Chapter 11
Efficacy of Cognitive Strategy Instruction in Developmental Dyscalculia, With and Without Neuropsychological Intervention:
Insight from a Validation Trial

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ABSTRACT

Developmental dyscalculia is a neuro-developmental disorder, affecting an individual's ability to acquire mathematics skills, which cannot be explained by intelligence, educational background, or visual/hearing impairment. The study aims to compare whether there is significant improvement in math, cognitive, and adaptive functioning when a cognitive strategy instruction program in math is delivered with or without neuropsychological intervention in children with developmental dyscalculia and/or low achievement in math, and to find whether significant difference exists between the experimental groups in terms of effects of intervention. The sample comprises of 14 subjects of 7-10 age group identified from regular schools and randomly assigned to experimental groups one and two and given remediation. Findings reveal that while both the experimental groups showed improvement following interventions in specific math, cognitive, and adaptive variables, the differential improvement in effect of intervention has been found only in adaptive and maladaptive measures in the experimental group one.

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INTRODUCTION

Mathematical skill acquisition is important for academic success during school years, adeptness in meaningful adaptive functioning and increases chances for employability in adult life. However there are wide individual differences in the ability to use these skills. It has also been observed that children may have relative weakness in certain areas of Math while being proficient in others.. Developmental dyscalculia (DD) is a neuro-developmental disorder that affects an individual's ability to acquire mathematics skills, which cannot be explained by measured intelligence, educational background or visual/hearing impairment (DfES, 2001). It is a type of Specific Learning Disorder (SLD), which is diagnosed when significant under-achievement in Math occurs in children with average and above average intelligence, due to underlying cognitive processing problems. Low-achievement in Math is not uncommon among school going population whose reasons include improper study habits, inappropriate teaching, parental illiteracy and inadequate home stimulation, low intelligence and emotional problems.DD is distinguished from other causes of low achievement in Math, due to the presence of an innate, highly specific impairment in the capacity for understanding numbers viz., the defective number module (Butterworth, 2005) or the number sense deficit (Dehaene, 2001), a domain specific cognitive deficit, the neural substrate of which is the Horizontal intra-parietal sulcus, a specific region of the parietal cortex. Number processing deficits arise when this core capacity fails to develop normally, however domain general cognitive factors also contribute to the different aspects of math which include attention, working memory, long-term memory, processing speed (Fuchs et.al, 2006) and visual-spatial skills (Geary, 1993).Epidemiological research of dyscalculia has increased over the past two decades, the results of which show that its prevalence is no less than that of dyslexia, ranging from 3-14% (Barbaresi, Katusic, Colligan,; Gross-Tsur, Manor & Shalev, 1996; von Aster et.al., 2007; Badian, 1983). In India, Ramaa & Gowramma (2002), has estimated a prevalence rate of 5.98%for dyscalculia, among primary school children. DD is a Specific Learning Disorder which has gained the attention of educators & scientists relatively late compared to Dyslexia. However it's debilitating effects on affected children not only impairs academic performance in Math, but often leads to negative attitude and Mathematics anxiety (Cemen,1987),which is a state of discomfort occurring as a response to situations involving math tasks, perceived to be threatening to self-esteem. Increased Math anxiety is also associated with decreased working memory capacity (Ashcraft & Kirk, 2001), a key cognitive factor in mathematical performance.

This disorder is characterized by math problems stemming from the core deficits of impaired numerosity processing manifested as 1) poor enumeration skills which includesa) poor "subitizing" which is the innate ability to recognize quantities less than 4 without actual counting, in less than 100 milliseconds; b) slow, inaccurate counting skills and c) poor estimation skill (a strategy employed when a stimulus display has a large number of items, presented briefly); 2) slower response time in magnitude comparison (Landerl, Bevan & Butterworth, 2004) and 3) Reverse distance effect i.e., it takes longer to decide that 9 is larger than 2, than 9 is larger than 8, as they take longer time to count from 2 to 9 than 8 to 9 (Butterworth, 1999). They also show 1) difficulty to learn and recall number facts evident from increased frequency of errors and increased reaction time in recalling (Geary & Hoard, 2001);2) immature strategy use, like use of finger counting for more number of years while solving problems (Geary, 1993), commit errors of miscounting or loosing track of counting process (Jordan & Montani, 1997) ; 3)number comprehension as well as production deficits (Dehaene & Cohen 1995) including transcoding from verbal to Arabic representations i.e., eighty four to 804, which happens due to the disruptions in the syntactic structure of number processing (Seron & Fayol, 1994); 4)difficulty in complex calculations