Early Parenting Intervention and Adverse Family Environments Affect Neural Function in Middle Childhood

Supplemental Information

Early home environment

The Home Observation for Measurement of the Environment (HOME), Third Edition (1, 2), Infant/Toddler version, was implemented at the baseline assessment as an indicator of early home environment risk. Both parental behavior and the quality of the physical environment are assessed as part of this measure. The HOME contains 45 items and 6 subscales that assess 1) Responsiveness: the extent of the parent's emotional and verbal responsiveness to the child, 2) Acceptance: parental acceptance of suboptimal behavior and avoidance of restriction or punishment, 3) Organization: including regularity and predictability of the environment inside and outside of the home, 4) Learning Materials: provision of appropriate play and learning materials to support the child's cognitive development, 5) Involvement: extent of parental involvement with the child, and 6) Variety in daily stimulation: amount and range of daily stimulation, particularly related to the daily routine and incorporation of high quality social experiences. Eighteen items are based on observation, 15 are based on interview with the parent, and 12 are based on interview or observation. Trained research assistants administered HOME assessments at the baseline visits. Lower scores on the HOME indicate lower quality early home environment, and have been associated with risk for childhood maltreatment (3, 4). 93.3% of HOME scores assessed in this sample fell below average of HOME scores measured in a nationally representative sample. Of those, 24.4% of these scores fell in the lowest quartile of scores, suggesting significant

early home risk in this sample (5). Adequate test-retest reliability, internal consistency, and validity (1-3) have been established for this measure.

EEG recording

At the 8 year assessment, EEG was recorded while participants sat quietly in a chair in front of a computer screen, alternating one minute epochs of keeping their eyes open (the “Eyes Open” (EO) condition), while viewing a neutral image on a computer screen (a picture of stones resting on sand) and one minute of sitting with their eyes closed (the “Eyes Closed” (EC) condition), for a total of six minutes. Children were prompted by experimenters to keep their eyes closed or remain fixated on the screen as needed. EEG was recorded from an electrode cap consisting of 32 Ag/AgCl electrodes, placed according to the International 10-20 system (6). Advanced Neuro Technology Acquisition hardware (ANT, Enschede, the Netherlands) was used for EEG recording. The amplifier gain was 20K and the ground electrode (AFz) was located midway between Fpz and Fz. No filtering was applied online. The continuous EEG was digitized at 1024 samples per second. EOG was not collected.

EEG processing

EEG data were processed using the Boston EEG Automated Processing Pipeline (7) and Harvard Automated Processing Pipeline for EEG (8). EEG data were filtered using low (cut off 250Hz) and high (cut off 1hz) pass filters. Data were then resampled to a sampling rate 250Hz. A cleanline filter (9) using an EEG-lab plug in (10) was also applied to remove line noise. Eye blinks, EOG and motion artifacts were removed using

wavelet cleaning and ICA and MARA (11) (run as EEG-lab plug ins). No participant had more than 8 bad channels. Continuous data were detrended using the mean. Next, an amplitude-based artifact detection was applied to remove data above 150 μV. Finally, cleaned data were segmented into 1-second epochs for analyses.

For estimates of PSD, a discrete Fourier Transform with a 1-second Hanning window was then applied to the data. Spectral power (μV^2) was computed for the following frequency bands: theta (4-6Hz), low alpha (6-9Hz), high alpha (9-12Hz), and beta (12-20Hz). As in prior studies, we quantified separate power estimates for low alpha (6-9Hz) and high alpha (9-12Hz) to account for established developmental increases in alpha power and frequency across development (12).

The logarithm with base ten of spectral power for each frequency band was used in analyses. As is common in developmental studies involving EEG, we also computed relative power for each frequency band. Relative power represents the amount of spectral power relative to the total power in the EEG power spectrum at that electrode site. Given that relative power is a proportion score, an increase in absolute power in one frequency band affects relative power values in other bands. An advantage of relative power is that it minimizes inter-individual differences in electrophysiological activity related to skull thickness and other anatomical features. The examination of relative power is therefore useful for studies where children vary in age at the time of EEG assessment or in longitudinal studies (13, 14) and can be helpful for controlling for inter-individual differences and in identifying specific absolute changes (15, 16). To limit the number of comparisons, we reduced data from 32 channels to 7 regions from electrodes placed at Frontal pole (FP; average of Fp1, Fpz, and Fp2), Frontal (F;

average of F3, Fz, and F4), Fronto-Central (FC; average of F7, F3, Fz, F4, F8), Central (C; average of C3, Cz, C4), Central Parietal (CP; average of Cp5, Cp1, Cp2, Cp6), Parietal (P; average of P7, P3, Pz, P4, P8), and Occipital (O; average of O1, Oz, O2), sites. Data from temporal channels (T7 and T8) were excessively noisy and were not included in analyses. We had no hypotheses regarding laterality; therefore, electrodes from left, midline, and right hemisphere scalp regions were averaged together for each region.

Preliminary analyses. Data were inspected for outliers defined as values that fell 3 SD outside of the mean. No outlying EEG data points were identified. The number of artifact-free windows ranged from 340 to 1049 epochs (M=561.67, SD=86.22). There were no associations between the number of artifact-free epochs and any independent (income, home, intervention type) or dependent (spectral power) variables, all p values > .05.

Analytic approach. We used four separate marginal models, one for each frequency band of interest (theta, low alpha, high alpha, beta) to test effects. An autoregressive (AR1) covariance structure best fit the data in all models. We first examined the four models with relative spectral power as the dependent variable.

Region was entered as a within-subjects factor. For all models, residuals were visually inspected and confirmed as normally distributed. Children assigned to the ABC versus DEF intervention did not differ in terms of gender distribution, age at which they enrolled in the intervention, early home risk scores, or cognitive function, as measured

with the WJ-III (all *p* values > .05). Family income at infancy and the EEG assessment were only modestly correlated (*r*=.263, *p*=.013). Income was not significantly correlated with total HOME scores during infancy (*r*=.085, *p*=.413) and only modestly associated with total HOME scores at the 8 year assessment (*r*=.252, *p*=.017). Age at which children enrolled in the intervention was not significantly associated with early adverse home risk scores on the HOME (*r*=-.102, *p*=.441). Therefore, there was minimal risk for variance inflation due to multicollinearity based on these associations between independent variables of interest.

Supplementary Table S1. Risk Index Variables

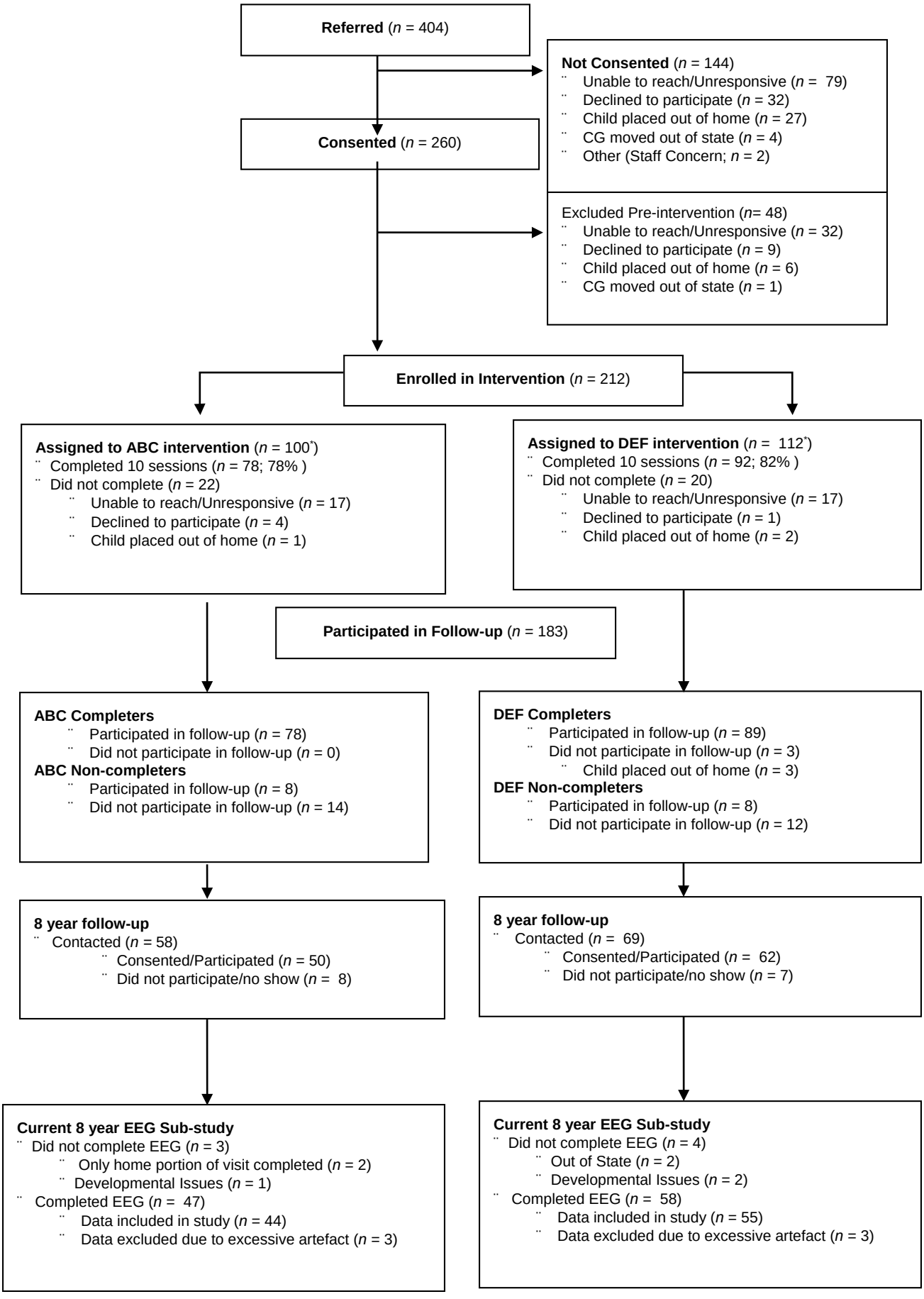
Risk Indicators	Number and Percentage of risks present in RCT Sample	
	%	N
Child was born at low birth weight	16.5	16
Child was exposed to teratogens prenatally	24.7	24
Family has an income to needs ratios that falls < 1	74.2	72
Mother has a significant history of mental health problems	55.8	57
Mother has a significant history of substance abuse/use problems	41.2	40
Mother did not complete high school	37.1	36
Mother or other Head of Household has a history of unemployment	64.9	63
Mother has a significant history of criminal involvement	22.7	22
Mother was a teenager (less than 18) when she had the child	42.3	41
Mother is a single parent	61.9	60
Family has experienced residential/home instability	71.1	69
Mother has a history of relationship instability	69.1	67
Family has been homeless	21.6	21
Child has been separated from mother	25.8	25
Other children in the home have been separated from mother	30.9	30

Supplementary Table S2. Family Income at Baseline and 8-year Follow-up Visit

	Baseline Assessment				8 Year Assessment					
	ABC		DEF		Comparison Group		ABC		DEF	
Income Range	%	n	%	n	%	n	%	n	%	n
<10,000	59.6	28	78.6	44	1.2	1	19.1	9	22.4	13
10,000-19,999	17.0	8	12.5	7	12.1	10	25.5	12	24.1	14
20,000-29,999	14.9	7	7.1	4	14.4	12	17.0	8	12.1	7
30,000-39,999	2.1	1	1.8	1	16.8	14	12.8	6	19.0	11
40,000-59,999	--	--	--	--	24.1	20	14.9	7	6.9	4
60,000-90,000	--	--	--	--	--	--	2.1	1	1.7	1
Not reported	6.4	3	3.4	2	10.8	9	8.5	4	13.8	8

Note: ABC=Attachment and Biobehavioral Catch up; DEF=Developmental Education for Children.

Supplementary Figure S1. CONSORT diagram.



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