RESEARCH SUMMARY

Structural Variations in Prefrontal Cortex Mediate the Relationship between Early Childhood Stress and Spatial Working Memory

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Stress can affect social, cognitive and physiological functions of the body, with low levels of stress having a beneficial effect, whilst high levels have negative cognitive effects. High levels of stress can alter the hippocampus and pre-frontal cortex (PFC) in the brain. Stress can have a particularly negative effect on the 'executive functions' of the brain, such as control of inhibitions, cognitive flexibility, sustained attention and working memory. To date little is known about the neurobiological correlates of stress-induced changes in the developing brain.

Animal studies have shown that chronic levels of high stress can lead to structural changes in the PFC. During childhood and adolescence the PFC is continually changing, making it vulnerable to the effects of chronic stress in early life. This study looked at whether individual differences in the PFC were caused by the cumulative effects of life stress on the developing brain. In particular, they looked at whether working memory was affected by cumulative life stress and the extent to which this affected individual brain changes.

Sixty-one children participated in the study, completing an interview and MRI scan. Maternal education was used as a measure of socioeconomic status. Children who had suffered physical abuse or other forms of maltreatment were excluded from the study. Development of puberty was measured by a nurse, as maturation of puberty may be affected by cumulative life stress which may also affect brain development. An executive functioning assessment was also carried out on the children. Cumulative life stress was assessed by administering a questionnaire to both parents and children. An independent team then rated the level of stress on a 10-point scale. Parents completed another questionnaire to assess secondary psychopathology.

The study showed that development of puberty was affected by cumulative life stress. As the researchers had hypothesized, portions of the PFC were shown to be smaller with higher levels of cumulative life stress and smaller PFC volumes were associated with poorer executive functioning. Adolescents who have experienced high levels of stress may lose grey matter in the brain at a faster rate than those who have not experienced similar levels of stress.

A limit of the study is that only one brain scan was carried out on the children, which could mean that as the brain is still developing it could 'equalise' itself over time. Environmental factors, such as exercise and environment enrichment, could help to reduce the negative effects over time.

Additional areas of the brain, aside from the PFC were also seen to be affected by cumulative life stress, areas such as those related to sensory processing and multisensory integration. Changes in areas of the brain such as these could affect behaviours such as controlling attention, regulating emotions and memory formation. By linking cumulative life stress to alterations in the brain and linking the alterations to behavioural performance the research suggests that structural differences in the PFC may be one way by which cumulative life stress leads to poor executive functioning. Damage to the PFC may lead to impairments in planning, goal-attainment, problem-solving and regulation of emotions. Structural stress-induced changes in this region of the brain could lead to impairment in such processes meaning that cognitive performance during development could be impaired.

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