The impact of a poverty reduction intervention on infant brain activity

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Early childhood poverty is a risk factor for lower school achievement, reduced earnings, and poorer health, and has been associated with differences in brain structure and function. Whether poverty causes differences in neurodevelopment, or is merely associated with factors that cause such differences, remains unclear. Here, we report estimates of the causal impact of a poverty reduction intervention on brain activity in the first year of life. We draw data from a subsample of the Baby's First Years study, which recruited 1,000 diverse low-income mother–infant dyads. Shortly after giving birth, mothers were randomized to receive either a large or nominal monthly unconditional cash gift. Infant brain activity was assessed at approximately 1 y of age in the child's home, using resting electroencephalography (EEG; *n* = 435). We hypothesized that infants in the high-cash gift group would have greater EEG power in the mid- to high-frequency bands and reduced power in a low-frequency band compared with infants in the low-cash gift group. Indeed, infants in the high-cash gift group showed more power in high-frequency bands. Effect sizes were similar in magnitude to many scalable education interventions, although the significance of estimates varied with the analytic specification. In sum, using a rigorous randomized design, we provide evidence that giving monthly unconditional cash transfers to mothers experiencing poverty in the first year of their children's lives may change infant brain activity. Such changes reflect neuroplasticity and environmental adaptation and display a pattern that has been associated with the development of subsequent cognitive skills.

poverty | unconditional cash transfer | randomized control trial | infant brain activity | EEG

Early childhood poverty has long been associated with lower school achievement, educational attainment, and adult earnings (1–4). Moreover, from early childhood through adolescence, higher family income tends to be associated with higher scores on assessments of language, memory, self-regulation, and social-emotional processing (5–8). Furthermore, poverty has been correlated with the structural development and functional activity of brain regions that support these skills. For example, higher family income is associated with a larger surface area of the cerebral cortex, particularly in regions that support children's language and executive functioning (9, 10). This association is strongest among the most economically disadvantaged families (9), suggesting that a given increase in family income may be linked with greater differences in brain structure among economically disadvantaged children compared with more advantaged peers (11).

Economic disadvantage has also been associated with differences in electrical brain activity, a key aspect of brain function that is measured by electroencephalography (EEG) (12–16). EEG measures brain activity along two primary dimensions: frequency and power. "Frequency" refers to oscillatory brain activity that occurs throughout the brain at different rates. Neuroscientists traditionally divide the continuous frequency spectrum into bands. Some of these bands represent lower-frequency (slower) oscillations (e.g., the theta-band), and some represent higher-frequency (faster) brain activity in the mid to high portions of the frequency spectrum (e.g., the alpha-, beta-, and gamma-bands). All individuals have brain activity across the frequency spectrum throughout the brain. "Power" refers to the amount of brain activity in a certain band measured across the scalp, broadly reflecting the electrical activity of the underlying brain. Power varies across frequency bands and between people. "Absolute power" refers to the amount of brain activity measured at a certain frequency (or within a certain frequency band). "Relative power" expresses absolute power as a fraction of power summed across all frequency bands.

Childhood EEG-based brain activity demonstrates a specific developmental pattern. As children mature from the neonatal period through middle childhood, they tend to show a decrease in brain power in the low-frequency portion of the frequency spectrum, as well an increase in brain power in the mid- to high-frequency portions of the frequency spectrum (17–20). Individual differences in this pattern, particularly in absolute power, have been associated with children's cognitive and behavioral outcomes. For example, more absolute power in mid- to high- (i.e., alpha, beta, and gamma) frequency bands has been associated with higher language (21–24), cognitive (21, 25), and social-emotional (26) scores, whereas more absolute or relative low-frequency (i.e., theta) power has been associated with the development of behavioral, attention, or learning problems (27–29).

Significance

This study demonstrates the causal impact of a poverty reduction intervention on early childhood brain activity. Data from the Baby's First Years study, a randomized control trial, show that a predictable, monthly unconditional cash transfer given to low-income families may have a causal impact on infant brain activity. In the context of greater economic resources, children's experiences changed, and their brain activity adapted to those experiences. The resultant brain activity patterns have been shown to be associated with the development of subsequent cognitive skills.

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At birth, family income appears to be unrelated to brain activity, as measured by EEG (23). However, some studies find that family income quickly begins to predict differences in the neurodevelopmental patterns described above. Specifically, several studies with small sample sizes have suggested that within the first several years of life, children from lower-income families average more low-frequency (i.e., theta) EEG band power, and less mid- to high-frequency (i.e., alpha, beta, and gamma) band power compared with children from higher-income homes (13–15, 30). Similar patterns of more low-frequency band power and less mid- to high-frequency band power have also been found among children facing other forms of early adversity (31–33) and, in some of these studies, these differences appear to persist throughout childhood and early adolescence (13, 14, 34–36). Of course, these general patterns conceal considerable heterogeneity; not all children facing poverty or other forms of adversity will show evidence of these neurodevelopmental differences.

Neuroplasticity, or the concept that children's brains adapt to their environmental contexts, is one path through which these differences are thought to emerge. That is, the structure and function of the developing brain adapt in response to different experiences. Brain activity may thus be one mechanism by which early adverse experiences shape subsequent child developmental outcomes.

Despite the correlational evidence linking income to early childhood cognitive development, it is unclear whether poverty causes developmental differences early in life (37). Support for a causal role comes from rigorous quasiexperimental studies that have linked increases in family income to higher school achievement and educational attainment, as well as to better physical and mental health (38). On the other hand, many other characteristics of individuals and their environments have been linked to these kinds of child outcomes (39). A careful experimental manipulation is needed to differentiate between these alternate interpretations.

The Baby's First Years study (BFY; https://www.babysfirstyears.com) is the first randomized control trial of poverty reduction in early childhood, and was designed to address whether poverty reduction causes changes in children's brain development (40). Based on prior economic research showing that relatively modest differences in early childhood family income are associated with better school achievement (41–43), BFY randomized 1,000 low-income mothers living in four geographically diverse United States metropolitan areas to receive either a large cash gift of $333 per month (termed the "high-cash gift group") or a nominal cash gift of $20 per month (the "low-cash gift group") for the first several years of their children's lives. These cash gifts took the form of unconditional cash transfers provided on a debit card; participating mothers were told that the money could be used in any way they wished, with no restrictions. The $313/mo difference between the amount received by the high-cash and low-cash gift groups amounted to $3,756 per year. Here we report the differential impacts of these unconditional cash transfers on infant brain activity at 1 y of age. We preregistered our analytic plan and hypothesized that infants of mothers randomized to the high-cash gift group would show greater mid- to high-frequency (i.e., alpha, beta, gamma) power and decreased low-frequency (i.e., theta) power when compared with infants of mothers randomized to the low-cash gift group.

Results

We recorded and analyzed the resting brain activity of 435 of the 1,000 infants whose mothers had been randomized to receive either a large monthly cash gift or a nominal monthly cash gift. (See *SI Appendix*, SI1 for a complete description of recruitment, retention, and EEG data collection procedures, including pandemic-related considerations with regard to in-person data collection.) Descriptive statistics for participant baseline characteristics are presented in Table 1. Mothers and infants were from racially and ethnically diverse backgrounds, with the majority of mothers identifying as Black or Hispanic. By design, all infants were healthy at birth (*SI Appendix*, SI1), and mothers reported average household incomes of just over $20,000 in the calendar year prior to the birth. On average, the cash gifts amounted to an approximate 20% boost in annual income for the mothers in the high-cash gift group.

In order to compare age-1 brain activity of infants in the high-cash and low-cash gift groups, intent-to-treat (ITT) analyses were conducted on absolute and relative EEG power in four power bands: theta, alpha, beta, and gamma. (See *SI Appendix*, SI2 for information on EEG processing, *SI Appendix*, SI3 for a discussion of absolute vs. relative power, and *SI Appendix*, SI4 for information on preregistration and hypotheses.) Table 2 shows these ITT estimates before and after adjustments for baseline covariates and multiple hypothesis testing. The effect size column standardizes each adjusted coefficient by dividing it by the SD of the given outcome measure within the low-cash gift group in the $n = 435$ EEG sample. The study was originally designed to have the statistical power to detect an effect size of 0.21 SD for any single hypothesis (*SI Appendix*, SI4). Despite the relatively small departures in baseline balance between the high-cash and low-cash groups shown in Table 1, we note that some of the ITT estimates change when covariates are added to the models.

In the case of absolute power, the high-cash gift group showed higher power in the three mid- to high-frequency bands (alpha, beta, and gamma) but not in the low-frequency theta-band (top rows of Table 2). When ranked by effect sizes, group differences in EEG power in the beta-band were largest (effect size = 0.26, beta = 0.414, $P = 0.02$, for the model with covariates and site fixed effects), followed by the gamma-band (effect size = 0.23, beta = 0.221, $P = 0.04$). Both P levels were below the 0.05 threshold when treated as independent measures, but not after Westfall–Young (44) multiple-testing adjustments. Group power differences in the alpha-band (effect size = 0.17, beta = 0.720, $P = 0.07$) were smaller and at the margins of statistical significance. Small and statistically nonsignificant differences in absolute power were found in the theta-band (effect size = 0.02, beta = 0.396, $P = 0.83$). (See *SI Appendix*, SI5 for a similar pattern in weighted analyses that adjust for demographic differences between the $n = 435$ EEG sample and the $n = 931$ full sample of BFY mother/infant dyads interviewed at age 1.)

Differences in relative power were qualitatively similar but uniformly smaller than those observed for absolute power, with the high-cash gift group showing greater mid- to high-frequency relative power in the alpha-, beta-, and gamma-bands. These differences did not reach conventional levels of statistical significance (bottom rows of Table 2; for a more complete discussion of absolute and relative power, see *SI Appendix*, SI3). In contrast, relative theta-power was greater in the low-cash gift group with an effect size of 0.21, with the difference at the margins of statistical significance (*SI Appendix*, SI4).

Figs. 1 and 2 display the differences between absolute power brain activity in the high-cash gift group and the low-cash gift group across the frequency spectrum and across the scalp. Specifically, Fig. 1*A* displays *z*-scores of absolute EEG power across the full power spectrum separately for infants in the high-cash and low-cash gift groups, while Fig. 1*B* shows the corresponding group differences in *z*-scores across the power spectrum. Fig. 2 shows a topographic heat map of the distribution of EEG absolute power across the scalp within each of the four

Table 1. Characteristics of EEG sample

	Low-cash gift EEG sample		High-cash gift EEG sample		P value
		n		*n*	of group difference
Child is female	49.8	251	44.0	184	0.23
Child age at visit (mo)	12.93 (1.66)	251	12.60 (1.13)	184	0.02
Mother education (y)	11.9 (3.1)	248	12.1 (3.1)	183	0.60
Mother race/ethnicity					
White, non-Hispanic	11.6	251	6.0	184	0.05
Black, non-Hispanic	38.6	251	47.3	184	0.07
Multiple, non-Hispanic	5.6	251	2.7	184	0.15
Other or unknown	4.4	251	2.7	184	0.36
Hispanic	39.8	251	41.3	184	0.76
Household combined income at baseline (dollars)	$22,739 (20,875)	238	$20,213 (14,402)	168	0.18
Number of artifact-free EEG epochs	288.2 (183.7)	251	284.3 (189.2)	184	0.83

Data are presented as mean (SD) or %. Child age and number of epochs were measured at the time of the age 1 visit. All other characteristics were measured at baseline prior to random assignment. Household income measures are as reported by mother at time of baseline. This includes two outlier values in the low-cash gift group (>3 SD above the mean), which results in the large SD for the low-cash gift group for the household income measure. Reported *P* values of mean differences are unadjusted. For site-adjusted *P* values and a joint test of orthogonality for baseline measures, see *SI Appendix*, Table SI1.1.

power bands, separately for the high-cash and low-cash gift groups.

Power data plotted in Fig. 1 are standardized (*z*-scored) based on the full EEG sample within each of the 48 single-hertz bins, with the boundaries of the theta-, alpha-, beta-, and gamma-frequency bands delineated. Given the standardization, the vertical distance between the two lines in Fig. 1*A* reflects standardized differences between infants in the high-cash and low-cash gift groups. These differences in *z*-scores are shown in Fig. 1*B*. Absolute power in the high-cash gift group is estimated to exceed absolute power in the low-cash gift group in all mid- to high-frequency single-hertz bins above 6 Hz: that is, including the entirety of the alpha-, beta-, and gamma-portions of the frequency spectrum.

Fig. 2 reinforces these differences by displaying the distribution of power across the scalp for both groups in each frequency band. Warmer colors represent more power in each respective frequency band, illustrating that the high-cash gift group appears to show more beta- and gamma-power relative to the low-cash gift group. Exploratory post hoc regional analyses are broadly consistent with the group differences illustrated in Fig. 2. Both before and after Westfall–Young adjustment, the high-cash gift group shows more frontal absolute beta-power (effect size = 0.32, beta = 0.46, $P_{\text{unadjusted}} = 0.01$, $P_{\text{adjusted}} = 0.02$); more central absolute beta-power (effect size = 0.28, beta = 0.59, $P_{\text{unadjusted}} = 0.02$, $P_{\text{adjusted}} = 0.05$); and more frontal absolute gamma-power (effect size = 0.26, beta = 0.238, $P_{\text{unadjusted}} = 0.02$, $P_{\text{adjusted}} = 0.04$) (*SI Appendix*, SI6).

Given our hypotheses of positive differences across all mid- to high-frequency portions of the power spectrum, we aggregated power across all three of our preregistered mid- to high-frequency power bands. Such a summary index approach is a commonly used data-reduction technique in the social sciences (45, 46), and serves as a post hoc complement to our preregistered Westfall–Young multiple comparison adjustment. While this approach ignores the biological and functional significance of the EEG bands, it has the benefit of enabling us to statistically estimate ITT differences for a single aggregated mid- to high-frequency index score (*SI Appendix*, SI7). Consistent with our band-based results, we find that the infants in the high-cash gift group had more mid- to high-frequency band absolute power than infants in the low-cash gift group (effect size = 0.25, beta =

Table 2. Cash-gift treatment effects on EEG power

	Low-cash gift group mean (SD)	High-cash gift group mean (SD)	OLS with site fixed effects (SE)	OLS with site fixed effects and covariates (SE)	Effect size (including covariates)	*P* value (no adjustments)	Westfall–Young adjusted *P* value	*n*
Absolute alpha	7.441 (4.213)	7.667 (3.896)	0.294 (0.381)	0.720 (0.396)	0.17	0.07	0.12	435
Absolute beta	1.874 (1.592)	2.167 (2.281)	0.307 (0.187)	0.414 (0.176)	0.26	0.02	0.07	435
Absolute gamma	0.986 (0.947)	1.137 (1.202)	0.155 (0.103)	0.221 (0.109)	0.23	0.04	0.12	435
Absolute theta	40.268 (23.317)	38.887 (16.578)	−0.961 (1.860)	0.396 (1.869)	0.02	0.83	0.84	435
Relative alpha	0.148 (0.040)	0.152 (0.045)	0.004 (0.004)	0.006 (0.005)	0.16	0.17	0.31	435
Relative beta	0.038 (0.027)	0.042 (0.036)	0.004 (0.003)	0.005 (0.003)	0.19	0.09	0.19	435
Relative gamma	0.020 (0.018)	0.022 (0.021)	0.002 (0.002)	0.003 (0.002)	0.16	0.18	0.31	435
Relative theta	0.794 (0.070)	0.784 (0.083)	−0.010 (0.007)	−0.014 (0.008)	−0.21	0.07	0.17	435

OLS, ordinary least squares. Effect size (column 5) was computed by dividing the covariate-adjusted treatment effect (column 4) by the SD of the EEG sample low-cash group. Unadjusted *P* values (column 6) and preregistered Westfall–Young adjusted *P* values (column 7), which adjust for multiple hypothesis testing, are both reported. For the Westfall–Young adjustment, the four frequency bands (theta, alpha, beta, gamma) for absolute power are placed into one family and the four frequency bands (theta, alpha, beta, gamma) for relative power were placed into a second family. These *P* values are associated with the treatment coefficient and effect size in a regression with site-level fixed effects and covariates. Covariate-adjusted models include the following maternal self-report covariates from the BFY baseline survey conducted at the time of enrollment: mother's age, completed maternal schooling, household income, net worth, general maternal health, maternal mental health, maternal race and ethnicity, marital status, number of adults in the household, number of other children born to the mother, maternal smoking during pregnancy, maternal alcohol consumption during pregnancy, father living with the mother, child's sex, child's birth weight, child's gestational age at birth. Models also control for child's age at interview (in months), and the total number of usable epochs. Missing data for covariates impute the mean value from the EEG analytic sample. Relative power calculated at the child-level. Robust SEs are given in parentheses for OLS models (columns 5 and 6). SDs provide in parentheses in columns 1 and 2.

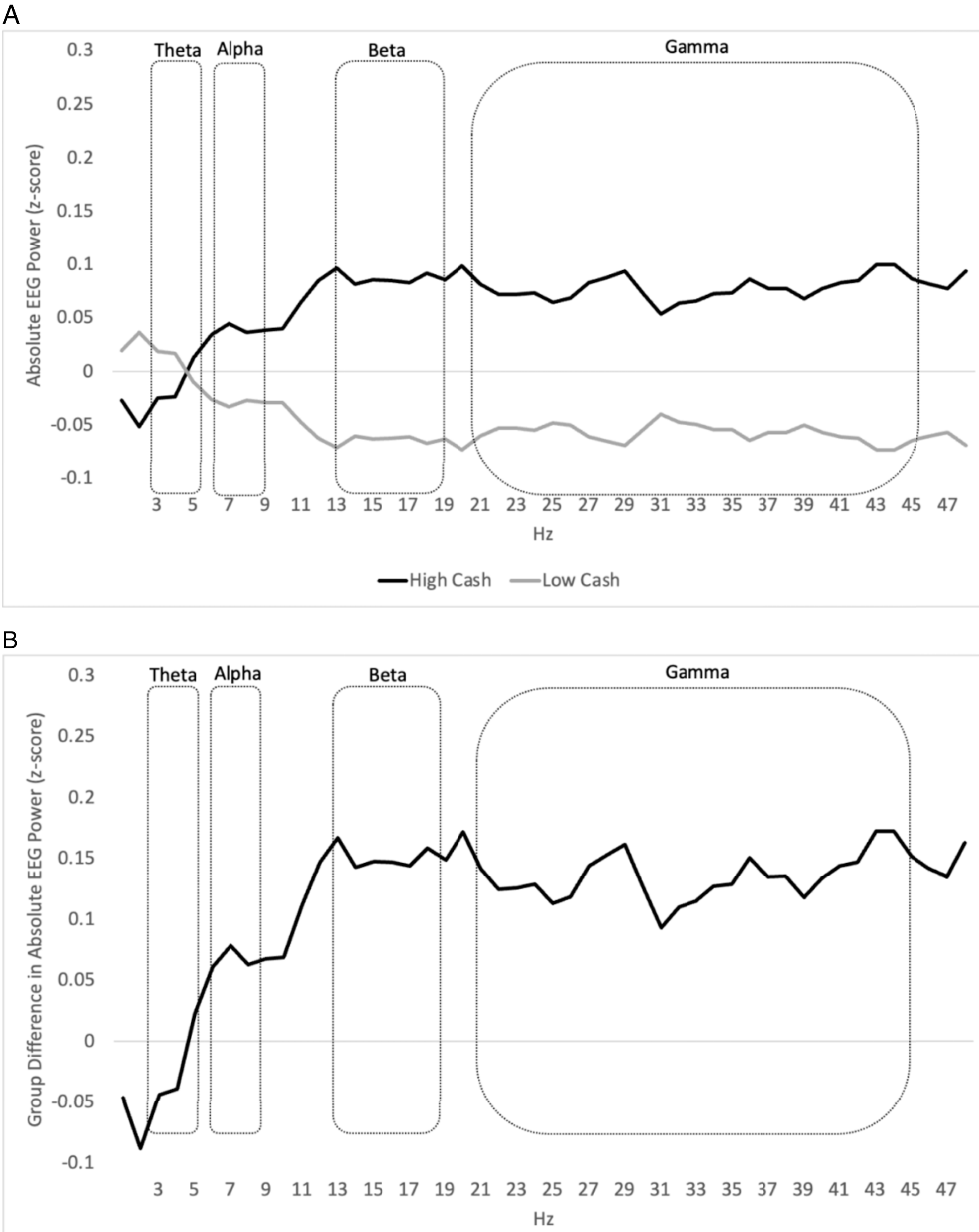

Fig. 1. (*A*) Standardized mean absolute EEG power is presented separately for the high-cash and low-cash gift groups. The high-cash gift group's means are depicted with a solid black line and the low-cash gift group's means are depicted with a solid gray line. The power spectrum is displayed continuously with single-hertz bins on the *x* axis, standardized absolute power on the *y* axis, and with the boundaries of the preregistered theta-, alpha-, beta-, and gamma-frequency bands delineated, demonstrating that the pattern of results is consistent across the spectra and that a small number of single-hertz bins did not unduly impact the results shown in Table 2. Because power values were standardized (*z*-scored) using the mean and SD of the entire n = 435 sample, the two lines are mirror images of one another. This graph is intended for illustrative purposes only and does not include adjustment for covariates; statistical testing was conducted on aggregations of single-hertz bin values within a given frequency band (e.g., theta). (*B*) The difference between standardized EEG absolute power (*z*-scores) in the high-cash vs. low-cash gift groups is depicted with a solid black line. The power spectrum is displayed continuously with single-hertz bins on the *x* axis, group differences in standardized on the *y* axis, and with the boundaries of the preregistered theta-, alpha-, beta-, and gamma-frequency bands delineated, demonstrating that the pattern of results is consistent across the spectra and that a small number of single-hertz bins did not unduly impact the results shown in Table 2. This graph is intended for illustrative purposes only and does not include adjustment for covariates; statistical testing was conducted on aggregations of single-hertz bin values within a given frequency band (e.g., theta) and is shown in Table 2.

13.35, $P = 0.02$) (*SI Appendix*, Table SI7.1). Thus, the direction and approximate size of intervention effects on mid- to high-frequency absolute power are similar when power is analyzed in preregistered bands, disaggregated into single-hertz bins, examined within regions or aggregated across bands.

Discussion

While family income has been found to be associated with developmental differences in children's brain structure and function, there is considerable debate as to whether growing up in poverty causes differences in early brain development, or whether poverty is merely correlated with other factors that are the true cause of early differences (37). Here, using a randomized control trial design, we offer evidence on this correlation vs. causation debate by showing that an intervention designed to reduce poverty appeared to cause changes in children's brain functioning in ways that have been linked to subsequent higher cognitive skills.

Specifically, infants whose mothers were randomized at the time of their birth to receive a large monthly unconditional cash transfer showed greater mid- to high-frequency absolute EEG power in the alpha-, beta-, and gamma-bands (effect sizes = 0.17 to 0.26), compared with infants whose mothers were randomized to receive a nominal monthly unconditional cash transfer. In contrast, our findings do not provide consistent support for the hypothesis that the high-cash gift group would show less low-frequency power in the theta-band.

Impact estimates for each of the three mid- to high-frequency power bands were uniformly positive, with the high-cash gift group displaying higher power values than the low-cash gift group (Fig. 1 and Table 2). In the case of absolute power for the beta- and gamma-bands, the magnitudes of effect sizes were consistent with those that the study was designed to be able to detect for independent hypotheses (*SI Appendix*, SI4). Notably, however, estimates of the effect of the cash gift in these two highest-frequency bands were statistically significant before, but not after, adjustments for multiple comparisons.

To investigate the robustness of these findings, we consider three additional forms of evidence. First, when disaggregating the mid- to high-frequency (alpha, beta, and gamma) portion of the spectrum into single-hertz bins, we found that infants in the high-cash gift group display higher power than infants in the low-cash gift group, across the entire frequency spectrum from 6 to 49 Hz (Fig. 1). Second, the neural regions driving these impacts (Fig. 2 and *SI Appendix*, SI6) are broadly consistent with those reported in previous correlational work linking income to brain activity (13–15, 24, 35) and linking brain activity to language (21, 22) and cognitive outcomes (23, 25). Some of these fronto-central regional effects in the beta- and gamma-bands remain significant after adjusting for multiple comparisons (*SI Appendix*, Table SI6.1). Third, similar group differences were found for a post hoc composite index of mid- to high-frequency power, with infants in the high-cash gift group having significantly higher values on this index score than infants in the low-cash gift group (*SI Appendix*, Table S17.1). But while most of our evidence points to a plausible causal impact of the cash gifts, not all evidence presented here survives stringent multiple comparison correction, precluding full confidence in being able to reject the null hypotheses. Caution and further replication are therefore clearly warranted.

On balance, though, we judge that the weight of the evidence supports the conclusion that monthly unconditional cash transfers given to the mothers in our study affected brain activity in their infants. This is notable because the patterns of neural activity we observe in the high-cash gift group have been correlated with higher language (21–24), cognitive (21, 25), and social-emotional (26) scores later in childhood and adolescence. Moreover, the observed effects in the alpha-, beta-, and gamma-bands are similar in magnitude to those reported in other large-scale environmental interventions. For example, a meta-analysis of 747 randomized control trials of educational interventions targeting standardized achievement outcomes found an average effect size of 0.16 SDs (47).

Children's brain development reflects an adaptation to their lived experiences (48, 49). Importantly, different brain activity patterns are likely to be adaptive in different contexts, and a typically developing brain will adapt to the environment it experiences (50). In some cases, such malleability may confer obvious benefits, whereas in other cases, it may lead to the development of adaptive but costly strategies for optimizing biological fitness under scarce conditions (51). In the latter case, adaptation does not necessarily represent dysfunction or dysregulation, but rather, an expected and appropriate response to the environment (52).

The present study provides evidence of neuroplasticity of the infant brain on a relatively brief time scale, following 1 y of an intervention designed to increase family economic resources. Because of the randomized design, any group differences in brain activity found here reflect neural adaptation to the associated environmental change. That is, in the context of greater economic resources, children's experiences changed, and their brain activity adapted to those experiences. However, we do not yet know which experiences were involved in generating these impacts. Future work will examine potential mechanisms affected by the cash gifts, including household expenditures, maternal labor market participation, maternal parenting behaviors, and family stress, noting that pathways may operate in different ways across different children and families.

Several limitations should be noted when interpreting these results. First, the extent to which individual differences in infant brain activity are stable over time is not yet known (53). Second, because of the pandemic, EEG data could not be collected on the full $n = 1{,}000$ study sample. Although recruitment had been designed to provide comparable samples of participants across the recruitment year, the pandemic truncated our in-person data-collection effort, reducing the sample size considerably and decreasing the precision of our estimates. The extent to which the results presented here would have generalized to the full study sample is unknown (*SI Appendix*, SI5 and SI8). Third, we do not know whether the neurodevelopmental effects of this poverty reduction intervention will translate into differences in direct assessments of children's skills and behavior. While associations between infant brain activity and subsequent cognitive, linguistic, and social-emotional functioning have been observed in other samples (22, 23, 25, 26), some studies do not find that infant brain activity predicts subsequent skills (22, 26). The BFY study will continue to follow these children through at least the first 4 y of life, to determine whether treatment impacts on brain activity persist and extend to direct measures of children's cognitive and behavioral outcomes.

Despite the limitations in statistical power, the pattern of impacts, which resulted from a rigorous random assignment study design, were consistent with hypotheses, were similar in magnitude to effects on cognitive outcomes from other scalable interventions, and were largely robust to various tests (*SI Appendix*, SI4–SI9), leads us to conclude that these findings are important and unlikely to be spurious.

The present results suggest that providing monthly unconditional cash support to families living in poverty may impact early childhood brain activity, highlighting the importance of centering children's development and well-being at the forefront of policy considerations. However, while it might be tempting to draw policy conclusions, we caution that the present findings pertain only to the first 12 mo of a multiyear

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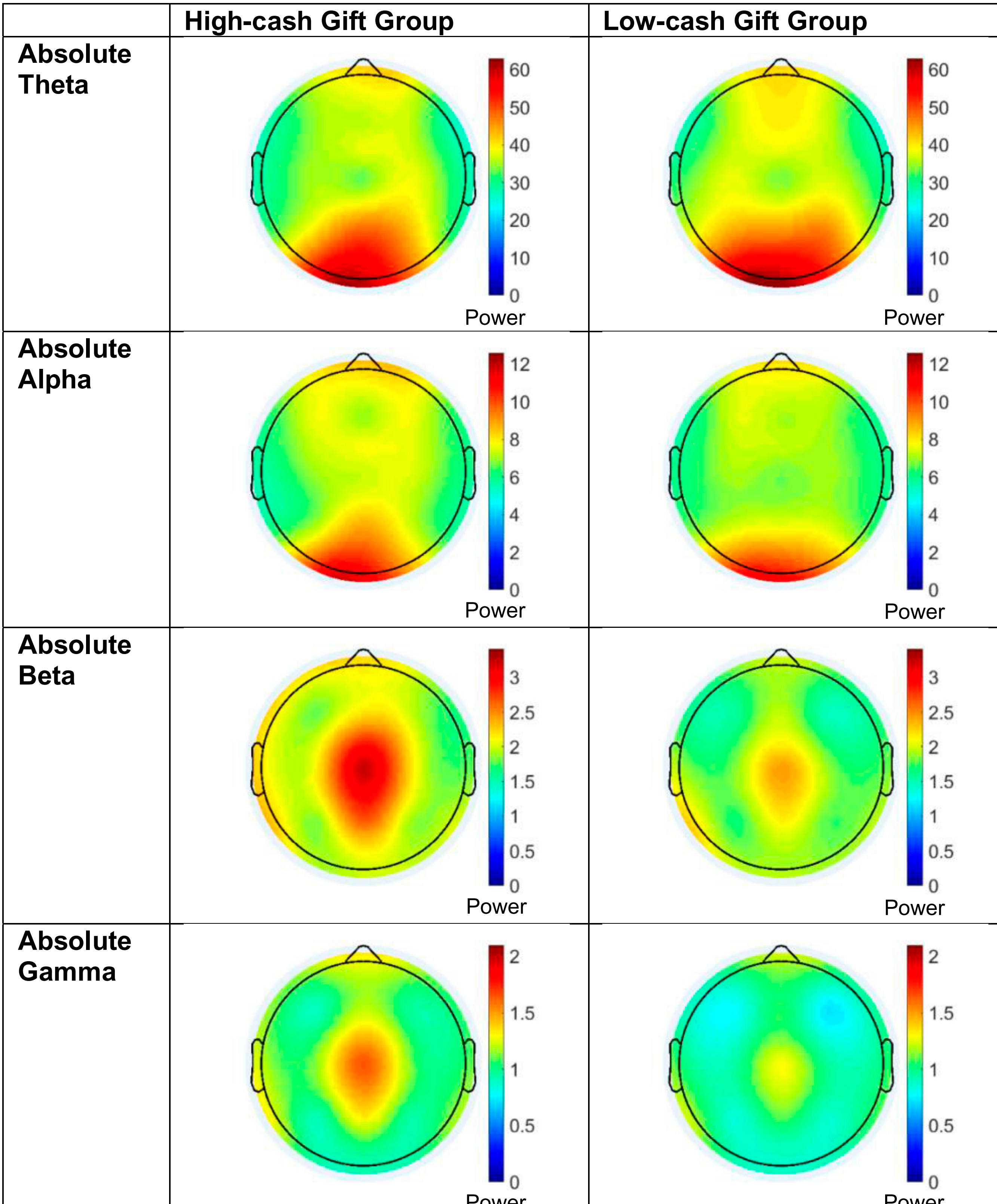

Fig. 2. Topographic heat maps show the distribution of absolute theta-, alpha-, beta-, and gamma-power across the scalp for the high-cash gift group (*Left*) and low-cash gift group (*Right*). Warmer colors represent more power in each respective frequency band. Heat maps also illustrate the absence of any major artifact (e.g., remaining eye blinks). Regional differences are explored in *SI Appendix*, SI6. Additionally, because the EEG data are referenced to an average of the T7 and T8 electrodes, the temporal data are estimated from the surrounding electrodes for visualization purposes only.

unconditional cash transfer intervention. Recent legislation and policy proposals provide income supplements to low-income families in the form of Child Tax Credit payments with higher payments in early childhood, but none would limit assistance to the first year of life (54). For our part, we do not suggest that a 12-mo intervention alone would be likely to have lasting effects, nor that cash transfer policies obviate the need for direct service interventions, such as well-child pediatric visits, home visitation, or high-quality early childhood education. Nonetheless, by targeting families during children's earliest years, BFY has found important evidence of the effects of increased income during a time when children's brains are particularly sensitive to experience. Traditionally, debates over income transfer policies directed at low-income families in the United States have centered on maternal labor supply rather than child well-being. Our findings underscore the importance of shifting the conversation to focus more attention on whether or how income transfer policies promote children's development.

Materials and Methods

Participants. One thousand mother/infant dyads were enrolled in BFY over a 13-mo period beginning in May 2019. Mothers were recruited in hospital postpartum wards in four United States metropolitan areas: New York City, the greater New Orleans metropolitan area, the greater Omaha metropolitan area, and the Twin Cities (Minneapolis and St. Paul) metropolitan area. Shortly after giving birth, 40% of the mothers were randomly chosen to receive a large monthly cash gift of $333 per month (high-cash gift group) and the remaining 60% received a nominal monthly cash gift of $20 per month (low-cash gift group) for the first several years of their children's lives. Random assignment was a continuous process over the enrollment period. At the time of enrollment, the mothers were told that the monthly cash gifts would continue for 40 mo, and that the study team would follow up with them annually for the next 3 y to assess child development and family life. Subsequently, the cash gifts were extended for an additional 12 mo, through child age 52 mo, and planned follow-up was extended through at least a 4-y period. Prior to launching the study, we secured approvals from state or local officials to ensure that participants would not lose eligibility for most public benefits due to the cash gift. The Institutional Review Boards of Teachers College, Columbia University; the University of California, Irvine; and the New York State Psychiatric Institute approved this study. Informed consent was collected by trained interviewers via an electronic consent form that was read to participants either in person or over the phone (consent collection method was consistent with the method of administration for the maternal survey). For more information concerning eligibility criteria, study design, and baseline data see https://www.babysfirstyears.com, Noble et al. (40), and the Interuniversity Consortium for Political and Social Research (ICPSR) data repository (55).

The present study centers on those infants from whom data were collected during the 1-y visit (mean = 12.92 mo, SD = 1.89). Initially, these 1-y visits were conducted in families' homes. However, because of the COVID-19 pandemic and concerns for participant and interviewer safety, in-person data collection was halted on March 14, 2020, a point at which roughly two-thirds of the recruited infants had reached 12 mo of age. At that time, the survey data collection mode switched from in-person (n = 605) to phone (n = 326). All age-1 measures requiring in-person assessment were suspended at that point, including measures of infant brain activity. In total, 931 mothers eventually completed the age-1 survey (93% completion rate; complete survey information available at https://www.babysfirstyears.com) but only 605 were interviewed in the home, making their infants potentially eligible for EEG-based data collection.

Given that the focus of the present study is on infant brain activity, our primary analyses are limited to the 435 families who completed in-person EEG data collection with usable data prior to the onset of the pandemic ($mean_{age}$= 12.79 mo, SD= 1.47) (see *SI Appendix*, SI1 for CONSORT diagram; *SI Appendix*, SI5 and SI8 for more information on the generalizability of findings in the prepandemic sample to the full sample; and *SI Appendix*, SI8 and SI10 for information about maternal report of infant developmental milestones, which are available for the full sample).

EEG Data Collection. To assess brain activity, EEG data were collected using a mobile system in the home. The utility, feasibility, and cultural appropriateness of mobile EEG were evaluated prior to the commencement of data collection through a series of pilot visits and focus groups [see Troller-Renfree et al. (56) for full details of piloting and interviewer training]. Following this piloting process, a team of interviewers was trained to collect in-home EEG.

EEG was recorded using a 20-channel Neuroelectrics cap with an Enobio 20 amplifier (Neuroelectrics). The sampling rate was 500 Hz and data were referenced online to a DRL/CMS reference configuration placed on or near the mastoid bone. During the recording, infants sat on their caregivers' laps while watching infant-friendly wordless videos or observing bubbles or infant toys. Recordings lasted a maximum of 7 min with a goal of recording at least 5 min of artifact-free data. Data were analyzed off-line by data processors who were blind to participant group (See *SI Appendix*, SI2, SI3, and SI9 for information on EEG data processing and analysis).

Of the 605 participants who completed age-1 visits before the onset of the pandemic, 577 mothers consented to EEG data collection (95.4% consent rate). A total of 142 infants of these consenting mothers did not contribute a usable EEG recording, for reasons including infant fussiness (n = 62), excessive artifact during recording (n = 52), technical problems (n = 16), poor cap fit (n = 9), and interviewer error (n = 3). Ultimately, usable data were obtained from 435 infants for analysis (75.4% of participants who consented to EEG collection). The heat maps in Fig. 2 illustrate the absence of any major artifact (e.g., remaining eye blinks).

Preregistration and Statistical Analysis. In keeping with its randomized control trial study design, BFY preregistered data collection and analysis plans (ClinicalTrials.gov Identifier: NCT03593356; for more information about preregistered analyses and hypotheses, see *SI Appendix*, SI4). Consistent with our preregistration and in light of the nearly universal take-up of our cash gifts in both high-cash and low-cash gift group families, ITT differences were estimated using a simple regression framework. All models were estimated using robust SEs (57) and estimated ITT differences without, and then with, baseline demographic child and family characteristics to improve the precision of our estimates.

Data Availability. Anonymized data have been deposited in ICPSR, https://www.icpsr.umich.edu/web/DSDR/studies/37871/versions/V2 (55) and https://www.openicpsr.org/openicpsr/project/159422/ (58).

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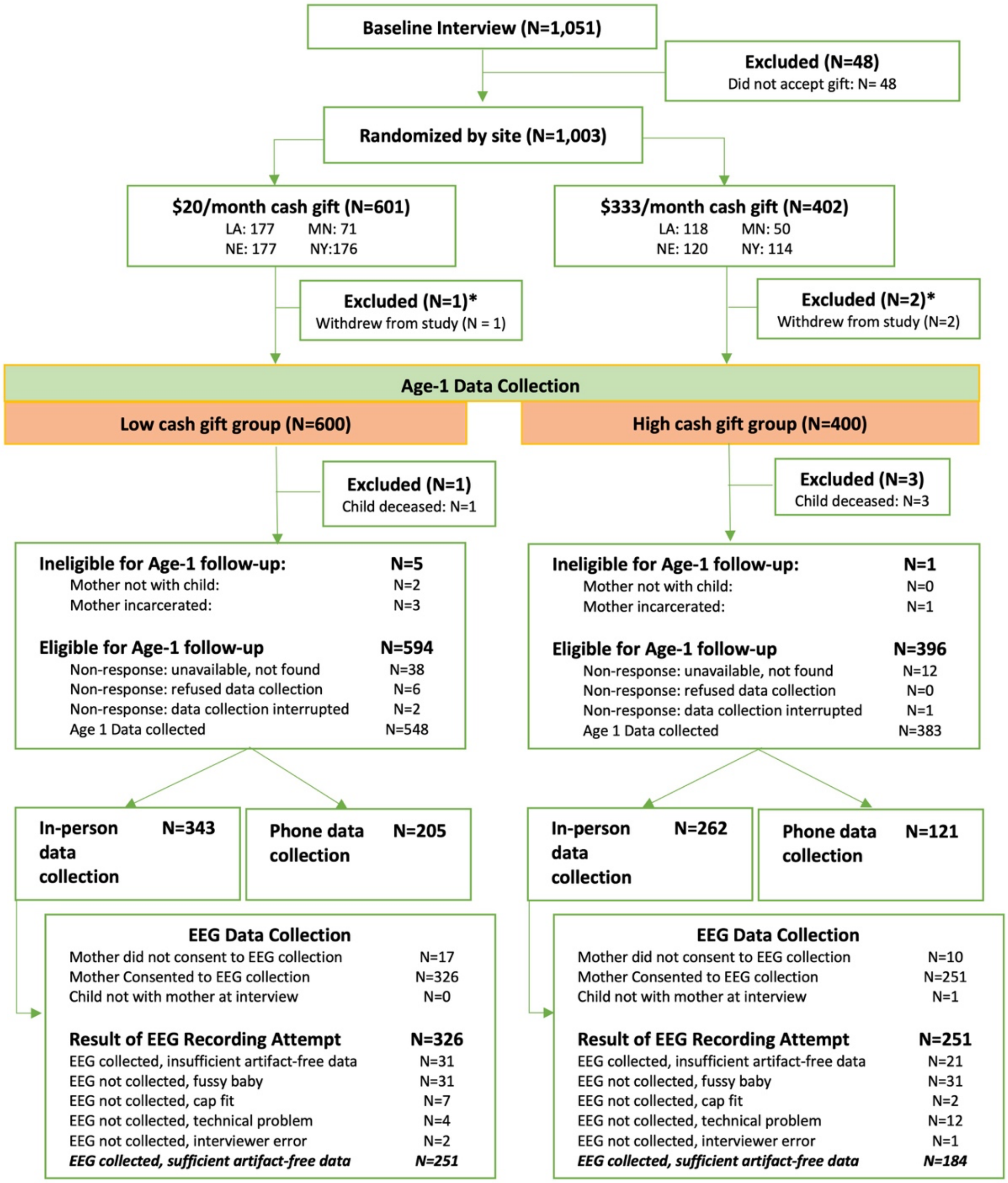
Supplemental Information

Here we provide supplemental information to accompany the main manuscript. In SI1 we explain participant recruitment and examine baseline balance. SI2 provides details on our EEG data processing and analysis. In SI3 we discuss similarities and differences between absolute and relative power measures. In SI4 we discuss our preregistration procedures and hypotheses. In SI5 we conduct weighted analyses to assess the robustness of our results to (1) differences in the composition of the sample at baseline across treatment groups, and (2) differences in the composition of the EEG sample compared with the full study sample. In SI6 we present ITT impacts on regional EEG power. In SI7 we present a robustness check, in the form of a social science-style summary index, summing across the mid-to-high-frequency pre-registered bands. In SI8 we present ITT impacts on a behavioral complement to the measures of brain activity, the Ages and Stages Questionnaire-3 (ASQ-3) Communication Subscale. This subscale of the ASQ-3 screens for language delay, by asking mothers to report on the child's language milestones. We additionally examine differences in ASQ-3 scores between the EEG subsample and full analytic sample to assess the robustness of our results. In SI9 we provide a final robustness check on our EEG results by showing ITT impacts on the log-transformed EEG power spectrum. In SI10 we investigate the relations between EEG power and infant language milestones.

SI1. Participant recruitment and age-1 follow-up

Baby's First Years (BFY) was designed to estimate the causal impact of a poverty reduction intervention on children's early development (see Noble et al., 2021 (1) for complete details on study design). Between May 2018 and June 2019, 1,000 mother-infant-dyads were recruited to participate in the BFY study. BFY sample recruitment was restricted to mothers of newborns whose self-reported income in the prior calendar year was below the federal poverty line. Additional study inclusion criteria were: (1) mother was of legal age for informed consent (age 18 or older in NY, MN and LA; 19 or older in NE); (2) infant was admitted to the newborn nursery, and not the neonatal intensive care unit; (3) mother was residing in the state of recruitment (needed to ensure the cash gift would not be counted in determining eligibility for that state's public antipoverty benefits); (4) mother reported not being "highly likely" to move to a different state or country within 12 months; (5) infant was discharged in the custody of the mother; and (6) mother spoke either English or Spanish. Using a joint test, mother-infant dyads assigned to the high-cash and low-cash gift groups were shown to be comparable across a large set of demographic characteristics gathered at baseline just prior to random assignment (Noble et al., 2021 (1); CONSORT diagram Figure SI1.1). Mothers were randomly assigned within each of the four sites to either the high-cash gift condition of $333/month (40% of the sample) or low-cash gift condition of $20/month (60% of the sample). The cash gifts were disbursed on debit cards branded 4MyBaby, which were activated in the hospital at the time of recruitment, while the mother was in the postpartum ward. Mothers received monthly text messages to alert them each month when the cards were reloaded.

Figure SI1.1. Consort diagram.



*Participants withdrew from study prior to spending any money on card and only a few days after randomization. Thus, they were not considered as the **target sample** for future waves of data collection.

Between July 2019 and July 2020, we attempted to contact as many of the 1,000 study participants as possible and interview them close as possible to their children's first birthdays. We completed interviews with 931 participants (see below). However, as explained in the main text, in-home interviews were completed with only 605 families. Age-1 data collection rates are also summarized in the CONSORT Figure SI1.1.

From the Age 1 in-home visits, usable EEG data were obtained from 435 of the 605 infants who were tested in person. We assessed whether the baseline characteristics of the 435 differed from the 170 infants tested from whom usable EEG data were not obtained (Table SI1.1). A joint test of differences across all of the baseline measures fell well short of conventional levels of statistical significance (Joint Test: $Chi^2(25) = 30.25$, p-value = 0.22, n = 605), suggesting the two groups were broadly similar. For comparisons of individual characteristics, see Table SI1.1.

At the point in-person data collection was halted, we had a somewhat higher response rate among the high-cash gift group (66%) than the low-cash gift group (57%). To investigate the possible implications of this for our analysis sample, we examined balance across baseline characteristics between the high-cash and low-cash gift groups for the subset of children who contributed usable EEG data (SI Table 1.2). Here again, few differences were apparent and a joint test across all of the baseline measures showed a *p* value of .09 (joint test: $Chi^2(26) = 36.10$, p-value = 0.09, n = 435). For comparisons of individual characteristics, see Table SI1.2.

Table SI1.1 Balance on baseline characteristics comparing children who had usable EEG data and children who had in-person data collection but contributed no usable EEG data.

	Non-EEG In-Person Sample		EEG Sample		Std Mean Difference		
	Mean (sd)	N	Mean (sd)	N	Hedges' g	Cox's Index	p-value
Child is female	0.500	170	0.474	435		-0.06	0.54
Child weight at birth (pounds)	7.1 (1.0)	170	7.1 (1.0)	434	0.06		0.49
Child gestational age (weeks)	39.0 (1.1)	170	39.1 (1.4)	432	0.07		0.42
Mother age at birth (years)	26.7 (5.0)	170	27.2 (6.1)	435	0.08		0.26
Mother education (years)	11.8 (2.7)	169	12.0 (3.1)	431	0.06		0.52
Mother race/ethnicity: white, non-Hispanic	0.106	170	0.092	435		-0.10	0.51
Mother race/ethnicity: Black, non-Hispanic	0.447	170	0.423	435		-0.06	0.21
Mother race/ethnicity: multiple, non-	0.041	170	0.044	435		0.05	0.92

Hispanic							
Mother race/ethnicity: other or unknown	0.041	170	0.037	435		-0.07	0.61
Mother race/ethnicity: Hispanic	0.365	170	0.405	435		0.10	0.03
Mother marital status: never married	0.500	170	0.467	435		-0.08	0.32
Mother marital status: single, living with partner	0.253	170	0.241	435		-0.04	0.73
Mother marital status: married	0.194	170	0.207	435		0.05	0.58
Mother marital status: divorced/separated	0.018	170	0.041	435		0.51	0.06
Mother marital status: other or unknown	0.035	170	0.044	435		0.14	0.63
Mother health is good or better	0.871	170	0.910	435		0.24	0.18
Mother depression (CESD)	0.7 (0.4)	170	0.7 (0.4)	435	-0.03		0.54
Cigarettes per week during pregnancy	4.7 (16.6)	170	4.3 (18.6)	432	-0.02		0.68
Alcohol drinks per week during pregnancy	0.0 (0.0)	170	0.1 (0.6)	433	0.11		0.06
Number of children born to mother	2.6 (1.4)	170	2.4 (1.4)	435	-0.11		0.19
Number of adults in household	2.0 (0.9)	170	2.1 (1.0)	435	0.07		0.41
Biological father lives in household	0.429	170	0.340	435		-0.23	0.04
Household combined income	\$21,189 (17,663)	160	\$21,694 (18,496)	406	0.03		0.89
Household income unknown	0.059	170	0.067	435		0.08	0.69
Household net worth	-\$3,386 (12,763)	154	-\$1,495 (32,496)	386	0.07		0.31
Household net worth unknown	0.094	170	0.113	435		0.12	0.39

Joint Test: $Chi^2(25)$= 30.25, p-value= 0.22, n=605. (includes all observations. Standard joint test estimate drops 9 observations due to collinearity in a small number of observations with values for child's weight unknown, gestational age unknown, and mother's cigarette and alcohol use unknown)

Notes: "sd" = standard deviation. P-values were derived from a series of OLS bivariate regressions in which each respective baseline characteristic was regressed on the treatment status indicator using robust standard errors and site-level fixed effects. The bivariate regressions were also run without site-level fixed effects, and the p-values differed on average by 0.050 but result in no difference in substantive understanding or statistical significance interpretation. The p-values without fixed effects do not appear in the table. The joint test of orthogonality was conducted using a probit model with robust standard errors and site-level fixed effects. Standardized mean differences were calculated using Hedge's g for continuous variables and Cox's Index for dichotomous variables. If there were more than 10 missing cases for a covariate, missing data dummies were included in the table and the joint test. If there were fewer than 10 cases missing, missing data dummies were not included in the table but were included in the joint test; additionally, the joint test imputes mean values for missing variables. Chi-square tests of independence were conducted for the two categorical variables: mother race/ethnicity and mother marital status. For both tests, p>0.05. All respondents with missing data for baseline variables for child's weight, gestational age, mother's cigarette use, and mother's alcohol use were in the EEG sample, perfectly predicting. We present the results of the joint test that include these observations and exclude these variables for the full sample (which would be dropped in the standard test due to collinearity). If we instead remove these observations from the sample for the joint-test, the sample for the joint-test is slightly reduced, and the estimates are as follows: Joint Test: $Chi^2(25)$ = 30.74, p-value = 0.20, n = 596.

Table SI1.2 Balance on baseline characteristics between the low-cash and high-cash gift groups for children who had usable EEG data.

	Low-Cash EEG Sample		High-Cash EEG Sample		Std Mean Difference		
	Mean (sd)	N	Mean (sd)	N	Hedges' g	Cox's Index	p-value
Child is female	0.498	251	0.440	184		-0.14	0.23
Child weight at birth (pounds)	7.1 (1.0)	250	7.2 (1.0)	184	0.14		0.12
Child gestational age (weeks)	39.1 (1.3)	248	39.0 (1.4)	184	-0.02		0.98
Mother age at birth (years)	26.8 (6.1)	251	27.7 (6.2)	184	0.13		0.11
Mother education (years)	11.9 (3.1)	248	12.1 (3.1)	183	0.05		0.58
Mother race/ethnicity: white, non-Hispanic	0.116	251	0.060	184		-0.44	0.02
Mother race/ethnicity: Black, non-Hispanic	0.386	251	0.473	184		0.22	0.12
Mother race/ethnicity: multiple, non-Hispanic	0.056	251	0.027	184		-0.46	0.10
Mother race/ethnicity: other or unknown	0.044	251	0.027	184		-0.31	0.30
Mother race/ethnicity: Hispanic	0.398	251	0.413	184		0.04	0.25
Mother marital status: never married	0.426	251	0.522	184		0.23	0.07
Mother marital status: single, living with partner	0.263	251	0.212	184		-0.17	0.24
Mother marital status: married	0.215	251	0.196	184		-0.07	0.75
Mother marital status: divorced/separated	0.052	251	0.027	184		-0.41	0.25
Mother marital status: other or unknown	0.044	251	0.043	184		-0.02	0.92
Mother health is good or better	0.884	251	0.946	184		0.50	0.02
Mother depression (CESD)	0.7 (0.4)	251	0.7 (0.4)	184	-0.07		0.33
Cigarettes per week during pregnancy	5.4 (22.5)	249	2.9 (11.4)	183	-0.13		0.11
Alcohol drinks per week during pregnancy	0.1 (0.6)	249	0.1 (0.6)	184	-0.01		0.97
Number of children born to mother	2.4 (1.3)	251	2.5 (1.4)	184	0.11		0.29
Number of adults in household	2.2 (1.1)	251	2.0 (0.9)	184	-0.19		0.05
Biological father lives in household	0.378	251	0.288	184		-0.25	0.05
Household combined income	$22,739 (20,875)	238	$20,213 (14,402)	168	-0.14		0.15
Household income unknown	0.052	251	0.087	184		0.33	0.17

Household net worth	-$904 (41,220)	222	-$2,296 (13,761)	164	-0.04		0.62
Household net worth unknown	0.116	251	0.109	184		-0.04	0.85

Joint Test: Chi^2 (26)= 36.10, p-value= 0.09, n=435 (includes all observations. Standard joint test estimate drops 6 observations due to collinearity in a small number of observations with values for child's weight unknown, gestational age unknown, and mother's alcohol use unknown.)

Notes: "sd" = standard deviation. P-values were derived from a series of ordinary least squares bivariate regressions in which each respective baseline characteristic was regressed on the treatment status indicator using robust standard errors and site-level fixed effects. The bivariate regressions were also run without site-level fixed effects, and the p-values differed on average by 0.021 and result in no difference in substantive understanding or statistical significance interpretation. The p-values without fixed effects do not appear in the table. The joint test of orthogonality was conducted using a probit model with robust standard errors and site-level fixed effects. Standardized mean differences were calculated using Hedge's g for continuous variables and Cox's Index for dichotomous variables. If there were more than 10 missing cases for a covariate, missing data dummies were included in the table and the joint test. If there were fewer than 10 cases missing, missing data dummies were not included in the table but were included in the joint test; additionally, the joint test imputes mean values for missing variables. Chi-square tests of independence were conducted for the two categorical variables: mother race/ethnicity and mother marital status. For both tests, p>0.05. All respondents with missing data on gestational age, child's weight, and maternal alcohol use are in the low-cash group. We present the results of the joint test that include these observations and exclude these variables for the full sample (which would be dropped in the standard test due to collinearity). If we instead remove these observations from the sample for the joint-test, the sample for the joint-test is slightly reduced, and the estimates are as follows: Joint Test: $Chi^2(26) = 35.62$, p-value = 0.10, n = 429.

SI2. EEG data processing and analysis

EEG was analyzed using the EEGLAB toolbox (2), MATLAB (The MathWorks, Natick, MA), and a low-density version of the MADE pipeline (3) known as the miniMADE pipeline (4). Data were high-pass filtered at 0.3 Hz and low-pass filtered at 50 Hz. Then, data were segmented into epochs of 1 s with 50% overlap between epochs. Epochs were baseline corrected to the mean voltage of each epoch. To remove ocular artifact, a voltage threshold rejection (+/- 250 μV) was applied to two frontal channels (FP1, FP2). If both frontal electrodes exceeded the voltage threshold of +/- 250 μV in an epoch, that epoch was removed from processing. For the remaining channels, those channels containing artifact in each epoch were identified using three criteria: a voltage threshold (+/- 250 μV), a flat channel threshold (range < 1 microvolt for at least half of the epoch), and a jump channel threshold (increases greater than 50 microvolts from sample to sample). Finally, data were re-referenced to an average of T7 and T8.

Following preprocessing, thresholds were applied to ensure adequate artifact-free data remained for each participant prior to power decomposition. First, consistent with previous studies (5), at least 80% (16 out of 20) of electrodes were required to contribute usable data for any given epoch. Second, split-half reliabilities were computed and examined and a cutoff of 20 epochs was selected so that each band had at least good (>.8) split-half reliability (for more information see Troller-Renfree et al., 2021). Epochs with fewer than 16 artifact-free electrodes and participants with fewer than 20 artifact-free epochs were excluded from further analysis (see CONSORT Diagram in SI1 for more information on participant exclusion). After data cleaning was completed, the mean number of epochs per participant was 286.5 (for the low-cash gift group: *M* = 288.2, *SD* = 183.7; for the high-cash gift group: *M* = 284.3, *SD* = 189.2).

A Fast Fourier Transformation (FFT) with a 1-second Hanning window was applied to the epoched data (See SI9 to see results when power spectra are log-transformed). Consistent with other infant studies (5, 6), absolute spectral power (μV2) was computed for the theta (3-5 Hz), alpha (6-9 Hz), beta (13-19 Hz), and gamma frequency ranges (21-45 Hz) (to see group differences [z-scores] by single-Hz bins, see Figure 1). Additionally, relative power was computed by dividing the absolute power within one frequency band (e.g., theta) by total absolute power from all frequency bands (theta, alpha, beta, and gamma). Analysis code is available at https://github.com/ChildDevLab.

SI3. Differences between absolute vs. relative power

As discussed in the main text, "absolute power" refers to the brain activity measured across the scalp. Absolute power is typically measured across the frequency spectrum, either in different individual frequency bins, or averaged across individual frequencies within a certain frequency band. "Relative power" refers to the proportion of voltage in one frequency band as it relates to the total power across all bands.

As expected based on the 1/f shape of the EEG power spectrum, the present study reported that absolute theta band power was larger in magnitude than absolute power in the alpha, beta, and gamma bands (see Table 2). That is, theta power makes up a greater proportion of total power than do any of the other bands. Due to this difference in magnitude between the lower and higher frequency bands -- and because relative power is a proportion of power in one band to total power – relative power can be more sensitive to differences in lower bands versus upper bands (6, 7). In our case, we observed no major differences in absolute theta power between the two groups. In addition, because absolute values of the low-frequency and high-frequency bands are positively correlated, we might expect that standardized group differences in relative power in each mid-to-high-frequency band would be smaller in magnitude, as reported in the main text.

We also note that, in the literature linking SES to brain activity, income has been linked to absolute power (6–12) more commonly than to relative power (10–13). While some studies show associations between income and absolute, but not relative power (6, 7), we are not aware of any studies showing the reverse pattern. Likewise, the literature linking brain activity to language, cognitive, and behavioral outcomes has also more commonly examined absolute power (9, 14–18). However, some studies have found links between these outcomes and both absolute and relative power, or relative power alone (19–21). It is not uncommon for the magnitude of results to differ depending on the type of power examined – particularly when there is a substantial amount of between-subject variation in the magnitude of absolute power values. In our case, our findings generally suggest that the Baby's First Years poverty reduction intervention had a greater impact on mid-to-high-frequency absolute power compared with relative power. However, as the past correlational literature linking income with EEG outcomes is inconsistent in terms of the power type, frequency band, and brain regions examined, further study and replication is needed.

SI4. Preregistration and hypothesis testing

As a randomized control trial, the Baby's First Years project preregistered its analyses with ClinicalTrials.gov (Identifier: NCT03593356) in 2018. At that time, EEG-based analyses were preregistered in three bands: theta, alpha, and gamma, with a multiple comparison correction for both absolute and relative power in these three bands. Given the expectation of at least 80% retention of our initial sample of 1,000 participants, we were powered to detect effect sizes of .21 or greater, and we hypothesized that EEG effects would be within this range. These bands were selected because, at the time of preregistration, the evidence we were aware of from several small-scale correlational studies linked income to differences in resting EEG power in those bands (6, 8, 13), but not in the beta band. Thus, beta activity was not originally preregistered in 2018, owing to sparse evidence at the time on its association with income. However, between 2018 and the present investigation, evidence has emerged linking income to beta activity, including from the first and senior authors' lab (7, 11).

When we began to analyze data for the current paper, the authors agreed that evidence justified positive group-difference hypotheses related to beta power, and they updated their analytic plan to reflect this. To investigate whether the addition of beta power affected our key results, we compared estimates of group differences in power when multiple testing adjustments did and did not include beta power. Results showed that Westfall-Young adjusted p-values changed minimally (Δp = .00 to .02) and significance ($p<.05$) did not change (see Table SI4.1 for preregistered Westfall-Young adjusted p-values).

Table SI4.1. Preregistered cash-gift treatment effects on EEG power with various multiple comparison adjustments.

	Effect Size (from Table 2)	Westfall-Young Adjusted p-value (from Table 2; adjustment for alpha, beta, gamma and theta)	Westfall-Young Adjusted p-value (preregistration; adjusted only for alpha, gamma and theta)	N
Absolute Alpha	0.17	0.12	0.12	435
Absolute Gamma	0.23	0.12	0.12	435
Absolute Theta	0.02	0.84	0.84	435
Relative Alpha	0.16	0.31	0.31	435
Relative Gamma	0.16	0.31	0.31	435
Relative Theta	-0.21	0.17	0.15	435

Notes: Effect size (column 1) was computed by dividing the covariate-adjusted treatment effect with the standard deviation of the EEG sample low-cash group. The Westfall-Young adjustment from the main text (column 3), adjusts for the four frequency bands (theta, alpha, beta, gamma) for absolute power into one family and the four frequency bands (theta, alpha, beta, gamma) for relative power were placed into a second family. The Westfall-Young adjustment from the preregistered analyses (column 4), adjusts for the three frequency bands (theta, alpha, gamma) for absolute power into one family and the three frequency bands (theta, alpha, gamma) for relative power were placed into a second family The p-values for both Westfall-Young Adjustments (columns 3 and 4) are associated with the treatment coefficient and effect size in a regression with site-level fixed effects and covariates. Models include the following maternal self-report covariates from the BFY baseline survey conducted at the time of enrollment: mother's age, completed maternal schooling, household income, net worth, general maternal health, maternal mental health, maternal race and ethnicity, marital status, number of adults in the household, number of other children born to the mother, maternal smoking during pregnancy, maternal alcohol consumption during pregnancy, father living with the mother, child's sex, child's birth weight, child's gestational age at birth. Models also control for child's age at interview (in months), and the total number of usable epochs. Missing data for covariates impute the mean value from the EEG analytic sample. Relative power calculatd at the child level.

SI5. Weighted analyses to adjust for selection into the EEG sample

We constructed two types of weights to assess potential differences that may have resulted from selection into the EEG sample, using the Toolkit for Weighting and Analysis of Nonequivalent Groups (TWANG) (22). Broadly, TWANG uses generalized boosted models to flexibly estimate propensity scores and analytic weights.

We first constructed Inverse Probability of Treatment Weights (IPTW), which are intended to estimate the average treatment effect on the treated (ATT). In this approach, participants from the low-cash gift group with usable EEG data are weighted by the odds of being in the high-cash gift group with EEG data, thereby creating a weighted sample in which the low-cash and high-cash gift groups have similar baseline characteristics. We use these weights to assess the sensitivity of our results to any imbalance in baseline characteristics between the low-cash and high-cash gift groups in the EEG sample (Table SI5.1).

Additionally, we created a set of non-response weights intended to adjust for missing EEG data. These weights adjust by the inverse probability of providing enough usable EEG data to be included in our EEG sample; they result in the EEG sample having characteristics similar to the full age-1 BFY analytic sample, including all participants who contributed data, either in-person or over the phone (N=931; see Table SI5.1.).

While the overall pattern of results is robust to both weighting adjustments, the magnitude of our estimates is somewhat sensitive to the adjustments, particularly the IPTW-ATT weights. Specifically, when applying the IPTW weights, designed to address an imbalance between high-cash and low-cash gift groups, the magnitude of estimates decreases for most power bands, suggesting our estimates may be sensitive to some of the observed imbalance between high-cash and low-cash gift groups. When applying the non-response weights, our results are broadly similar, with a slight decrease in the magnitude of effect sizes. These weights are intended to assess whether the same pattern of results might hold had the EEG sample had characteristics similar to the full age 1 BFY analytic sample. Though this suggests we might expect broadly similar results, we cannot know for certain whether the results presented here would have generalized to the full sample.

Table SI5.1 Cash-gift treatment effect size estimates for base and covariate-adjusted models, applying no weights, inverse probability of treatment weights – average treatment effect on the treated (IPTW-ATT), and non-response weights – average treatment effect (NRW-ATE).

	Unweighted (Taken from Table 2)				IPTW-ATT		NRW-ATE		
	Low-Cash EEG Sample mean	High-Cash EEG Sample mean	Effect Size (base)	Effect Size (with covariates)	Effect Size (base)	Effect Size (with covariates)	Effect Size (base)	Effect Size (with covariates)	Unweighted N
Absolute Alpha	7.441	7.667	0.07	0.17	0.07	0.13	0.07	0.17	435
Absolute Beta	1.874	2.167	0.19	0.26	0.18	0.17	0.13	0.21	435
Absolute Gamma	0.986	1.137	0.16	0.23	0.11	0.13	0.14	0.21	435
Absolute Theta	40.268	38.887	-0.04	0.02	-0.05	-0.01	-0.02	0.04	435
Relative Alpha	0.148	0.152	0.09	0.16	0.13	0.18	0.06	0.13	435
Relative Beta	0.038	0.042	0.15	0.19	0.13	0.12	0.07	0.12	435
Relative Gamma	0.020	0.022	0.11	0.16	0.07	0.09	0.07	0.12	435
Relative Theta	0.794	0.784	-0.14	-0.21	-0.14	-0.17	-0.08	-0.15	435

Notes: This table shows the presented ITT effects (columns 5-8) weighted to adjust for possible biases in the EEG subsample. The unweighted columns (3-4) show ITT effect size estimates for base and covariate-adjusted models, applying no weights. IPTW-ATT signifies Inverse Probability of Treatment Weights (IPTW), which are intended to estimate the average treatment effect on the treated (ATT). NRW-ATE signifies inverse probability weights intended to adjust for missing EEG data. These weights estimate the Average Treatment Effect (ATE) across the full Age 1 analytic sample. The IPTW-ATT present a weighted sample in which the low- and high-cash gift groups in the EEG sample have similar baseline characteristics (columns 6-7). The NWR-ATE weights adjust so that the EEG sample has characteristics similar to the full age 1 BFY analytic sample, including all participants who contributed data, either in-person or over the phone (N=931). Base and covariate-adjusted effect sizes are presented for the three different models. Effect sizes for base models are computed by dividing the treatment effect for a model including only a treatment indicator and site-level fixed effects by the standard deviation of the low-cash EEG sample. Effect size for covariate-adjusted models are computed by dividing the treatment effect for a model including site-level fixed effects and covariates by the standard deviation of the low-cash EEG sample. Weighting models use baseline covariates to estimate propensity scores and create analytic weights. Balance diagnostics suggest weighting was successful at reducing observed baseline imbalance in measured characteristics.

SI6. Effect of the cash-gift treatment on EEG power by region

The preregistered findings presented in the main manuscript detailed how a monthly unconditional cash gift changed whole-brain activity in four bands (theta, alpha, beta, and gamma). While whole-brain effects are informative, they are not most commonly examined in the EEG literature. Previous EEG studies examining the association between socioeconomic status (SES) and brain activity have all examined how EEG power differed not only by power band, but also by the brain region over which electrodes were placed (e.g., frontal, central, parietal, etc.).

Past correlational research has reported socioeconomic disparities in regional brain activity in the theta (8–10), alpha (8–10, 12), beta (7, 11, 12), and gamma bands (6, 11). Within the theta band, higher SES has been related to less theta power in the frontal, temporal, and parietal regions (8–10). For the alpha band, higher SES has been related to more alpha power in all regions, including frontal (8–10, 12), temporal (8, 10), central (9, 10, 12), parietal (10), and occipital (8, 10, 12) regions. Likewise, for beta power, higher SES has been related to more power in the frontal (11), temporal, (7, 12) central (7, 11, 12), parietal (11), and occipital (7, 12) regions. Finally, in the gamma band, higher SES has been related to more power in the frontal (6, 11), central (11), and parietal (11) regions. Broadly, the majority of these studies suggest that greater socioeconomic resources are related to less low-frequency power (theta) and more mid-to-high-frequency power (alpha, beta, gamma), but also suggest that the observation of these effects may vary by brain region. As a result, considering regional differences may add important, novel information to the whole-brain findings reported in the main text.

To investigate regional effects, we averaged available data from electrodes in each of four regions: frontal, central, parietal, and occipital (see Figure SI6.1). Of note, the temporal electrodes served as our reference electrodes, so it is impossible to investigate group differences in these regions. For statistical analyses, Westfall-Young corrections were applied within each band (correcting for the four regions as a family).

Table SI6.1 shows ITT estimates by region within each band, before and after adjustments for baseline covariates and multiple comparisons. First, for alpha power, the high-cash gift group showed more absolute power than the low-cash gift group in the frontal region (effect size = 0.19, *ß* = 0.804, $p = 0.05$); however, this effect did not survive Westfall-Young adjustment (p =.12). No significant regional differences in relative alpha power were present.

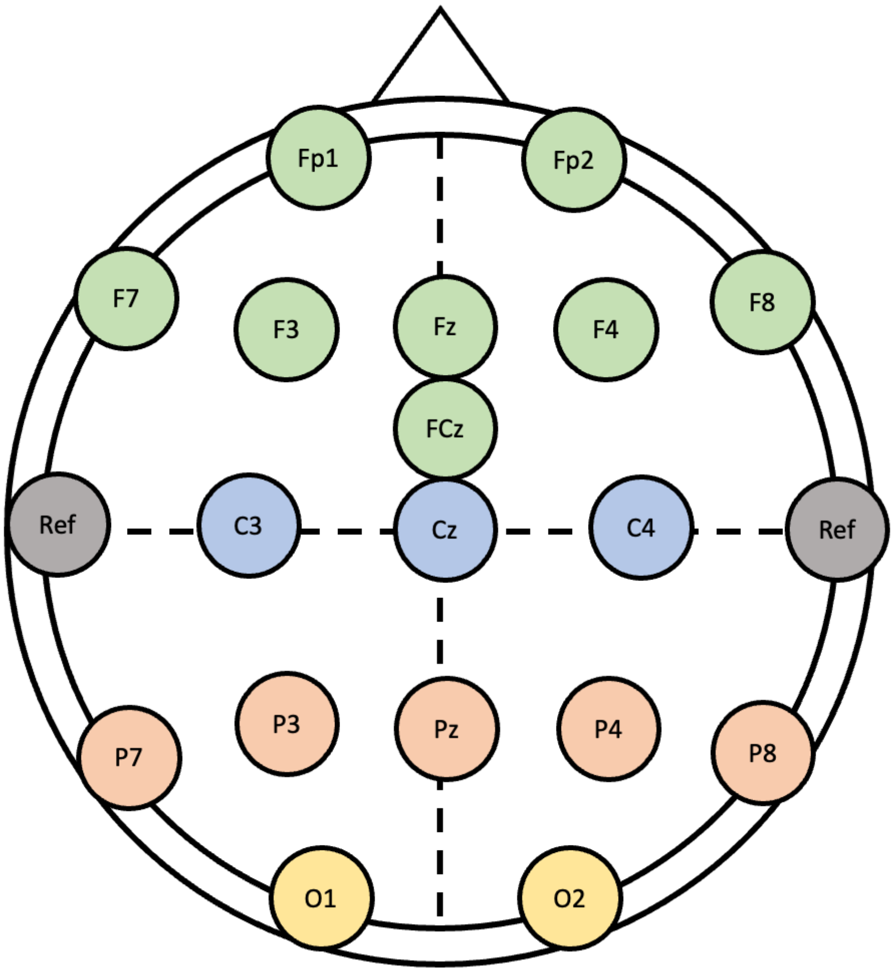
For beta power, the high-cash gift group showed more absolute power in the frontal (effect size = 0.32, *ß* = 0.460, $p = 0.01$) and central (effect size = 0.28, *ß* = 0.585, $p = 0.02$) regions, and more relative power in the frontal region (effect size = 0.24, *ß* = 0.007, $p = 0.04$), as compared with the low-cash gift group. Differences in frontal ($p = 0.02$) and central ($p = 0.05$) absolute power remained significant after Westfall-Young adjustment, while differences in relative power fell to the margins of significance (p =0.10).

For gamma power, group differences in absolute power were observed in the frontal (effect size = 0.26, *ß* = 0.238, $p = 0.02$) and central regions (effect size = 0.26, *ß* = 0.317, $p =$ 0.04). The frontal effect remained significant (frontal: p =.04), whereas the central effect fell to the margins of significance (central: p = .08) after Westfall-Young adjustment for multiple comparisons. No significant regional differences were observed in relative gamma power.

Finally, for theta power, there were no regional effects for absolute power. For relative power, the high-cash gift group showed less theta activity in the frontal region (effect size = -0.25, *ß* = -0.018, $p = 0.04$); however, after Westfall-Young adjustment, this difference fell to the margins of significance ($p = 0.09$).

Altogether, our regional analyses show patterns consistent with the whole-brain analyses reported in the main text, with the high-cash gift group showing more absolute mid-to-high-frequency power, as well as some evidence for less low-frequency relative power, as compared with the low-cash gift group. However, importantly, regional analyses provide further evidence that these whole-brain differences are driven by larger, statistically significant differences in the frontal and central areas of the brain. This pattern is consistent with a number of previous papers that have shown that increased socioeconomic resources are related to increased absolute mid-to-high-frequency power in the frontal and central regions (6, 8–10, 12) as well as decreased relative low-frequency power in frontal regions (10). The frontal region is of particular interest given that increased mid-to-high-frequency power in the frontal region has been related to subsequent higher language (14, 15), cognitive (16, 17, 23), and socioemotional (18) scores.

Figure SI6.1. Electrodes by region.



Electrode groupings by region. Electrode locations are approximate and follow the conventional EEG electrode locations. Each region is designated both by color and leading letter of electrode (e.g., P or F). Frontal is shown in green, central is shown in blue, parietal is shown in orange, and occipital is shown in yellow.

Table SI6.1. Cash-gift treatment effects on EEG power by region.

	Low-Cash Gift Group mean	High-Cash Gift Group mean	OLS w/FE	OLS w/FE w/covariates	Effect Size	p-value	Westfall-Young Adjusted p-value	N
				Absolute Power				
				Alpha				
Central	6.897	7.190	0.354	0.694	0.14	0.14	0.28	435
Frontal	7.085	7.456	0.436	0.804	0.19	0.05	0.12	435
Occipital	10.352	10.477	0.187	0.941	0.14	0.17	0.28	435
Parietal	7.172	7.166	0.074	0.513	0.11	0.20	0.28	435
				Beta				
Central	1.998	2.431	0.443	0.585	0.28	0.02	0.05	435
Frontal	1.762	2.131	0.384	0.460	0.32	0.01	0.02	435
Occipital	1.901	1.940	0.053	0.202	0.11	0.22	0.22	435
Parietal	1.966	2.158	0.206	0.324	0.17	0.09	0.13	435
				Gamma				
Central	1.043	1.264	0.223	0.317	0.26	0.04	0.08	435
Frontal	0.968	1.146	0.183	0.238	0.26	0.02	0.04	435
Occipital	0.887	0.922	0.038	0.108	0.11	0.31	0.31	435
Parietal	1.020	1.130	0.114	0.181	0.17	0.14	0.20	435
				Theta				
Central	36.067	35.329	-0.307	1.077	0.04	0.64	0.92	435
Frontal	35.860	35.338	-0.122	1.069	0.05	0.56	0.92	435
Occipital	58.813	55.890	-2.607	-0.646	-0.01	0.86	0.93	435
Parietal	42.424	39.898	-2.037	-0.674	-0.02	0.77	0.93	435
				Relative Power				
				Alpha				
Central	0.150	0.151	0.001	0.003	0.06	0.61	0.62	435
Frontal	0.156	0.162	0.005	0.008	0.18	0.14	0.30	435
Occipital	0.148	0.150	0.002	0.006	0.13	0.29	0.43	435
Parietal	0.138	0.142	0.004	0.006	0.16	0.17	0.31	435
				Beta				
Central	0.044	0.049	0.005	0.006	0.18	0.13	0.25	435
Frontal	0.040	0.046	0.006	0.007	0.24	0.04	0.10	435
Occipital	0.029	0.030	0.001	0.002	0.08	0.40	0.39	435
Parietal	0.038	0.042	0.003	0.004	0.14	0.20	0.29	435
				Gamma				
Central	0.023	0.025	0.002	0.003	0.13	0.28	0.45	435

Frontal	0.022	0.025	0.003	0.003	0.18	0.11	0.22	435
Occipital	0.014	0.014	0.000	0.001	0.06	0.55	0.54	435
Parietal	0.020	0.022	0.001	0.002	0.10	0.38	0.50	435
				Theta				
Central	0.783	0.775	-0.007	-0.012	-0.14	0.24	0.35	435
Frontal	0.782	0.768	-0.014	-0.018	-0.25	0.04	0.09	435
Occipital	0.809	0.806	-0.003	-0.009	-0.12	0.26	0.35	435
Parietal	0.803	0.795	-0.008	-0.013	-0.17	0.14	0.25	435

Notes: "OLS" = Ordinary Least Squares; Effect Size was computed by dividing the covariate-adjusted treatment effect (column 4) with the standard deviation of the EEG sample low-cash group. Unadjusted p-values (column 6) and Westfall-Young adjusted p-values (column 7), which adjust for multiple hypothesis testing, are both reported. For the Westfall-Young adjustment, each absolute and relative frequency band was put into its own family; therefore, this adjusts within a specific band (e.g., Absolute Alpha). Both sets of p-values are associated with the treatment coefficient and effect size in a regression with site-level fixed effects and covariates. Models include the following pre-registered maternal self-report covariates from the BFY baseline survey conducted at the time of enrollment: mother's age, completed maternal schooling, household income, net worth, general maternal health, maternal mental health, maternal race and ethnicity, marital status, number of adults in the household, number of other children born to the mother, maternal smoking during pregnancy, maternal alcohol consumption during pregnancy, father living with the mother, child's sex, child's birth weight, child's gestational age at birth. Models also control for child's age at interview (in months), and the total number of usable epochs. Missing data for covariates impute the mean value from the EEG analytic sample. Absolute power within each band is calculated by averaging the power band measure from electrodes within each region (i.e., Occipital Absolute Alpha averages measures of Absolute Alpha from the two electrodes in the Occipital region). Relative power is calculated as a ratio of an absolute measure and the total power within each region.

SI7. Cash-gift Treatment Impacts on a Post-Hoc Composite Index of Mid-to-High-Frequency Brain Activity

As a robustness check of the effects of the cash-gift intervention on infant brain activity, we constructed a single post-hoc composite measure that aggregated across the portion of the spectrum defined by the three mid-to-high-frequency bands. Because this approach is focused on estimating intent-to-treat differences in a single index score, there is no need for multiple-testing adjustments. To construct this index of mid-to-high-frequency power, we summed the absolute power values across the entire mid-to-high-frequency portion of the power spectrum, in each single-Hz bin from 6 Hz – 49 Hz. In this way, we can assess the intent-to-treat impact of the cash gifts on a single measure of absolute power, employing data from across the mid-to-high-frequency (including alpha, beta, and gamma) regions of the power spectrum. We acknowledge that this approach ignores functional definitions of these mid-to-high-frequency bands, the overall shape of the power spectrum, as well as the data shape within each of the individual frequency bands. Rather, we use this summary index approach (24, 25) as a useful complement to addressing problems encountered with statistical power when each band is considered separately.

ITT analyses of the mid-to-high-frequency power index in Table SI7.1 show that the high-cash gift group had greater composite mid-to-high-frequency absolute power than the low-cash gift group (effect size = 0.25, ß = 13.35, p = 0.02).

Table SI7.1 Cash-gift treatment effects on summed high frequency single-hz bins (6-49)

	Low-Cash Gift Group mean (sd)	High-Cash Gift Group mean (sd)	OLS with site fixed effects (se)	OLS with site fixed effects and covariates (se)	Effect Size	p-value	N
Sum of High Frequency Single-Hz Bins (6-49)	79.018 (52.518)	86.888 (64.442)	8.414 (5.591)	13.354 (5.632)	0.25	0.02	435

Notes: "OLS" = Ordinary Least Squares; "sd" = standard deviation; "se" = standard error. The sum of high frequency bins sums single-Hz bins beginning with those in the alpha band. It includes each bin, regardless of whether the bin is included in one of the power bands. OLS = Ordinary Least Squares. Effect size (column 5) was computed by dividing the covariate-adjusted treatment effect (column 4) with the standard deviation of the EEG sample low-cash group. Unadjusted p-values (column 6) are reported. Models include the following maternal self-report covariates from the BFY baseline survey conducted at the time of enrollment: mother's age, completed maternal schooling, household income, net worth, general maternal health, maternal mental health, maternal race and ethnicity, marital status, number of adults in the household, number of other children born to the mother, maternal smoking during pregnancy, maternal alcohol consumption during pregnancy, father living with the mother, child's sex, child's birth weight, child's gestational age at birth. Models also control for child's age at interview (in months), and the total number of usable epochs. Missing data for covariates impute the mean value from the EEG analytic sample. All models are estimated using robust standard errors. Relative power is calculated at the child level. Standard errors in parentheses for OLS models (columns 4 and 5). Standard deviations are shown in parentheses for group means.

SI8. Cash-gift treatment impacts on maternal report of infant language milestones in the EEG sample and the full analytic sample

As a behavioral complement to the EEG-based measures of brain activity, we conducted ITT analyses of mothers' reports of their infants' achievement of age-appropriate language milestones. We hypothesized that mothers randomized to the high-cash gift group would report that their infants were meeting more age-appropriate language milestones compared with infants of mothers randomized to the low-cash gift group.

Infant language milestones were assessed using the Ages and Stages Questionnaire (ASQ-3) Communication subscale (26). The ASQ-3 uses maternal report to screen for developmental delays. The Communication subscale of the ASQ-3 includes six items measuring children's developmentally-appropriate language skills (e.g., "Does your baby make two similar sounds, such as "ba-ba," "da-da," or "ga-ga"?"). The items in the ASQ-3 differ by child age, and mothers were administered the correct form based on the child's age at the time of the interview. For each item, mothers reported whether their infant demonstrated a given skill regularly, sometimes, or not yet. Scores were calculated by summing the item scores. Raw scores were then z-scored using age-normed means and standard deviations for the ASQ-3. Higher z-scores indicated that the child demonstrated higher levels of developmentally-appropriate language skills relative to the skills of same-aged peers. The ASQ-3 has shown strong concurrent validity with the Battelle Developmental Inventory screener (86% precent agreement), two-week test-retest reliability (r =.75-.82), inter-observer reliability (r =.43-.69), and internal consistency (α =.51 to .87)(26).

For the n=435 subset of mother/infant dyads who contributed usable EEG data, ITT analyses revealed that infants in the high-cash gift group had achieved more age-appropriate language milestones than infants in the low-cash gift group (ß = 0.189, p = 0.03, effect size = 0.22). However, results for the full sample (n=900), showed smaller and, despite the larger sample size, nonsignificant differences (*ß* = 0.075, *p* = 0.21, effect size = 0.08) (see SI10 for associations between EEG power and infant language milestones).

These differences may stem from several sources. First, moving the collection of the ASQ-3 from in-person to over the phone may have elicited different responses from mothers, obscuring our ability to detect group differences. However, mean language milestone scores did not differ between in-person and phone-based collection (*p* = 0.67), rendering this possibility less likely.

Second, impacts of the cash gift on children's language milestone development may have differed in meaningful ways before the pandemic compared with after the onset of the pandemic. For example, an examination of the raw means reveals that the high-cash gift group mean score was similar before the pandemic (M = .299) compared with after the onset of the pandemic (M = .271), whereas the low-cash gift mean was somewhat lower before the pandemic (M = .168) compared with after pandemic onset (M = .239). Such a pattern could potentially be explained if the high-cash gift group experienced greater language input than the low-cash gift group before the pandemic, but language input was equalized after the onset of the pandemic when all children, regardless of group, may have been more likely to spend time at home with family members.

Finally, because these participants from whom usable EEG data were obtained comprised a non-random subset of the larger BFY sample, it may be that children who successfully completed EEG data collection differ meaningfully from those who did not, in a way that interacted with the cash gift to predict language milestones. This possibility is rendered somewhat less likely from the NRW-ATE analyses described in SI5, which suggested that the findings in the EEG subgroup would have been similar had the EEG sample had characteristics similar to the full age 1 BFY analytic sample.

This uncertainty about why treatment group differences in the ASQ were evident in the EEG subgroup but not in the full sample suggests that caution in interpreting the main findings of this manuscript is merited. In particular, it suggests the possibility that some of the brain activity findings may not have generalized to the portion of the sample surveyed following the onset of the pandemic. In future waves of the study, which are intended to take place once it is safe and feasible to assess all participants in-person, brain activity will be assessed among the full sample. Notably, the measure of children's language milestones was limited to maternal report; subsequent waves of data collection will directly measure children's cognitive and behavioral outcomes in a laboratory setting, providing a much more sensitive measure of child development that is free from the bias of maternal reporting.

SI9. Logged vs unlogged power spectra

There is some debate within the field of psychophysiology as to whether power spectra should be log transformed prior to band power computation. For primary analyses, participants' power spectra were not log-transformed, because we lacked a theoretical reason suggesting that a log-transformation would impact ITT estimates. However, as a robustness check, we also computed and examined log-transformed band power. Group differences were qualitatively similar to those presented in Table 2, although effects sizes were somewhat smaller, and results fell below conventional levels of statistical significance (see Table SI9.1 for regression tables).

Table SI9.1. Regressions estimating cash-gift treatment effects on log-transformed EEG power.

	Low-cash Gift Group mean (sd)	High-cash Gift Group mean (sd)	Ordinary least squares with fixed effects (se)	Ordinary least squares with fixed effects and covariates (se)	Effect Size	p-value	Westfall-Young adjusted p-value	N
Absolute Alpha (log)	0.808 (0.223)	0.824 (0.208)	0.020 (0.020)	0.043 (0.022)	0.19	0.05	0.14	435
Absolute Beta (log)	0.382 (0.194)	0.403 (0.215)	0.023 (0.019)	0.037 (0.020)	0.19	0.06	0.14	435
Absolute Gamma (log)	0.236 (0.157)	0.252 (0.175)	0.016 (0.016)	0.026 (0.017)	0.16	0.13	0.23	435
Absolute Theta (log)	1.453 (0.256)	1.463 (0.198)	0.015 (0.021)	0.034 (0.023)	0.13	0.15	0.23	435

Relative Alpha (log)	0.279 (0.028)	0.279 (0.029)	0.001 (0.003)	0.003 (0.003)	0.11	0.31	0.49	435
Relative Beta (log)	0.125 (0.042)	0.129 (0.045)	0.004 (0.004)	0.007 (0.004)	0.16	0.13	0.29	435
Relative Gamma (log)	0.075 (0.039)	0.078 (0.041)	0.003 (0.004)	0.004 (0.004)	0.11	0.28	0.49	435
Relative theta (log)	0.521 (0.080)	0.514 (0.083)	-0.008 (0.008)	-0.014 (0.009)	-0.18	0.10	0.24	435

Notes: "OLS" = Ordinary Least Squares; "sd" = standard deviations; "se" = standard errors. In contrast to the results presented in Table 2, the power spectrum measures in this table were log-transformed. Effect size (column 5) is computed by dividing the covariate-adjusted treatment effect (column4) with the standard deviation of the EEG sample low-cash group. Unadjusted p-values (column 6) and Westfall-Young adjusted p-values (column 7), which adjust for multiple hypothesis testing, are both reported. For the Westfall-Young adjustment, the four frequency bands (theta, alpha, beta, gamma) for absolute power are placed into one family and the four frequency bands (theta, alpha, beta, gamma) for relative power were placed into a second family. These p-values are associated to the treatment coefficient and effect size in a regression with site-level fixed effects and covariates. Models include the following maternal self-report covariates from the BFY baseline survey conducted at the time of enrollment: mother's age, completed maternal schooling, household income, net worth, general maternal health, maternal mental health, maternal race and ethnicity, marital status, number of adults in the household, number of other children born to the mother, maternal smoking during pregnancy, maternal alcohol consumption during pregnancy, father living with the mother, child's sex, child's birth weight, child's gestational age at birth. Models also control for child's age at interview (in months), and the total number of usable epochs. Missing data for covariates impute the mean value from the EEG analytic sample. Relative power is calculated at the child level. Robust standard errors are given in parentheses.

SI10. Associations between EEG power and language milestones

A growing body of research suggests that resting EEG power is associated with language skill (7, 14–16). We investigated whether this was in the case in the EEG sample by estimating correlations between EEG power and language milestone scores (see Table SI10.1). Results showed no significant statistical associations between language milestones and either absolute or relative power in any whole-brain or regional analysis (*p*'s > .05).

The nonsignificant association between EEG power and language milestones may stem from several sources. First, our language milestone assessment, the ASQ-3 communication scale, relies on maternal report of six items. While this measure is valid and reliable as a broad screener for delayed language milestones, it does not capture the fine-grained variability in child language development that is likely necessary to see brain-behavior associations. Furthermore, parental report on infant language development can be flawed and influenced by factors other than a child's language skill. For example, parental educational attainment may lead to different response on a language screener (27). Another possibility is that the high-cash gift group may have engaged more frequently with their children than the low-cash gift group, providing a greater opportunity for the high-cash gift group to observe language milestones in their children. Finally, relations between EEG power and language skill tend to get stronger across development (7, 14–16). Indeed, it is not uncommon that brain activity in infancy fails to predict concurrent language skill, but instead predicts future language ability (16). Thus, while we did not detect a significant correlation between whole-brain EEG power and language milestones, it is possible that such an association would exist with more sensitive measures, and/or will emerge at later waves of data collection.

Table SI10.1. Associations between EEG power and language milestones

	Correlation (*r*) with Language Milestones (Standardized)	p-value	N
Absolute Alpha	0.041	0.39	431
Absolute Beta	-0.007	0.88	431
Absolute Gamma	-0.014	0.77	431
Absolute Theta	0.028	0.56	431
Relative Alpha	0.041	0.39	431
Relative Beta	-0.029	0.55	431
Relative Gamma	-0.030	0.54	431
Relative Theta	-0.003	0.95	431
Index of High-Frequency Power	0.005	0.92	431

Notes: This table shows the correlation between whole-brain EEG power and language milestones. Pearson's correlation coefficients are reported in Column 2 and associated p-values are reported in Column 3. The difference in sample size is due to missing ASQ measures for four children in the EEG sample.

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