

Intersectional inequality of individual and area-level disadvantage on cognitive ageing in the UK

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BACKGROUND

METHODS

RESULTS

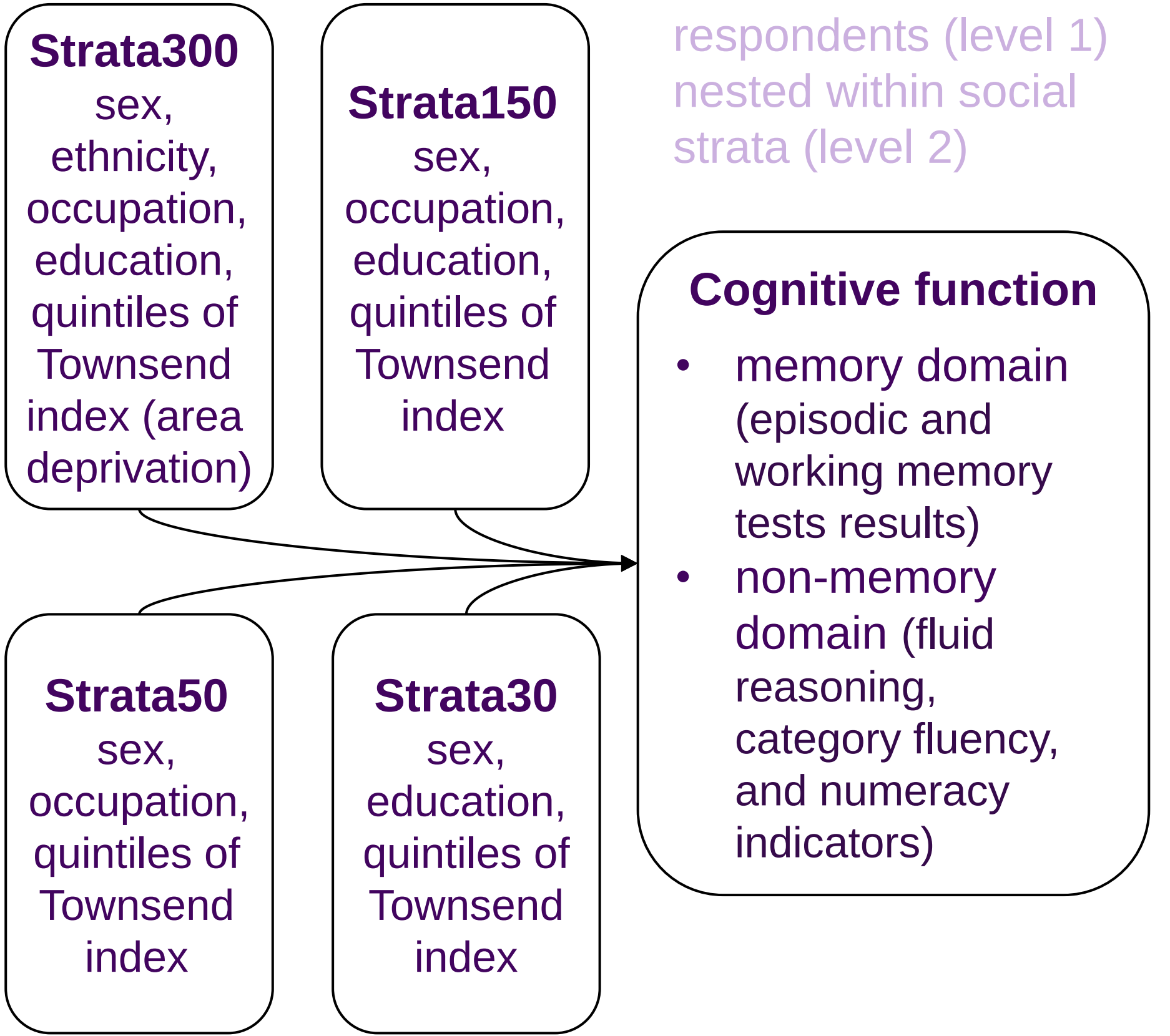
Socioeconomic inequalities in cognitive ageing are widely recognized, but the extent to which neighborhood context and individual-level factors contribute remains unclear. In addition, whether intersectional individual and area-level social positions contribute to heterogeneity in cognitive outcomes is insufficiently understood.

CONCLUSION

- Differences in cognitive outcomes across intersectional social strata were largely explained by the additive effects of neighborhood deprivation and individual social characteristics, with minimal residual between-stratum heterogeneity.
- Cognitive inequalities are primarily driven by broad structural socioeconomic disadvantage, supporting population-level strategies to reduce neighborhood and social inequalities in cognitive health.

Data from the Health Assessment of the UK Household Longitudinal Study, including 13,174 participants aged 16+

Multilevel Analysis of Individual Heterogeneity and Discriminatory Accuracy (MAIHDA)



$y_{ij} = \beta_0 + u_j + e_{ij}$ Intersectional model

$y_{ij} = \beta_0 + \beta_1 x_{1j} + \dots + \beta_p x_{pj} + u_j + e_{ij}$ Additive main effects model

$$\tilde{\beta}_{0j} = \widehat{R}_j \bar{y}_{\cdot j} + (1 - \widehat{R}_j) \hat{\beta}_0, \quad \widehat{R}_j = \frac{\hat{\sigma}_u^2}{\hat{\sigma}_u^2 + \frac{\hat{\sigma}_e^2}{n_j}}$$
$$u_j \sim N(0, \sigma_u^2)$$
$$e_{ij} \sim N(0, \sigma_e^2)$$

	Model 0 Estimate (95% CI)	Model 1 Estimate (95% CI)
Panel A: memory domain		
Fixed Effects: Regression coefficients		
Intercept	0.715 (0.690 to 0.739) ***	0.756 (0.742 to 0.770) ***
Quintiles of Townsend index (Ref: most deprived)		
2		0.023 (0.007 to 0.038) **
3		0.027 (0.012 to 0.043) ***
4		0.037 (0.021 to 0.052) ***
5 (least deprived)		0.043 (0.027 to 0.058) ***
Random Effects:		
Variance intercept (stratum 30)	0.005 (0.003 to 0.008)	0.000 (0.000 to 0.000)
Variance residual	0.018 (0.018 to 0.019)	0.018 (0.018 to 0.019)
Summary Statistics		
Intraclass Correlation Coefficient (ICC)	0.200	0.006
Proportional Change in Variance (PCV)	Ref	97.4%
Panel B: non-memory domain		
Fixed Effects: Regression coefficients		
Intercept	0.536 (0.510 to 0.561) ***	0.600 (0.594 to 0.607) ***
Quintiles of Townsend index (Ref: most deprived)		
2		0.021 (0.013 to 0.028) ***
3		0.029 (0.022 to 0.036) ***
4		0.039 (0.032 to 0.045) ***
5 (least deprived)		0.048 (0.041 to 0.055) ***
Random Effects:		
Variance intercept (stratum 30)	0.005 (0.003 to 0.008)	0.000 (0.000 to 0.021)
Variance residual	0.011 (0.011 to 0.012)	0.011 (0.011 to 0.012)
Summary Statistics		
Intraclass Correlation Coefficient (ICC)	0.303	0.000
Proportional Change in Variance (PCV)	Ref	100.0%

Maximum likelihood estimation used for all models shown. Model 0 includes the random intercept for strata only. Model 1 includes the strata random intercepts, and fixed main effects for Townsend index and individual level social factors to assess additive structural components. * p < 0.05, p < 0.01, *** p < 0.001.

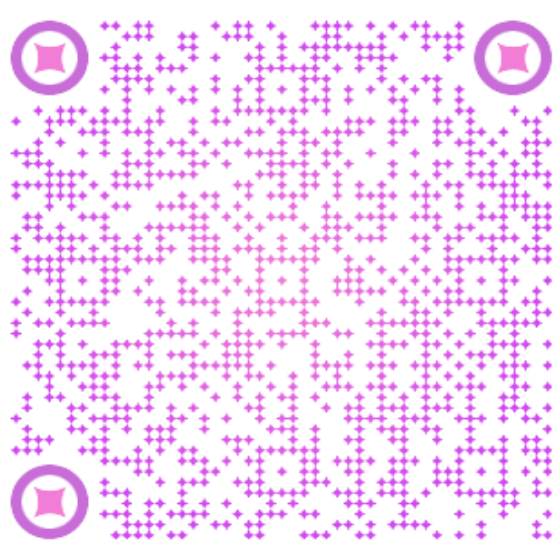
	Memory domain		
	Stratum 300	Stratum 150	Stratum 50
ICC_Model 0	0.197	0.187	0.108
ICC_Model 1	0.007	0.006	0.006
PCV	97.2%	97.5%	94.8%
	Non-memory domain		
	Stratum 300	Stratum 150	Stratum 50
ICC_Model 0	0.297	0.279	0.157
ICC_Model 1	0.006	0.004	0.008
PCV	98.6%	98.9%	95.6%

Higher area-level socioeconomic advantage was associated with better memory and non-memory cognitive performance, with clear dose-response gradients across deprivation quintiles.

MAIHDA models showed moderate between-stratum variation in cognitive outcomes in the null models (ICC = 20%-30.3%), but this was almost entirely explained by the additive effects of area deprivation and individual social characteristics (PCV = 97.4%-100.0%).

Residual between-stratum variance was minimal after adjustment (ICC = 0.0%-0.6%), indicating little evidence of additional intersectional heterogeneity beyond additive structural inequalities.

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