

Can Rhythmical Auditory Stimulation Alter Gait Pattern in Children with Asperger Syndrome?

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Abstract

The aims of this study were to evaluate the gait abnormalities in children with Asperger syndrome (AS) and to investigate the effectiveness of rhythmical auditory stimulation (RAS) on gait training in children with this condition. Five children with AS (mean age: 8.5 ± 2.0 years) and 6 children with normal development (mean age: 9.5 ± 2.0 years) participated in this study. The participants were asked to walk on a treadmill under each of the following conditions conducted in sequence: (1) walk at a comfortable speed with no RAS (baseline), (2) walk at a comfortable speed accompanied by RAS (sound-on condition), and (3) walk again at a comfortable speed with no RAS (sound-off condition). The temporal and kinematic gait parameters of the walking in each condition were recorded with a VICON 370 system. No significant differences were found among the baseline, sound-on, and sound-off gait parameters in either group. The children with AS rotated their pelvis more during walking than the control group did at baseline ($p=0.018$) and during the sound-on ($p=0.011$) condition. Moreover, the control group spent less time in the double-leg supporting position in the sound-on and subsequent sound-off condition than the AS group did. No statistically significant differences were found between the two groups in all other gait parameters (i.e., step length, step width, step height, hip and knee joint angles at mid-stance phase of gait) in the three testing conditions. The children with AS demonstrated excessive pelvic rotation during walking when compared to children with normal development. A short period of gait training with RAS might not be able to improve the walking pattern in children with AS.

Keywords: Autism spectrum disorder; Sound cue; Walking pattern; Gait training; Movement disorder

Introduction

Asperger syndrome (AS), a form of autism spectrum disorder, is a fairly common condition among children and youth. It is estimated that as many as 48 per 10,000 children have this disorder [1]. According to the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR), children with AS are characterized by impairment in social interaction, occupation, or other functions [2]. They also demonstrate repetitive and restricted stereotyped patterns of behavior, activities, and interests [2]. Although AS is foremost a social disorder, sensorimotor impairments are widely reported in this group of children [3-5]. Wing first reported that children with AS tend to have poor motor skills, coordination, and balance problems that may affect their daily function, sporting skills, and writing ability [6,7]. Using the standardized Bruininks Oseretsky Test of Motor Proficiency [8], Ghaziuddin and Butler also reported that gross motor skills such as running speed and agility are inferior in children with AS when compared to the norm [3].

Walking is amongst the most important and fundamental motor skills that a child needs to acquire during the first few years of life [9]. It has been reported that although children and adults with autism can walk independently [4,10], they demonstrate atypical gait characteristics such as decreased knee flexion in early stance [10] and more oscillations or rotational movements of the head, shoulders, and trunk [4]. These preliminary findings, if confirmed, would signify great functional disturbance in children with AS and may affect their activity participation [11]. Therefore, further research on the gait pattern in this particular group of children is deemed necessary.

The use of sound to improve health was first introduced by the famous ancient Greek philosophers Aristotle and Plato [12]. When compared to other kinds of external cues, auditory cues were found to be more matched with the rhythmical and continuous movement patterns of humans (e.g., walking) [13]. Nowadays, auditory cues are one of the most common treatment modalities used in neurological rehabilitation [14]. For example, patients with Parkinson's disease

demonstrate a smoother and more organized gait pattern under the influence of an external auditory cue [14,15], possibly because the sound cue improves attention and guides movements [16]. Children with AS, similar to patients with Parkinson's disease, also show structural deficits in the basal ganglia and have movement deficits [17-19]. Therefore, we hypothesized that rhythmical auditory stimulation (RAS)-assisted gait training might also improve the walking pattern in children with AS. This study had two aims: (1) to evaluate gait abnormalities in children with AS and (2) to investigate the immediate and carry-over effects of RAS-assisted gait training on the gait pattern in this particular group of children.

Materials and Methods

Participants

Children with AS were recruited from local Child Assessment Centres, non-government organizations, and the clinic of our University. Inclusion criteria were (1) a formal diagnosis of AS according to the DSM-IV-TR [2], (2) age of 6 to 12 years old, (3) no known co-morbidities, and (4) studying in mainstream schools. Exclusion criteria were (1) formal diagnosis of emotional, neurological, hearing, visual, movement, or other psychiatric disorders, (2) significant musculoskeletal injuries or cardiopulmonary conditions that may influence walking pattern, (3) children who could not follow simple

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