Altered brain development following global neglect in early childhood

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*This is an Academy version of a paper presented at Society for Neuroscience Annual Meeting, New Orleans, 1997

Official citation: Perry, BD and Pollard, D. *Altered brain development following global neglect in early childhood.* Society For Neuroscience: Proceedings from Annual Meeting,New Orleans, 1997

Introduction

Each year in the United States alone, over 500,000 children suffer from some version of "neglect." Neglected children brought to the attention of the Child Protective Services has a much higher probability of emotional, behavioral, cognitive, social and physical delays and dysfunction than "comparison" children. It is becoming increasingly clear that the nature, timing and extent of neglect in childhood are critical in determining the nature and extent of these deficits (Perry et al., 199 5; Courchesne et al., 1994).

This observation may seem somewhat obvious to individuals familiar with the principles of neurodevelopment and the animal studies documenting the critical role of sensory stimulation in organizing the developing central nervous system. Indeed, use (or activity) dependent development and modification of neural systems is one of the core principles of neurodevelopment (see Singer, 1995). In animals raised in sensory depriving situations, a host of abnormalities in neurochemical and neuroarchitectural organization have been documented (e.g., Darwin, 1868; Ebinger, 1974; Cragg, 1975). The functional consequences of sensory deprivation during neurodevelopment can be significant. Indeed , in some severe deprivation situations, sensory deprivation or sensory disorganization during critical or sensitive periods can result in permanent dysfunction (e.g., Spitz & Wolf, 1946; Perry, 1997). This has ominous implications for human development.

While many studies have described various functional consequences following neglect in childhood, few have examined aspects of neurodevelopment in neglected children. The present study reports a preliminary examination of measures of brain growth in a large group of neglected children.

Method

Children (ages 0 to 17) were referred to our specialty clinic for evaluation by Child Protective Service or other agencies working with children following abuse or neglect. Comprehensive physical, developmental and neuropsychiatric evaluations were conducted to assist in placement and treatment planning. As part of this evaluation, comprehensive pre- and perinatal history were obtained, as were various measures of growth
(height, weight and frontal-occipital circumference: FOC).

Charts were reviewed for evidence of pre-natal drug exposure (PND) and neglect. Neglect was considered global neglect when a history of relative sensory deprivation in more than one domain was obtained (e.g., minimal exposure to language, touch and social interactions). Chaotic neglect is far more common and was considered present if history was obtained that was consistent with physical, emotional, social or cognitive neglect. When possible history was obtained from multiple sources (e.g., investigating CPS workers, family, police).

Based upon these reviews, the neglected children (n= 122) were divided into four groups: Global Neglect (GN; n=40); Global Neglect with Prenatal Drug Ex posure (GN+PND; n=18); Chaotic Neglect (CN; n=36); Chaotic Neglect with Prenatal Drug Exposure (CN+PND; n=28). Measures of growth were compared across group and compared to standard norms developed and used in all major pediatric settings.

In cases where neuroimaging studies had been conducted as part of a medical or neurological evaluation, these images were examined in a retrospective fashion. Neuroradiologists had read the scans in context of the original medical or neurological referral and, typically, were unaware of the neglect or psychosocial situation of the child.

Results

Growth

Dramatic differences from the norm were observed in FOC (suggesting de creased brain growth) for the globally neglected children (see Figures). This group

6;s mean FOC was only in the 10th percentile, while height and weight measures of growth demonstrated less difference (30-40th percentile). In contrast , the chaotically-neglected children did not demonstrate this marked group difference in FOC.

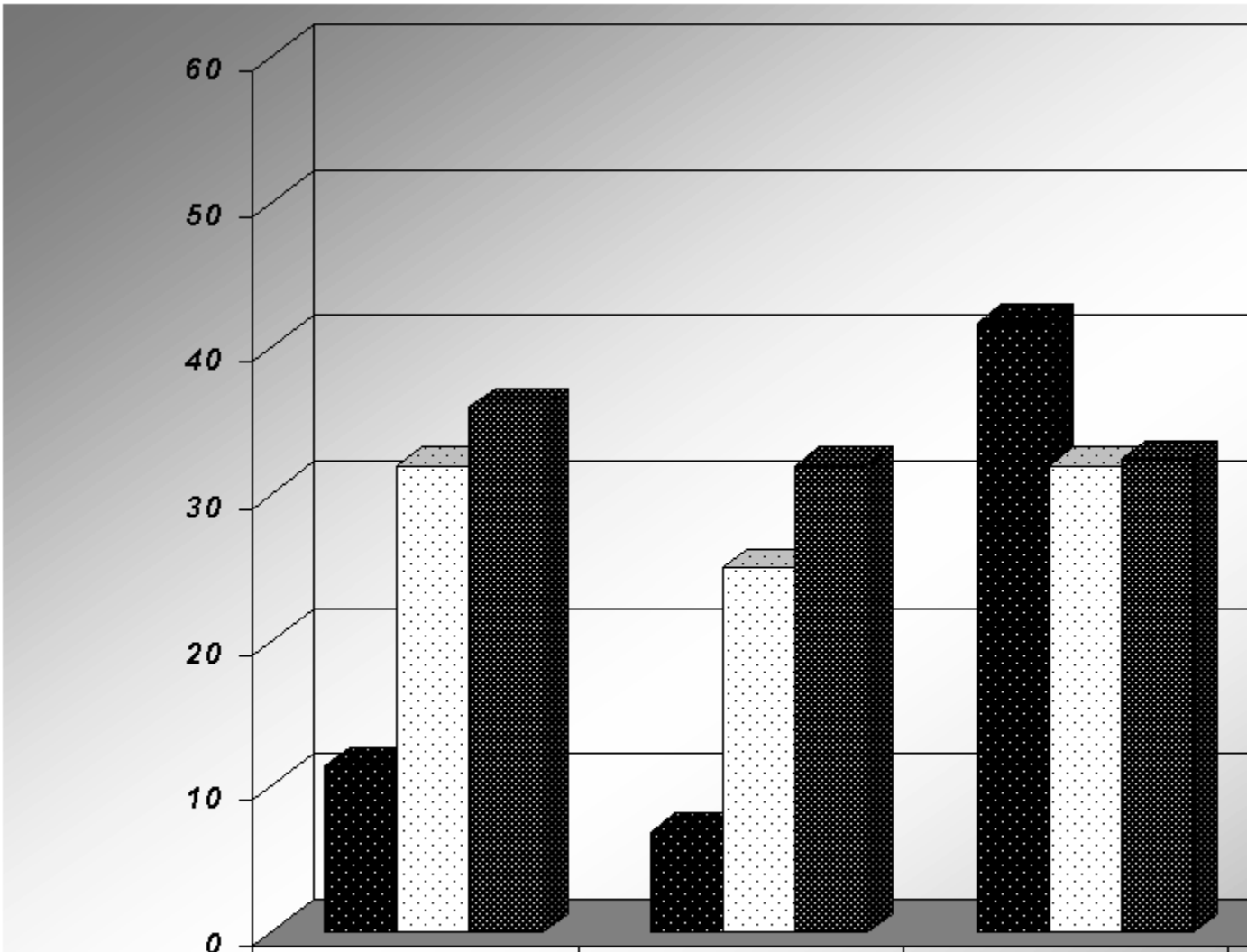
Pre-natal drug exposure appeared to have an interactive, but complex effect on growth. In the global neglect population, it appeared to exacerbate the observed growth differences. In the chaotic neglect group, however, no differences in growth were observed.

Neuroimaging

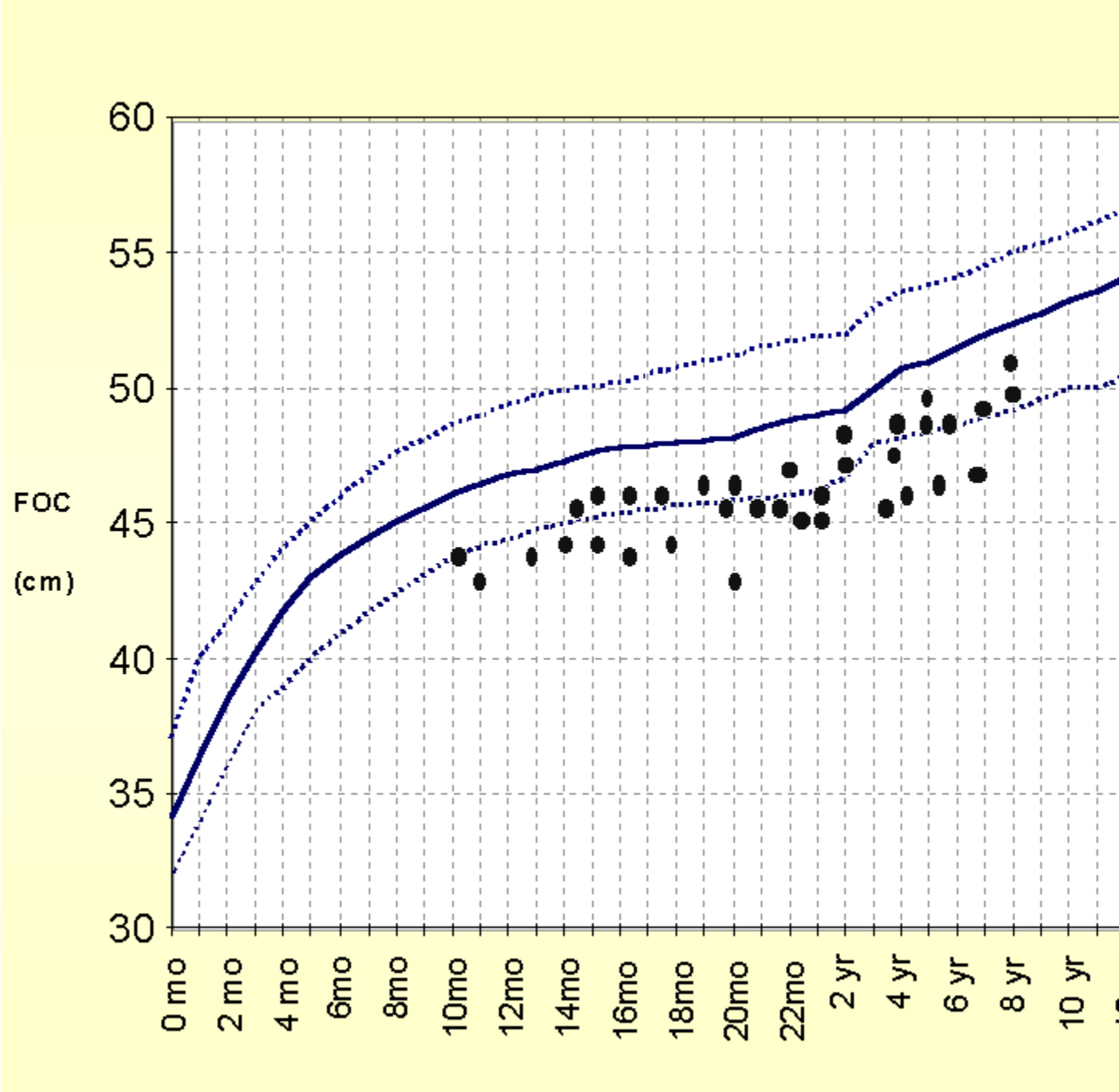
Neuroradiologists interpreted 3 of 26 scans abnormal from the children with chaotic neglect (11.5 %) and in 11 of 17 of the children with global neglect (64. 7 %). The majority of the readings were "enlarged ventricles" or "cortical atrophy." Few focal abnormalities were noted.

Normal vs. Abnormal CT or MRI Scans in Neglected Children

	Normal	**Abnormal**
Chaotic Neglect	18	1
Chaotic Neglect + PND	5	2
Global Neglect	3	8
Global Neglect + PND	3	3



	GLOBAL	GLOBAL + PND	CHAOTIC
FOC	11.4	6.9	41.7
HEIGHT	32	25	32
WEIGHT	36	32	32.4



Discussion

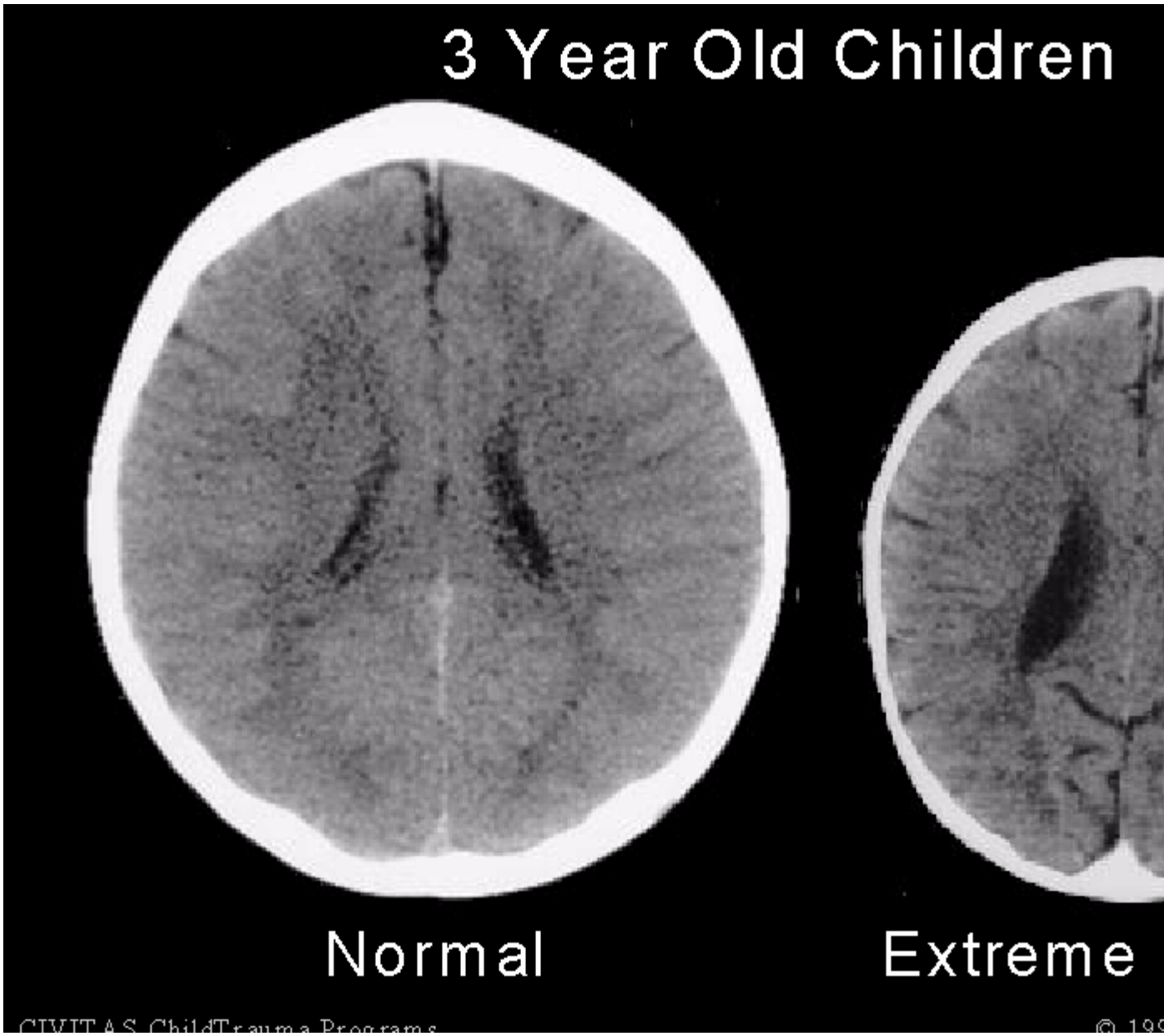
These findings strongly suggest that when early life neglect is characterized by decreased sensory input (e.g., relative poverty of words, touch and socia l interactions) it will have a similar effect on humans as it does in other mammalian species. Sensory deprivation has been demonstrated to alter the physical growth and organization of the brain in animals.

The present studies suggest that the same is true for children globally neglected in the first three years of life. It is important to emphasize the timing of the neglect. The brain is undergoing explosive growth in the first years of life, and, thereby, is relatively more vulnerable to lack of organizing experiences during these periods. These unfortunate globally neglected children (some literally were raised in cages in dark rooms for the first years of their lives) appear to have altered brain growth.

There are likely many factors contributing to this observation. Nutrition is one key aspect. Based upon the relative impact on the brain as opposed to other growth, a total nutritional explanation is inadequate. It is likely that the actual lack of experiences (sound, smell, touch) associated with global neglect in these children plays a major role.

While the actual size of the brain in chaotically neglected children did not appear to be different from norms, it is reasonable to hypothesize that organizational abnormalities exist.

Volumetric studies of key areas are indicated, as are MRI studies to examine the functional impact of neglect; global or chaotic.



These images illustrate the negative impact of neglect on the developing brain. In the CT scan on the left is an image from a healthy three year old with an average head size. The image on the right is from a three year old child suffering from severe sensory-

deprivation neglect. This child's brain is significantly smaller than average and has abnormal development of cortex.

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