Changing caregiving quality for neurodevelopmentally at-risk infants:

Executive function and behavior outcomes

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Abstract

Neurodevelopmental impairment in infancy is an established risk factor for poor cognitive and behavior outcomes later in life. However, environmental factors such as high quality caregiving could be protective against these biological risks. Longitudinal data from the National Survey of Child and Adolescent Well-Being was used to assess the relationship between difficult temperament and risk for neurodevelopmental impairment in infancy and outcome behavior problems and executive function five years later. Quality of caregiving these children received at both ages was measured. Change in caregiving quality was tested as a moderator in difficult temperament predicting behavior problems, and risk for neurodevelopmental impairment predicting executive function. It was hypothesized that increases in the quality of caregiving would result in (a) fewer problem behaviors based on initial measures of difficult temperament, and (b) better than expected executive function outcomes based on initial risk for neurodevelopmental impairment. Difficult temperament was found to predict problem behaviors 5 years later. Similarly, risk for neurodevelopmental impairment in infancy was found to predict lower executive functioning 5 years later. Findings from this study could guide the development of effective interventions for children displaying neurodevelopmental impairment shortly after birth.

Keywords: Neurodevelopmental Impairment, NSCAW, Executive Function, Behavior Problems, HOME

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Near the end of the first year of life, normally developing infants derive a sense of security from their caregivers (Cicchetti, Rogosch, & Toth, 2006). Environmental factors such as high quality caregiving can be protective against genetic and environmental risk factors which result in neurodevelopmental impairment. Neurodevelopmental impairments reflect deficits in central nervous system development and have been linked with a host of maladaptive outcomes (Jaffee, 2007). However, when the caregiver is not consistently available, organized attachment behavior breaks down (Van Ijzendoorn, Schuengle, & Bakermans-Kranenburg, 1999). This poor quality caregiving results in an exacerbation of existing risk factors and an increased likelihood of deleterious outcomes associated with those risk factors (Laught, Esser, & Schmidt, 2001). Poor caregiving quality can also effect development of neural pathways impacting executive functioning processes such as planning, goal-directed behavior, inhibiting action, utilizing working memory, and controlling emotions (DeBellis, 2001). This study will examine the moderating effect of changes in caregiving quality on behavioral outcomes and executive functioning in a sample of neurodevelopmentally at-risk infants.

Neurodevelopmental Impairment

Neurodevelopmental impairments are deficits in the growth and development of the central nervous system, with effects on emotion capacities, learning ability, memory, and motor function. Children who exhibit moderate- to high-risk for neurodevelopmental impairment in infancy are at risk for deleterious cognitive and behavior outcomes at later ages (Jaffee, 2007). The Bayley Infant Neurodevelopmental Screener (BINS) is commonly used to identify infants at risk for neurodevelopmental problems (Aylward & Verhulst, 2000). In a longitudinal, follow-up

study of preterm infants and full-term infants who experienced perinatal complications, Aylward and Verhulst (2000) found that moderate- to high-risk status at ages 6-24 months was indicative of clinically significant cognitive developmental impairment in verbal, perceptual, motor, quantitative, and memory domains at 36 months of age.

Difficult temperament in infancy is another indicator of neurodevelopmental impairment. Difficult temperament is characterized by fussiness, irritability, and low levels of positive affect. In a longitudinal study of 370 children assessed initially at 6 months and then at 5 and 15 years of age, children who exhibited difficult temperament during the first 5 years of life were at increased risk for persistent aggressive, antisocial outcomes in middle childhood and adolescence if they were raised under conditions of adversity (Brennan, Hall, Bor, Najman, & Williams, 2003). Adversity was indicated by both social risk (mother's negative attitude toward infant, inadequate parental monitoring, harsh discipline style, lack of parental acceptance, exposure to consistent poverty, etc.) and biological risk (birth complications, maternal illness during pregnancy, etc.). Another study found that children who are temperamentally fearful and withdrawn are able to successfully regulate their own conduct when mothers use gentle, inductive disciplinary techniques. Temperamentally undercontrolled children were observed to regulate their own conduct in the context of warm, supportive relationships with a parent (Kochanska, 1997). This emphasizes that other factors moderate the relationship between being at-risk and developing problems. These studies indicate that environmental factors may play a role in either protecting against negative outcomes or exacerbating already present risks. These environmental factors include caregiving quality (including abuse and neglect), which will now be considered in more detail.

Environmental Factors

Caregiving Quality. High quality caregiving has been shown to protect at-risk children from poor developmental outcomes. High quality caregiving is characterized by providing cognitively stimulating and emotionally supportive environments. Cognitive stimulation promotes language development while emotional support fosters the formation of behavioral control and emotion regulation. The responsiveness of caregivers impacts the development of infants' trust in others and self-regulation skills (Laucht, Esser, & Schmidt, 2001).

One frequently used measure of caregiving quality is the Home Observation for Measurement of the Environment (Caldwell & Bradley, 1984). The HOME reflects mental health of caregivers and interactions between caregiver and child. It has been shown to predict cognitive development and attachment status in both normative and at-risk populations. Higher scores are associated with more favorable outcomes and are considered to indicate more developmentally favorable home environments (Burgess & Borowsky, 2010). In a study looking at children ages 1 to 3 who were born prematurely and were living in poverty, Bradley et al. (1994) used the HOME as a measure of parenting behavior and social and physical aspects of the home environment. This study found that children who were functioning in the normal range for cognitive, social/adaptive, health, and growth parameters at age 3 were receiving more responsive, accepting, stimulating, and organized care relative to children who were functioning more poorly.

Abuse and Neglect. At one end of the spectrum, high quality parenting can protect at-risk children from poor outcomes. At the other extreme, childhood maltreatment has been linked with a number of negative outcomes, including poor cognitive performance, school adaptation problems, behavioral problems, and peer relationship difficulties (Jaffe & Maikovich-Fong,

2011). Child abuse and neglect have also been shown to increase the risk for antisocial, narcissistic, paranoid, and passive-aggressive personality disorders after controlling for parental education and psychiatric disorders (DeBellis, 2001). Impairments in language, self-regulation, fine and gross motor movements, and deficits in the regulation of behavior and emotion have also been found (Jaffee, 2007).

The cognitive and behavioral deficits observed in maltreated children may reflect underlying changes in brain structure or function. Orderly brain development in infancy is dependent on sensitive interactions with the primary caregiver (Glaser, 2000). According to developmental-organizational theory, maltreatment results in a disturbed parent-child attachment relationship (Gunnar, Fisher, and The Early Experience, Stress, and Prevention Network, 2006). Without sensitive interactions, the maturation of brain areas such as the frontal lobes will not progress optimally. Frontal lobe areas are involved with planning, reasoning, judgment, impulse control, and memory – all of which are referred to as executive function. These areas also contribute to inhibition of automatic emotional responses and with regulation in response to emotionally arousing stimuli (Glaser, 2000).

Neurodevelopmental impairment and abuse/neglect are unique constructs. However, it is without doubt that they are correlated. It is likely that early abuse and neglect increase the risk for neurodevelopmental impairment, but impairment can also result from non-abusive situations (e.g. environmental factors). This study looks at outcomes of children who were reported for suspected abuse and neglect; these children were found to be at higher risk for neurodevelopmental impairment than the national average for comparably aged children.

The NSCAW Study

The National Survey of Child and Adolescent Well-Being (NSCAW) is a nationally representative longitudinal sampling of children who were reported to Child Protective Services for allegations of abuse or neglect. The cohort is comprised of 5,501 children, age less than 1 to 14 years at baseline. Five waves of data collection were completed over five years. This study lends itself longitudinal research of developmental outcomes based on initial characteristics; the influence of varying conditions (such are caregiving quality) can also be examined.

Many researchers have used the NSCAW study to look at the longitudinal outcomes of children of different ages. One such researcher, Sara Jaffee, has used the NSCAW study to examine how improvements in caregiving quality affected outcomes of neurodevelopmentally at-risk infants. Jaffee (2007) found that children who had improvements in caregiving quality over 18 months had better than expected/predicted preschool language abilities and fewer problem behaviors, given initial risk for neurodevelopmental impairment and temperament, respectively. Furthermore, risk-status for neurodevelopmental impairment increased the likelihood of poor cognitive and behavioral outcomes when children were exposed to ongoing adversity, in the form of poor caregiving quality.

The Current Study

The current study sought to expand on the work of Sara Jaffee (2007) in a number of ways. While Jaffee looked at outcomes 18 months post-baseline, the present study examined outcomes 5 years post baseline. The current study utilized executive function data, which had not been previously studied. Executive function outcomes provide evidence on the neural development of children when they are 5-6 years old. At these ages, children are about to start formal schooling; development of executive function abilities is critical for success in the

classroom. Investigating the moderation by changing caregiving quality on the aforementioned relationships provides important guidance for the development of interventions targeted at parenting.

The overall goal of this study was two-fold: First, changes in caregiving quality were examined for moderation of the relationship between difficult temperament and subsequent behavior problems. Difficult temperament was used as an indicator of neurodevelopmental impairment. It was hypothesized that children with high caregiving quality would exhibit fewer behavior problems than children with lower caregiving quality, given initial temperament. High quality caregiving would protect against risk. Furthermore, it was expected that a positive increase in caregiving quality from the initial measurement to the assessment of outcomes would result in fewer problem behaviors compared to children experiencing a decrease in caregiving quality, especially for children with poor initial temperament. It was unknown how children experiencing an increase or decrease in caregiving quality would compare with children experiencing either constant high or low caregiving quality, with respect to problem behavior outcomes. This part of the analysis utilized data from children who were 3-24 months of age at Wave 1. This age range was used because it includes the largest number of children for whom all measures of interest were collected.

As a secondary exploratory analysis, the ability of initial neurodevelopmental impairment risk status to predict later executive function abilities was examined. Moderation by changing caregiving quality was also examined. Neurodevelopmental impairment is associated with children who have experienced abuse and neglect. Because abuse and neglect impact the development of frontal lobe brain regions responsible for executive function, it was expected that children at higher risk for neurodevelopmental impairment will perform less well on tasks of

executive functioning. Again, it was hypothesized that high quality parenting would protect against neurodevelopmental impairment, resulting in higher executive functioning compared to children with lower quality parenting. Furthermore, it was expected that children experiencing increases in caregiving quality would display better executive functioning compared to children experiencing decreases in caregiving quality. It was unknown how children experiencing an increase or decrease in caregiving quality will compare to children experiencing either constant high or constant low caregiving quality, with respect to executive functioning outcomes. This part of the analysis utilized a subsample of the children from the prior analyses. Data from children who were 3-12 months of age at Wave 1 was used because this includes the largest number of children for whom all measures of interest were collected.

Methods

Sample: NSCAW Data. The target population of the NSCAW Child Protective Services (CPS) sample consists of all children in the United States who were reported to Child Protective Services for allegations of abuse or neglect from October 1999 to December 2000. Four states were excluded from the target population because state law required that first contact with families be made by agencies. A two-stage stratified sample design was used in order to obtain a sample that was nationally representative of the target population. The resulting sample was comprised of 5,501 children less than 1 year old to 14 years at the baseline period (October 1999-December 2000).

In the first sampling stage, the United States was divided into nine strata. Eight of these strata corresponded to the eight states with the largest child welfare caseloads, and the ninth stratum consisted of the remaining 38 states and the District of Columbia. Primary sampling units (PSUs) were then created and randomly selected within each of the nine strata. PSUs were

defined as geographic regions encompassing the population served by a single Child Protective Services agency. In the second stage of sampling, equal numbers of children were selected from each PSU, regardless of PSU size. Additional information detailing the sampling methodology can be found in the NSCAW Data File User's Manual. The sample includes cases in which children received on-going services and cases in which no services were received, either because the suspected abuse or neglect was unsubstantiated or because it was determined that services were not required.

Data were collected via interviews and measurement instruments administered to children, current caregivers, former caregivers, investigative caseworkers, and teachers. Field staff who conducted interviews underwent a 12-day training session. Five waves of data collection were completed: Wave 1 at baseline, Wave 2 at 12 months post baseline, Wave 3 at 18 months post baseline, Wave 4 at 36 months post baseline, and Wave 5 at 59-97 months post baseline. In collecting Wave 5 data, children in the Infant Cohort (children less than 12 months old at Wave 1) were fielded first (n=1196), when they were five to six years old from September 2005 to February 2006. Following this was follow-up for children who had been 12-48 months old at Wave 1 (n=1120), from February-November 2006. The present study utilizes child and current caregiver instruments from Wave 1 and Wave 5. Many instruments are valid only for particular ages, and so were not administered at all waves. Furthermore, some measurements had different age-specific versions, which often have varying numbers of items.

In order for results to be generalized to the entire population of children who had contact with CPS, the data must be weighted. National analysis weights specific for each child for Wave 1 and Wave 5 data were used in the present study. These analysis weights are the product of the probability that a PSU would be selected (first stage of sampling) and the probability that a

specific child would be selected (second stage of sampling). Weights were adjusted to account for missing data and nonresponse. In order for the weights to be correctly applied, SPSS 19.0 Complex Samples was used for analyses (SPSS: An IMB Company, 2008).

While the sample consists of children who were investigated for suspected abuse and neglect, high quality caregiving was still present in some cases. It should be noted that some children were removed from their biological parents and placed in the care of other family members or foster parents between Wave 1 and Wave 5 data collection. Instances of placement change will likely show greater variability in caregiving quality than cases where children remained with the same caregiver. It is also possible that original caregiving quality improved, worsened, or the suspected abuse or neglect was unfounded. Some parents were referred to services that targeted parenting skills or addressed substance use or mental health problems.

Measures of Interest.

Bayley Infant Neurodevelopmental Screener (BINS). The BINS was administered to children in Wave 1 who were less than two years of age. The BINS is a screening tool used to identify infants between the ages of 3 and 24 months with developmental delays or neurological impairments (Aylward, 1995). Four conceptual assessment areas are included: basic neurological functions/intactness (of the infant's central nervous system), receptive functions (sensation and perception), expressive functions (fine, oral, and gross motor skills), and cognitive processes (memory/learning and thinking/reasoning). There are six age sets of the BINS: 3-4 months, 5-6 months, 7-10 months, 11-15 months, 16-20 months, and 21-24 months. Typical assessment items include reaching for and transferring blocks, looking for fallen items, types of vocalizations, and scooting movements. Each set has 11-13 items; each item is scored as optimal or non-optimal based on a priori decision rules. The number of optimal responses is summed to provide a

summary score. Based on predetermined summary cut scores, infants are considered either low risk, moderate risk, or high risk. Infants whose scores categorize them as either moderate risk or high risk were combined into an 'at-risk' sample. For all analyses, the infants in this study were categorized by a dichotomous variable as either 'at-risk' or 'low-risk' for neurodevelopmental impairment. This resulted in 87% of the 3-12 month old sample being categorized as 'at-risk'. The NSCAW sample is well suited for this study because it has such a large number of at-risk infants.

The BINS has demonstrated moderate construct validity, as evidenced by correlations with the Mental Development (.63) and Psychomotor Development (.47) indexes of the Bayley Scales of Infant Development – Second Edition and the Battelle Developmental Inventory at 12 months for the Communication (.50), Cognitive (.51), and Motor (.50) domains (Aylward, 1995). Internal consistency for the age groups (3-24 months) in the NSCAW sample is acceptable, with Cronbach's alphas ranging from .73 to .84. Inter-rater reliability increased with age: .79 for children 6 months of age, .91 for children 12 months of age, and .96 for children 24 months of age (Aylward, 1995).

Temperament Scale. Emotional regulation/temperament was measured in Wave 1 via questions asked of the current caregiver adapted from the measure, How My Infant Usually Acts, previously used in the National Longitudinal Survey of Youth's Infant Behavior Questionnaire (The National Longitudinal Surveys: NLSY79 Child & Young Adult Users Guide, 2004). For children less than 12 months of age, the temperament score was the sum of the reversed scores for positive affect, friendliness, and predictability, and the fearfulness subscores (14 items). For children older than 12 months and younger than 24 months, the temperament score was the sum of the reversed scores for positive affect and friendliness, and the fearfulness subscores (11

items). Z-scores were then calculated to standardize the two versions, allowing for comparisons among all children. Higher raw scores (positive z-scores) indicate more difficult temperament. Because the temperament scale used in NSCAW was adapted from existing measures, norms are not available. The reliability of the difficult temperament scale was $\alpha = .62$.

Home Observation for Measurement of the Environment-Short Form (HOME-SF). The HOME-SF was administered to current caregivers in Wave 1 and Wave 5. The HOME-SF measures the quality and quantity of stimulation and support in the home environment (Caldwell & Bradley, 1984). The HOME has been adapted for use in many national studies; the version used in NSCAW is the short version previously employed by the National Longitudinal Survey of Youth. The scripted items of this measure were used in the current study. Examples of scripted items include: *How often do you get a chance to read stories to your child? How much time does your child spend watching television on a typical day? How many times in the past month did you tell your child you love him/her? How often does your child eat a meal with his/her mother/father?* Cognitive stimulation and emotional support subscores were summed to provide the total score. Internal consistency was greater than .80 for total scores. Internal consistency is generally low: for children age 2 and younger, Cronbach's alphas are less than .45; for children 3-5 years old, Cronbach's alphas range from .41 to .71 (Bradley, 1994). The number of items varied from 20-26 depending on the age of the child. Z-scores were calculated for the cognitive stimulation subscore, emotional support subscore, and the total score for each wave in order to standardize for different numbers of items. As stated previously, the HOME will be used as a measure of caregiving quality in this study.

Child Behavior Checklist for Ages 4-18. The CBCL was administered in Wave 5 to children's current caregiver. The problem scale is composed of 113 items in eight syndromes:

withdrawn, somatic complaints, anxious/depressed, social problems, thought problems, attention problems, delinquent behavior, and aggressive behavior as well as an 'other problems' category of 33 items (Achenbach, 1991). The items were rated on a 3-point Likert-type scale (*not true*, *somewhat or sometimes true*, *very true or often true*). A Total Problems score is calculated from the totals of each syndrome and the other problems items. Current analyses depend on age- and gender-standardized total problem behavior score (M = 53.5, *Std. Dev*. = 11.4). Construct validity was good when compared to similar scales from other instruments (.59 to .88). Internal consistency in the NSCAW sample is high for the 4- to 15-year-olds (Total Problem Behavior = .96).

Income. Total combined income of the family for the past year was reported. Income was divided into 6 categories by $10,000 intervals (0 = under $10,000; $10,000-$19,999; $20,000-$29,999; $30,000-$39,999; $40,000-$49,999; 5 = $50,000 or higher). Average income at Wave 1 was 1.70 (SE =.073) and average income at Wave 5 was 2.36 (SE = .115).

Executive Function: Follow-Up of Infant Cohort at Wave 5. 1,196 children from the CPS sample qualified for the infant follow-up. Of these, approximately 58% completed the Color Flanker task (n=694), an assessment of executive function. Executive function represents the coordination of several component skills, including working memory, inhibitory control, and attentional set shifting (Clark, Pritchard, & Woodward, 2010). Baddeley (1996) divided executive functioning into distinct processes. The construct of inhibition is most commonly used when describing executive function. Inhibition is the suppression of dominant action tendencies in favor of more goal-appropriate behavior. Inhibition is likely the key factor in executive function given that other executive function constructs involve inhibitory processes (Barkley, 1997). Other constructs proposed by Baddeley (1996) include selective attention (information

from one stream receives attention while irrelevant material is discarded), updating (encoding and evaluation of incoming information for relevance to the task at hand, and the subsequent revision of the information held in memory), and dual-task performance (the ability to coordinate performance to two tasks simultaneously). Inhibiting is necessary in each of these processes; updating requires discarding irrelevant incoming information and suppression of obsolete information. Shifting requires suppression of an old mental set in favor of a new one.

Executive functioning was tested with a Shape Go-NoGo task and a Color Flanker task. Each test was administered on a laptop. In this study, data from the Color Flanker task was used as a measure of executive functioning. In each trial, five red or blue circles were presented in a row. The child was instructed to press one of two mouse buttons within a two-second window indicating the color of the middle circle. In congruent trials, the colors of all the circles were the same, whereas the color of the middle circle was different from the others in incongruent trials. Correct answers caused a smiley face to appear on the screen while incorrect answers elicited a frowny face. An omission error occurred if the child did not respond within the two second window. A commission error occurred if the child indicated the incorrect color of the center circle. Percent of omission errors in congruent trials was highly correlated with percent of omission errors in incongruent trials (r =.97, p <.001, n=694). Therefore, the values were averaged for each participant to yield a combined percent omission errors that was used to represent executive function outcomes in all analyses. Response times were also measured for each trial; there were three blocks of trials.

McDermott, Perez-Edgar, & Fox (2007) tested children 4, 5, and 6 years of age with three different versions of the Flanker test. The three versions included the color version (incongruent trials included red and green circles), shape version (white stars and triangles), and

fish version (illustrated fish facing opposite directions). The color flanker, the same as used in the present study, appeared to be the simplest task – children across all age groups exhibited the greatest ease in responding quickly and accurately. This study showed that color flanker task is an appropriate assessment for selective attention for children as young as 4 years of age.

Results

Results are presented in four parts. First, correlations between risk for neurodevelopmental impairment, temperament, caregiving quality at Wave 1 and Wave 5, executive function outcomes, and problem behaviors are presented. Second, children were identified as doing better or worse than expected on Wave 5 outcome measures based on Wave 1 measures. Specifically, difficult temperament was used to predict behavior problems, and initial neurodevelopmental impairment risk was used to predict executive function outcomes. Next, analyses are presented which examine Wave 1 and Wave 5 HOME scores to determine if there were changes in the quality of caregiving. And lastly, analyses are presented which look correlations between caregiving quality and better than expected behavior/executive functioning outcomes given initial measures, and regression analyses looking at (a) whether better/worse than expected behavior problems as a function of initial temperament was predicted from changes in quality of caregiving; and (b) whether better/worse than expected executive functioning as a function of initial risk for neurodevelopmental impairment was predicted from changes in quality of caregiving. Because of sample design, data from children ages 3 to 24 months at Wave 1 was used in the analysis of temperament and behavior problems (n=1720), and data from children ages 3 to 12 months at Wave 1 was used in the analysis of neurodevelopmental impairment and executive function outcome (n=1152). This latter sample is referred to as the Infant Cohort.

Correlations between Study Variables.

Correlations between measures of interest are shown in Table 1 and Table 2. Table 1 shows correlations for children ages 3-24 months (at Wave 1), while Table 2 shows correlations for the Infant Cohort. Neurodevelopmental impairment distinguishes children who were at moderate- to high-risk from those who were at low-risk. Risk for neurodevelopmental impairment was positively correlated with difficult temperament ($r = .16$, $p \leq .001$, n = 1548). Difficult temperament and problem behavior were positively correlated ($r = .19$, $p \leq .05$, n = 1335). Risk and executive function were negatively correlated ($r = -.13$, $p \leq .001$, n=617). Additional correlations looking at executive function measures were calculated which are not included in either Table 1 or Table 2. The correlations between risk and commission errors reflected a non-significant trend for both the congruent ($r = .06$, $p = .264$, n = 640) and incongruent trials ($r = .06$, $p = .291$, n = 640). Risk was significantly correlated with the mean reaction time in both the congruent ($r = .10$, $p = .016$, n=637) and incongruent trials ($r = .10$, $p = .018$, n=637). The correlation between risk and percent correct responses in the congruent trials was significant ($r = -.17$, $p \leq .001$, n=640), and was a trend in the incongruent trials ($r = -.09$, $p = .057$, n=640).

For both age groupings of children, although total HOME score from Wave 1 was positively correlated with total HOME score from Wave 5 (3-24 months: $r = .18$, $p \leq .01$, n = 696; Infant cohort: $r = .18$, $p \leq .01$, n = 664). The modest size of this correlation indicates considerable change between Wave 1 and Wave 5 HOME scores. Cognitive stimulation and emotional support subscores correlated positively between waves for both age groups: cognitive stimulation (3-24 months: $r = .13$, $p = .01$, n = 696; Infant cohort: $r = .14$, $p \leq .05$, n = 664), emotional support (3-24 months: $r = .14$, $p \leq .05$, n = 696; Infant cohort: $r = .14$, $p \leq .05$, n =

664). Risk status was negatively correlated with total HOME scores at Wave 1 in both samples (3-24 months: r = - .12, $p \leq .05$, n = 1577; Infant cohort: r = -.14, $p \leq .01$, n = 1066). Risk was not significantly correlated with HOME scores in Wave 5 for either sample.

Furthermore, difficult temperament as measured in Wave 1 was negatively correlated with Wave 1 cognitive stimulation (r = -.14, $p \leq .01$, n=1664) and the total HOME score in Wave 1 (r = -.13, $p \leq .01$, n=1664); difficult temperament was not significantly correlated with any Wave 5 HOME scores. Problem behavior measured at Wave 5 was not significantly correlated with any Wave 1 or Wave 5 HOME scores. There were no significant correlations between Wave 1 or Wave 5 HOME scores and percent omission errors.

Determining Which Children had Better or Worse Outcomes than Expected.

It was next determined if children were doing better or worse than expected on Wave 5 outcome measures based on Wave 1 measures. Total behavior problem scores from Wave 5 were regressed on difficult temperament scores in Wave 1, and the residualized scores were saved (range -34.32 to 29.68). Figure 1 shows the histograms of the residualized scores. This was completed for the sample of children ages 3-24 months at Wave 1. As stated by Jaffee (2007), residualized scores as measures of change over time are preferable to difference change scores because they take into account potential differences in variance at the two time points. Positive residualized scores indicated that children had higher than expected problem behavior scores at Wave 5, given initial temperament. Negative residualized scores indicated that children had lower than expected behavior problem scores given initial temperament. 52.6% of the children had lower behavior problem scores than expected based on initial difficult temperament.

For the Infant Cohort, the percent of omission errors from Wave 5 was regressed on risk for neurodevelopmental impairment in Wave 1, and the residualized scores were saved (range -

25.99 to 82.52). Figure 2 shows the histogram of residualized scores. Positive residualized scores indicate a higher percentage of omission errors than expected at Wave 5, given initial risk for neurodevelopmental impairment (therefore, worse executive functioning), whereas negative residualized scores indicate better than expected executive function abilities at Wave 5 given initial risk for neurodevelopmental impairment. 61.8% of the children had better executive function abilities than expected based on initial risk for neurodevelopmental impairment.

Changing Quality of Caregiving.

To determine if there were improvements in the quality of caregiving, standardized Wave 5 HOME scores were regressed on standardized Wave 1 HOME score - residualized scores were saved. This was done separately for the total score (3-24 months range -3.39 to 1.88; Infant Cohort range -3.37 to 1.90), cognitive stimulation subscore (3-24 months range -4.38 to 1.63; Infant Cohort range -4.36 to 1.65), and emotional support subscore (3-24 months range -3.71 to 1.72; Infant Cohort range -3.70 to 1.72). Figure 3 shows the histogram of total HOME residualized scores for children ages 3-24 months, while Figure 4 shows cognitive stimulation residuals for children ages 3-24 months, and Figure 5 shows emotional support residuals for children ages 3-24 months. Positive residualized scores indicate that children were experiencing better caregiving quality/more cognitive stimulation/more emotional support than expected at Wave 5 given initial scores in Wave 1. Negative residualized scores indicate that the child was receiving poorer quality caregiving/less cognitive stimulation/less emotional support than expected at Wave 5 given initial scores in Wave 1. In other words, positive residualized scores indicated an improvement in caregiving quality while negative residualized scores indicated a decline in caregiving quality. 57.3% of the children showed improvement in total caregiving quality (57.4% of the Infant Cohort), 61.9% of the children showed improvement in cognitive

stimulation received (61.6% of the Infant Cohort), and 51.6% of the children showed improvement in emotional support received (51.4% of the Infant Cohort).

Moderation by Changing Quality of Caregiving.

First, analyses were conducted to examine whether caregiving quality was associated with (a) better than expected behavior outcomes given initial difficult temperament, and b) better than expected executive function outcomes given initial risk for neurodevelopmental impairment. Correlations between behavior problem residualized scores/executive function residualized scores and HOME scores were non-significant for total HOME scores, cognitive stimulation subscores, and emotional support subscores at both Wave 1 and Wave 5.

OLS analyses were conducted to look at (a) the relationship between changes in quality of caregiving and initial temperament predicting behavior; and (b) the relationship between changes in quality of caregiving and initial risk for neurodevelopmental impairment predicting executive function. Behavior problem residualized scores were regressed separately on each of the residualized HOME scores (total score, cognitive stimulation subscore, and emotional support subscore). Gender, income at Wave 1, and income at Wave 5 were controlled for. Only children with complete data were included in these analyses (n = 614), and results did not reach significance. Specifically, changes in overall caregiving quality, cognitive stimulation, or emotional support did not significantly predict better than expected behavior, given difficult temperament. This was true when the entire sample was analyzed together, when girls and boys were analyzed separately, and when families below the poverty line at either Wave 1 or Wave 5 were analyzed separately, and when families below the poverty line at both Wave 1 and Wave 5 were analyzed separately.

Similarly, the executive function residualized scores were regressed on each of the residualized HOME scores. Gender, income at Wave 1, and income at Wave 5 were controlled for. Only children with complete data were included in these analyses (n=396), and again results did not reach significance. Specifically, changes in overall caregiving quality, cognitive stimulation, or emotional support did not significantly predict better than expected executive function, given risk for neurodevelopmental impairment. This was true when the entire sample was analyzed together, when girls and boys were analyzed separately, and when families below the poverty line at either Wave 1 or Wave 5 were analyzed separately, and when families below the poverty line at both Wave 1 and Wave 5 were analyzed separately

Discussion

The present study examined whether risk for neurodevelopmental impairment assessed in infancy predicted problem behavior and executive function outcomes 5 years later. This study models the design of Jaffee (2007), who found that children who experienced improvements in cognitive stimulation had higher than expected language scores 18 months later, and children experiencing improvements in emotional support had fewer than expected behavior problems. The study extends Jaffee's work in a number of ways: outcomes were examined 5 years post baseline rather than 18 months, and executive function data was examined for the first time. In agreement with prior research, difficult temperament was found to significantly predict problem behaviors. Mott et al. (1995) found significant correlations between difficult temperament measured in young children and behavior problems 6 years later; for one-year olds at the initial measurement period, temperamental positive affect and temperamental friendliness were both inversely correlated with subsequent behavior problems.

It was hypothesized that improvements in the quality of caregiving from initial measurement to the assessment of outcomes would result in fewer problem behaviors compared to instances of a decrease in caregiving quality. These relationships proved non-significant. These findings differ from previous research: Laught, Esser, and Schmidt (2001) looked at whether early, responsive caregiving could moderate the developmental outcomes of infants born with biological risk (premature births) or psychosocial risk (adverse family factors). Children with high psychosocial risk who experienced responsive mothering had significantly lower problem and externalizing scores, less hyperactivity, and fewer defiant and conduct problems than high psychosocial risk children with non-responsive mothers.

There are numerous interpretations for the present results differing from previous literature. It may be that the HOME scale used to assess the quality of caregiving was not sufficiently sensitive. It is also important to remember that many children have close relationships with individuals other than their parents. In a situation of poor quality caregiving, a close supportive relationship with a grandparent, aunt, uncle, or sibling might have had a protective influence. This would not have been accounted for in the current study.

It was found that initial neurodevelopmental impairment risk status predicted later executive function. Being at-risk was significantly correlated with lower executive function outcomes. The specific variable used to represent executive function outcome was the percent of omission errors committed in the Color Flanker Task. While risk-status was significantly correlated with this measure, there was not a significantly relationship between risk-status and percent of commission errors committed in the same task. Therefore, being at risk for neurodevelopmental impairment was correlated with higher rates of omission errors, but not with making more commission errors.

Rates of commission errors and omission errors were found to be uncorrelated in a Go/NoGo test of executive function (Bezdjian, Baker, Lozano, & Raine, 2009). Halperin et al. (1988) tested children in grades 1-6 using the continuous performance test, which assessed individuals' attention and impulsivity. They found omission errors were significantly correlated with teacher ratings of greater inattention; omission errors were also positively correlated with the inattention-passivity factor on the Conners Teacher's Questionnaire. The same study found that commission errors were significantly correlated with higher levels of impulsivity and hyperactivity; commission errors were also positively correlated with conduct problems and hyperactivity factors on the Conners Teacher's Questionnaire. Similarly, using a Go/NoGo task for children ages 9-10 years, Bezdjian, Baker, Lozano, & Raine (2009) found that errors of omission were significantly correlated with symptom counts for inattention in both caregiver and teacher reports, while errors of commission were significantly correlated with symptom counts of hyperactivity-impulsivity. Therefore, results from the present study suggest that being at-risk for neurodevelopmental impairment is associated with deficits in attention (omission errors), but not necessarily problems with hyperactivity or impulsivity (commission errors).

Executive function is of interest because it is associated with later academic and cognitive outcomes. Clark, Pritchard, & Woodward (2010) found that lower executive functioning performance as measured by tests of inhibitory control, set shifting, and metacognitive planning at age 4 years was associated with lower mathematics achievement at age 6. In a study of 11- and 12-year old children, St. Clair-Thompson and Gathercole (2006) found that inhibition is dissociable from other executive functions in children. When controlling for working memory, inhibition was significantly associated with higher scoring in each

academic area tested (English, math, and science), indicating that inhibitory skills support general academic learning.

It was expected that children experiencing increases in caregiving quality would display better than expected executive functioning compared to children experiencing decreases in caregiving quality. However, OLS analysis did not find significant moderation by changes in caregiving quality. Again, there are numerous possible reasons why the findings differed from the hypothesis. An interesting study by Ackerman (2006) found that early experiences of caregiver instability, physical abuse, or neglect were not significant predictors of performance on a computerized task of executive function in 7-11 year old adopted children. However, these experiences of early relationship adversity was significantly associated with poor inhibitory control, inattention, aggression, and working memory difficulties as assessed by parent behavior rating instruments. These factors all contribute to executive function. While some studies such as that conducted by McDermott, Perez-Edgar, & Fox (2007) found the color flanker task to be appropriate for use with young children, using a computerized task to assess aspects of executive function might not be the best choice. These children likely have limited experience using computers. Future studies might consider alternative assessment techniques with higher ecological validity.

While both OLS regressions showed non-significant relationships between the residualized scores and changes in quality of caregiving, it is interesting to note that only 13% of the sample was low-risk for neurodevelopmental impairment, but 52.6% showed better than expected behavior outcomes and 61.8% showed better than expected executive function outcomes. Therefore, there are still environmental factors that contribute to protecting against biological risks leading to poor outcomes.

In this study, it was assumed that changes in the quality of caregiving affect children's outcomes, rather than children's temperament or biological risk affecting the quality of caregiving they receive. This assumption was supported by the findings of Jaffee (2007). Jaffee performed a 'natural experiment' by looking at children who were removed from the care of their biological parents during a longitudinal study. She found that quality of caregiving predicted language scores and problem behavior, while neither neurodevelopmental risk nor difficult temperament predicted changes in caregiving quality. Therefore, looking at the relationship of parenting affecting child outcomes is supported.

There are a number of limitations in this study. It should be reiterated that the NSCAW sample is representative of children who were in contact with Child Protective Services, and is not representative of all children in the United States. By definition, this is a high-risk sample. While income was controlled, it is likely that other factors contributed to performance on outcome measures other than changes in the quality of caregiving. Some children experienced placement changes during the course of the study. Placement changes would be accompanied by different neighborhood characteristics, different caregiver and living situation characteristics, and an adaptation period. Additionally, better than expected outcomes did not indicate functioning in the normal range. Problem behavior scores below 60 indicate borderline or clinically significant problem behaviors. Of the children who were performing better than expected based on initial temperament, 36.3% still had scores below 60.

There are also a number of strengths associated with this study. The longitudinal nature of the NSCAW study allowed for the same children to be followed over the course of 5 years. Furthermore, because of the sample targeted by NSCAW, there were a large number of children who were at-risk for neurodevelopmental impairment. Initial data during infancy is critical for

the development of effective early interventions. Follow-up data around age 5 is especially useful because this is when most children start formal schooling. Deficits in behavior regulation and executive function abilities would negatively impact children's abilities to excel in the classroom. Additionally, this study looked at outcome measures 5 years post-baseline, while Jaffee's study (2007) looked at 18-month outcomes. This longer period provides more information concerning trajectories and outcomes.

The results of the present study did not support the hypothesis that higher quality caregiving would protect against negative outcomes associated with risk for neurodevelopmental impairment. However, it was found that risk in infancy could predict problem behavior and executive function deficits five years later. It was also found that risk for neurodevelopmental impairment is associated with deficits in attention, but not necessarily problems with hyperactivity or impulsivity. This information is valuable when developing appropriate interventions for children at risk for neurodevelopmental impairment. Early behavior therapy can be initiated for children at risk. Furthermore, cognitive skills therapy can be used to focus on developing attention skills. With early detection, efforts can be made to decrease or eliminate problems before children's entrance into formal schooling.

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Table 1.

Correlations of Measures of Interest for Children Ages 3-24 Months (in Wave 1).

		1	2	3	4	5	6	7	8	9
1	Neurodev. Risk W1	1.00								
2	Difficult Temperament W1	.16*** N=1548	1.00							
3	Cognitive Stimulation W1	-.15** 1577	-.14** 1664	1.00						
4	Emotional Support W1	-.04 1577	-.07 1664	.31*** 1720	1.00					
5	Total HOME W1	-.12* 1577	-.13** 1664	.75*** 1720	.86*** 1720	1.00				
6	Problem Behavior W5	.04 1257	.19* 1335	0 1382	-.08 1382	-.05 1382	1.00			
7	Cognitive Stimulation W5	0 637	-.09 691	.13** 696	.05 696	.12* 696	-.09 696	1.00		
8	Emotional Support W5	0 637	-.09 691	.15* 696	.14* 696	.18** 696	0 696	.31*** 696	1.00	
9	Total HOME W5	0 637	-.11 691	.18** 696	.11* 696	.18** 696	-.07 696	.85*** 696	.77*** 696	1.00

$*p \leq .05$ $**p \leq .01$ $***p \leq .001$

Table 2.

Correlations of Measures of Interest for the Infant Cohort (Children Ages 3-12 Months in Wave 1.)

		1	2	3	4	5	6	7	8
1	Neurodev. Risk W1	1.00							
2	Cognitive Stimulation W1	-.08 N=1066	1.00						
3	Emotional Support W1	-.13*** 1066	.31*** 1152	1.00					
4	Total HOME W1	-.14** 1066	.75*** 1152	.86*** 1152	1.00				
5	% Omission Errors (Exec. Function) W5	.13*** 617	0 669	-.09 669	-.06 669	1.00			
6	Cognitive Stimulation W5	-.03 606	.14* 664	.05 664	.12* 664	.09 482	1.00		
7	Emotional Support W5	0 606	.16* 664	.14* 664	.18** 664	.03 482	.30*** 664	1.00	
8	Total HOME W5	-.03 606	.18** 664	.11* 664	.18** 664	.08 482	.85*** 664	.76*** 664	1.00

$*p \leq .05$ $**p \leq .01$ $***p \leq .001$

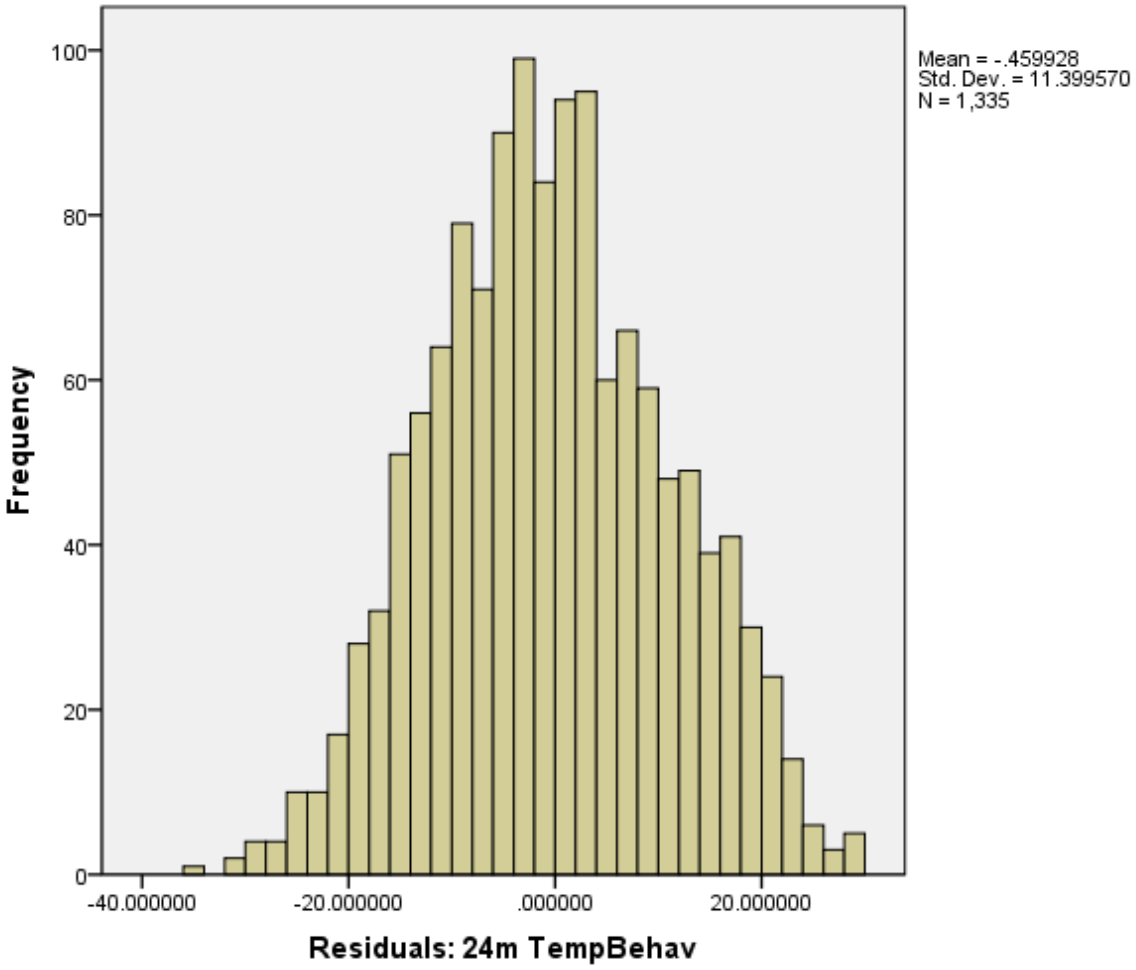

Figure 1.

52.6% of the children had lower behavior problem scores than expected based on initial difficult temperament (as shown by negative residualized scores).

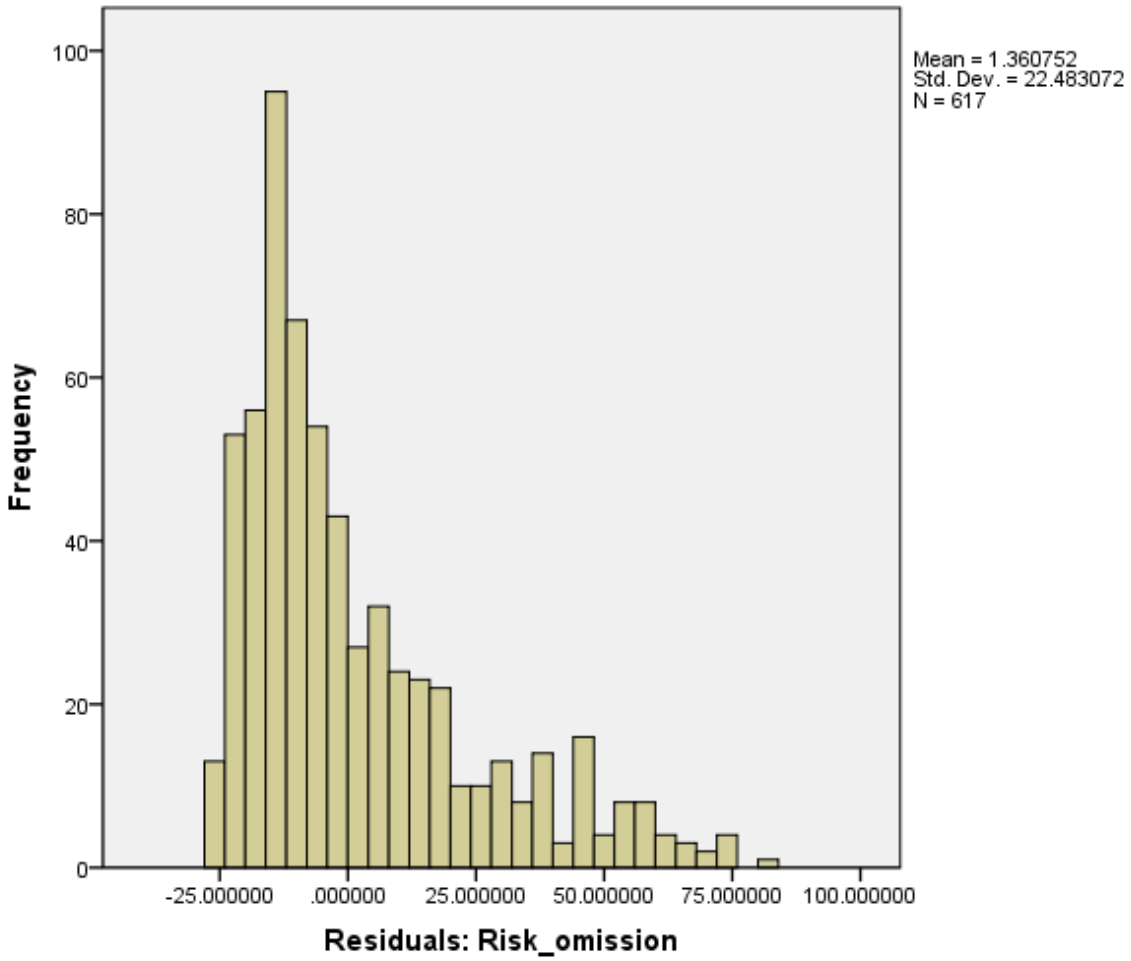

Figure 2.

61.8 % of the children had better than expected executive function outcomes based on initial risk for neurodevelopmental impairment (as shown by negative residualized scores).

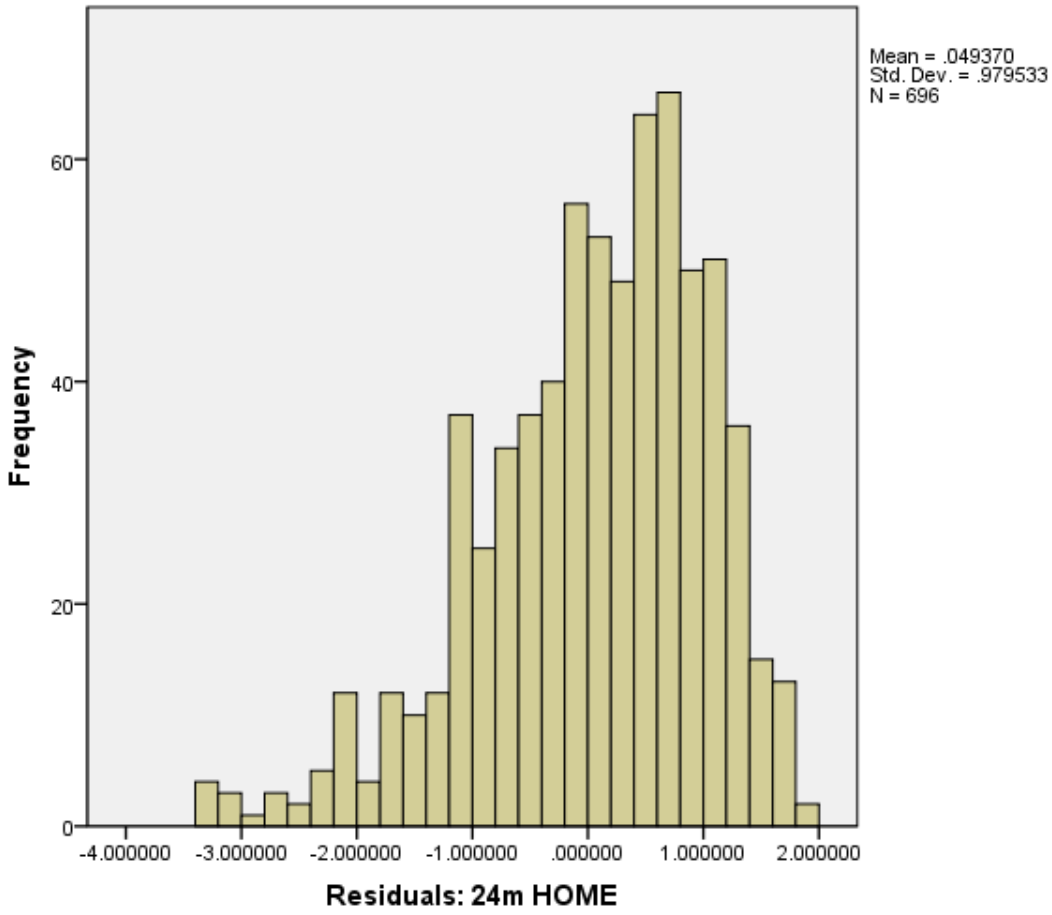

Figure 3.

57.3% of children ages 3-24 months at Wave 1 showed improvements in total caregiving quality (as shown by positive residualized scores).

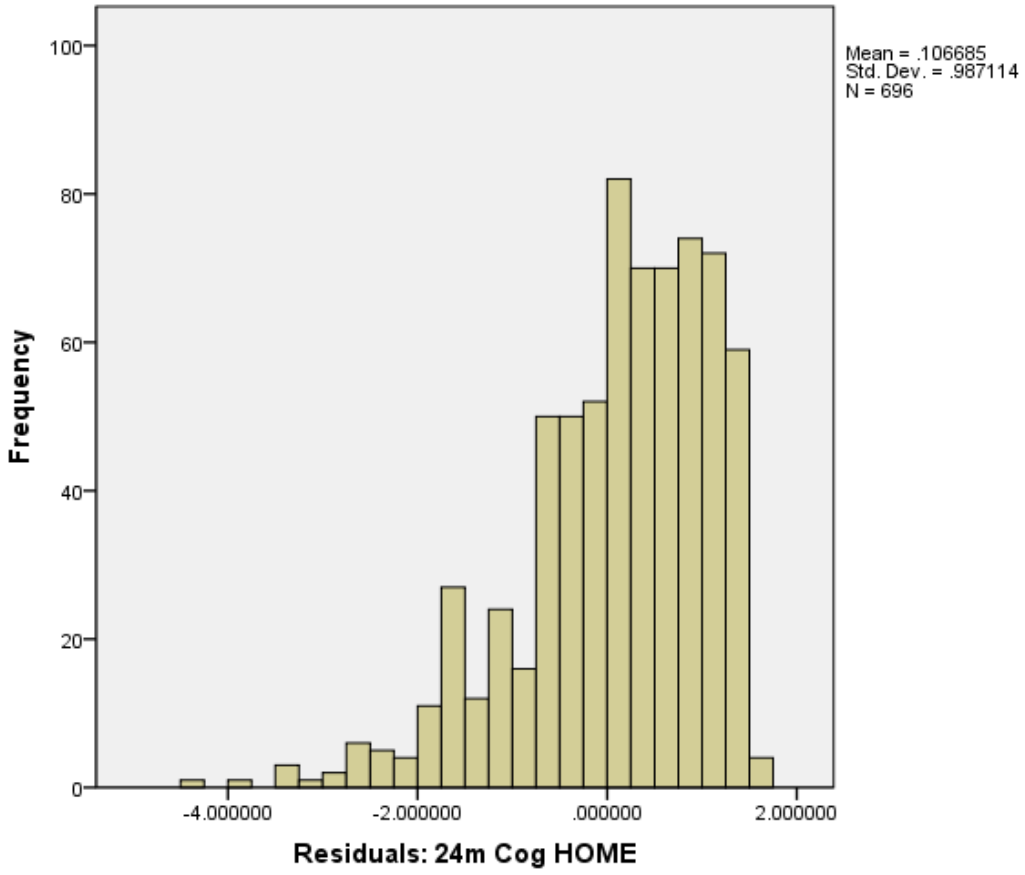

Figure 4.

61.9% of children ages 3-24 months at Wave 1 showed improvements in cognitive stimulation received (as shown by positive residualized scores).

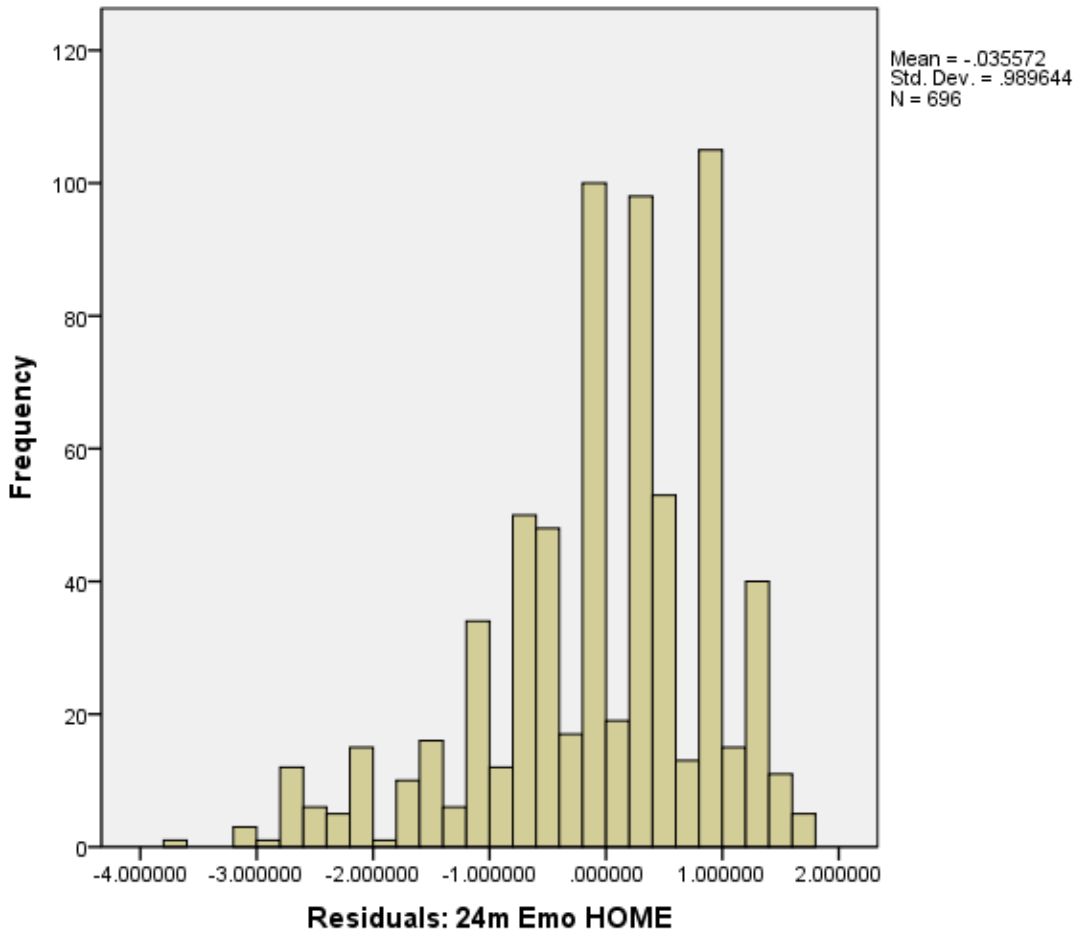

Figure 5.

51.6% of children ages 3-24 months at Wave 1 showed improvements in emotional support received (as shown by positive residualized scores).