What About The Children?

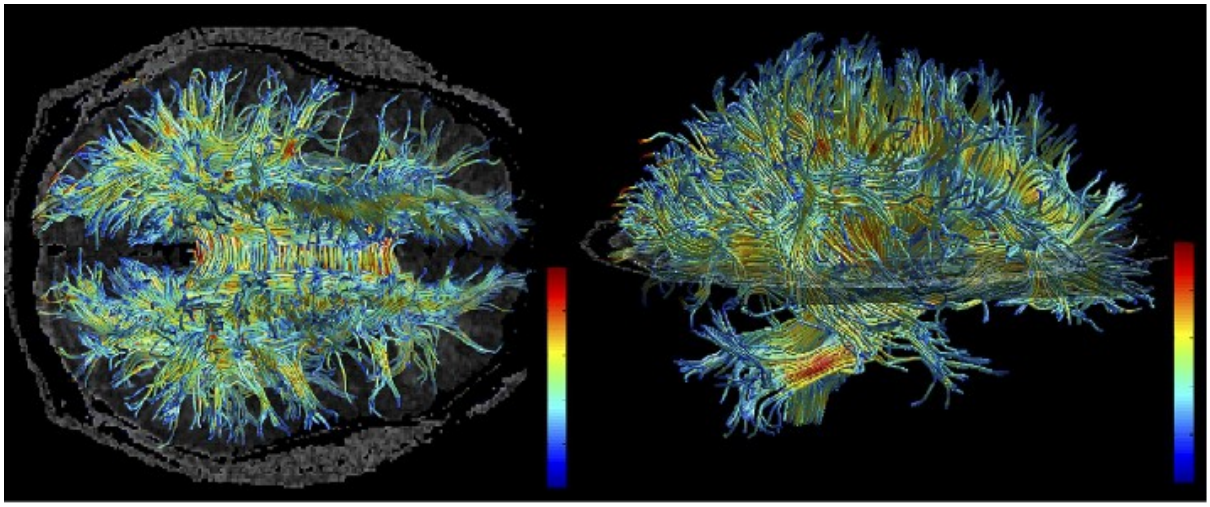
RESEARCH SUMMARY

Effect of Early Institutionalization and Foster Care of Long-term White Matter Development: a Randomized Clinical Trial.
Bick, J., Zhu,T., Stamoulis, C., Fox, N.A., Zeanah, C. & Nelson, C.A. (2015)
JAMA Pediatrics. Published online January 26, 2015.

The substance of the brain is largely composed of grey and white matter. Grey matter can be thought of as the computer-like processing regions of the brain. White matter is analogous to bundles of wires linking the processors. White matter is composed of myelinated nerve fibres; the myelin acts rather like an insulation layer round each individual fibre. In children, micro-structural changes in both grey and white matter are affected by emotional and cognitive development.

It is well known that the Romanian orphans that survived the downfall of the communist regime in Romania had been exposed to severe neglect. As a consequence, their brains were small and poorly developed compared with those of non-institutionalized children. Chugani *et al* (2001) were the first to analyze those children's internal brain structures using PET (Positron Emission Tomography) scans. This current paper has rigorously examined *in vivo* the development of the white matter in the brains of a group of institutionalized children (from the Romanian orphanages) and compared them with a group of formerly institutionalized children who were subsequently fostered in high quality family environments. Both of those groups were compared with an identical *in vivo* procedure (Diffusion Tensor Imaging (DTI) technique within an MRI scan (Magnetic Resonance Imaging)) performed on the brains of children who had not been institutionalized. DTI scans were performed at age 8 years. Figure 1 (Kubicki *et al* 2007 – not Bick *et al*) below, shows a pictorial representation of a brain DTI scan showing only white matter. The DTI technique measures the fractional anisotropy (FA) in the myelin sheath of the nerve fibre (anisotropy is the property of being directionally dependent. It can be defined as a difference when measured along different axes [xyz directions]); FA is a measure of diffusion in all directions. FA = 0 (blue) suggests diffusion is unrestricted in all directions; FA = 1 (red) suggests that diffusion is restricted.

Figure 1: White matter pathways in the human brain. Left picture illustrates the white matter tracts from above. Right picture shows white matter tracts viewed from the right hand-side. In both pictures the subject's eyes would point towards the right-hand side. The false colour indicates the fractional anisotropy for diffusion in the fibres: red for FA=1, blue for FA=0. (*Wikipedia Commons Licence*. *Reproduced from: Kubicki M. et al A review of diffusion tensor imaging studies in schizophrenia. J Psychiatr Res. 2007 Jan-Feb;41(1-2):15-30.*)



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136 Romanian children, aged about 2 years, who had spent at least half their life in an orphanage were used for the sample pool. Half of this group were randomly assigned to the group that would be fostered in a high-quality family environment; the other half remained in the orphanage. A third group of children with similar ages and gender distribution, that had never been institutionalised, were used as the control group. In the institutionalized group there was a high ratio of children to caregiver (about 12 children per caregiver). Social workers encouraged foster caregivers to develop committed and loving relationships with the foster children. There were 56 families giving foster care to 68 children; 87% of the foster children remained with the foster family. Of the three groups of children, 23 children were randomly selected for DTI scanning from the fostered group, 26 children were randomly taken from those remaining in institutional care and DTI scanned, as were 20 children who were randomly selected from the group which had never had institutional care. In the DTI scanning, 48 white-matter tracts from a standard set of tracts were examined.

FA was statistically distinct in the 3 groups of children in 4 of the 48 white-matter tracts. These tracts are the corpus callosum, both left and right external capsules and the right retrolenticular internal capsule. This is the first demonstration, in a randomized trial, that the microstructure of the myelinated fibres is associated with child neglect in the 2 groups of institutionalised children. Axons are tube-shaped, so diffusion can move in a direction radially across the tube, or axially along the tube. The analysis of DTI can be further refined to determine the direction of the anisotropy in terms of mean (MD), radial (RD), and axial (AD) diffusivity.

Below is table 1 which displays the data showing that extreme neglect in early life is associated with these fine structural changes in the white fibres.

Table 1. Fractional anisotropy and directional diffusivity in white-matter tracts associated with extreme neglect in early life. S denotes a statistically significant effect compared with children raised without neglect.

White matter tract	FA	MD	RD	AD
Corpus callosum	S	S	S	
Fornix crus				S
Cingulum		S	S	
Anterior frontostriatal circuitry				S
Superior frontostriatal circuitry		S		S
Corona radiate and external capsule	S	S	S	
Medial lemniscus		S		S
Retrolenticular internal capsule	S	S	S	

In contrast, the group of fostered children showed white-matter structural changes were mostly not significantly different from those of never-institutionalized children. These findings may suggest that early fostering, in a high-quality family environment, can ameliorate the effects of neglect on white matter structural changes in the brain. As yet, neurocognitive and behavioural changes have not been correlated with white-matter changes in early-life child neglect.

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