the individual associations between socioeconomic status and pubertal status and cortical thickness may differ between females and males. This study examines associations between whole brain CT, SES and pubertal development in early adolescence. Furthermore, this study explores how biological sex may moderate the relationships between SES and CT, SES and pubertal status, and pubertal status and CT.

## Methods

### Participants:

232 youth (57% female,  $M_{age}=11.00$ ,  $SD=1.48$  years) enrolled in the Temple Adolescent Development Study (TADS), a prospective longitudinal study of mood disorders in the greater Philadelphia area

### Measures:

**Pubertal Development Scale (PDS)** A six item self-report questionnaire assessing current pubertal status based on:

- ❖ Adrenal development, including body hair and skin change
- ❖ Gonadal development, including growth spurt in height, breast change (girls only)/voice change (boys only), and facial hair growth (boys only)/menstruation (girls only).

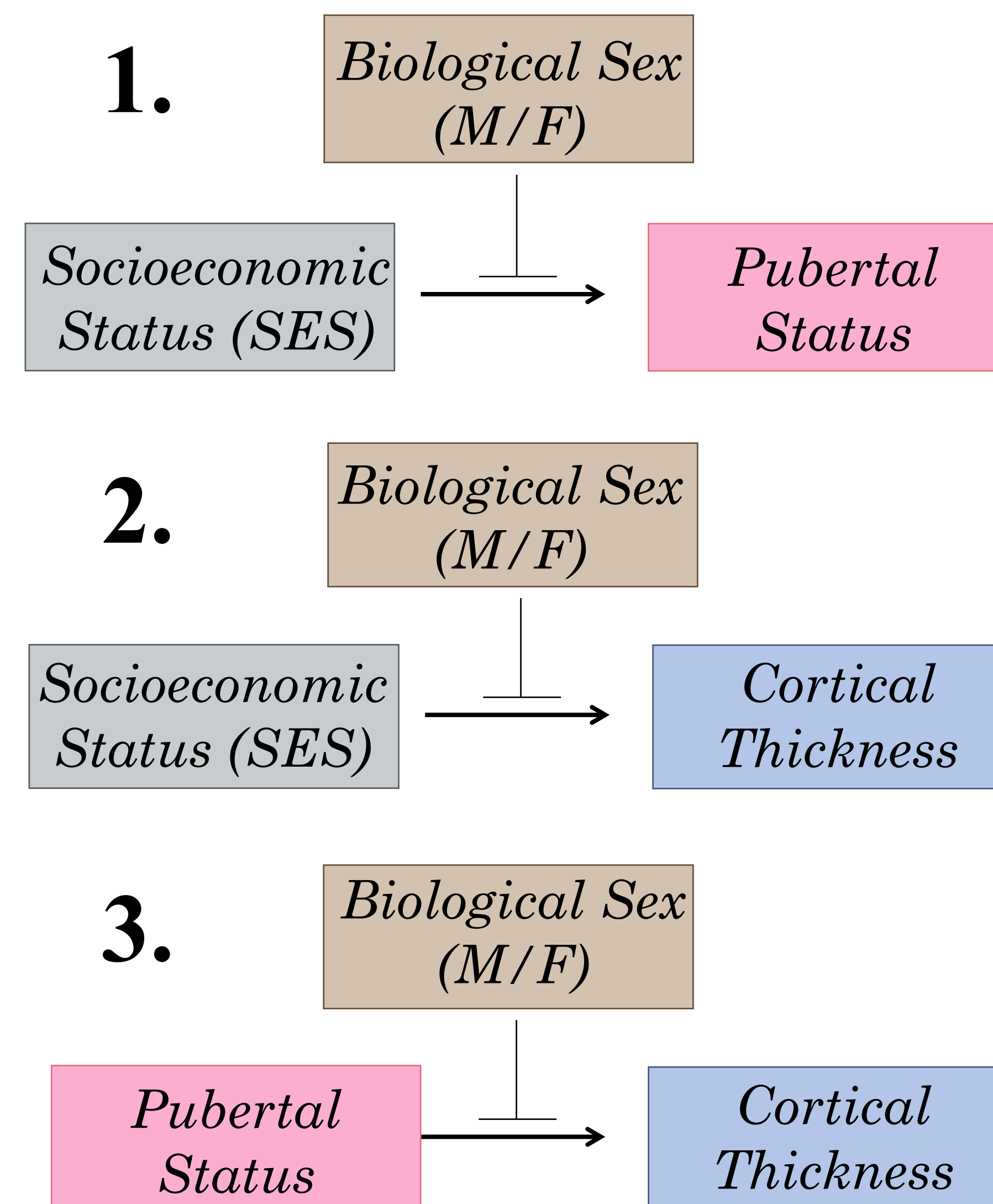
**Cortical Thickness (CT)** Overall CT was estimated separately for the left and right hemispheres using FreeSurfer V6.0.

**Median Neighborhood Income** Indexed via geocoding of address to determine median neighborhood income based on publicly available census data gathered through the U.S Census Bureau in 2017.

**Data Analytic Plan** Multiple regression analyses were conducted using SPSS to examine main effect associations between SES and pubertal development, SES and CT, and pubertal development and CT, and the moderation of these association by biological sex. All models controlled for chronological age and race/ethnicity.

## References

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**3.1 Main Effect of Gonadal Pubertal Development on Cortical Thickness**

Outcome:	Left Hemisphere		Right Hemisphere	
	B	t-value	B	t-value
Age	-0.152	-1.766	-0.112	-1.296
Race	-0.007	-0.075	-0.042	-0.477
Ethnicity	-0.148	-1.677	-0.134	-1.505
Sex	0.141	1.629	0.132	1.521
PDS Gonadal	0.041	0.464	0.069	0.776
	F(5) = 2.192		F(5) = 1.875	
R Squared	0.074		0.064	
Adjusted R Squared	0.040		0.030	

Note: \*  $p < .05$ ; \*\*  $p < 0.01$

**1. Main Effect of SES on Pubertal Development**

Outcome:	Adrenal		Gonadal	
	B	t-value	B	t-value
Age	0.402	6.200**	0.216	3.186**
Race	0.046	0.627	-0.037	-0.483
Ethnicity	0.051	0.729	0.05	0.683
Sex	-0.168	-2.594**	0.358	5.277**
Median Income	-0.133	-1.989*	-0.084	-1.196
	F(5) = 11.990**		F(5) = 7.411**	
R Squared	0.247		0.168	
Adjusted R Squared	0.226		0.145	

Note: \*  $p < .05$ ; \*\*  $p < 0.01$

**2. Main Effect of SES on Cortical Thickness**

Outcome:	Left Hemisphere		Right Hemisphere	
	B	t-value	B	t-value
Age	-0.154	-2.006*	-0.122	-1.594
Race	0.044	0.514	0.016	0.186
Ethnicity	-0.191	-2.323*	-0.185	-2.249*
Sex	0.139	1.821	0.140	1.831
Median Income	0.167	2.129*	0.174	2.212*
	F(5) = 3.995**		F(5) = 3.823**	
R Squared	0.115		0.11	
Adjusted R Squared	0.086		0.082	

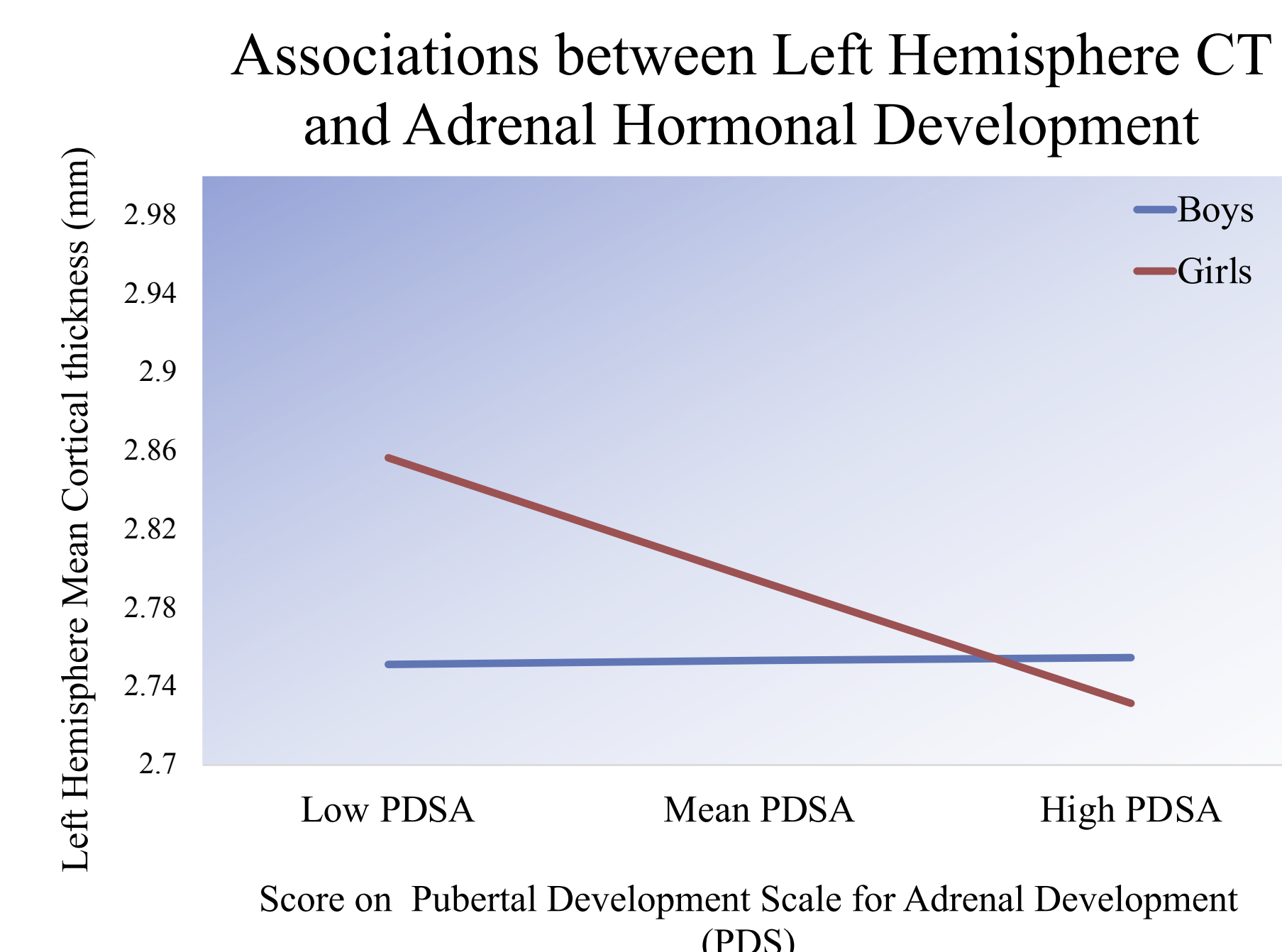
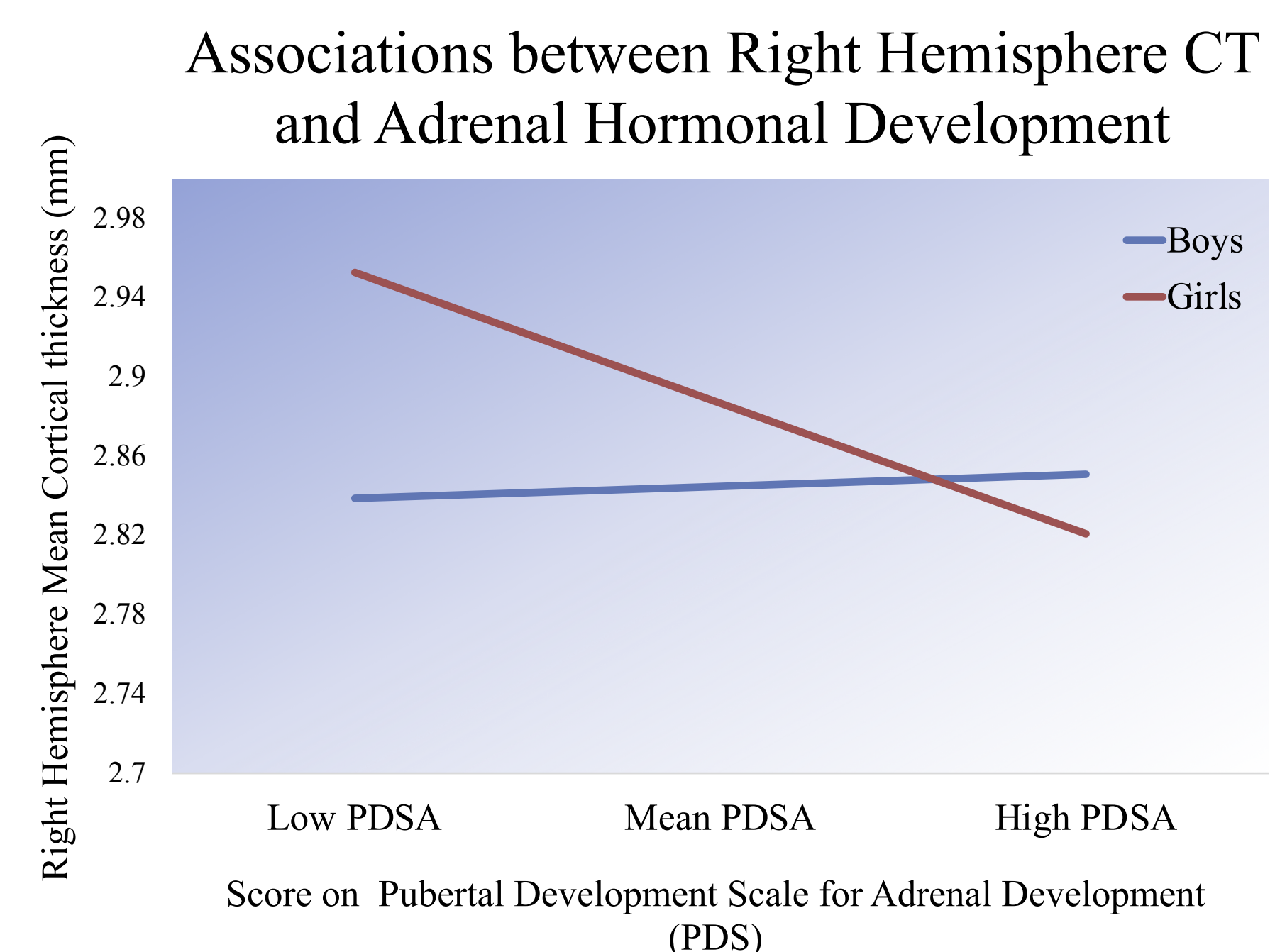
Note: \*  $p < .05$ ; \*\*  $p < 0.01$

**3.2 Main Effect of Adrenal Pubertal Development on Cortical Thickness**

Outcome:	Left Hemisphere		Right Hemisphere	
	B	t-value	B	t-value
Age	-0.100	-1.084	-0.064	-0.691
Race	0.003	0.032	-0.036	-0.404
Ethnicity	-0.141	-1.601	-0.124	-1.404
Sex	0.139	1.668	0.142	1.695
PDS Adrenal	-0.097	-1.034	-0.070	-0.740
	F(5) = 2.376*		F(5) = 1.863	
R Squared	0.079		0.063	
Adjusted R Squared	0.046		0.029	

Note: \*  $p < .05$ ; \*\*  $p < 0.01$

## Moderation Results



## Results

### Main Effects:

- ❖ SES was significantly negatively associated with adrenal hormonal development, but not gonadal hormonal development
- ❖ SES was significantly positively associated with CT in the left and right hemispheres.
- ❖ There were no significant association between adrenal hormonal development and CT or between gonadal hormonal development and CT.

### Moderation Results:

- ❖ Sex did not significantly moderate associations between SES and CT (left:  $B = .089$ ,  $t = .265$ ,  $p = .792$ ; right:  $B = .249$ ,  $t = .742$ ,  $p = .459$ ) or SES and pubertal development (adrenal:  $B = -.094$ ,  $t = -.321$ ,  $p = 0.749$ ; gonadal:  $B = -.111$ ,  $t = -.364$ ,  $p = 0.716$ ).
- ❖ However, sex significantly moderated the relationship between adrenal hormonal development and CT in the left and right hemispheres.
  - ❖ For boys, the association between adrenal hormonal development and CT was nonsignificant (left:  $B = .016$ ,  $t = .161$ ,  $p = .872$ ; right:  $B = .057$ ,  $t = .581$ ,  $p = .562$ ).
  - ❖ For girls, there was a significant negative association between adrenal hormonal development and CT. (left:  $B = -.225$ ,  $t = -2.238$ ,  $p = .027$ ; right:  $B = .214$ ,  $t = -2.131$ ,  $p = .035$ ).
- ❖ Sex did not moderate the association between gonadal hormonal development and CT.

## Discussion

### Conclusions

- ❖ Current findings suggest that youth growing up in low income neighborhoods demonstrate more advanced adrenal development in early adolescence and reduced cortical thickness.
- ❖ In girls, more advanced adrenal development was associated with reduced overall CT.
- ❖ In boys, there is no effect of pubertal development on cortical maturation.
- ❖ Sex did not moderate association between gonadal development and cortical maturation.

### Future Directions

- Further investigation of why adrenal hormone development, and not gonadal, contributes to sex-specific associations with cortical development is indicated.
- Future research should examine these associations using additional measures of pubertal development (e.g., blood hormone assays) across stages of puberty (e.g. mid to late adolescence).
- Incorporating assessments of psychological symptoms and considering cortical regions known to be implicated in emerging psychopathology (e.g. anterior cingulate cortex) would be useful to explore clinically relevant implications of the relationships found between socioeconomic status, pubertal status and cortical thickness.