

Note to readers with disabilities: *EHP* strives to ensure that all journal content is accessible to all readers. However, some figures and Supplemental Material published in *EHP* articles may not conform to [508 standards](#) due to the complexity of the information being presented. If you need assistance accessing journal content, please contact ehp508@niehs.nih.gov. Our staff will work with you to assess and meet your accessibility needs within 3 working days.

Supplemental Material

Lifelong Residential Exposure to Green Space and Attention: A Population-based Prospective Study

Payam Dadvand, Christina Tischer, Marisa Estarlich, Sabrina Llop, Albert Dalmau-Bueno, Monica López-Vicente, Antònia Valentín, Carmen de Keijzer, Ana Fernández-Somoano, Nerea Lertxundi, Cristina Rodríguez-Dehli, Mireia Gascon, Monica Guxens, Daniela Zugna, Xavier Basagaña, Mark J Nieuwenhuijsen, Jesus Ibarluzea, Ferran Ballester, Jordi Sunyer

Table of Contents

Table S1. Characteristics of NDVI and VCF maps applied in our analyses.

Figure S1. Normalized Difference Vegetation Index (NDVI) maps applied to assess residential surrounding green cover at birth and 4/5-year, and 7-year follow-ups. **Source:** U.S. Geological Survey; GloVis: Global Visualization Viewer. Available: <http://glovis.usgs.gov/>

Figure S2. Vegetation Continuous Fields (VCF) maps applied to assess residential surrounding tree cover at birth and 4/5-year, and 7-year follow-ups. **Source:** Earth Science Data Interface (ESDI) maintained by the Global Land Cover Facility (GLCF), Maryland University.

Table S2. Description of characteristics of the study participants in 4/5 and 7-year follow-ups across cohorts included in the analyses. P-values are reported for chi-squared test for categorical variables and Mann–Whitney U test for continuous variables.

Table S3. Spearman's correlation coefficients between averages of Normalized Difference Vegetation Index (NDVI) and Vegetation Continuous Fields (VCF) over a 500 m buffer around participants' addresses at birth and 4/5-year and 7-year follow-ups, separately for all study participants (A) and those who did not move home during the follow-ups (B).

Table S4. Adjusted mean ratios (95% confidence interval, CI) in omission and commission errors and regression coefficient (95% CI) for hit reaction time-standard error (HRT-SE) associated with an IQR increase in the average of Normalized Difference Vegetation Index (NDVI) and Vegetation Continuous Fields (VCF, % tree cover) surrounding participants' residences separately for Sabadell and Valencia cohorts.

Table S5. Adjusted mean ratios (95% confidence interval, CI) in omission and commission errors and regression coefficient (95% CI) for hit reaction time-standard error (HRT-SE) associated with an IQR increase in the average of Normalized Difference Vegetation Index (NDVI) and Vegetation Continuous Fields (VCF, % tree cover) surrounding participants' residences based on negative binomial (for omission and commission errors) and linear regression models (for HRT) with cohort as a categorical predictor variable.

Greenness maps

Supplemental Material, Table S1. Characteristics of NDVI and VCF maps applied in our analyses.

Greenness	Cohort	Follow-up years	Satellite	Sensor	Date
NDVI					
Birth	Sabadell	2004-2007	Landsat 5	TM ^a	18 May 2007
	Valencia	2004-2006	Landsat 5	TM ^a	16 May 2007
4/5-year	Sabadell	2009-2011	Landsat 5	TM ^a	10 May 2010
	Valencia	2009-2011	Landsat 5	TM ^a	24 May 2010
7-year	Sabadell	2012-2013	Landsat 8	OLI ^b & TIRS ^c	5 May 2014
	Valencia	2012-2013	Landsat 8	OLI ^b & TIRS ^c	3 May 2014
VCF					
Birth	Sabadell	2004-2007	Landsat 7	ETM+ ^d	1 January 2005
	Valencia	2004-2006	Landsat 7	ETM+ ^d	1 January 2005
4-year	Sabadell	2009-2011	Landsat 7	ETM+ ^d	1 January 2010
	Valencia	2009-2011	Landsat 7	ETM+ ^d	1 January 2010
7-year	Sabadell	2012-2013	Landsat 7	ETM+ ^d	1 January 2015
	Valencia	2012-2013	Landsat 7	ETM+ ^d	1 January 2015

^a Thematic Mapper.

^b Operational Land Imager.

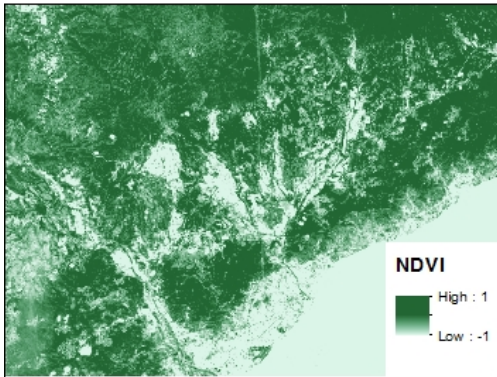
^c Thermal Infrared Sensor.

1) Normalized Difference Vegetation Index (NDVI): To achieve maximum exposure contrast, we looked for available cloud-free Landsat 5 and 8 images during springs/autumns (i.e. the maximum vegetation period of the year for our study region) of the relevant years to each follow-up from the NASA's Earth Observing System Data and Information System (EOSDIS) website. Based on this search we generated our NDVI maps using the images described in the table below.

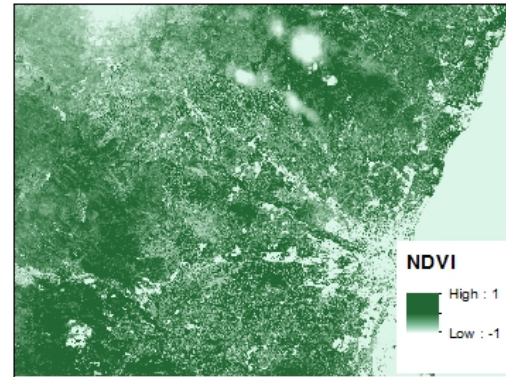
2) Vegetation Continuous Fields (VCF): We downloaded VCF maps from the Earth Science Data Interface (ESDI) maintained by the Global Land Cover Facility (GLCF), Maryland University.

Supplemental Material, Figure S1. Normalized Difference Vegetation Index (NDVI) maps applied to assess residential surrounding green cover at birth and 4/5-year, and 7-year follow-ups. **Source:** U.S. Geological Survey; GloVis: Global Visualization Viewer. Available: <http://glovis.usgs.gov/>)

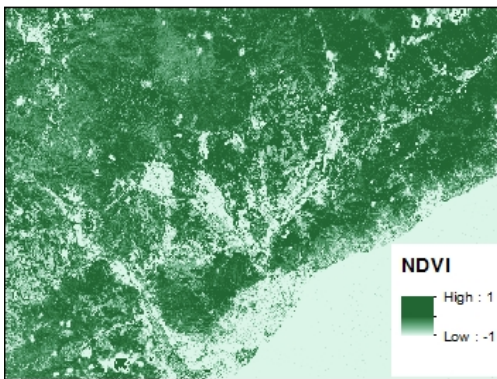
Sabadell (Birth)



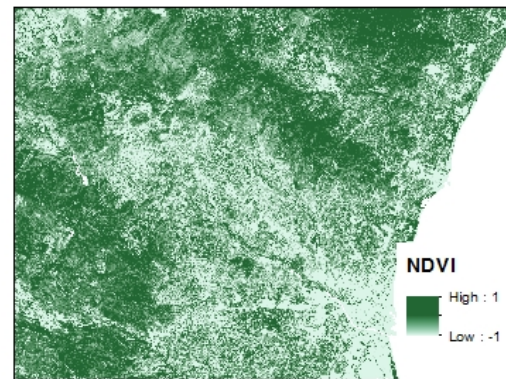
Valencia (Birth)



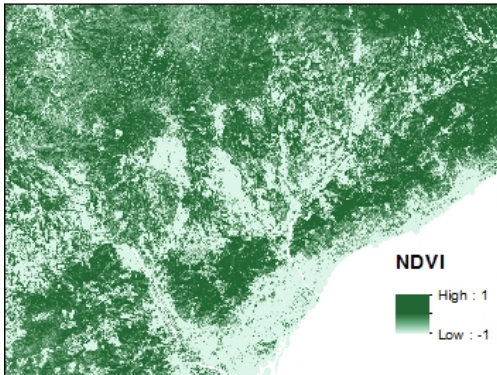
Sabadell (4-year follow-up)



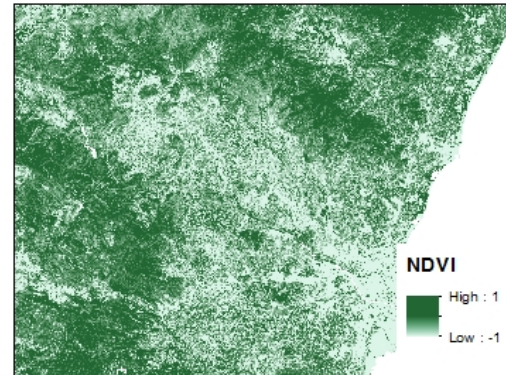
Valencia (5-year follow-up)



Sabadell (7-year follow-up)

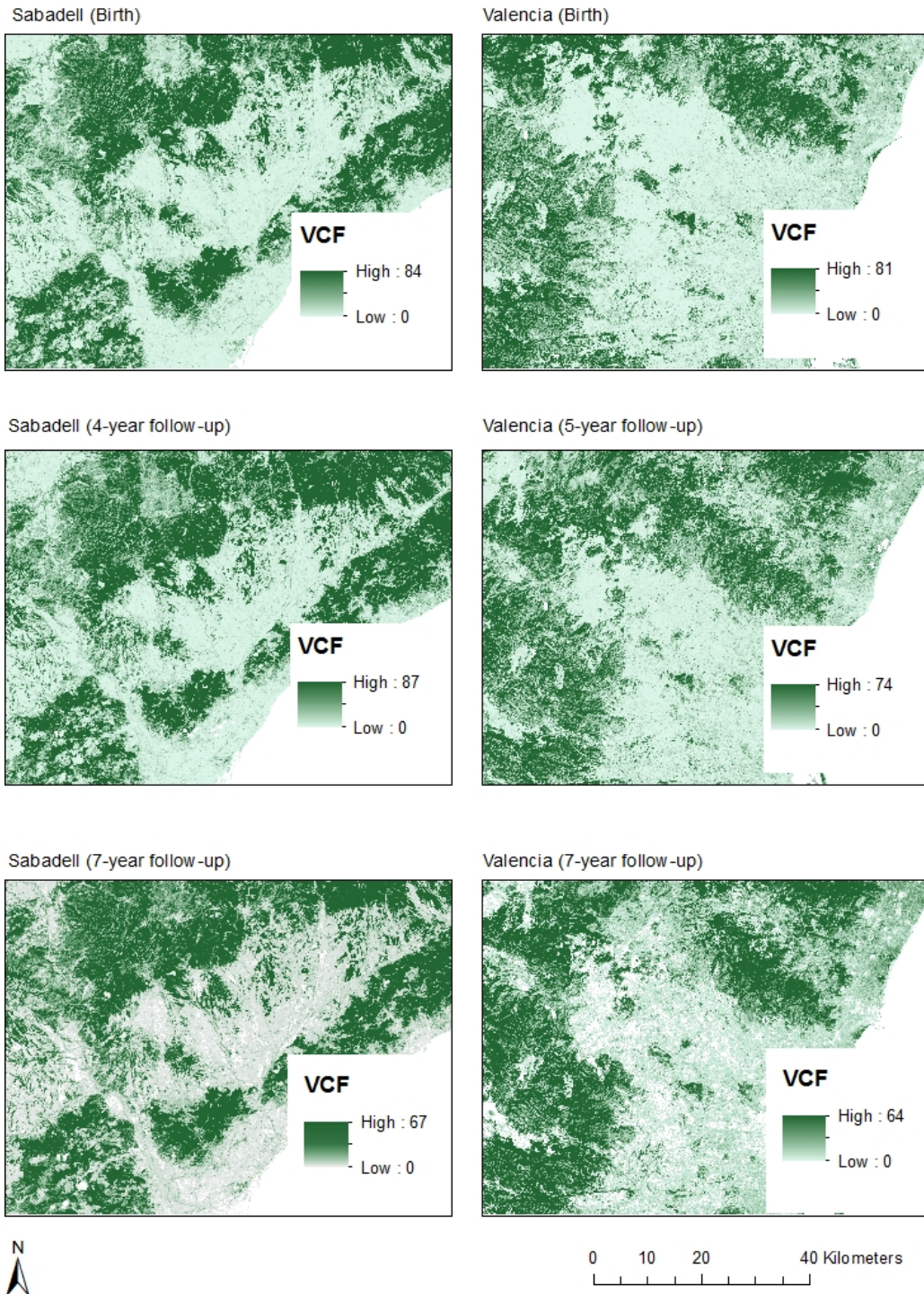


Valencia (7-year follow-up)



Supplemental Material, Figure S2. Vegetation Continuous Fields (VCF) maps applied to assess residential surrounding tree cover at birth and 4/5-year, and 7-year follow-ups.

Source: Earth Science Data Interface (ESDI) maintained by the Global Land Cover Facility (GLCF), Maryland University.



Supplemental Materials, Table S2. Description^a of characteristics of the study participants in 4/5 and 7-year follow-ups across cohorts included in the analyses. P-values are reported for chi-squared test for categorical variables and Mann–Whitney U test for continuous variables.

Characteristics	Sabadell						Valencia					
	Birth (n=740)	Age 4 (n=364)	Age 7 (n=530)	p- value ^b	p- value ^c	p- value ^d	Birth (n=787)	Age 5 (n=524)	Age 7 (n=448)	p-value ^b	p- value ^c	p- value ^d
Sex (Female)	49.1%	49.2%	47.8%	0.67	0.98	0.63	47.0%	48.5%	50.0%	0.63	0.60	0.31
Child age	***	4.7 (0.2)	6.7 (0.7)	<0.01	***	***	***	5.6 (0.2)	7.5 (0.2)	<0.01	***	***
Preterm birth (Yes)	2.7%	1.7%	2.1%	0.64	0.27	0.48	6.0%	5.2%	4.9%	0.86	0.53	0.43
Maternal educational attainment				0.69	0.11	0.20				0.79	0.03	0.01
No or primary school	27.5%	23.7%	23.4%				33.9%	27.7%	26.3%			
Secondary school	43.3%	41.0%	43.8%				42.6%	43.9%	43.3%			
University	29.2%	35.3%	32.9%				23.5%	28.4%	30.4%			
Maternal Iq^e	10.5 (4.5)	10.5 (3.7)	10.5 (4.4)	0.6	0.35	0.65	9.8 (4.4)	9.8 (4.4)	9.8 (3.7)	0.48	0.83	0.37
Maternal smoking during pregnancy (Yes)	29.8%	26.9%	27.3%	0.91	0.33	0.34	41.3%	38.2%	36.8%	0.67	0.30	0.15
Exposure to environmental tobacco smoke at 4/5 year follow-up (Yes)	***	45.3%	46.0%	0.85	***	***	***	52.9%	52.3%	0.84	***	***
Exposure to environmental tobacco smoke at 7 year follow-up (Yes)	***	***	27.9%	***	***	***	***	***	33.0%	***	***	***
Neighborhood socioeconomic status^f	0.7 (0.4)	0.7 (0.4)	0.7 (0.4)	0.95	0.32	0.23	0.6 (0.2)	0.6 (0.2)	0.6 (0.1)	0.48	0.50	0.17

^a For continuous variables, median (IQR) and for categorical variables count (percentage) of each category has been reported.

^b p-value for the difference between participants included in the 4/5-year and 7-year follow-ups

^c p-value for the difference between participants included at birth and in the 4-year follow-up

^d p-value for the difference between participants included at birth and in the 7-year follow-up

^e Wechsler Adult Intelligence Scale (WAIS-IV), Similarities subscale.

^f Urban vulnerability index.

Supplemental Materials, Table S3: Spearman’s correlation coefficients between averages of Normalized Difference Vegetation Index (NDVI) and Vegetation Continuous Fields (VCF) over a 500 m buffer around participants’ addresses at birth and 4/5-year and 7-year follow-ups, separately for all study participants (A) and those who did not move home during the follow-ups (B).

A)

	NDVI			VCF		
	Birth	4/5-year	7-year	Birth	4/5-year	7-year
NDVI						
Birth	1					
4/5-year	0.76	1				
7-year	0.68	0.83	1			
VCF						
Birth	0.52	0.33	0.55	1		
4/5-year	0.44	0.48	0.71	0.88	1	
7-year	0.45	0.50	0.78	0.83	0.94	1

B)

	NDVI			VCF		
	Birth	4/5-year	7-year	Birth	4/5-year	7-year
NDVI						
Birth	1					
4/5-year	0.95	1				
7-year	0.88	0.86	1			
VCF						
Birth	0.52	0.39	0.64	1		
4/5-year	0.56	0.46	0.73	0.95	1	
7-year	0.58	0.50	0.79	0.90	0.96	1

Supplemental Materials, Table S4. Adjusted^a mean ratios (95% confidence interval, CI) in omission and commission errors and regression coefficient (95% CI) for hit reaction time-standard error (HRT-SE) associated with an IQR increase in the average of Normalized Difference Vegetation Index (NDVI) and Vegetation Continuous Fields (VCF, % tree cover) surrounding participants' residences separately for Sabadell and Valencia cohorts.

Greenness exposure	Median (IQR) greenness (0-4/5 years)	K-CPT ^b			Median (IQR) greenness (0-7 years)	ANT ^c		
		Omission error	Commission error	HRT-SE (ms)		Omission error	Commission error	HRT-SE (ms)
NDVI								
Sabadell								
100m buffer	0.195 (0.080)	0.91 (0.85, 0.98)	1.04 (0.98, 1.09)	-1.0 (-2.5, 0.5)	0.199 (0.085)	0.95 (0.82, 1.09)	1.01 (0.92, 1.12)	-7.0 (-15.1, 1.1)
300m buffer	0.241 (0.105)	0.88 (0.81, 0.96)	1.03 (0.97, 1.09)	-1.4 (-3.1, 0.4)	0.243 (0.114)	0.93 (0.81, 1.06)	1.00 (0.91, 1.11)	-10.6 (-18.9, -2.4)
500m buffer	0.261 (0.102)	0.89 (0.82, 0.97)	1.02 (0.96, 1.09)	-1.1 (-2.9, 0.6)	0.263 (0.108)	0.94 (0.82, 1.07)	1.00 (0.91, 1.11)	-10.0 (-18.3, -1.7)
Valencia								
100m buffer	0.190 (0.069)	0.86 (0.78, 0.95)	0.98 (0.94, 1.03)	-1.2 (-2.6, 0.2)	0.188 (0.082)	1.01 (0.85, 1.20)	1.01 (0.89, 1.13)	-2.6 (-14.4, 9.3)
300m buffer	0.223 (0.083)	0.82 (0.72, 0.93)	0.99 (0.92, 1.05)	-1.8 (-3.6, 0.0)	0.219 (0.080)	0.94 (0.75, 1.16)	0.95 (0.82, 1.10)	-3.2 (-17.9, 11.5)
500m buffer	0.239 (0.079)	0.80 (0.70, 0.91)	1.01 (0.94, 1.08)	-2.2 (-4.1, -0.4)	0.234 (0.078)	0.86 (0.68, 1.08)	0.91 (0.77, 1.07)	-9.0 (-25.1, 7.0)
VCF								
Sabadell								
100m buffer	1.640 (1.174)	0.93 (0.87, 1.00)*	1.05 (1.00, 1.11)	-0.8 (-2.12, 0.59)	1.737 (1.115)	1.03 (0.91, 1.16)	1.02 (0.94, 1.11)	-3.9 (-10.71, 2.85)
300m buffer	1.884 (1.279)	0.98 (0.93, 1.03)	1.03 (0.99, 1.07)	-0.3 (-1.39, 0.76)	1.971 (1.186)	1.03 (0.95, 1.11)	0.99 (0.93, 1.05)	-3.2 (-8.28, 1.83)
500m buffer	2.173 (1.465)	0.99 (0.94, 1.03)	1.01 (0.98, 1.05)	-0.3 (-1.26, 0.70)	2.233 (1.408)	1.03 (0.96, 1.10)	0.99 (0.94, 1.05)	-2.3 (-6.92, 2.37)
Valencia								
100m buffer	0.300 (0.560)	0.98 (0.93, 1.05)	0.99 (0.96, 1.02)	0.0 (-0.84, 0.88)	0.390 (0.617)	1.00 (0.90, 1.11)	1.00 (0.95, 1.07)	-1.3 (-8.36, 5.80)
300m buffer	0.550 (0.608)	0.98 (0.91, 1.04)	0.99 (0.96, 1.03)	-0.1 (-1.14, 0.85)	0.649 (0.6669)	0.98 (0.88, 1.09)	1.00 (0.93, 1.07)	-1.1 (-8.92, 6.73)
500m buffer	0.710 (0.521)	0.96 (0.89, 1.04)	0.99 (0.95, 1.03)	-0.6 (-1.72, 0.59)	0.785 (0.560)	0.95 (0.84, 1.07)	0.98 (0.90, 1.07)	-4.1 (-13.32, 5.17)

^a Mixed effects models with random intercepts for cohort (binomial for omission and commission errors and linear for HRT-SE) adjusted for age at the time of attention test, sex, history of preterm birth, maternal educational attainment, maternal IQ, maternal smoking during pregnancy, exposure to environmental tobacco smoke, neighborhood socioeconomic status.

^b Conners' Kiddie Continuous Performance Test.

^c Attentional Network Task.

Supplemental Materials, Table S5. Adjusted^a mean ratios (95% confidence interval, CI) in omission and commission errors and regression coefficient (95% CI) for hit reaction time-standard error (HRT-SE) associated with an IQR increase in the average of Normalized Difference Vegetation Index (NDVI) and Vegetation Continuous Fields (VCF, % tree cover) surrounding participants' residences based on negative binomial (for omission and commission errors) and linear regression models (for HRT) with cohort as a categorical predictor variable.

Greenness exposure	Median (IQR) greenness (0-4-5 years)	K-CPT ^b			Median (IQR) greenness (0-7 years)	ANT ^c		
		Omission error	Commission error	HRT-SE (ms)		Omission error	Commission error	HRT-SE (ms)
NDVI								
100m buffer	0.193 (0.074)	0.90 (0.85, 0.96)	1.01 (0.97, 1.04)	-1.6 (-2.1, -0.1)	0.194 (0.087)	1.00 (0.90, 1.11)	1.03 (0.96, 1.11)	-4.0 (-10.6, 2.6)
300m buffer	0.229 (0.089)	0.87 (0.81, 0.94)	1.00 (0.96, 1.05)	-1.4 (-2.6, -0.2)	0.232 (0.097)	0.97 (0.87, 1.08)	1.03 (0.95, 1.11)	-6.4 (-13.4, 0.6)
500m buffer	0.245 (0.091)	0.87 (0.81, 0.94)	1.01 (0.97, 1.06)	-1.4 (-2.6, -0.2)	0.247 (0.102)	0.95 (0.85, 1.06)	1.02 (0.94, 1.10)	-7.7 (-14.9, -0.5)
VCF								
100m buffer	0.700 (1.315)	0.97 (0.93, 1.02)	1.01 (0.99, 1.04)	-0.3 (-1.0, 0.5)	1.162 (1.514)	1.02 (0.97, 1.07)	1.02 (0.95, 1.11)	-1.9 (-6.7, 3.0)
300m buffer	0.964 (1.295)	0.98 (0.93, 1.02)	1.01 (0.98, 1.03)	-0.3 (-1.0, 0.5)	1.388 (1.469)	1.00 (0.96, 1.05)	1.03 (0.97, 1.09)	-2.1 (-6.4, 2.2)
500m buffer	1.088 (1.372)	0.98 (0.94, 1.02)	1.00 (0.98, 1.03)	-0.4 (-1.1, 0.3)	1.495 (1.573)	0.99 (0.95, 1.04)	1.02 (0.96, 1.08)	-2.4 (-6.7, 1.8)

^a Mixed effects models with random intercepts for cohort (binomial for omission and commission errors and linear for HRT-SE) adjusted for age at the time of attention test, sex, history of preterm birth, maternal educational attainment, maternal IQ, maternal smoking during pregnancy, exposure to environmental tobacco smoke, neighborhood socioeconomic status.

^b Conners' Kiddie Continuous Performance Test.

^c Attentional Network Task.