

Analysis

Results

Study Population

This study examined a sample of children of female participants from the National Longitudinal Survey of Youth (NLSY). Beginning in 1986, extensive assessments were administered every other year to these children. At least one interview was obtained on 9,360 children. A much smaller number of children were included in this study. The selection criteria and number of participants are described in Figure 1. Children were excluded from this study if they were not between the ages of 6 and 8 during the first wave of measurement, they did not have complete measures of interest at the first wave of measurement, or if they were a sibling of another child included in the study.

Descriptive Statistics

Table 1: Population summary at each follow up time point

	Overall	Baseline	First Follow Up	Second Follow Up	Third Follow Up
N	1393	405	387	301	300
Reading Score (SD)	4.14 (1.64)	2.52 (0.92)	4.08 (1.08)	5.01 (1.16)	5.77 (1.25)
Antisocial Score (SD)	1.88 (1.93)	1.66 (1.66)	2.03 (2.04)	1.83 (1.90)	2.06 (2.15)
Child Age (SD)	6.92 (0.63)	6.93 (0.64)	6.93 (0.64)	6.90 (0.63)	6.89 (0.62)
% Male	711 (51.0)	203 (50.1)	195 (50.4)	157 (52.2)	156 (52.0)
Mom's Age	28.26 (2.92)	25.53 (1.88)	27.55 (1.87)	29.55 (1.85)	31.55 (1.89)
Cognitive Stimulation (SD)	8.91 (2.56)	8.89 (2.58)	8.93 (2.54)	8.88 (2.60)	8.95 (2.56)
Emotional Stimulation (SD)	9.21 (2.31)	9.20 (2.31)	9.23 (2.31)	9.20 (2.33)	9.19 (2.31)

A total of 405 children were enrolled in the study. 711 (51%) were male and mean age was 6.92 (SD 0.63) at baseline. Mean home cognitive stimulation is 8.89 (SD 2.58) and home emotional

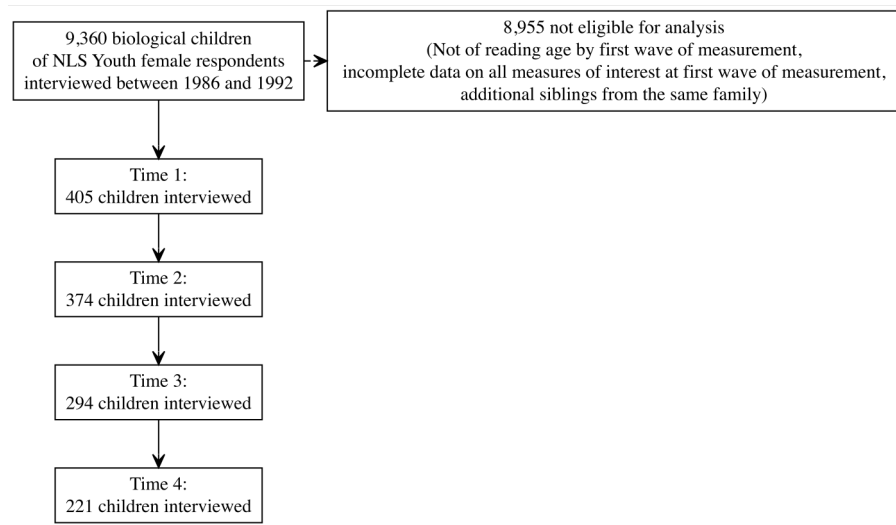


Figure 1: It was possible for a child to be missing at one time point but be present at a later time point

stimulation was 9.20 (SD 2.31) at baseline and both were similar throughout the visits. All participants had baseline data recorded. 18 subjects were missing at first follow up, 104 at second follow up and 105 at the third follow up. It was possible for children to be missing at one time point (after baseline) but be present at a later point in the study. Reading comprehension scores showed substantial change over the 6-year follow-up period Table 1. The mean reading score at baseline was 2.52 (sd: 0.92). The average reading score jumped to 4.08 (sd: 1.08) at the first follow-up, then increased more gradually at the second and third follow-ups (5.01 (sd:1.16) and 5.77 (sd: 1.25), respectively). Measures of antisocial behavior remained relatively stable across the follow-up period (Table 1). Average antisocial behavior score at baseline was 1.66 (sd: 1.66) and only increased to 2.06 (sd: 2.15) by the third follow-up measurement.

Reading Comprehension Scores

Table 2 displays the main and interaction effects of at-home emotional support and cognitive stimulation scores on reading comprehension scores, as well as estimates for other predictors from the Gaussian GEE model with an exchangeable correlation structure. We observed variation in the impact of emotional and cognitive scores at each follow-up timepoint. The effect modification per additional follow-up for cognitive scores was 0.01 (95% CI: 0 to 0.03) after adjusting for other predictors. This indicates that as children aged, the influence of cognitive stimulation on reading scores intensified, albeit not significantly ($P=0.16$). Comparatively, the role of emotional stimulation escalated more prominently over time, with an effect modification of 0.03 (95% CI: 0.01 to 0.05) after adjusting for other predictors, denoting that the emotional stimulation score amplified with each extra follow-up ($P<0.001$).

The main effects of emotional and cognitive stimulation quantify the baseline association between these scores and reading proficiency. A one-unit increase in the cognitive score corresponded to a 0.08 (95% CI: -0.01 to 0.18) uptick in reading ability after adjusting for other predictors, hinting at some effect of cognitive scores on literacy skills, though not conclusively ($P=0.08$). The emotional support score's baseline impact on reading comprehension was 0.05. Every additional emotional support point yielded a 0.05 (95% CI: -0.03 to 0.13) rise in scores after adjusting for other predictors, an influence not strongly linked to variation in reading outcomes ($P=0.24$). This suggests other modeled predictors better elucidate reading score variability. The estimated interaction between emotional and cognitive scores at baseline was 0.00 (95% CI: -0.01 to 0.01) after adjusting for other predictors, offering no evidence that one predictor's effect changes across levels of the other ($P=0.38$).

Table 2: Gaussian GEE Main Effects on Reading Comprehension Score

Model Term	Estimate	95% CI	P-value	Significance
(Intercept)	-3.61	(-4.69, -2.54)	0.00	*
Sex Male	-0.08	(-0.25, 0.09)	0.34	
Cog. Score	0.08	(-0.01, 0.18)	0.08	
Emo. Score	0.05	(-0.03, 0.13)	0.24	
Age	0.80	(0.67, 0.93)	0.00	*
Follow Up Period	2.03	(1.55, 2.5)	0.00	*
Cog. Score * Follow Up Period	0.01	(0, 0.03)	0.16	
Emo. Score * Follow Up Period	0.03	(0.01, 0.05)	0.00	*
Age * Follow Up Period	-0.19	(-0.25, -0.12)	0.00	*
Cog. Score * Emo. Score	0.00	(-0.01, 0.01)	0.38	

^a Terms with '*' denote interactions

^a Cog. Score = Cognitive Stimulation at Home Score

^a Emo. Score = Emotional Stimulation at Home Score

Reading score variability was largely explained by the follow-up period and child age at baseline. On average, reading scores rose by 2.03 (95% CI: 1.55 to 2.50) points per follow-up interval after adjusting for other predictors, affirming that literacy skills saw a statistically significant improvement with age over time ($P < 0.001$). Additionally, older children initially showed markedly higher reading achievement ($P < 0.001$). An extra baseline year corresponded with a 0.80 (95% CI: 0.67 to 0.93) increase in score, after adjusting for other predictors.

We further investigated the main and interaction effects of age, time, emotional, and cognitive scores using regression effect plots. Figure 2 presents estimated reading score trajectories over time for children of varying baseline ages, selected per study inclusion criteria. The greatest difference in mean reading scores occurs at baseline, with the youngest children displaying the steepest growth in reading skills on average. By the third follow-up, children across all starting ages converge to more similar average reading score levels.

Secondary analysis- Antisocial behavior

As a secondary outcome, we assessed the impact of emotional support and cognitive stimulation at home at baseline using Gaussian GEE model with exchangeable correlation structure. The results are presented in Table 3. We have found no evidence that change in emotional support scores ($P = 0.58$) or, cognitive stimulation ($P = 0.89$) is statistically related to change in the

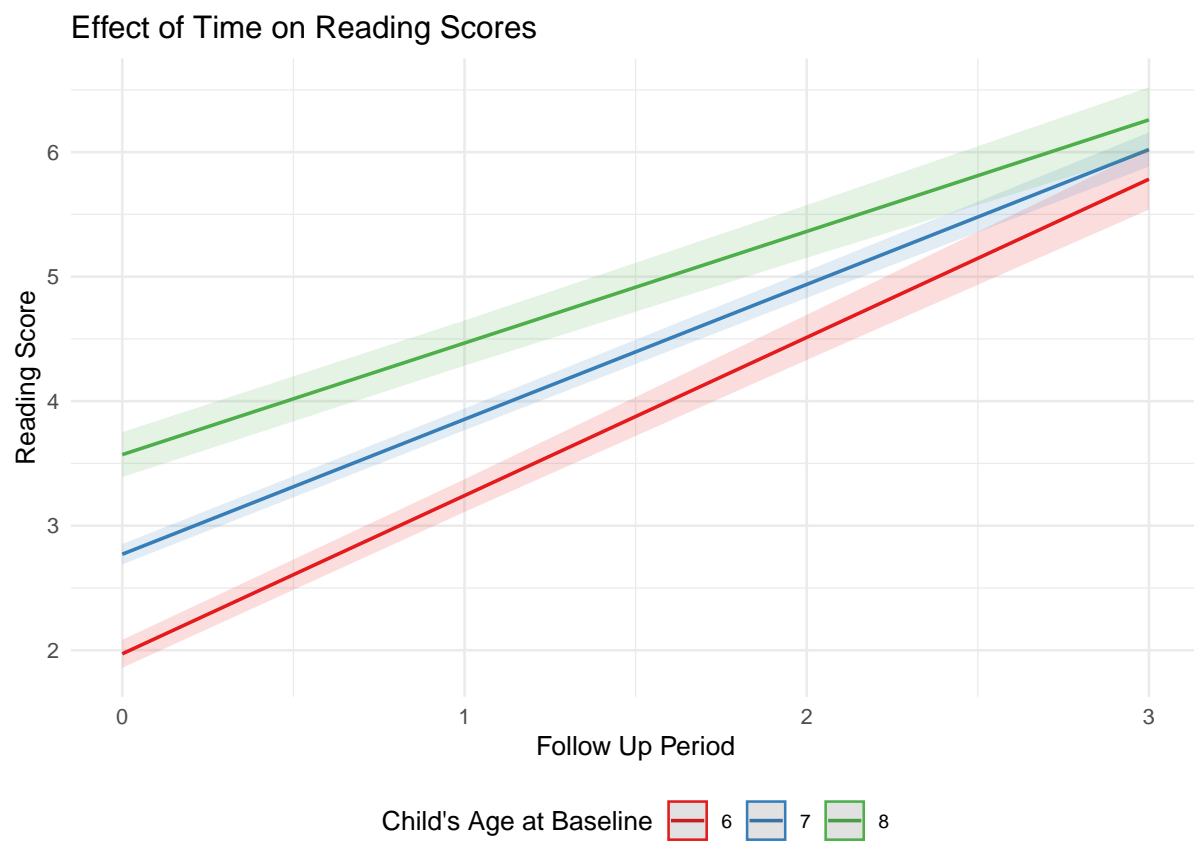


Figure 2: Estimated Trajectories in Reading Scores Over time

antisocial behavior scores. Additionally, there is no evidence that the effect of cognitive scores varies at different levels of emotional scores ($P = 0.36$), and vice versa.

Table 3: Gaussian GEE Main Effects on Antisocial Behavioral Score

Model Term	Estimate	95% CI	P-value	Significance
(Intercept)	0.90	(-1.57, 3.36)	0.48	
Sex Male	0.86	(0.58, 1.14)	0.00	*
Age	0.25	(0.02, 0.48)	0.03	*
Cog. Score	0.02	(-0.21, 0.24)	0.89	
Emo. Score	-0.06	(-0.28, 0.15)	0.58	
Follow Up Period	1.07	(0.26, 1.89)	0.01	*
Follow Up Period * Age	-0.14	(-0.25, -0.02)	0.02	*
Cog. Score * Emo. Score	-0.01	(-0.03, 0.01)	0.36	

^a Terms with '*' denote interactions

^a Cog. Score = Cognitive Stimulation at Home Score

^a Emo. Score = Emotional Stimulation at Home Score

Table 3 presents other predictors that have stronger effects that help explain variability in the antisocial scores. Similar to the reading score analysis, follow-up time period, age of a child at baseline and their interaction were strong predictors of antisocial behavior change and development. Figure 3 presents marginal effects of follow up times on antisocial scores for children with varying baseline ages. It appears that, on average, younger children had lower baseline antisocial scores, which grew at a steeper rate over the course of six years. In contrast, the oldest children at baseline had approximately 25% higher antisocial scores, which did not change greatly over time.

We also found an important effect of sex on the antisocial scores. During the model building and variable selection process we did not find significant interactions between sex and other predictors of antisocial scores. We estimated the marginal effect of sex for males at 0.86 (95% CI: 0.58 to 1.14) compared to females, after adjusting for other factors. This factor has no interaction with other predictors, we estimated constant differences between males and females in terms of their respective antisocial scores at all time points, while accounting for other variables. There is strong statistical evidence ($P < 0.001$) that the average antisocial behavior score for males was at all times 0.86 points higher when compared to females.

Discussion

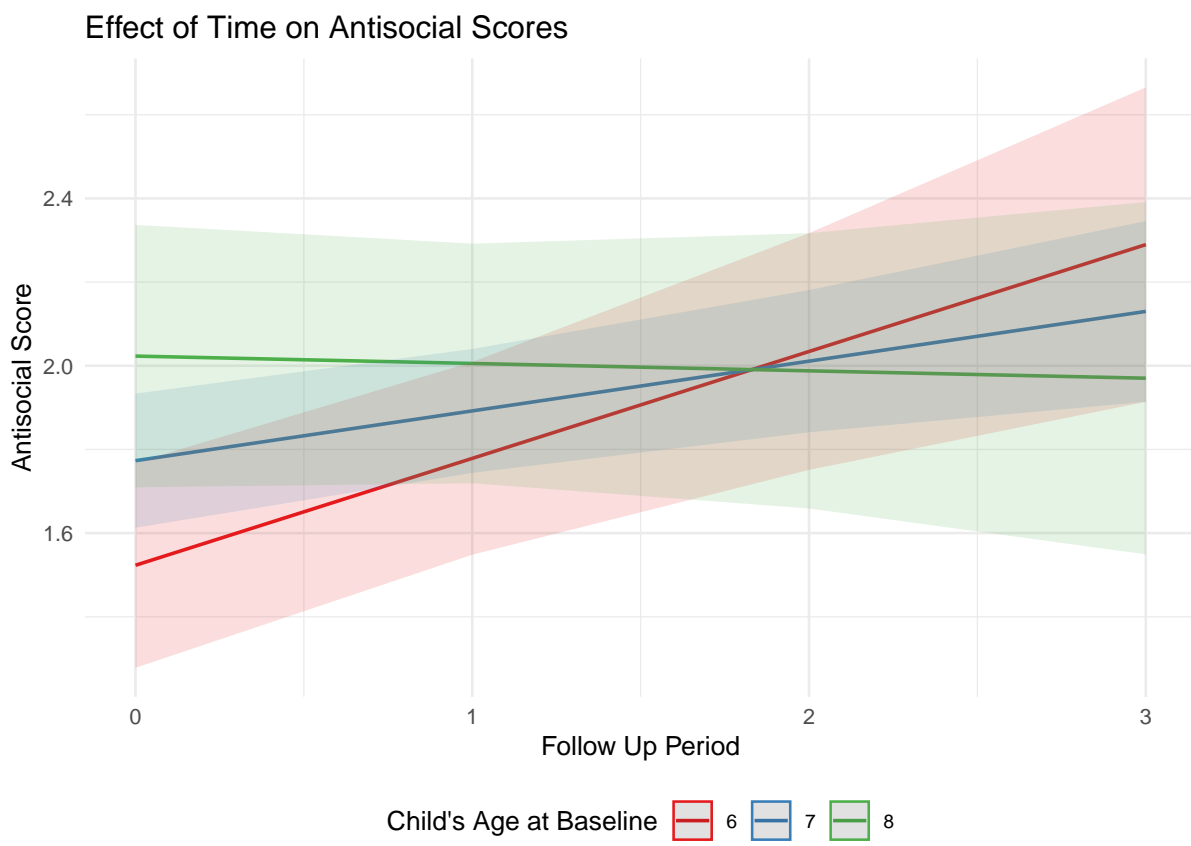


Figure 3: Estimated Antisocial Score Trajectories.