Supplemental material

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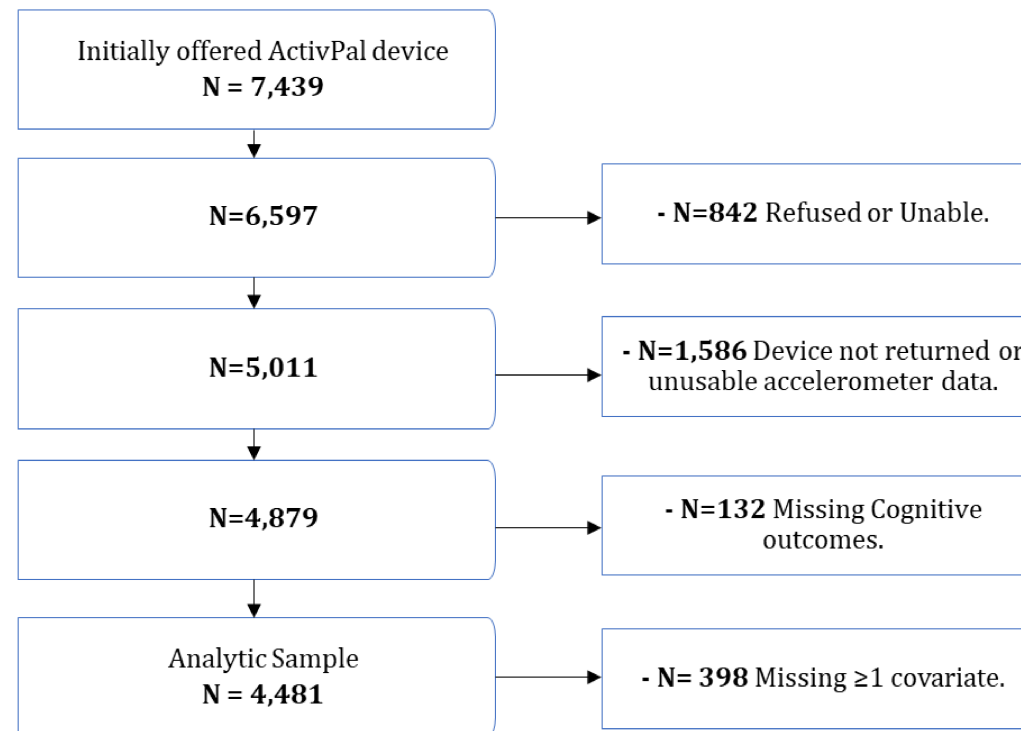*J Epidemiol Community Health*

Supplementary Material

Daily movement and cognition in mid-life: A cross-sectional compositional analysis of the 1970 British Cohort Study.

Supplementary Figure 1. STROBE diagram of sample derivation.

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Supplementary Figure 2. Comparison of participant average daily movement and excluded sample.

Participant PA Compositional Centre (Hours)
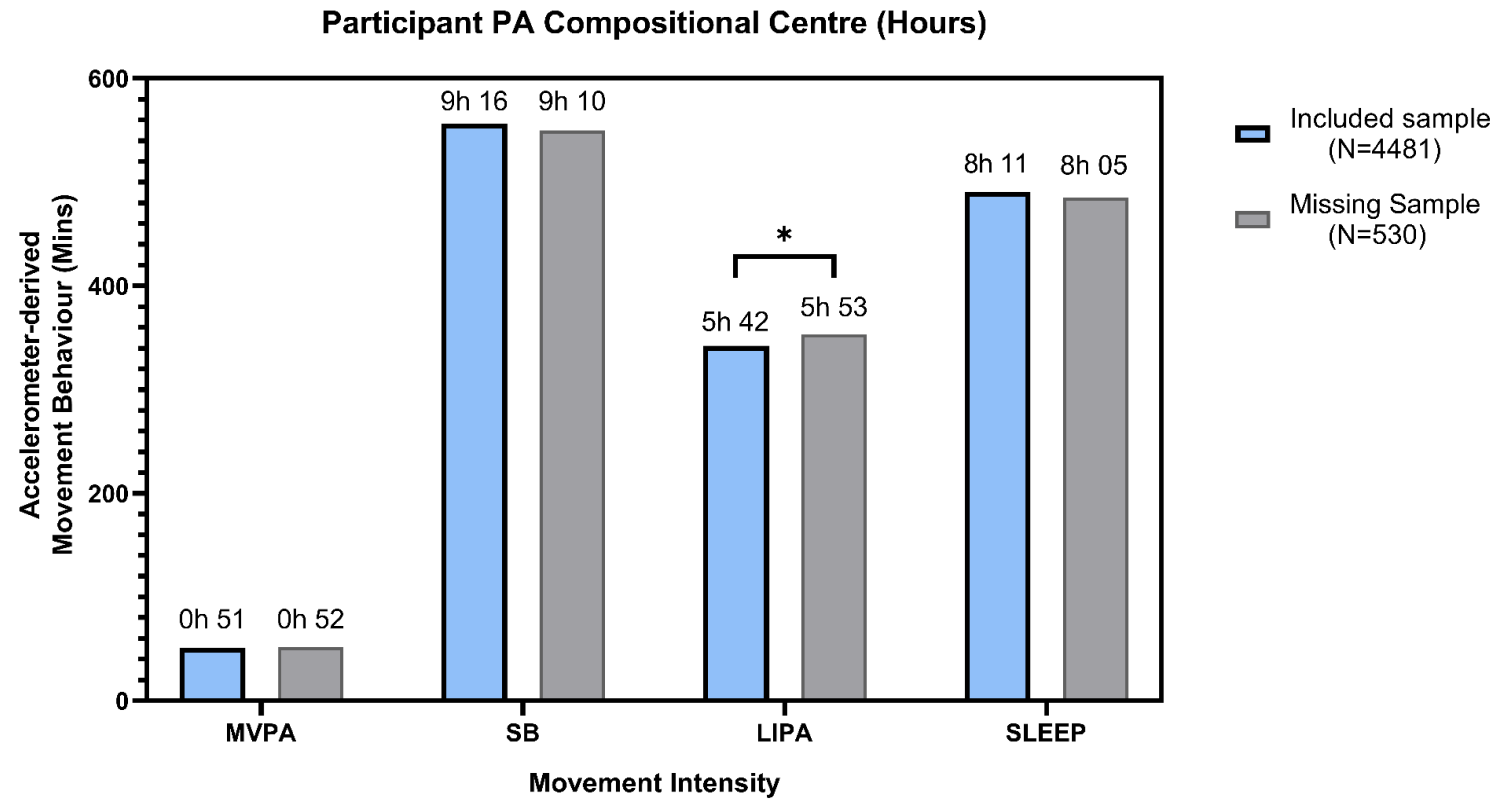
* p<0.05, independent samples t-test.

Supplementary Figure 3. Distribution of raw executive function scores (count of letters missed & number of letters process in 2-letter cancellation task; animals named in verbal-fluency task)
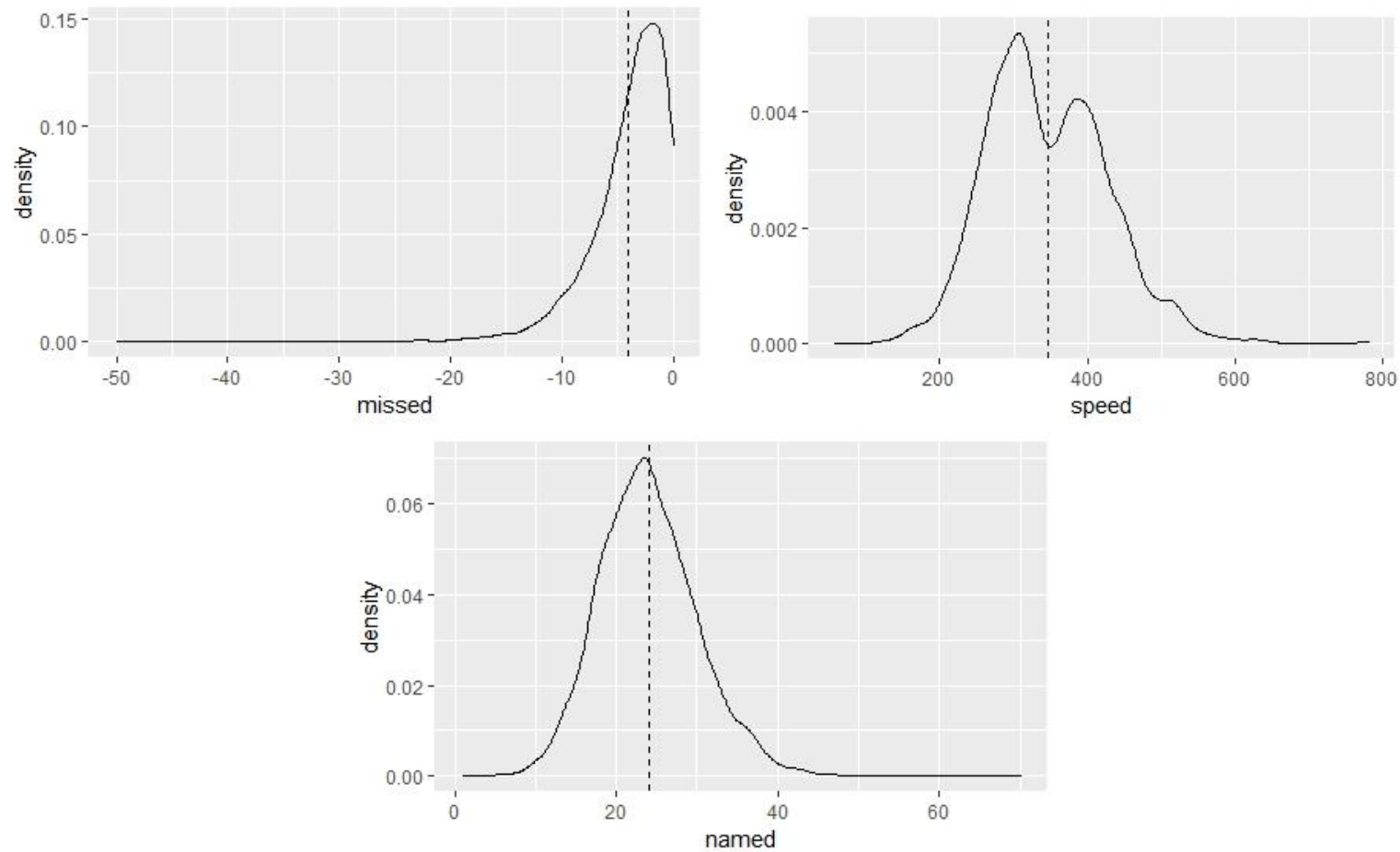
Supplementary Figure 4. Distribution of raw memory scores (*L* – Immediate recall; *R* – Delayed recall)
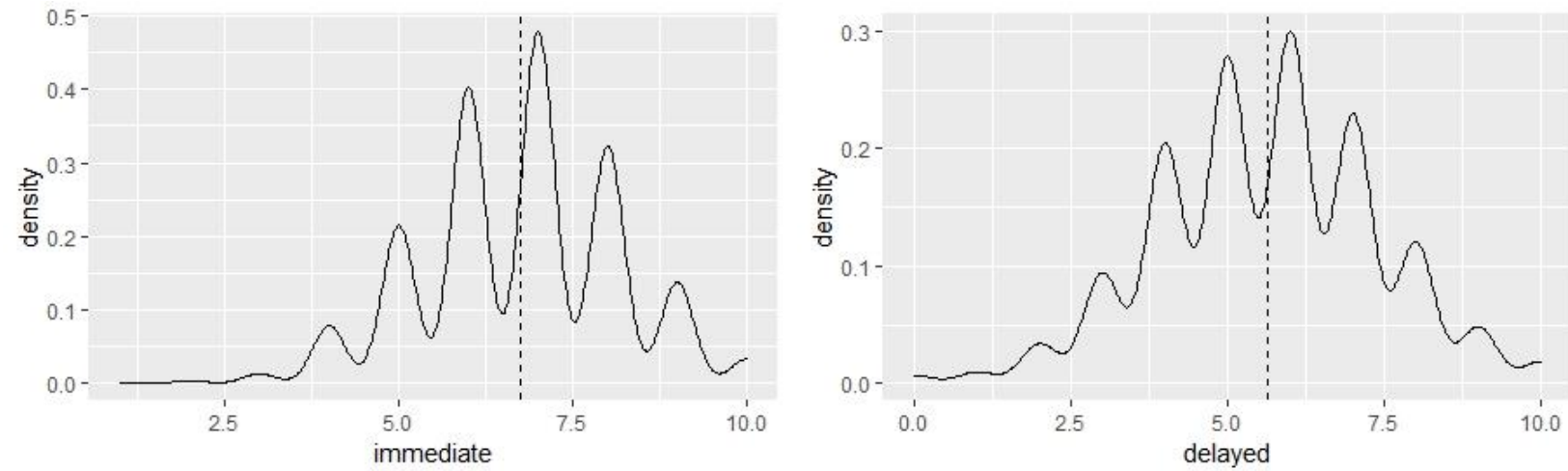
Supplementary Table 1 | Pearson correlations of movement behaviours necessitating the compositional modelling approach.

	MVPA	LIPA	SLEEP	SB
MVPA	1.00	0.21	-0.12	-0.32
LIPA	0.21	1.00	-0.27	-0.77
SLEEP	-0.12	-0.27	1.00	-0.37
SB	-0.32	-0.77	-0.37	1.00

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Supplementary Table 2 | Estimated coefficients for linear regression model of isometric log ratio (ILR) coordinates of daily time composition and participant composite cognition z-scores

ILR Coordinate	Unadjusted			Adjusted for sociodemographic factors including age, sex, education, marital status and occupational PA.			Further adjustment for health and lifestyle factors including disability, BMI, depressive symptoms, smoker status and alcohol consumption.		
	Coef.	95% CI	p-value	Coef.	95% CI	p-value	Coef.	95% CI	p-value
$\sqrt{\frac{3}{4}}\ln\frac{MVPA}{\sqrt[3]{SB\times LIPA \times SLEEP}}$	0.096	(0.069 - 0.123)	**<0.001**	0.045	(0.017 - 0.074)	**0.002**	0.024	(-0.006 - 0.053)	0.114
$\sqrt{\frac{3}{4}}\ln\frac{SB}{\sqrt[3]{LIPA\times SLEEP \times MVPA}}$	0.078	(0.034 - 0.123)	**<0.001**	0.056	(0.015 - 0.105)	**0.009**	0.077	(0.032 - 0.122)	**<0.001**
$\sqrt{\frac{3}{4}}\ln\frac{LIPA}{\sqrt[3]{SLEEP \times MVPAxSB}}$	-0.088	(-0.177 - -0.049)	**<0.001**	-0.025	(-0.066 - 0.016)	0.230	-0.016	(-0.057 - 0.025)	0.438
$\sqrt{\frac{3}{4}}\ln\frac{SLEEP}{\sqrt[3]{MVPA\times SB\times LIPA}}$	-0.086	(-0.142 - -0.030)	**0.003**	-0.080	(-0.136 - -0.024)	**0.005**	-0.084	(-0.140 - -0.029)	**0.003**

Coefficients of ILR-transformed coordinates (log-ratio of one behaviour relative to all others) is not immediately interpretable.

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Supplemental Table 3. Estimated coefficients for linear regression model of isometric log ratio (ILR) coordinates of daily time composition and participant memory z-scores.

| ILR Coordinate	Unadjusted			Adjusted for sociodemographic factors including age, sex, education, marital status and occupational PA			Further adjustment for health and lifestyle factors including disability, BMI, depressive symptoms, smoker status and alcohol consumption.		
	Coef.	**95% CI**	**p-value**	**Coef.**	**95% CI**	**p-value**	**Coef.**	**95% CI**	**p-value**
$\sqrt{\frac{3}{4}}\ln\frac{MVPA}{\sqrt[3]{SB\times LIPA\times SLEEP}}$	0.118	(0.069 - 0.169)	**<0.001**	0.046	(-0.003 - 0.095)	0.064	0.012	(-0.038 - 0.062)	0.635
$\sqrt{\frac{3}{4}}\ln\frac{SB}{\sqrt[3]{LIPA\times SLEEP\times MVPA}}$	0.127	(0.044 - 0.209)	**0.003**	0.048	(-0.035 - 0.131)	0.257	0.087	(0.003 - 0.171)	**0.042**
$\sqrt{\frac{3}{4}}\ln\frac{LIPA}{\sqrt[3]{SLEEP\times MVPA\times SB}}$	-0.115	(-0.189 - -0.040)	**0.003**	0.021	(-0.055 - 0.096)	0.593	0.034	(-0.041 - 0.110)	0.373
$\sqrt{\frac{3}{4}}\ln\frac{SLEEP}{\sqrt[3]{MVPA\times SB\times LIPA}}$	-0.131	(-0.236 - -0.027)	**0.014**	-0.115	(-0.216 - -0.014)	**0.026**	-0.117	(-0.218 - 0.016)	**0.023**

Coefficients of ILR-transformed coordinates (log-ratio of one behaviour relative to all others) is not immediately interpretable.

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Supplemental Table 4 | Estimated coefficients for linear regression model of isometric log ratio (ILR) coordinates of daily time composition and participant executive function z-scores.

ILR Coordinate	Unadjusted			Adjusted for sociodemographic factors including age, sex, education, marital status and occupational PA.			Further adjustment for health and lifestyle factors including disability, BMI, depressive symptoms, smoker status and alcohol consumption.		
	Coef.	95% CI	p-value	Coef.	95% CI	p-value	Coef.	95% CI	p-value
$\sqrt{\frac{3}{4}}\ln\frac{MVPA}{\sqrt[3]{SB\times LIPA \times SLEEP}}$	0.148	(0.107 - 0.190)	**<0.001**	0.089	(0.047 - 0.129)	**<0.001**	0.064	(0.021 - 0.106)	**0.004**
$\sqrt{\frac{3}{4}}\ln\frac{SB}{\sqrt[3]{LIPA\times SLEEP \times MVPA}}$	0.092	(0.023 - 0.161)	**0.008**	0.063	(-0.007 - 0.132)	0.077	0.087	(0.017 - 0.158)	**0.015**
$\sqrt{\frac{3}{4}}\ln\frac{LIPA}{\sqrt[3]{SLEEP \times MVPAxSB}}$	-0.132	(-0.194 - -0.070)	**<0.001**	-0.054	(-0.117 - 0.009)	0.095	-0.051	(-0.114 - 0.012)	0.113
$\sqrt{\frac{3}{4}}\ln\frac{SLEEP}{\sqrt[3]{MVPA\times SB\times LIPA}}$	-0.109	(-0.196 - -0.022)	**0.014**	-0.097	(-0.182 - -0.013)	**0.023**	-0.998	(-0.184 - -0.015)	**0.021**

Coefficients of ILR-transformed coordinates (log-ratio of one behaviour relative to all others) is not immediately interpretable.

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Supplementary Figure 5: Unadjusted isotemporal substitutions between PA intensities and participant memory z-scores.
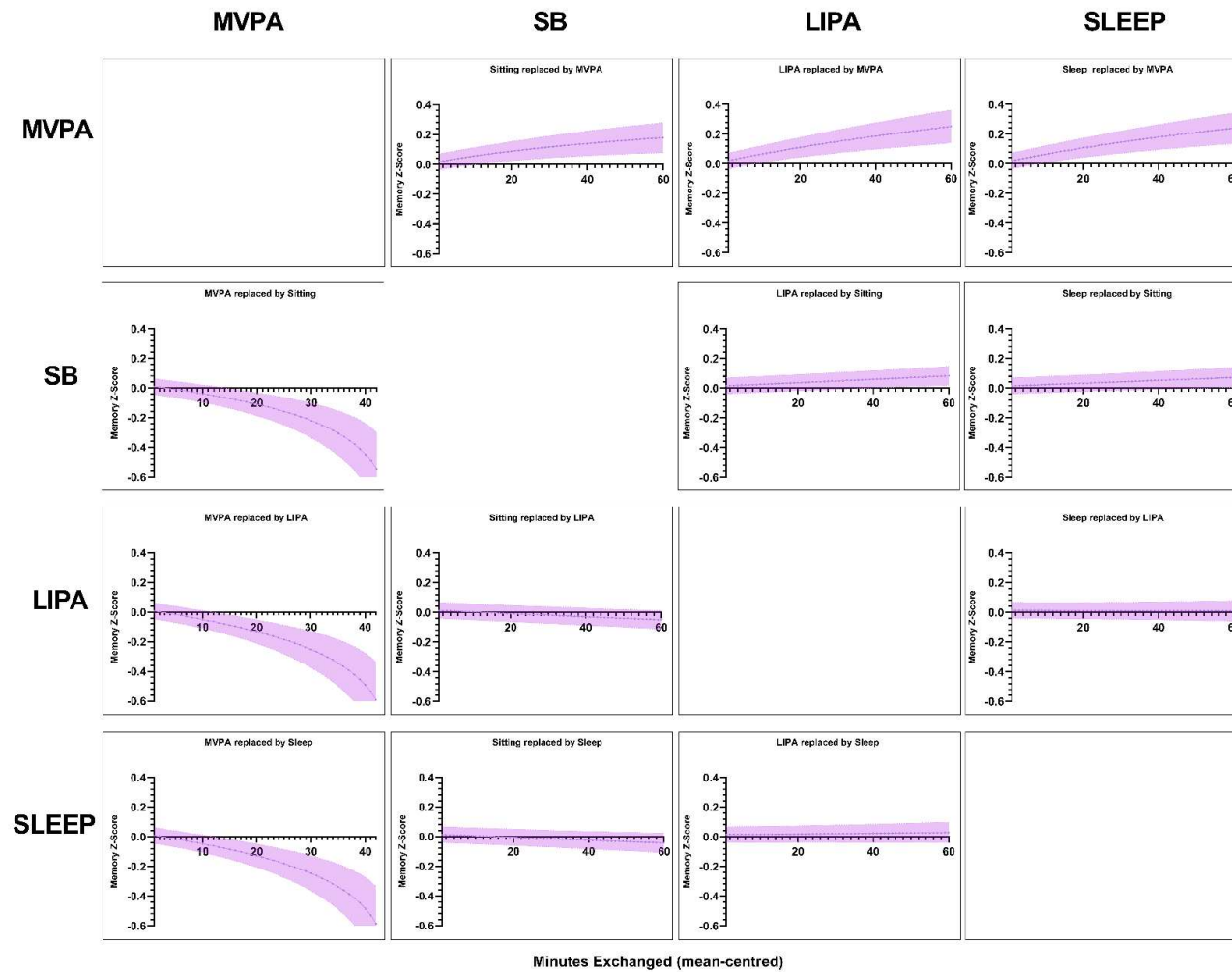
Supplementary Figure 6: Unadjusted isotemporal substitutions between PA intensities and participant executive function.
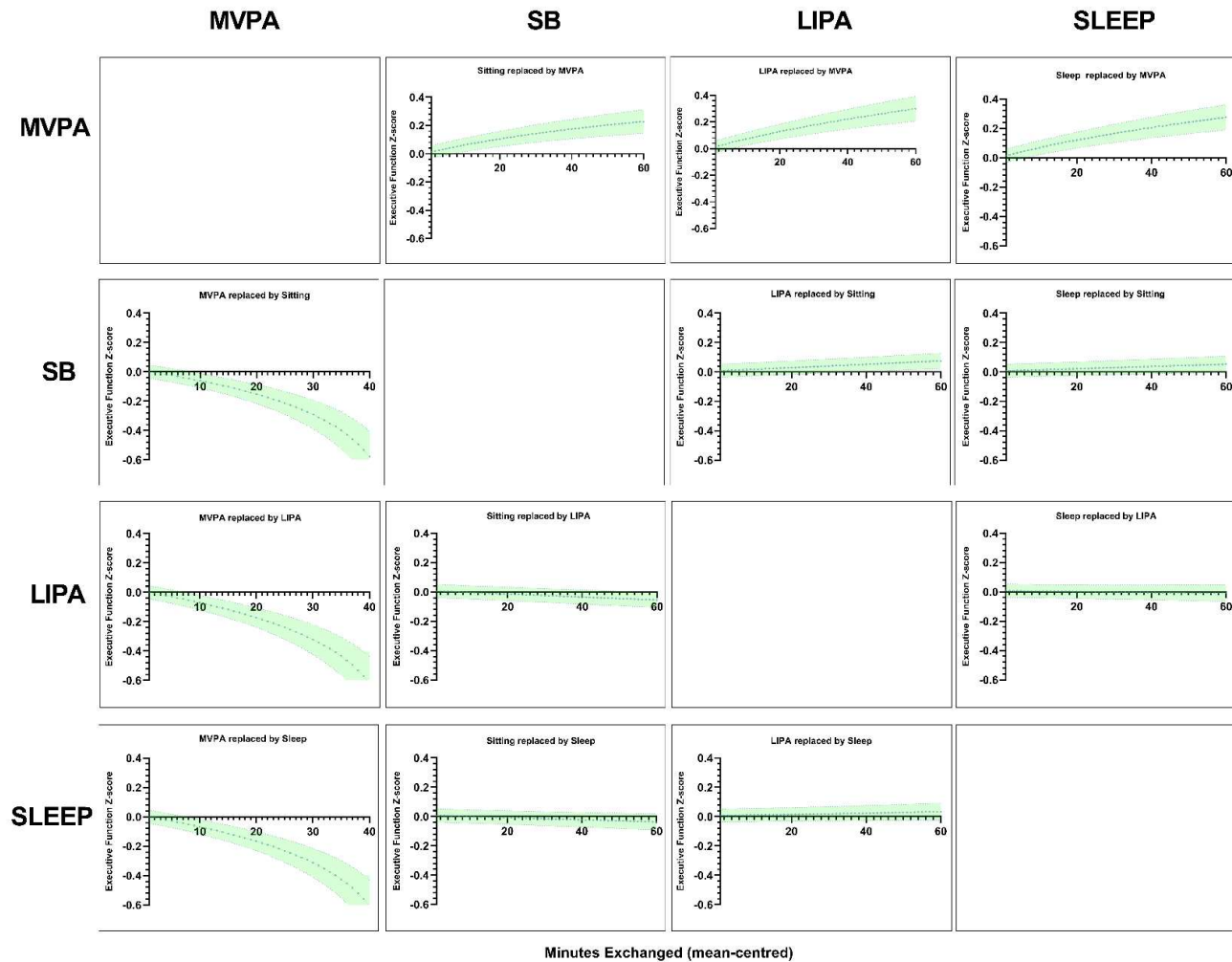
Supplementary table 5 | Figure 7: Unadjusted education interaction and isotemporal substitutions with composite cognition on outcome stratified by education type (abbreviated).

Parameter	Coef	Standard Error	t-value	p-value
ILR1. (mvpa)	0.089	0.030	2.999	0.003
ILR2. (sedent)	0.134	0.048	2.812	0.005
ILR3. (LIPA)	-0.039	0.053	-0.728	0.467
Education1	-0.374	0.177	-2.114	0.035
Education2	-0.108	0.302	-0.357	0.721
Education3	0.647	0.179	3.608	0.000
Education4	0.806	0.316	2.548	0.011
mvpa*Education1	**-0.119**	**0.040**	**-2.990**	**0.003**
sedent*Education1	-0.011	0.064	-0.171	0.864
LIPA*Education1	0.066	0.072	0.916	0.360
mvpa*Education2	-0.133	0.068	-1.951	0.051
sedent*Education2	0.023	0.110	0.211	0.833
LIPA*Education2	-0.023	0.111	-0.205	0.838
mvpa*Education3	0.004	0.041	0.091	0.928
sedent*Education3	-0.090	0.068	-1.324	0.186
LIPA*Education3	0.091	0.076	1.198	0.231
mvpa*Education4	-0.049	0.072	-0.677	0.498
sedent*Education4	-0.251	0.133	-1.883	0.060
LIPA*Education4	0.026	0.130	0.203	0.839

Supplementary Table 6 | Figure 8: Unadjusted occupation interaction and isotemporal substitutions with composite cognition on outcome stratified by occupation PA type (abbreviated).

Parameter	Coef	Standard Error	t-value	p-value
ILR1. (mvpa)	0.043	0.090	0.478	0.632
ILR2. (sedent)	-0.123	0.164	-0.749	0.454
ILR3. (LIPA)	-0.066	0.167	-0.395	0.693
Occupation Type 1	0.689	0.416	1.657	0.098
Occupation Type 2	0.330	0.448	0.737	0.461
Occupation Type 3	0.051	0.426	0.120	0.905
Occupation Type 4	-0.423	0.511	-0.827	0.408
mvpa*Occupation Type 1	0.029	0.092	0.314	0.754
sedent*Occupation Type 1	0.154	0.169	0.910	0.363
LIPA*Occupation Type 1	0.137	0.172	0.795	0.427
mvpa*Occupation Type 2	-0.009	0.101	-0.086	0.932
sedent*Occupation Type 2	0.214	0.178	1.207	0.228
LIPA*Occupation Type 2	0.064	0.183	0.349	0.727
mvpa*Occupation Type 3	-0.011	0.095	-0.120	0.904
sedent*Occupation Type 3	0.190	0.172	1.104	0.270
LIPA*Occupation Type 3	0.054	0.177	0.307	0.759
mvpa*Occupation Type 4	-0.072	0.113	-0.636	0.525
sedent*Occupation Type 4	**0.321**	**0.191**	**1.680**	**0.093**
LIPA*Occupation Type 4	0.168	0.214	0.783	0.434

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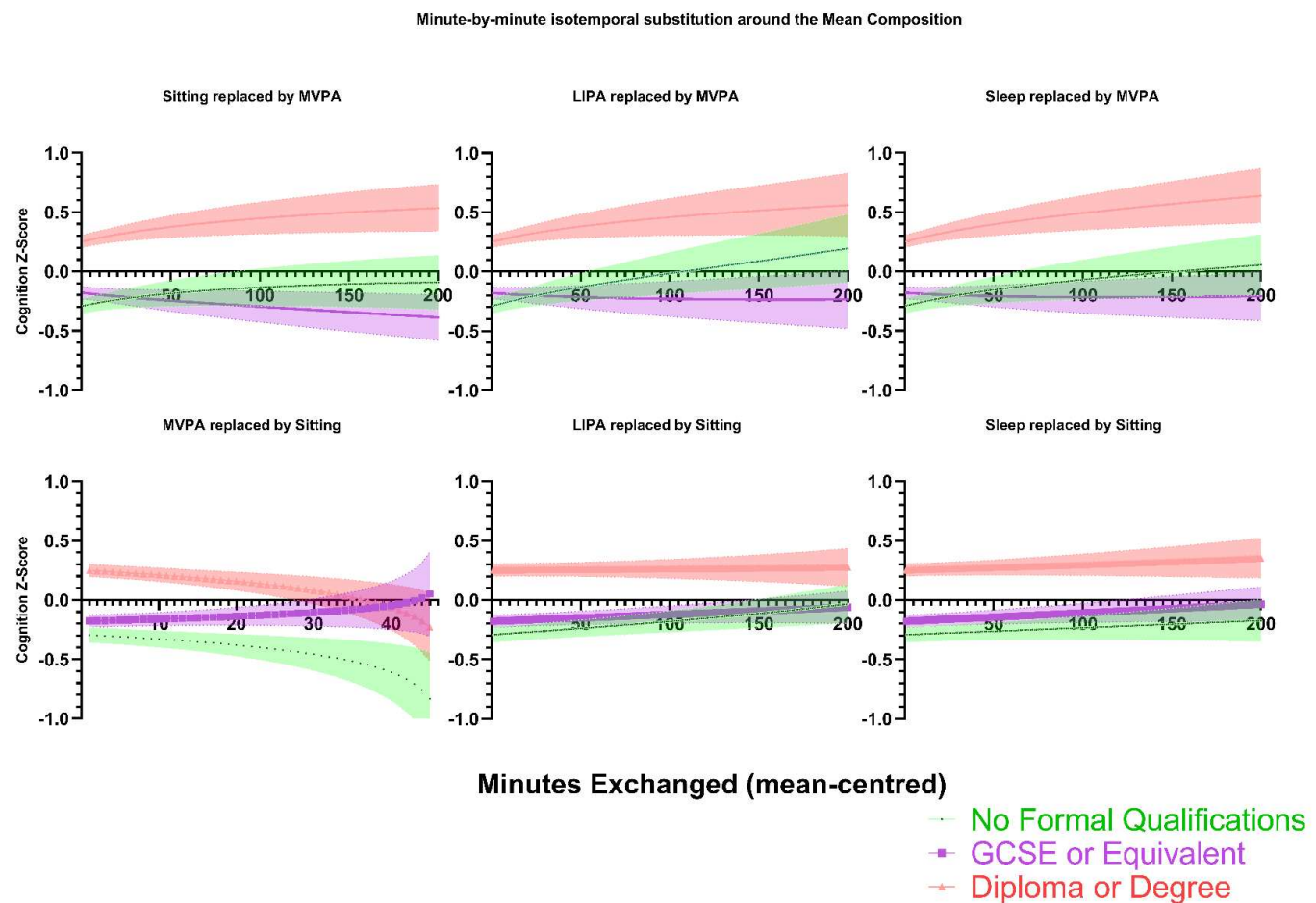
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Figure 7. Relative causal effect on composite cognitive z-scores and 95% confidence intervals (Stratified by educational level) of isotemporal substitutions between each movement component and SB and MVPA centred at the mean composition. Substitutions were performed on the unadjusted ILR model presented in eTable 1 in the supplement.
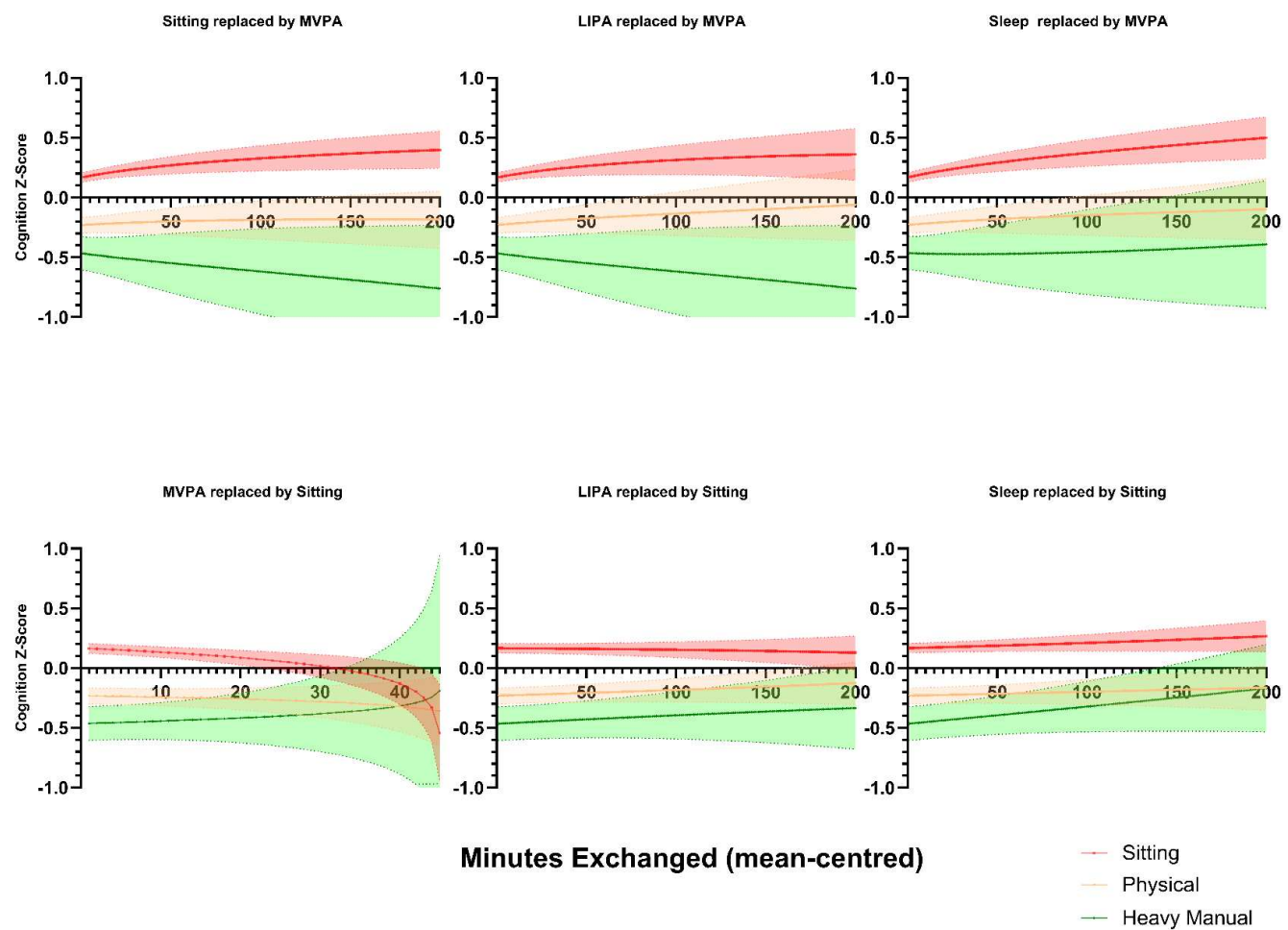
Figure 8. Relative causal effect on composite cognitive z-scores and 95% confidence intervals (Stratified by occupational PA level) of isotemporal substitutions between each movement component and SB and MVPA centred at the mean composition. Substitutions were performed on the unadjusted ILR model presented in eTable 1 in the supplement.

Supplementary Table 7 | Unadjusted estimates repeated with complete sample (N=4879 with accelerometer & cognition data)

ILR Coordinate	Unadjusted		
	Coef.	**95% CI**	**p-value**
$\sqrt{\frac{3}{4}}\ln\frac{MVPA}{\sqrt[3]{SB \times LIPA \times SLEEP}}$	0.094	(0.068 - 0.118)	**<0.001**
$\sqrt{\frac{3}{4}}\ln\frac{SB}{\sqrt[3]{LIPA \times SLEEP \times MVPA}}$	0.078	(0.036 - 0.121)	**<0.001**
$\sqrt{\frac{3}{4}}\ln\frac{LIPA}{\sqrt[3]{SLEEP \times MVPA \times SB}}$	-0.088	(-0.127 - -0.050)	**<0.001**
$\sqrt{\frac{3}{4}}\ln\frac{SLEEP}{\sqrt[3]{MVPA \times SB \times LIPA}}$	-0.084	(-0.138 - -0.030)	**0.002**

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Supplementary Table 8 | Cognition scores of individuals excluded due to missing covariates.

Cognition Raw Scores	Included (N=4481) Mean (SD)	Excluded (N=398) Mean (SD)
Immediate Recall	6.75 (6.7)	6.44 (1.45)
Delayed Recall	5.63 (1.77)	5.24 (1.86)
Processing Speed	346.27 (82.78)	332.85 (82.74)
Processing Accuracy	4.03 (3.68)	4.22 (4.09)
Verbal Fluency	23.98 (6.10)	23.11 (6.20)

Supplementary Table 9 | Movement behaviour of individuals excluded due to missing cognition only.

Cognition Raw Scores	Included (N=4481)	Excluded (N=132)	p-value
MVPA (mean mins)	50.80	50.95	0.947
LIPA (mean mins)	342.14	353.10	0.296
SB (mean mins)	556.44	549.64	0.564
SLEEP (mean mins)	490.46	486.46	0.523

*p-values tested by independent samples t-test