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CHILDHOOD BEHAVIOUR

The effect of rhythmic exercises on cognition and behaviour of maltreated children: A pilot study☆

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Summary *Objectives:* This study assesses the effect of rhythmic exercises using Rhythmex® program on the cognitive function and behaviour of maltreated children living in a group residential facility.
Method: School age children (ages 6–9) participated in the study, one group of 23 children exercised with Rhythmex rhythmic exercise program for eight weeks, 2–3 times a week, for 5 min, while a second group of 14 children did not exercise. Both groups took the Visual-Motor Integration (VMI) test pre- and post-intervention and social workers evaluated their behaviour on the Achenbach's Child Behaviour Checklist (CBCL) pre-intervention and then 12 months later.
Results: Improvement of 12 months on average in the VMI scores from pre- to post-intervention among the exercise group participants was observed compared with the control group. Aggressive behaviour was significantly lower on the Achenbach's CBCL aggression subscale among the exercise group participants compared with the control group.
Conclusion: Rhythmic exercises for 5 min, 2–3 times a week for 8 weeks appear to be effective in improving VMI scores and lowering aggressive behaviour among maltreated children when compared to children of the same age who did not participate in the rhythmic exercises program.

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Introduction

Exercises and physical activities are related to enhanced cognitive functioning and brain plasticity (Colcombe et al., 2006; Erickson et al., 2007a, b, c, 2009; Kramer et al., 2005, 2006; McAuley et al., 2004). Studies in animals and humans have revealed that after a period of exercise there is an increase in the levels of several neurotrophic factors related to cognitive functioning, neurogenesis, angiogenesis and plasticity (Deslandes et al., 2009). Factors like Brain Derived Neurotrophic Factor (BDNF), and Long-Term Potentiation (LTP) are essentials for hippocampal functioning, synaptic plasticity, and learning (Bliss and Collingridge, 1993; Cotman et al., 2007; Cotman and Engesser-Cesar, 2002; Winter et al., 2007; Ying et al., 2002). Review of studies of the benefits of exercises for mental function and psychological well-being of children suggests that systematic exercise programs are important for children's development affecting intelligence, cognition, and academic achievement (Davis et al., 2007; Tomporowski et al., 2008). Rhythmic exercises with auditory cues are different from aerobic or strength exercises as they do not increase heart rate or aerobic intake, but rather connect with a natural rhythm of the brain during bilateral movements (Banerjee and Jirsa, 2007). The following study reports on the effect of a rhythmic exercise program of moderate intensity exercises with a metronome, on the visual-motor integration of elementary school age children who have been maltreated and are now living in a group residential facility.

Motor coordination, emotions, and cognitive functions

Motor coordination problems in children have been linked to emotional difficulties and poor social skills (Cummins et al., 2005; Piek et al., 2008; Schoemaker et al., 1994; Schoemaker and Kalverboer, 1994; Skinner and Piek, 2001). Motor difficulty may affect the children's social status and emotional state if they perceive themselves as less physically and socially competent than their peers. Studies of children as young as six years of age have established a link between motor coordination difficulty and socio-emotional problems (Schoemaker et al., 1994). In a recent study by Piek et al. of preschool age children, motor ability was linked to a child's emotional state of anxiety/depression (Piek et al., 2008). Studies under functional MRI (fMRI) of the cortex have shown that cognition, emotion, perception and motor functions are intertwined within the neural structure (Afifi, 2003; Belmonte et al., 2004; Munakata et al., 2004). Earlier studies with school age children have reported that exercises improve motor and cognitive functions, emotional and social behaviour (Cummins et al., 2005; Serrien et al., 2007); this, in turn, can affect academic performance. The present study had investigated the effect of rhythmic exercises on the cognitive development of children who were maltreated or neglected. Maltreated, abused, or neglected children appear to have greater cognitive and academic deficits, social withdrawal, and limited peer interactions (English et al., 2005; Hildyard and Wolfe, 2002).

Rhythm and cognitive development

Recent studies of infants and young children have investigated the role of rhythm in learning and maturation processes affecting motor, speech, and language development. In a study of hand movements in infants, rhythmic pattern and organized movement were associated with normal development. Unstructured spontaneous hand movements of premature infants were more characteristic of infants with brain injuries, while infants without brain injuries exhibited a structured pattern of hand movements (Ohgi et al., 2008). Another study of language acquisition of infants has suggested that rhythmic pattern movements of infant hands are correlated with "first language" acquisition (Petitto et al., 2004). A study of children with Specific Language Impairment (SLI) has revealed co-occurring motor problems and rhythmic processing deficits, such as difficulty in following auditory cues in a rhythmically timed tapping task compared to other children of the same age (Corriveau and Goswami, 2009). Rhythmic exercises are timed activities and a recent study has linked general intelligence with the mean and variability of reaction time in elementary cognitive tasks, such as finger tapping (Ullen et al., 2008). In a recent study with Rhythmex, it has been suggested that Rhythmex can improve cognitive functions and emotional states in addition to improving motor dysfunction (Goldshtrom et al., 2010).

The purpose of this study was to assess the effect of Rhythmic Exercises with Auditory Cues (REAC) on cognitive performance and behaviour of maltreated children living together in a group residential facility using rhythmic exercises.

Rhythmic Exercise with Auditory Cues (REAC) in rehabilitation

Rhythmic exercises — exercises performed to an auditory cue (using a metronome) — have been proposed in multiple studies in the rehabilitation of people after brain injuries or lesions (i.e. stroke) with central or peripheral impairments, as a single modality or in combination with other modalities (Cauraugh et al., 2009; Cauraugh and Summers, 2005; Luft et al., 2004; Mudie and Matyas, 2000; Richards et al., 2008; Stewart et al., 2006; Whitall et al., 2000). While brain injury can cause impairment of one side or one extremity of the body, REAC exercise programs specify bilateral alternating movements of both sides, like the Bilateral Arm Training With Rhythmic Auditory Cueing (BATRAC) method for the upper extremities after stroke (Richards et al., 2008; Waller and Whitall, 2008; Whitall et al., 2000), and the Rhythmic Auditory Stimulation (RAS) method for lower extremities as walking exercises with Parkinson's patients (Ellis et al., 2008; Katherine et al., 2007; Password, 2007; Thaut et al., 1996, 1997, 2007), or as walking on a treadmill (van Wegen et al., 2006). The RAS protocol was also reported to help children diagnosed with cerebral palsy to improve their gait performance (Kwak, 2007).

The study used a rhythmic exercise program called Rhythmex®, a REAC exercise program with an auditory cue that is guided by five principles labelled A.B.C.D.R: A. Alternating hands and feet in movements, B. Bilateral