Effectiveness of Cognitive Orientation to daily Occupational Performance (CO-OP) on children with cerebral palsy: A mixed design

Neda Ghorbani:
Occupational Therapy Department, Tabriz University of Medical sciences, Tabriz, Iran.Email: ghorbanin@tbzmed.ac.ir

Mehdi Rassafiani:
Phd in Occupational Therapy, Occupational Therapy Department, Faculty of Allied Health, Kuwait University, Kuwait.
Pediatric Neurorehabilitation Research Center, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran.
Email: mrassafiani@yahoo.com

Sara Izadi-Najafabadi:
Biomechanics and Movement Science, Physical Therapy Department, University of Delaware, USA. E-mail: saraizad@udel.edu

Farzaneh,·Yazdani:
Faculty of Health and Life Sciences, Oxford Brookes University.
Email: fyazdani@brookes.ac.uk

NazilaAkbarfahimi:
Assistance professor, Department of Occupational Therapy, School of Rehabilitation, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran.

Naser Havaei:
Assistance professor, Department of Occupational Therapy, School of rehabilitation, Tabriz University of Medical sciences.

SorayaGharebaghy:
Department of Occupational Therapy, School of Rehabilitation, Iran University of Medical Sciences, Tehran, Iran. Email: Gharebaghy_ot@yahoo.com

Corresponding Author:
Soraya Gharebaghy: Department of Occupational Therapy, School of Rehabilitation Sciences, Iran University of Medical Sciences, Nezam St. Shah Nazari Ave. Madar Sq. MirdamadBiv. Tehran, Iran.
Email: Gharebaghy_ot@yahoo.com

Abstract

Background

Cerebral palsy (CP) is the most common cause of physical disabilities during childhood. Therapeutic interventions mainly focus on impairment reduction to address motor-based difficulties. In contrast, Cognitive Orientation to daily Occupational Performance (CO-OP) is a cognitive approach, providing intervention at the level of activity and participation.

Aims

This study aims to determine whether the CO-OP approach improves motor skills and achievement in motor-based occupational performance goals in children with CP.

Methods and Procedures

In this mixed design research (i.e., a multiple baseline single case experimental design and a one-group pretest-posttest design), five children with CP participated in 12 CO-OP intervention sessions. Repeated measures of motor skills for the multiple baseline single case experimental design were taken using the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP); pre- and post-measures of parent/child perception of performance and satisfaction were identified using the Canadian Occupational Performance Measure (COPM); level of achievement was identified using Goal Attainment Scaling (GAS).

Outcomes and Results

According to the BOTMP results, all children were able to engage in the CO-OP intervention to improve motor performance. Significant differences after treatment were found in both performance and performance satisfaction ratings using the COPM as rated by parents and children. The GAS results showed progress in achievement levels for all children; all goals were achieved or exceeded.

Conclusions and Implications

CO-OP intervention can be helpful in improving motor skills and achieving self-identified, motor-based goals in children with CP.

Keywords

Motor-based occupational performance, Cognitive approach, Single-subject design

1 Introduction

1.1 Cerebral Palsy (CP)

Cerebral palsy (CP) refers to non-progressive disorders resulting from lesions in an immature brain that cause activity limitations and voluntary movement disturbance (Coker-Bolt, Garcia, & Naber, 2014). This is the main cause of physical disabilities during childhood that limits children's ability to perform various daily activities successfully (Coker-Bolt et al., 2014; Rassafiani & Sahaf, 2011; Rosenbaum et al., 2007).

Neurological defects include neuromuscular and musculoskeletal problems, spasticity, muscle contracture, lack of coordination, loss of motor control and poor voluntary movements (Coker-Bolt, et al., 2014; Krigger, 2006). These issues can negatively impact participation in daily activities, and this in turn may lead to low levels of self-concept, self-esteem and social adjustment (Polatajko et al., 2001b; Sangster, Beninger, Polatajko, & Mandich, 2005). One of the main goals in occupational therapy for children with CP is to improve their functional abilities and achieve the appropriate skills necessary for daily living, leading to maximum independence in daily activities (Dalvand, Dehghan, Feizy, Amirsalai, & Bagheri, 2009; Rosenbaum et al., 2007).

Children with CP are either unable to move or have difficulties in movement and active interaction with their environment; subsequently, they tend to be passive with limited responses to their environment. Motor skills provide opportunities for these children to learn and to participate in educational environments, and to develop their sense of independence. While performing a movement, children get information and learn more about their environment (Barry, 2001).

1.2 Common Interventions used for Children with CP

Various therapeutic interventions are currently used in the management of children with CP. These interventions mainly address the body function impairments and activity limitations associated with CP to enhance the child's ability to experience and participate in life (Rassafiani, Sahaf, & Akbarfahimi, 2013). In other words, the most common current therapeutic approaches for children with CP are based on neuromaturational models of motor development called bottom-up approaches. The core elements of these models include improving performance components and reducing impairments. They have limited emphasis on participation and occupational performance (Weinstock-Zlotnick & Hinojosa, 2003). With reference to the International Classification of Functioning (ICF), developed by the World Health Organization (WHO), it is evident that these current interventions mainly address body structure and function, but not activity and participation levels (WHO, 2001). There is limited research supporting the notion that reducing the impairment level components and improving the performance components can develop overall occupational performance (Weinstock-Zlotnick & Hinojosa, 2003). In contrast, top-down approaches directly address deficits in activity and participation levels. Studies have shown that interventions focused on enabling active participation have positive effects on a person's quality of life (Barry, 2001). It is also demonstrated that children's participation in normal childhood activities influences their self-esteem and social adjustment (Krigger, 2006). Task-specific training is a top-down approach that is widely used to help children with CP; it focuses directly on activities that are meaningful and interesting.

There is a strong body of literature that supports the use of task-specific interventions including Constraint-Induced Movement Therapy (CIMT), Hand-Arm Bimanual Training

(HABIT), and Goal-Directed Training for children with CP (Carr & Shepherd, 1998), to maximize motor learning and neural plasticity (Carr & Shepherd, 1998; Rodger, Springfield, & Polatajko, 2007).

1.3 Cognitive Orientation to daily Occupational Performance (CO-OP)

Cognitive Orientation to (daily) Occupational Performance (CO-OP) is a cognitive-based approach developed by Polatajko and colleagues in the early 1990s. This approach is an effective treatment for children with motor-based learning disabilities, in particular children with Developmental Coordination Disorder (DCD) (Kumban, Amatachaya, Emasithi, & Siritaratiwat, 2013), and enhances their motor performance in everyday activities (Polatajko, 2004; Polatajko, Mandich, Miller, & Macnab, 2001a). CO-OP, as a problem-solving approach, enables children to find solutions to motor-based problems by using cognitive strategies (Polatajko et al., 2001a).

According to CO-OP, there are two types of cognitive strategy for skill acquisition: teaching the Global Problem Solving Strategy to the child, and guiding him/her to discover Domain Specific Strategies (DSSs) (Rodger & Polatajko, 2010). There is evidence highlighting the effectiveness of CO-OP for children with DCD (Mandich, Polatajko, & Rodger, 2003; Miller, Polatajko, Missiuna, Mandich, & Macnab, 2001; Sangster et al., 2005; Taylor, Fayed, & Mandich, 2007) and Pervasive Developmental Disorder (Phelan, Steinke, & Mandich, 2009; Rodger & Brandenburg, 2009; Rodger et al., 2007). There is only one published pilot study using CO-OP for children with CP; it suggests it is effective in achieving child-chosen goals and promoting skill acquisition (Cameron et al., 2016).

Task-specific training approaches, such as CIMT and HABIT, usually focus on upper limb function where children learn the required skills for a specific task (Carr & Shepherd, 1998; Rodger et al., 2007). Developing a person's ability to generalize and transfer skills to other everyday activities and goals is not inherent in such approaches. Hence, to learn any new skill, new task-specific interventions are required, potentially increasing the number of training sessions. In contrast, through the CO-OP approach, children learn strategies to solve problems and achieve all kinds of motor-based occupational performance (Polatajko, 2004) and so it is strong in generalization and transfer. In other words, using CO-OP children learn strategies to solve their motor problems and apply them beyond treatment sessions and to other motor tasks without supervision much more easily than in other forms of training. Therefore, the purpose of this mixed design was to investigate whether the CO-OP approach leads to motor-based, occupational performance goal achievement and improvement in motor skills in children with CP. CO-OP was developed to enable children with motor-based occupational performance difficulties who have problems in learning new skills. Considering this, CO-OP might be an effective intervention for children with CP.

2 Methods

2.1 Study Design

A mixed design including a multiple baseline single case experimental design and a one-group pretest-posttest design was used in this study. This mixed design benefits from both single case experimental design as well as whole group changes. Also, there was a limitation in repeating one of the outcome measures (i.e., Canadian Occupational Performance Measure) during the baseline and intervention phases. This research design allowed for the documentation

of the therapeutic effectiveness of a continuous treatment with a specific subject while taking into account economic considerations (Ottenbacher, 1986; Rassafiani & Sahaf, 2010). For multiple baseline single subject experimental design, assessment of motor skills was repeated in a baseline phase (phase A) and intervention phase (phase B) using the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP).

2.2 Participants

The inclusion criteria for participants were as follows: (a) being between seven and nine years of age; (b) being diagnosed with CP; (c) being at level I, II, or III according to the Gross Motor Function Classification Scale (GMFCS); (d) being at level I, II, or III according to the Manual Ability Classification System (MACS); (e) having experienced motor performance problems in daily activities, as reported by parents and/or children during interview; (f) having an IQ score of 85 or above according to the Raven Colored Progressive Matrices Test; and (g) having no visual or hearing problems. Participants in this study were Farsi-speaking children aged from seven to nine years old, receiving rehabilitation services through the rehabilitation centers at the Esfahan (Iran) and who met the other inclusion criteria. The children were recruited after obtaining ethical approval from the University of Social Welfare and Rehabilitation Sciences (USWR) Ethical Committee and parental consent.

2.3 Measurements

The instruments used for sample identification and recruitment were the Gross Motor Function Classification System (GMFCS), Manual Abilities Classification System (MACS), and the Raven Colored Progressive Matrices Test (RPM).

2.3.1 Gross Motor Function Classification System (GMFCS)

This instrument for children with CP (Palisano et al., 1997; Palisano, Cameron, Rosenbaum, Walter, & Russell, 2006) is based on self-initiated movements with particular emphasis on sitting (truncal control) and walking. The GMFCS uses five levels of classification based on the child's motor performance and describes the degree of impairment in gross motor skills. The GMFCS is widely used for children with CP and has excellent psychometric properties (Palisano et al., 1997). Both the therapists and parents' version of the GMFCS were validated in Farsi (Riahi, Rassafiani, & Binesh, 2013).

2.3.2 Manual Abilities Classification System (MACS)

The Manual Abilities Classification System (MACS) (Eliasson et al., 2006) is a tool administered to describe how children with CP use their hands to handle objects in everyday activities. It assigns children to five levels. Level I describes the child with the highest manual function and ability to handle objects easily and successfully; level V refers to the child with the lowest manual function, inability to handle objects, and severely limited ability to perform simple actions (Eliasson et al., 2006). The MACS has been validated in Farsi and has a high level of psychometric properties (Riyahi, Rassafiani, AkbarFahimi, Sahaf, & Yazdani, 2013).

2.3.3 Raven Colored Progressive Matrices Test (RPM)

The Raven Colored Progressive Matrices (Raven, Raven, & Court, 1956**)** is a nonverbal group test typically used to examine general human intelligence. It focuses on solving visual problems, as well as visual similarities and analogies in particular. It is the most common and popular test administered on individuals ranging from five-year-old children to the elderly. This

test is independent of culture, includes four subtests, and has been used with children aged from five to nine years (Iekta & Parand, 2006).

Outcome measurements used to compare pre- and post-intervention results included the Canadian Occupational Performance Measure (COPM) and Goal Attainment Scale (GAS).

2.3.4 Canadian Occupational Performance Measure (COPM)

The Canadian Occupational Performance Measure was used in this study to establish goals for each child prior to intervention (Law et al., 1998). It is a semi-structured interview designed to help clients identify occupational performance issues and priorities in the areas of self-care, productivity (school), and leisure, in which they have difficulty performing. In this study, children and their parents selected the "training goals" collaboratively by rating on a 10-point scale displaying their goals in terms of satisfaction and performance. The children and their parents scored the COPM independently before and after intervention based on goals set by the child and supported by the parents. Changes in performance and satisfaction scores pre- and post-intervention were determined separately. A change score of two points or more on the COPM is considered clinically significant (Law et al., 1998). Reliability and validity for the COPM has been demonstrated in both English and Farsi (Dehghan, Dalvand, Pourshahbaz, & Samadi, 2014).

2.3.5 Goal Attainment Scale (GAS)

The Goal Attainment Scale (Turner-Stokes, 2009) is a therapeutic method for setting goals and evaluating the functional goals achieved by children who are receiving intervention that may not be measurable through standardized assessments. The GAS is also a program evaluation tool

that facilitates patient participation in the goal-setting process. It includes: (a) identifying the practical goals, (b) specifying the expected level of results for each goal that involves a range of possible outcomes on a scale between -2 and +2, and (c) using the scale to evaluate the child's functional change following the intervention. There is still limited evidence supporting the reliability and validity of the GAS for detecting clinically significant changes. A change of two points on the GAS is generally recognized as significant (Turner-Stokes, 2009). In this study, COPM (both performance and satisfaction components) was used to assess children on two occasions, including before and after intervention delivery.

The Bruininks-Oseretsky Test of Motor Proficiency (BOTMP) was repeated in the baseline and intervention phases to assess motor skills.

2.3.6 Bruininks-Oseretsky Test of Motor Proficiency Measure (BOTMP)

This is a standardized, norm-referenced measure (Bruininks, 1978) used by occupational therapists in clinic and school practice settings. The BOTMP is individually administered and includes eight subtests that can yield three estimates of motor skills including gross motor, fine motor, and a combination of both for children aged between 4.6 and 14.6 years. The total score of the BOTMP was used to assess motor performance (Decker & Foss, 1997).

2.4 Procedure

In this mixed design study, six children were randomly divided into three groups according to a specific baseline period. These groups differed in the duration of the baseline period and the number of baseline assessments. Two children were in the first group with 12 sessions of repeated measures of the BOTMP in the baseline period. Two children were in the second group

with nine sessions of repeated measures of the BOTMP, and two children were in the third group with six repeated baseline measures of the BOTMP. Participants were assessed at two phases: the baseline period (phase A) and intervention period (phase B). In the intervention phase, all children were assessed six times by the BOTMP with each data point represented on the graph. One participant in the third group required a surgery and was excluded from the research at the fourth session of the baseline assessment. The study continued with five participants.

To monitor the effectiveness of an intervention in a multiple baseline single case experimental design, it is crucial to apply sensitive measures that allow consistent results across repeated measures and detect subtle changes in motor function. According the results of Wuang and Su's study (2009), the BOTMP has good internal consistency and excellent test-retest reliability over a two-week period. In addition, multiple baseline design was used for two reasons in this study: first, to show that the changes during the intervention phase were related to the intervention and not to other confounding factors; second, to show that although the duration of the baseline was different, there was little variation in the baseline with frequent measures. Measuring the participants using three different baselines showed similar results for all three groups. In other words, the trend in the baseline for all participants showed a direction of data points that was increasing. In the intervention phase, intervention did not alter the direction of the trend but the rate of increase changed as reflected in the slope of the line. These results mean that not only did the confounding variables have no influence on the children's performances, but also, the tool was valid enough not to be influenced by frequent use.

In the baseline phase and prior to intervention, each child selected three goals according to the COPM, then the therapist worked collaboratively with the child or her/his parent specifying the baseline and expected levels for all three goals by the GAS.

All children received 12 sessions (45–60 minutes each session, two sessions per week) of CO-OP intervention (phase B). In this phase, motor performance was measured using the BOTMP each week six times. An occupational therapist trained in the CO-OP approach delivered the CO-OP intervention according to the structure of sessions proposed by Polatajko et al. (2004). During intervention, each child was taught a Global Cognitive Strategy then was guided to discover Domain Specific Strategies (DSSs) in order to improve motor-based occupational performance problems. The child was then encouraged to generalize learned skills to other life situations. The COPM was again administered to both children and parents separately at the end of the intervention phase. The GAS was also used at this stage to evaluate the children's functional changes after the intervention phase.

3 Analysis

All data points of repeated measures by the BOTMP were recorded and marked on a graph using Microsoft Excel. One of the procedures for analyzing the data in single case experimental design is visual analysis of graphed data. Visual analysis relies on visual interpretation of changes in data patterns, levels, and slope both within and between experimental conditions (Rassafiani & Sahaf, 2010). The statistical procedure applied for this study was the Percentage of Non-overlapping Data (PND) and the Split-Middle Method of trend estimation (celeration line). The PND is non-overlapping between the baseline and successive intervention phases. The PND was calculated by the percentage of data points during the intervention that exceeded the highest

data point in the baseline. According to the results, if the PND is more than 90%, it shows a highly effective intervention (Morgan & Morgan, 2008). Please see Table 1 for further details.

Please insert table 1 here

The Celeration Line Method was then used to demonstrate the subjects' performance pattern. For trend estimation, the Split-Middle Method of trend was used. This method is based on the medians of two halves of the data series for which the trend line is being determined in the intervention and baseline phases (Wolery & Harris, 1982). The celeration line was drawn for the baseline data and then projected into the intervention phase. The proportion of data points above the celeration line in the intervention phase was calculated (Hojem & Ottenbacher, 1988; Morgan & Morgan, 2008; Zhan & Ottenbacher, 2001).

The COPM scores for the performance and satisfaction ratings of parents and children both pre- and post-intervention were recorded for each participant separately. A change score of two points or more on the COPM is considered clinically significant (Law et al., 1998).

In the GAS, a score of -2 described the child's baseline level of performance before intervention; then, for each goal provided a written description of the expected level of performance at the end of the intervention (0 rating) was made. The other levels were decided according to the Turner-Stokes guide (Turner-Stokes, 2009). Ratings of goal attainment at the end of the intervention were recorded. Level of achievement according to the GAS results is demonstrated for each child in Table 4.

4 Results

Participant's demographic characteristics are shown in Table 2. According to the Raven Colored Progressive Matrices Test results, all children have average to above average intelligence. All five children had problems in motor performance of daily activities according to their own and their parents' reports.

_____Please insert table 2 and 3 here_____

Table 3 contains the three goals of each child in order of priority and importance as well as the results of the COPM, both pre- and post-intervention, for the three child-chosen goals according to performance and satisfaction ratings of the parents and children. At the end of the intervention phase, the parents of all five children rated their performance significantly higher. Four of the five children rated it higher; one child was unable to complete the rating (Table 3). As shown in Table 3, although the ratings by parents were not exactly as those by the children, their rating and change in rating agreed with the results of the children's rating. The fifth client had difficulty in understanding the rating for the COPM. Therefore, only her parent's rating was used to evaluate the results of the intervention. Change in performance and satisfaction was established by calculating the difference between performance and satisfaction scores before and after the intervention. A change score of two points or more on the COPM is considered clinically significant (Law et al., 1998). The results of the COPM showed a clinically significant increase in both performance and satisfaction scores from pre- to post-intervention according to both the children and parents' ratings across all the goals, except for the fifth participant.

Please insert figure 1 here

Figure 1 illustrates motor performance of each participant according to the BOTMP. There are two sections in each figure indicating motor performance at the baseline (phase A) and intervention phases (phase B). Despite variability in the data, the results in the baseline phase and prior to the intervention phase showed no changes. However, during the intervention period there was a dramatic increase in motor performance. Visual and statistical analyses indicated a significant difference in motor performance during the intervention phase compared to the baseline phase toward increasing.

Please insert figure 2 here

The results of the PND indicated improvement in motor performance because of intervention in all participants (Table 4). Celeration line analysis indicated that all participants demonstrated an increase in slope in motor performance during the intervention phase, with a tendency toward improvement (Table 5). All children demonstrated slight variations in fluctuation patterns of performance during the intervention phase with an overall tendency toward improvement. The increasing slope of the line for each child in the intervention phase demonstrated changes compared to the baseline phase.

Please insert table 4 and 5 here

In all children, a score of -2 represents the child's baseline level before intervention. The results of the GAS showed that children receiving intervention according to the CO-OP approach achieved three child-chosen goals (Table 6). After the intervention period, all children reached

higher levels. Levels of the three goals in all children progressed from the baseline level of -2 to the expected level (level 0) or more than expected level (+1) after CO-OP intervention.

_____Please insert table 6 here _____

5 Discussion

The results of this study demonstrated that CO-OP intervention can improve motor skills among children with CP at level I of the GMFCS and levels I, II, or III of the MACS. The results also indicated that for the three chosen tasks all the children's (except child five) performance and satisfaction of their performance scores were greater after the intervention. The parents' ratings were in agreement with the results of the children. Four children (except the fifth child who had difficulty in understanding the COPM rating) and the parents of all children indicated clinically significant changes in performance and satisfaction with all goals according to the COPM, which indicates that the CO-OP is a suitable intervention for children with CP. These improvements in performance ratings suggest that the children with CP were able to engage successfully in CO-OP to improve their perceived performance of their motor-based goals.

The above-mentioned results are consistent with previous studies providing evidence for the effectiveness of CO-OP as an intervention to improve motor performance in children with DCD (Miller et al., 2001; Ward & Rodger, 2004), ADHD (Gharebaghy, Rassafiani, & Cameron, 2015), and CP (Cameron et al., 2016). The results of this study provide evidence for the effective application of CO-OP for children with CP. In other words, CO-OP appears to be effective in enabling children with CP to achieve their motor-based occupational performance goals.

All dimensions of motor skills including fine motor skills, gross motor skills, and coordination measured by the BOTMP were significantly improved following the 12 sessions of CO-OP intervention. The increasing slope of the second participant in the treatment phase demonstrated a perceptible change compared to the baseline phase but not as significant as those of other participants. Both visual and statistical analyses were performed to determine probable changes in the children's motor performance. Considering the improvement of motor difficulties through the adoption of the CO-OP approach for children with CP, the results can be deemed promising. The results of this study are consistent with the study by Polatajko et al., (2001), which showed improvement in performance of motor test components through CO-OP intervention, and with the study by Gharebaghy et al. (2015), which showed improvement of motor performance in the BOTMP in children with ADHD (Gharebaghy, et al., 2015).

The results of this study could help to develop a new treatment approach for children with CP. As can be seen in figure 1, the results in the last sessions are higher than those of the early sessions. Due to the severity of the performance problems of children with CP, the authors suggest increasing the number of treatment sessions to improve the chance of success of CO-OP with this group of children. It could be that a larger number of intervention sessions or a follow-up phase may yield better results.

Another interesting result of this study was that the children with CP who participated in the CO-OP intervention made clinical improvements in their self-identified goals according to the GAS. The main goal of working with children with CP was to improve their performance, so that the children were satisfied and performed the activity successfully. In this process, the children

with CP found alternative strategies to get the task done and sometimes found accommodation strategies in order to complete the task.

The results of this mixed design showed that the CO-OP might be an effective intervention for children with CP. Further research with a larger sample size is necessary in order to determine the effectiveness of the CO-OP approach with children with CP.

6 Limitations

One limitation for this study is the small sample size, which limits the ability to generalize the results. Therefore, to increase validity it is recommended that further research be conducted with a larger number of participants. Due to limited access to the BOT-2, the old version of the BOTMP was used. It is suggested that the new version of this measure is used in future studies. The BOTMP does not seem a good measure for evaluating the motor skills of children with CP. In further research with this population, it is suggested that a more sensitive test is used. According to the GMFCS, all participants were at level I. Therefore, the results of this study are generalizable only to children with CP at level I according to the GMFCS. It is suggested that in future studies, children at all levels of the GFMCS are considered.

7 Conclusion

This study aimed to investigate the effectiveness of the CO-OP approach for children with CP. In summary, this mixed design study indicates that the CO-OP intervention was helpful in improving motor skills and achieving self-identified motor-based goals in children with CP. CO-OP can be a new and effective approach to occupational therapy intervention with children with

CP. The results of this study will be used to conduct a randomized clinical trial with a larger group of children with CP in comparison with other traditional interventions.

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