

Estimating the evolution of disease in the Parkinson's Progression Markers Initiative

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Supplementary Appendix

[FIGUREA1.JPEG HERE]

Figure A.1: Distribution of estimate of time shift, $\hat{\delta}_t$ by disease status.

Abbreviations: PD, Parkinson Disease; HC, Healthy Control.

[FIGUREA2.JPEG HERE]

Figure A.2: Correlation between random slopes for pair of outcomes.

Abbreviations: PIGD, Posture Instability and Gait Difficulty; RBD, REM sleep behavior disorder; UPSIT, University of Pennsylvania Smell Identification Test; MOCA, Montreal Cognitive Assessment; HVL, Hopkins Verbal Learning Test; GDS, Geriatric Depression Scale; SFT, Semantic Fluency Test; SCOPA, Scale for Outcomes in Parkinson's; LINEORT, Line Orientation Test; UPDRS, Unified Parkinson Disease Rating Scale; STAI, State Trait Anxiety Index; PD, Parkinson Disease; HC, Healthy Control.

[FIGUREA3A.JPEG and FIGUREA3B.JPEG HERE]

(a) For 17 outcomes (b) For 9 outcomes with UPDRS separated

Figure A.3: Population level predicted severity for female with mean age and median latent time of a healthy control. The legend is ordered by the age at which the predicted severity level for each outcome is 0.5 (sliced horizontally).

Abbreviations: PIGD, Posture Instability and Gait Difficulty; RBD, REM sleep behavior disorder; UPSIT, University of Pennsylvania Smell Identification Test; MOCA, Montreal Cognitive Assessment; HVL, Hopkins Verbal Learning Test; GDS, Geriatric Depression Scale; SFT, Semantic Fluency Test; SCOPA, Scale for Outcomes in Parkinson's; LINEORT, Line Orientation Test; UPDRS, Unified Parkinson Disease Rating Scale; STAI, State Trait Anxiety Index; PD, Parkinson Disease; HC, Healthy Control.

[FIGUREA4A.JPEG AND FIGUREA4B.JPEG HERE]

(a) Female.

(b) Male.

Figure A.4: Positional variance diagram of the central ordering. The x-axis is the event position.

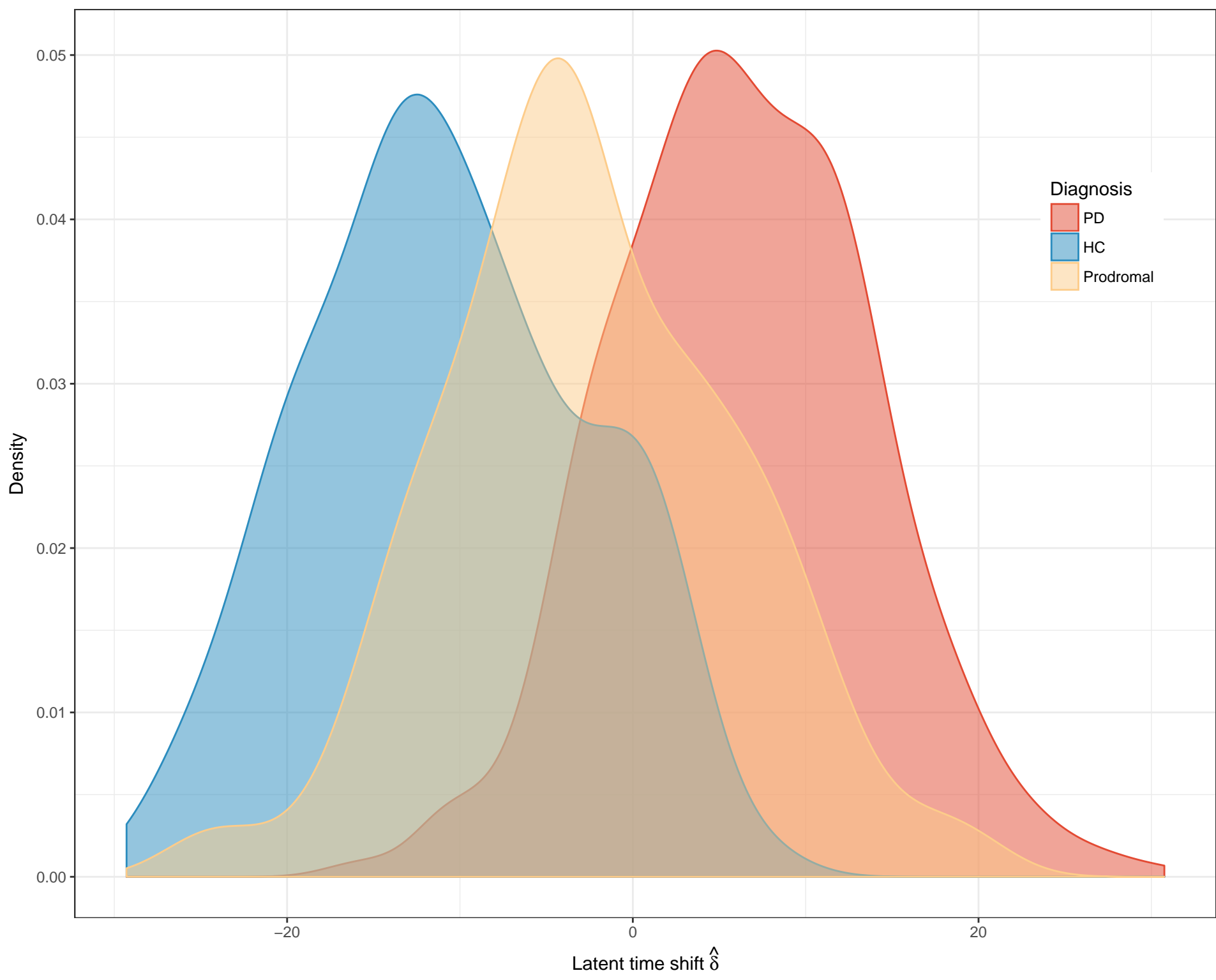
Abbreviations: PIGD, Posture Instability and Gait Difficulty; RBD, REM sleep behavior disorder;

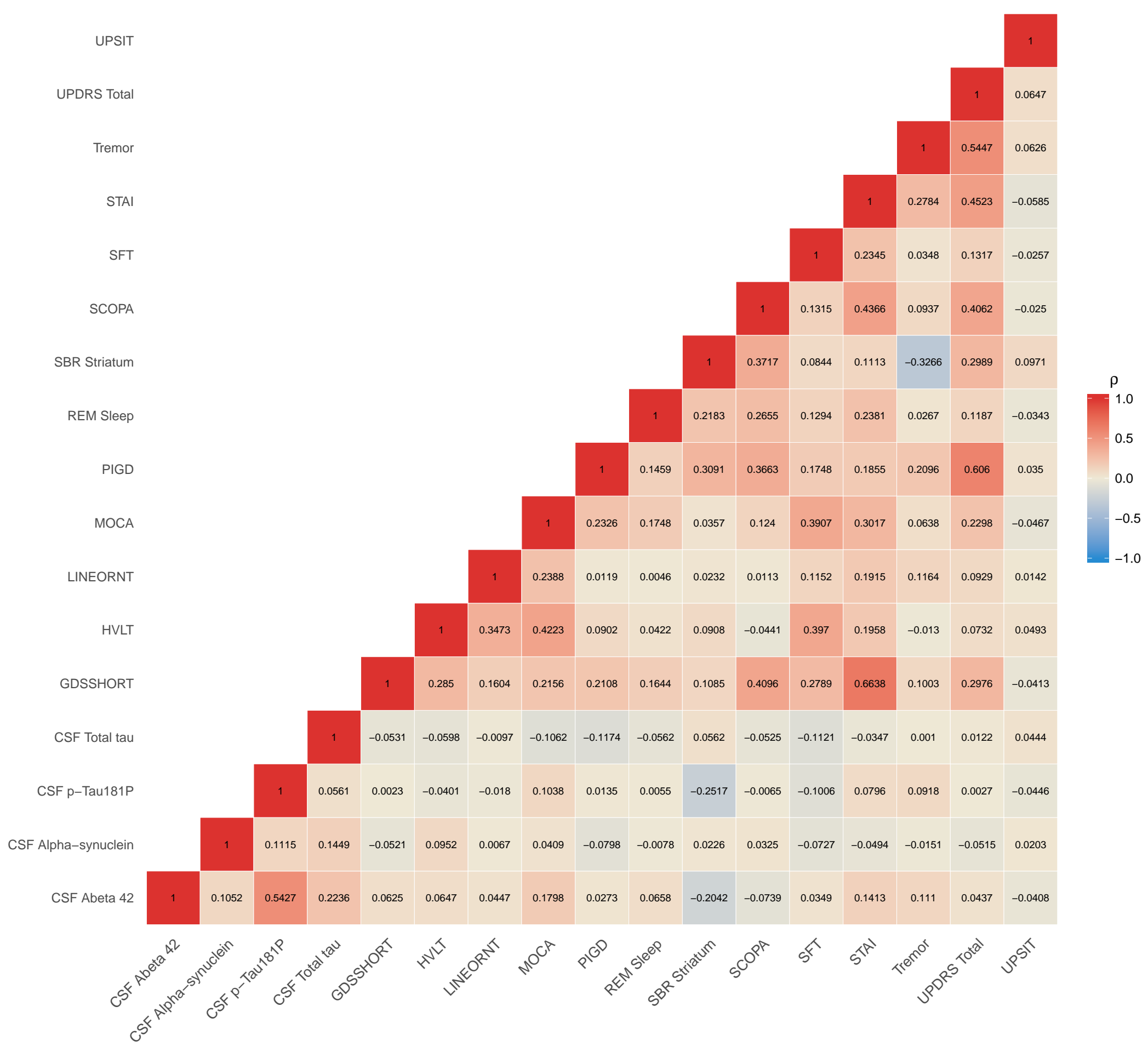
UPSIT, University of Pennsylvania Smell Identification Test; MOCA, Montreal Cognitive Assessment; HVL, Hopkins Verbal Learning Test; GDS, Geriatric Depression Scale; SFT, Semantic Fluency Test; SCOPA, Scale for Outcomes in Parkinson's; LINEORT, Line Orientation Test; UPDRS, Unified Parkinson Disease Rating Scale; STAI, State Trait Anxiety Index; PD, Parkinson Disease; HC, Healthy Control.

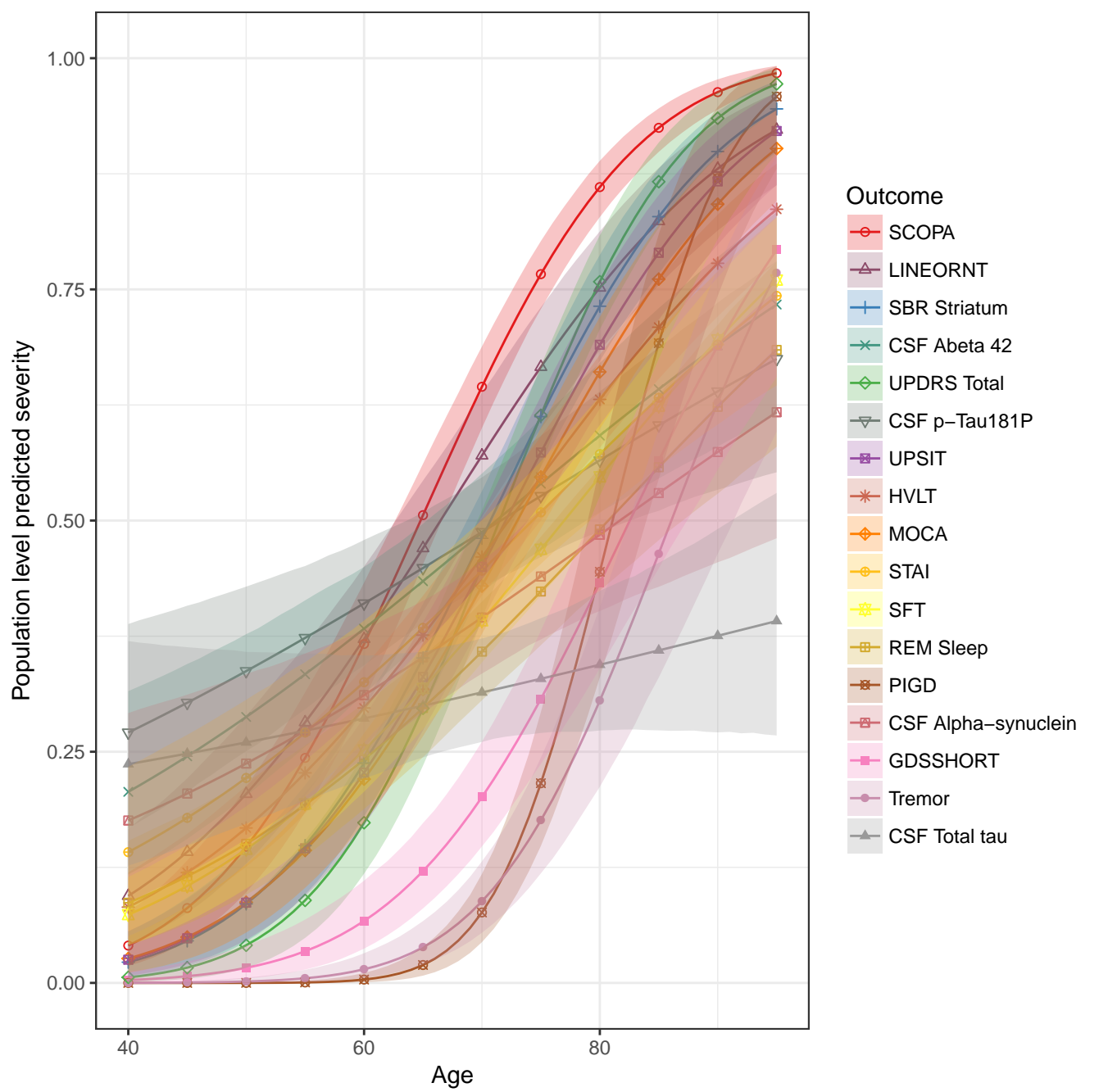
[FIGUREA5.JPEG HERE]

Figure A.5: Positional variance diagram of the central ordering

Abbreviations: PIGD, Posture Instability and Gait Difficulty; RBD, REM sleep behavior disorder; UPSIT, University of Pennsylvania Smell Identification Test; MOCA, Montreal Cognitive Assessment; HVL, Hopkins Verbal Learning Test; GDS, Geriatric Depression Scale; SFT, Semantic Fluency Test; SCOPA, Scale for Outcomes in Parkinson's; LINEORT, Line Orientation Test; UPDRS, Unified Parkinson Disease Rating Scale; STAI, State Trait Anxiety Index; PD, Parkinson Disease; HC, Healthy Control.







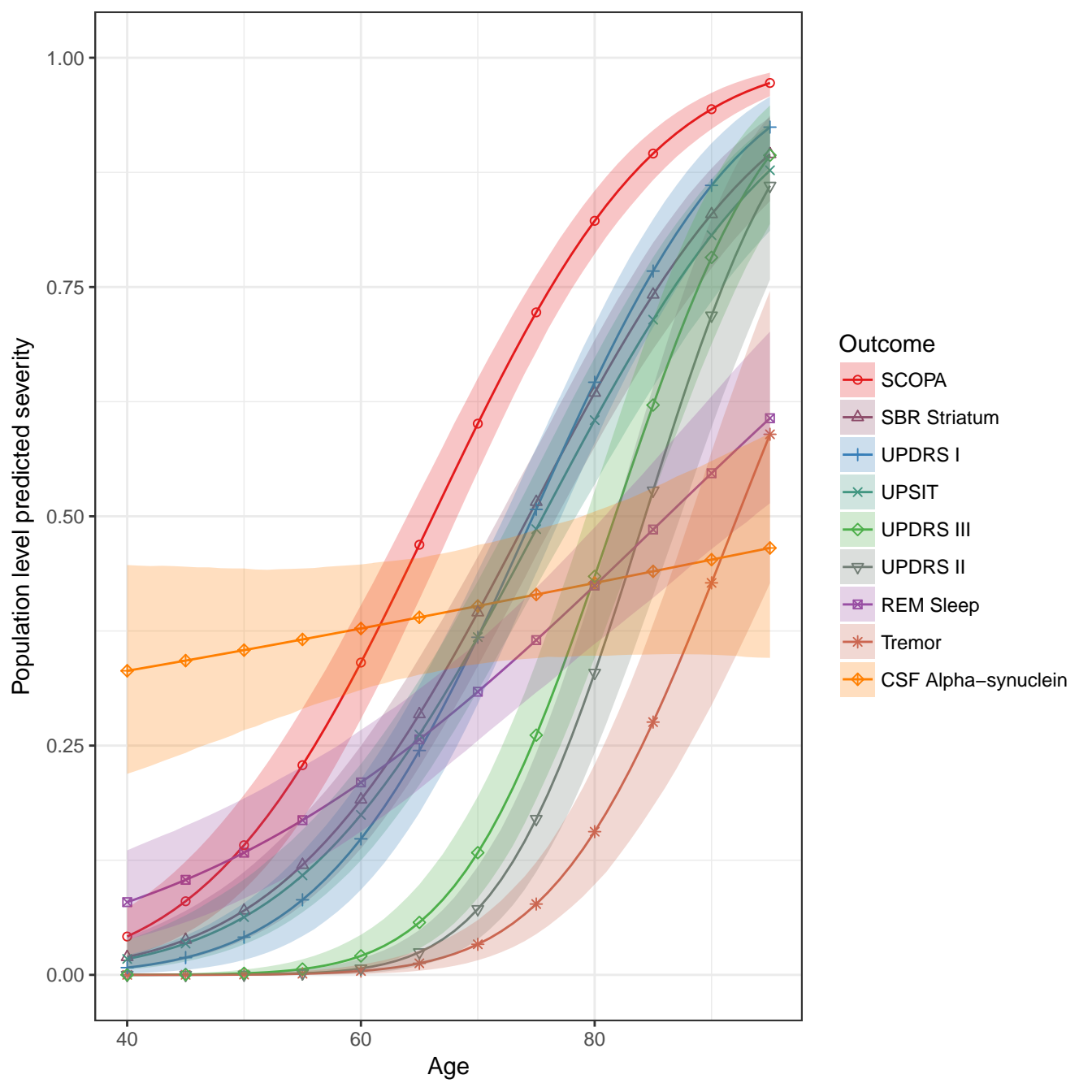


Table A. 1: Results of posterior estimates of parameters and corresponding 95% credible interval for all 17 outcomes from the Parkinson's Progression Markers Initiative (PPMI).

Parameter	Post. Mean	95% Credible	Parameter	Post. Mean	95% Credible	Parameter	Post. Mean	95% Credible
CSF Abeta 42			MOCA			Tremor		
Intercept	-0.099	(-0.586,0.405)	Intercept	-1.871	(-2.304,-1.431)	Intercept	-0.203	(-0.975,0.572)
Age	0.003	(-0.005,0.011)	Age	0.030	(0.023,0.036)	Age	-0.009	(-0.021,0.002)
Female	-0.073	(-0.234,0.076)	Female	-0.284	(-0.427,-0.148)	Female	-0.176	(-0.419,0.065)
Latent time, γ_1	0.023	(0.015,0.032)	Latent time, γ_8	0.945	(0.917,0.974)	Latent time, γ_{15}	0.094	(0.071,0.114)
Error Variance, σ_1	0.416	(0.387,0.448)	Error Variance, σ_8	0.945	(0.917,0.974)	Error Variance, σ_{15}	0.811	(0.796,0.827)
CSF Alpha-synuclein			PIGD			UPDRS Total		
Intercept	0.813	(0.342,1.274)	Intercept	-2.250	(-3.054,-1.4)	Intercept	-0.524	(-0.985,-0.06)
Age	-0.012	(-0.019,-0.004)	Age	0.016	(0.003,0.028)	Age	0.010	(0.003,0.017)
Female	-0.151	(-0.309,0.007)	Female	0.076	(-0.164,0.328)	Female	-0.047	(-0.188,0.098)
Latent time, γ_2	0.034	(0.024,0.045)	Latent time, γ_9	0.114	(0.085,0.139)	Latent time, γ_{16}	0.073	(0.054,0.088)
Error Variance, σ_2	0.424	(0.394,0.454)	Error Variance, σ_9	1.156	(1.134,1.178)	Error Variance, σ_{16}	0.349	(0.343,0.356)
CSF p-Tau181P			REM Sleep			UPSIT		
Intercept	0.352	(-0.109,0.81)	Intercept	0.317	(-0.121,0.745)	Intercept	-1.103	(-1.567,-0.642)
Age	-0.005	(-0.013,0.002)	Age	-0.006	(-0.013,0.001)	Age	0.019	(0.012,0.026)
Female	0.084	(-0.065,0.23)	Female	-0.115	(-0.256,0.027)	Female	-0.210	(-0.352,-0.067)
Latent time, γ_3	0.025	(0.017,0.033)	Latent time, γ_{10}	0.040	(0.03,0.05)	Latent time, γ_{17}	0.043	(0.032,0.055)
Error Variance, σ_3	0.717	(0.667,0.766)	Error Variance, σ_{10}	0.584	(0.568,0.6)	Error Variance, σ_{17}	0.218	(0.059,0.446)
CSF Total tau			SBR Striatum			Heterogeneous parameters		
Intercept	1.773	(1.318,2.252)	Intercept	-1.079	(-1.476,-0.681)	Intercept, τ_0	5.002	(4.19,5.831)
Age	-0.027	(-0.035,-0.02)	Age	0.018	(0.012,0.025)	Age, τ_1	-0.001	(-0.012,0.009)
Female	-0.223	(-0.374,-0.063)	Female	-0.084	(-0.211,0.043)	Female, τ_2	-0.063	(-0.287,0.159)
Latent time, γ_4	0.036	(0.025,0.046)	Latent time, γ_{11}	0.049	(0.035,0.061)			
Error Variance, σ_4	0.275	(0.255,0.295)	Error Variance, σ_{11}	0.212	(0.2,0.224)			
GDSHORT			SCOPA			Model comparison criteria		
Intercept	-0.388	(-1.044,0.287)	Intercept	-2.319	(-2.685,-1.933)	WAIC	117860.0	
Age	-0.002	(-0.012,0.008)	Age	0.033	(0.027,0.039)	LOOIC	120166.7	
Female	-0.097	(-0.302,0.115)	Female	0.504	(0.388,0.618)			
Latent time, γ_5	0.069	(0.051,0.084)	Latent time, γ_{12}	0.038	(0.029,0.047)			
Error Variance, σ_5	1.116	(1.088,1.147)	Error Variance, σ_{12}	0.469	(0.456,0.482)			
HVLT			SFT					
Intercept	-1.157	(-1.488,-0.813)	Intercept	-0.905	(-1.286,-0.536)			
Age	0.021	(0.016,0.026)	Age	0.017	(0.011,0.023)			
Female	-0.335	(-0.446,-0.224)	Female	-0.492	(-0.616,-0.368)			
Latent time, γ_6	0.022	(0.017,0.029)	Latent time, γ_{13}	0.022	(0.016,0.029)			
Error Variance, σ_6	0.551	(0.534,0.568)	Error Variance, σ_{13}	0.429	(0.417,0.443)			
LINEORNT			STAI					
Intercept	-2.041	(-2.609,-1.493)	Intercept	0.701	(0.26,1.139)			
Age	0.022	(0.014,0.03)	Age	-0.012	(-0.018,-0.005)			
Female	0.763	(0.592,0.932)	Female	0.136	(0.002,0.274)			
Latent time, γ_7	0.028	(0.019,0.038)	Latent time, γ_{14}	0.044	(0.033,0.054)			
Error Variance, σ_7	1.185	(1.152,1.22)	Error Variance, σ_{14}	0.594	(0.578,0.61)			