

Introduction

Personality denotes stable individual differences in behavior, cognition, and emotion (Mischel, 2004). It is linked to quality of social relationships, job performance, and to risk for mental disorders (Costa and McCrae, 1992a).

Previous work has shown that brain structure (Thompson, 2001), personality traits (Jang, 1996) and social skills (Scourfield, 1999) are highly heritable. However, heterogeneous relationships between NEO FFI items, social skills (Valk, 2015; Banissy, 2012), and brain structure (DeYoung, 2010; Nostro, 2016).

The aim of the current study is to assess whether personality traits and social skills share neurogenetic fingerprints. For this, we will assess the co-heritability of NEO FFI scores as well as 'Friendship' and 'Loneliness' with surface area and cortical thickness.

Methods

A sample composed for monozygotic, dizygotic as well as siblings and unrelated individuals was provided through the Human Connectome Project (HCP), WU-Minn Consortium, S1200 release (HCP, <http://www.hcp.org>, Van Essen, 2012). Cortical thickness (T2-corrected) and surface area were calculated using pre-processed and pre-segmented HCP data (Glasser *et al.*, 2013).

To map all subjects' brains to a common space, reconstructed surfaces were registered to the average cortical surface (fsaverage5) using a non-linear procedure that optimally aligned sulcal and gyral features across subjects (Fischl *et al.*, 1999). We extracted the trimmed mean ($\pm 10\%$ excluded) of the Schaefer parcellation (400 parcels based on the 7-networks) for mean thickness, and the sum of area in each cluster.

Subjects completed the English version of the NEO Five Factor Inventory (McCrae, 2004), as well as the NIH Friendship and Loneliness questionnaire (Cyranowski, 2013).

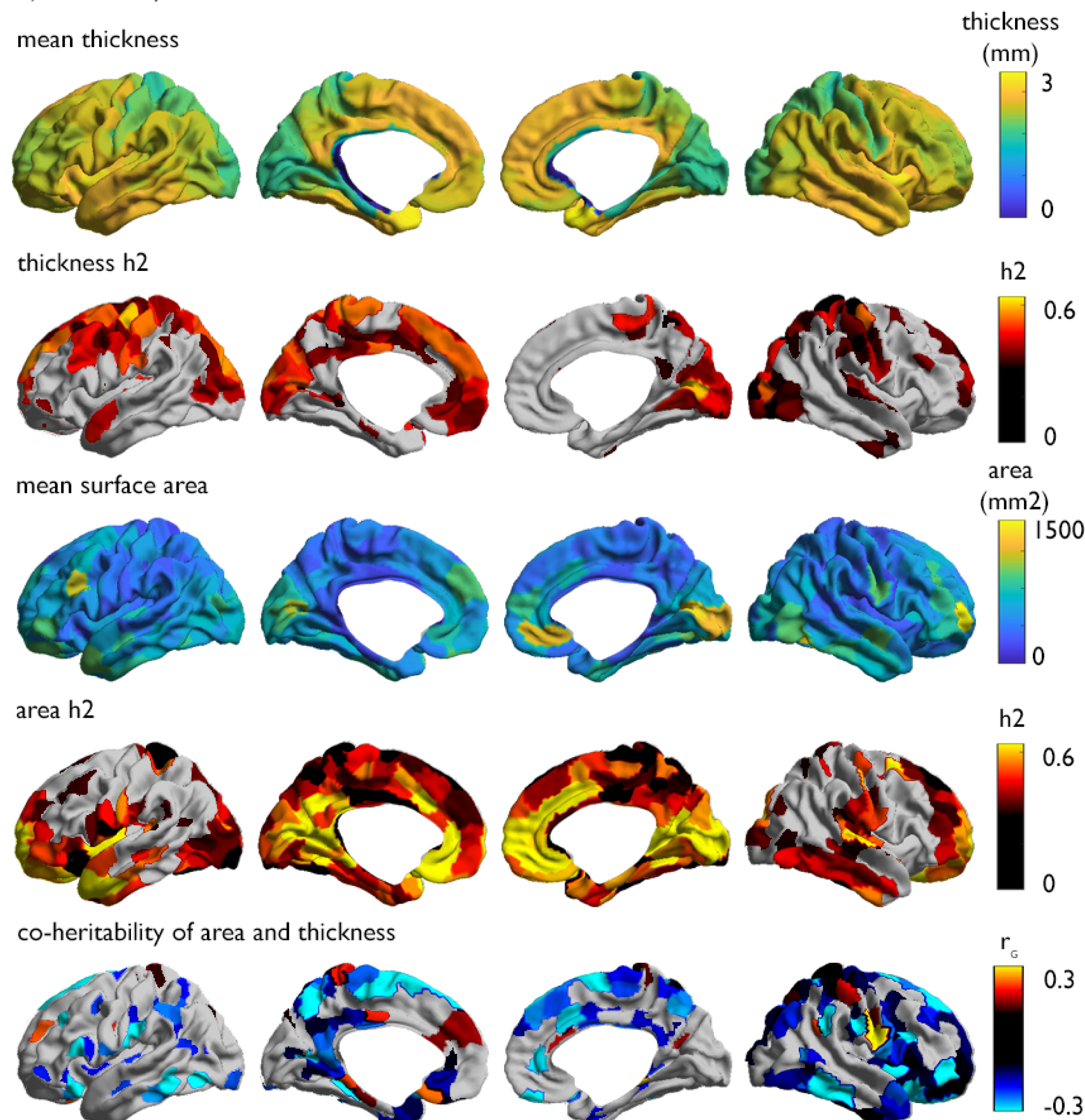
Univariate and bivariate analysis of heritability was performed using Solar Eclipse 8.3.1. (<http://solar-eclipse-genetics.org>). Solar uses maximum likelihood variance-decomposition methods to determine the relative importance of familial and environmental influences on a phenotype. Heritability (h^2) is the total additive genetic variance. Bivariate polygenic analyses were performed to estimate genetic (ρ_g) and environmental (ρ_e) correlations. We controlled for age, sex, age \times sex interaction, age², age² \times sex interaction. Here we focus on the genetic correlations, i.e., co-heritability.

Results

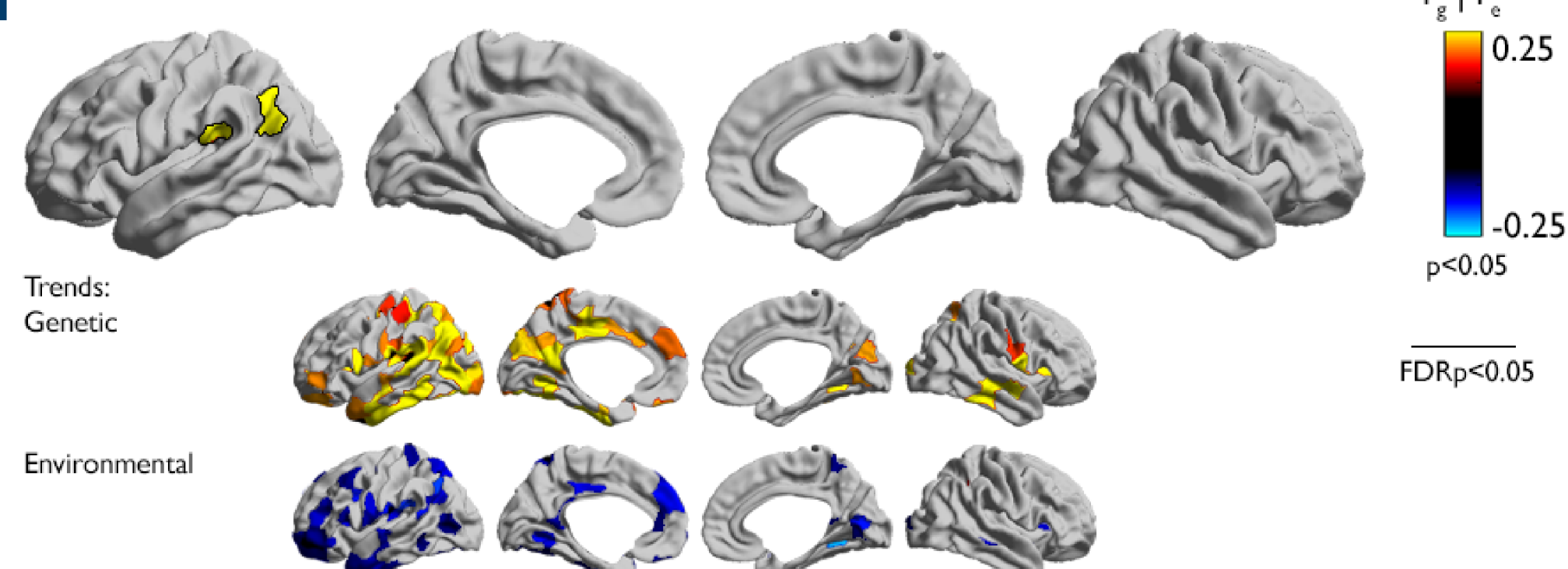
1 A) Heritability of the Big Five Personality dimensions

Heritability		Co-heritability				
	h^2	A	E	C	N	O
Agreeableness	0.29*					
Extraversion	0.44*		0.36			
Conscientiousness	0.43*	0.01	0.28			
Neuroticism	0.36*	-0.16	-0.31	-0.25		
Openness	0.57*	0.19	0.03	-0.27*	0.003	
		A	E	C	N	O

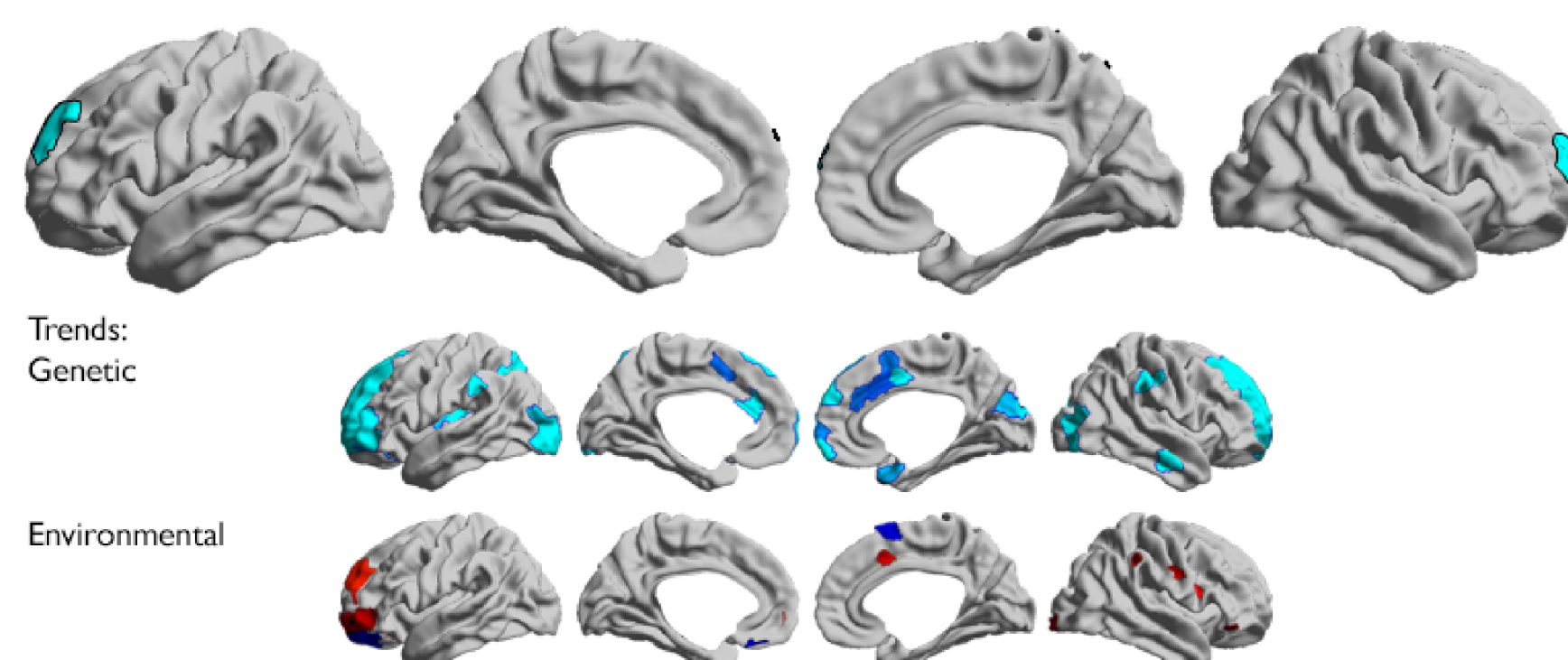
B) Heritability of brain structure



2 A). Significant co-heritability between cortical thickness and extraversion



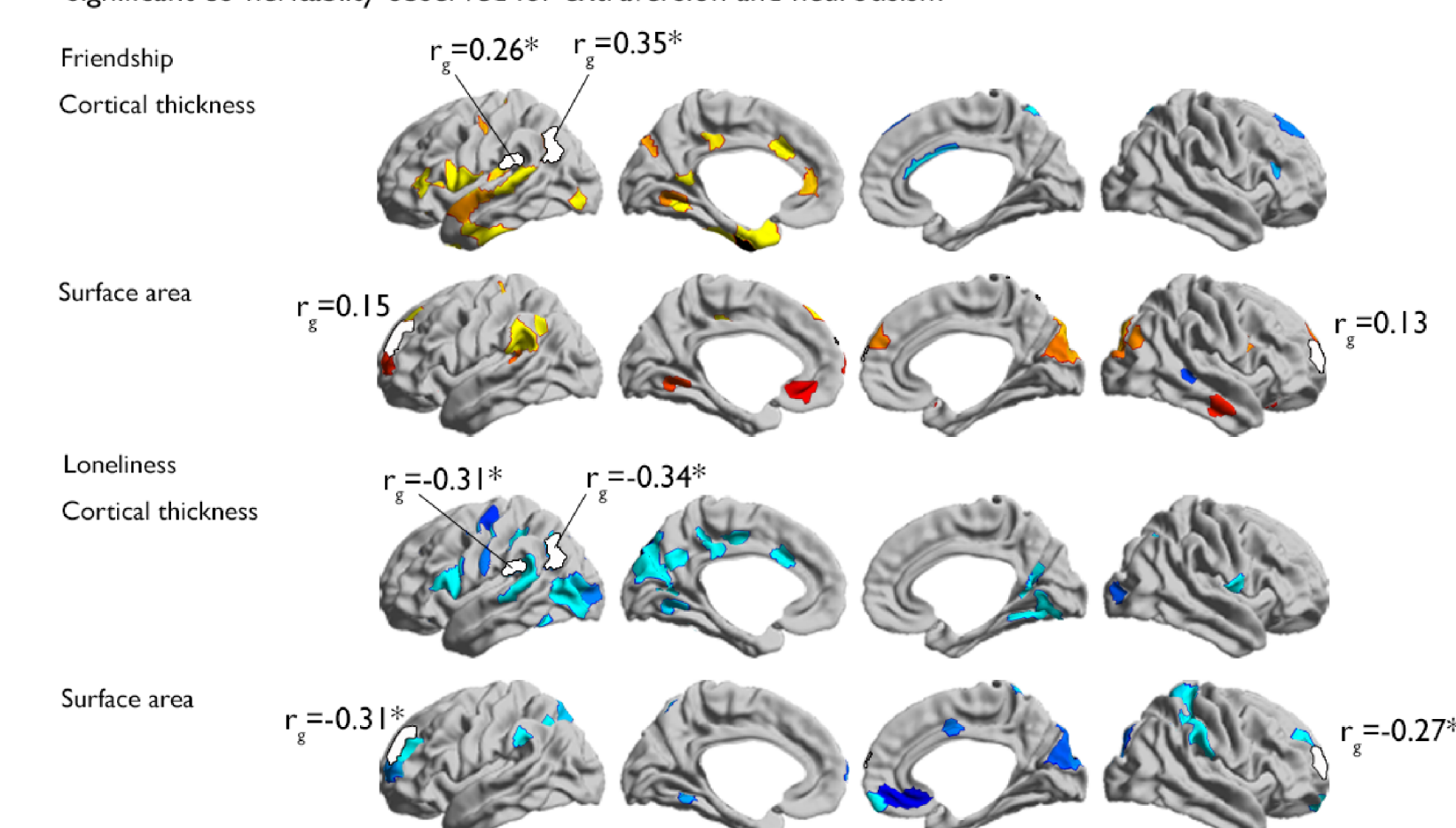
B). Significant co-heritability of surface area and neuroticism



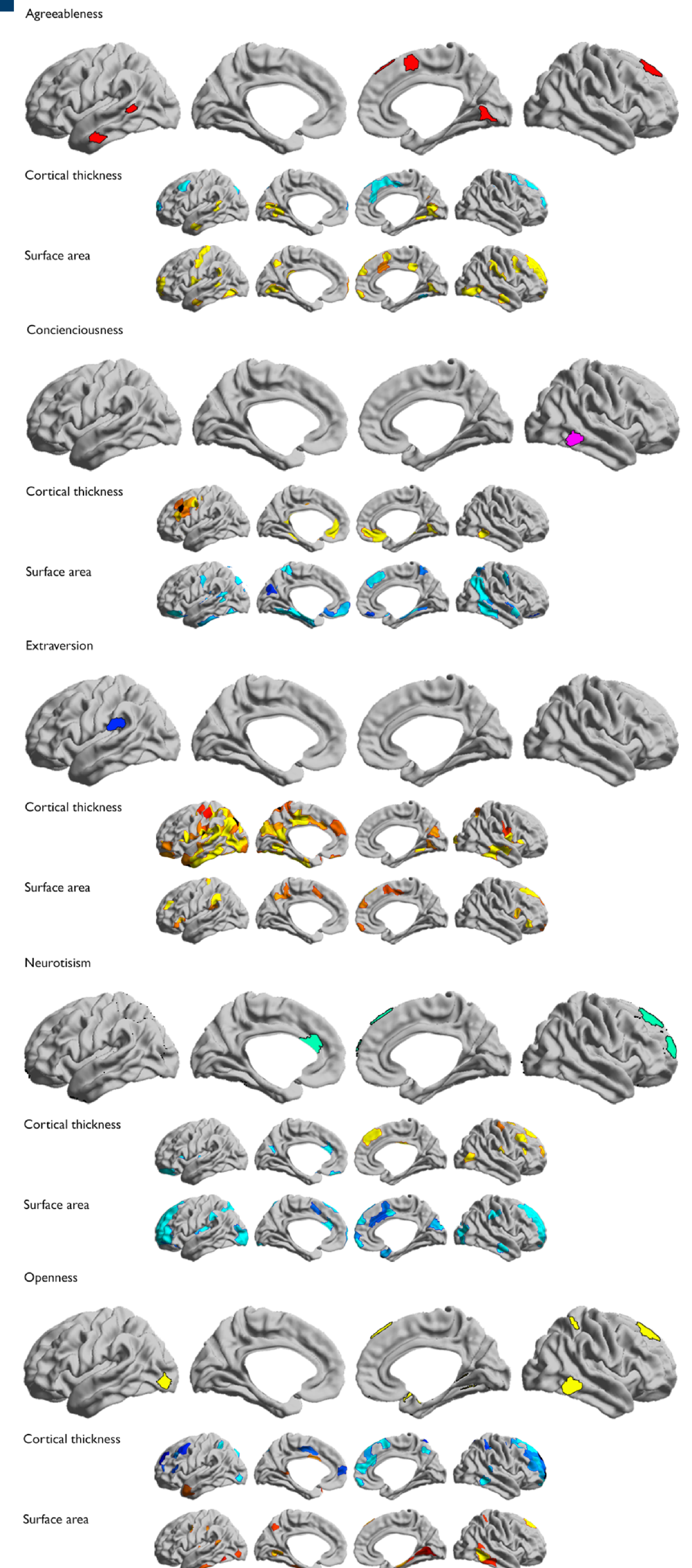
3 A) Heritability of Friendship and Loneliness and NEO FFI

Heritability	h^2	Co-heritability						
Friendship	0.42 ^a	F	0.32	0.25	0.67 ^a	-0.36 ^a	0.05	
Loneliness	0.39 ^a	L	-0.76	-0.22	-0.41 ^a	-0.56 ^a	0.66 ^a	0.18
		F	A	C	E	N	O	

B) Co-heritability of Friendship and Loneliness and brain structure, as well as post-hoc assessment within clusters of F2 of significant co-heritability observed for extraversion and neuroticism



4 Overlap of genetic co-heritability in surface area and cortical thickness



Summary and conclusion

In the current study, we investigated the heritability and co-heritability of brain structure and the Big Five personality scores and its relation to social connectedness.

- We observed both significant heritability as well as co-heritability patterns within the NEO-FFI scores
- We observed significant heritability of both surface-area and cortical thickness, yet at different locations
- Co-heritability analysis confirmed surface-area and thickness have varying patterns of heritability
- Both extraversion and neuroticism showed significant co-heritability with brain structural markers
- We observed co-heritability between various aspects of the Big Five and social-connectivity

- Regions that showed significant co-heritability for personality markers, also related to social skills, suggesting a shared neurogenetic basis of both
- Assessing the overlap between trends of co-heritability of each personality type, we observed differential patterns, both between area and thickness, as well as between NEO-FFI sub-score

These findings show inter-individual differences in personality, social skills and brain structure share some genetic influences, but also highlight specificity for each marker. Further research might profit from this as personality traits may become themselves clinically relevant in their extreme forms as personality disorders (Miller, 2001).

References

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