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Special Communication

Examining Conductive Education: Linking Science, Theory, and Intervention

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Abstract
Recognized in many European countries and Canada as a valid form of therapeutic and educational rehabilitation, conductive education (CE) emphasizes cognitive and motor learning principles for movement reeducation. This article illustrates how CE incorporates motor control and motor learning theories in conjunction with unique facilitation concepts, including rhythmic intention, task series, tailored low-tech equipment, and traditional facilitation concepts such as developmental sequence, manual facilitations, and multimodal interventions.

Uniquely, CE brings together task series practice and learning, including a lying program, sitting program, standing program, and walking program, along with activities of daily living within a group treatment model. The conductor uses cadence and rhythmic intention to encourage movement exploration in a scripted plan of care. The participants are active learners and use CE slatted equipment to help support movements. Full participation, to the best of the learners' ability, is realized with activity modifications made by the conductor.

Increased motor control arises through repetition, practice, functional context, and sensory feedback that provide guidance for intention and voluntary movement. Motor control and motor learning theories are foundational principles of CE. Individuals with neurologic injuries, including cerebral palsy, stroke syndrome, Parkinson disease, and traumatic brain injury, can benefit from CE. To date, although research studies cannot objectively compare one person's movement skills with another's, new research surrounding motor control and motor learning illustrates and supports the principles and practice of CE. CE is an educational therapy model for teaching and developing new movement skills for individuals with neurologic impairments. This article connects the current science of movement and

List of abbreviations: CE, conductive education; CP, cerebral palsy; MI, movement index; RI, rhythmical intention; ZPD, zone of proximal development.

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describes the unique principles involved with CE delivery as an intervention for individuals with neurologic impairments.

Conductive education (CE) is a unique classroom-based therapeutic system created for movement education instruction.[1-5] CE considers each patient or client to be a learner of new skills. Thus, in this article, patients and clients are referred to as student learners or participants. "Conductive" refers to an intervention style aimed at guiding, enabling, and motivating participants through creative conditions, allowing for successful motor and cognitive learning. CE is an active intervention that involves teaching and assumes that the process of learning belongs to the learner with a disability. CE interventions globally include the practice of planned and structured activities, which are individualized for each student with a disability and promote active learning. Principles of CE focus on the art of problem solving, address the presenting impairments and movement challenges, and implement individualized techniques and strategies to overcome and adapt to these challenges. "Education" is the imparting and acquiring of knowledge through teaching and learning. Conductor teachers and therapists facilitate cognitive, physical, personal, and social development in a classroom setting. Conductors are movement specialists whose philosophical orientation is that of an educator with understanding of cognitive development and learning theory. Conductors encourage participants to develop solutions to their own individual movement challenges through active problem solving. A range of techniques and teaching methods, based on motor learning, that apply to the learning of specific tasks are introduced within a group learning setting. Cognitive internalization of verbal instruction assists in the promotion of change in faulty movement patterns, with a strong emphasis on rhythmic movement.[2,3]

In a classroom-based learning and therapeutic environment, learners work together, motivate each other, and are emotionally invested, which in turn enhances their ability to learn and participate. Members of the group may be diverse in skills and performance, but they actively participate in the same task series, thus creating a microcommunity. The microcommunity opens the door for a positive and supportive learning environment where all participants celebrate the efforts and accomplishments of each learner. The net result is a sense of security and positive self-image. CE makes conscious use of the group dynamic by creating a community of active learners paired with the conductor teacher or therapist as the source for generalization and reinforcement of new intention and motivation of the members.[4]

Rhythmical intention (RI) is one of the primary methods of facilitation used in CE. RI is the interaction between language and movement, which can be integrated and mutually enhancing. The term "rhythmical intention" consists of 2 distinct elements: rhythm and intention. Combining speech and activity into a single circle of feedback creates the attainment of a goal that becomes conscious and verbally directed. The verbal direction determines the action. Hence, speech is accompanied by movements, which are executed rhythmically by counting or through the use of dynamic speech. Using verbal regulation and RI helps the learner to consciously initiate movement and to understand the movement, thus leading to voluntary control of the movement. The use of RI connects language to action. In CE, the conductor declares the intention, then the group repeats the declaration together before executing a movement. The group executes the action while counting rhythmically or using dynamic speech, as determined by the specific difficulties of the group. As the movement is performed repeatedly, internal speech exclusively can be used to perform the actions. When the movement becomes automatic, the need for speech diminishes.[4]

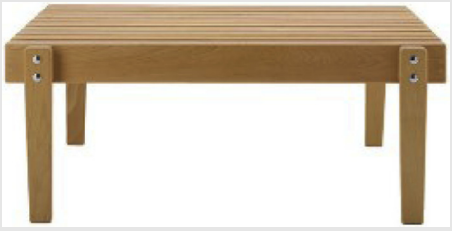
Conductor teachers and therapists are also adept in task analysis. Because learning occurs in a context-specific task and environment, objectives are planned to take place under various conditions. Task series, therefore, are done in different positions, including lying down, sitting, and standing, depending on the individual readiness of the learner.

In addition, Vygotsky's zone of proximal development (ZPD) and scaffolding help to explain the significance of the CE intervention. The ZPD describes what the learner can do independently, what the learner requires help to do, and what the learner cannot do at all.[6] CE facilitations and programming act as a conduit to allow the learner to progress safely and build confidence in learning and perhaps master meaningful functional skills. Scaffolding, a concept later attached to Vygotsky's ZPD, also fits well within the CE paradigm. Scaffolding describes how conductors modify and control portions of a task that the learner finds difficult so the learner can gain experience in what he or she can control, eventually allowing the learner to control more and the conductor to control less.[6]

Motor control and motor learning in relation to CE

CE methods align with the current understanding of motor control. "Motor control is defined as the ability to organize and control functional movements."[7(p.4)] Motor control is described as movement emerging from the interaction of 3 factors: the individual, the task, and the environment.[8] Neurologically, movement is organized around task and environmental demands. An individual generates

Table 1 CE Equipment

Equipment	Description
General wood design 	Natural, warm, readily available, and cost effective. Easy to adjust height of legs of plinth and stool, easy to move, and stackable. Multifunctional and provides proprioceptive sensory input to help with calming, focusing, and alerting body awareness. Provides tactile feedback and visual-spatial cues to allow for specific controlled facilitation of movement. The empty space allows for hands to grasp, hold, and release. The act of holding allows individuals to learn to sit upright, to stand up, to take steps, and how to work independently. The furniture creates the opportunity for self-assistance, self-correction, and problem-solving. Learned skills include symmetry of the body position, head control, look at hands and focus eyes on the activity as they grasp and release, sit on a stool, and stand up. Using the CE furniture in various ways helps participants to generalize the skills they learn in sessions and carry out different activities of daily living throughout the day (eg, eating, dressing, walking, and playing).
Plinth table 	Used for individual or group work with proprioception input for body awareness, direction, rolling, turning, and motor planning to carry out gross motor movements. The slats in the table facilitate learning to grasp and release in addition to pulling and scooting on the stomach. It also facilitates sitting upright, standing up, and taking side steps at the table. In addition, it is used for table task activities like eating meals, arts and crafts, and fine motor skill development.
Walking ladder 	Used as a support while sitting on a stool during sitting program, while standing during the standing program, and for walking. Designed to assist with standing and walking to promote independence while working on balance and coordination. Also used to teach transitioning from the floor to prone to standing, weight shifting, weight bearing, and transitioning skills in standing.

(*continued on next page*)

Table 1 (*continued*)

Equipment	Description
Wall ladder 	Used for sitting and standing task series. Designed to help with balance and coordination.
Floor ladder 	Used for walking, helps with balance and coordination, and promotes independent walking. It facilitates a child to lift the foot off the ground for each step and to plan where to place the foot on the floor.
Slatted stool 	Used for sitting task series and sitting at the table and to teach tall kneeling. The slats provide a ledge to grasp and promote balance and independent sitting.

(*continued on next page*)

Table 1 (*continued*)

Equipment	Description
Foot stool 	Allows for proper posture to maximize balance with 90-degree hip-to-knee and knee-to-foot alignment for feet to be flat while seated.
Handrail 	Used to help with balance while sitting at the plinth table. Also allows integration of the less dominant hand to facilitate grasping.
Handstick and ring  	Used in lying program to promote hand coordination, hand transfer, and grasping. Used in sitting position for coordination, balance, and stretching. Also used as a walking devise to take steps and learn stability control.

movement to meet the demands of the tasks required within a specific environment. In this way, the organization of the movement is constrained and motivated by factors that exist within the individual, the task, and the environment. An individual's capacity to meet interacting task and environmental demands is what determines the person's ability to function and create new potential.[8] Motor control principles are inherent to the process of CE as all 3 factors influence the assessment and development of each individual participant's program. CE evaluates a learner's functional capacity and alters both tasks and the environment to increase the individual's performance capacity.

Table 2 Principles of the task series

Components of Task Series	Description
Task series	Break down each movement to the simplest core building block of self-initiation of movement. Teaching 1 movement segment at a time, always preformed in the same order to connect consecutive movements into a motor sequence. The progression is from small simple movements (1 movement builds on the next through the connection of RI and songs consistently linked to a specific movement in the sequence) to gradually complete complex tasks. → Teach and acquire motor skills, cognitive concentration, problem-solving, communication, intrapersonal social skills, creativity, and imagination for day-to-day living and holistic personal development. This is achieved by integrating educational objectives and obtainable goals for meaningful academic, social, physical, and emotional growth toward independence.
Passive movement	Passive movement is performed by the conductor to RI → Participant learns, comprehends, and understands learning objective.
Active movement	Active movement is initiated or completed by the participant and the participant follows the RI created by the conductor. For participants with spasticity, count from 1 to 5 to allow enough time to complete movement. For participants with athetoid, count from 1 to 5 to maintain and hold the completed movement position. → Participant actively performs the learning objective.
Cognitive stage	Think about movement in relation to purpose and function. Using the word "I" makes the participant conscious of their self-intent. The word "I" in this context develops their personality, body image, self-awareness, and responsibility while completing the movement. For example, the conductor says "I put my hands on the table." Next, the conductor and participants say "I put my hands on the table. 1-2-3-4-5." The participants are learning to connect words to functional movement in structure, pattern, and repetition. The counting from 1 to 5 signals when to start and stop the movement and regulates the tempo to cognitively teach controlled voluntary production of movement.
Stabilization stage	Internalize, repeat, and practice the movement sequence until the movement is voluntarily automatic.
Automatic stage	Movement is voluntary and performed without hesitation or pre-thought preparation.
Generalization stage	Automatic movement can be used across all day-to-day functional settings.

Certain motor control approaches focus only on processes with an individual, without fully acknowledging the role of the environment or the task.[8] CE is a neuromotor rehabilitation approach that has a focus of incorporating the individual, the task, and the environment to obtain new levels of motor control.[1]

Additionally, movement emerges through the cooperative effort of many brain structures and processes, including the interaction of multiple systems such as sensory-perceptual, cognitive, and motor action. Sensory-perceptual systems of information are gathered by the brain and provide information about the body and the surrounding environment. It is also necessary for the brain to process the context of what it is experiencing to appropriately prepare for action. This progression of understanding involves cognition. Consciously directed movement cannot be performed in the absence of a goal or an understanding of the situation (these are both thinking related concepts). Therefore, cognition is needed for voluntary movement to occur. Unless movement is involuntary or reflexive, movement does not occur in the absence of intent. Thus, without desire, conscious movement processes will not be initiated. Integral to CE is the emphasis upon "intent" for function and an understanding of the movements required. As a holistic learning approach, CE emphasizes the cognitive and psychological aspects of learning movements. According to CE tenets, an individual must be able to think and plan how to move his or her body for a purposeful movement to occur.[1-3] CE incorporates motor control including the learner, the task being learned, and the environment. For the individual, CE builds on the learner's current motor function through the task series added to daily repetition of the same task series with the classroom-based environment to enhance motor control. The task series is a purposeful series of passive and active movements based on RI that allows a participant to learn controlled movement beginning in the lying position, moving to the sitting position, and then into the standing position.

Movement education incorporates techniques that involve learning how to think about the body and how it moves. Recently, Hedman et al described a continuum of movement that includes initial conditions, preparations, initiation, execution, and termination.[9] Within this continuum, the core tasks for movement observation include sitting, standing, sit-to-stand, stand-to-sit, walking, stepping up and down, reaching, grasping, and manipulating.[9] This model closely aligns to the CE method of using a task series with the underlying facilitations of CE, augmenting the motivation and importance of intent for movement.

Motor control theories

Currently, the dynamic systems theory offers the most comprehensive means of understanding movement, viewing the production of movement as the involvement of many interacting systems working cooperatively to achieve

action.[10] For a movement to occur smoothly, movement relies on accurately processing sensory information from the body and the environment. Sensory information received from the eyes, skin, ears, muscles, tendons, joints, and balance center all work together to inform the brain on how the movement feels and the context of the environment. As children mature through their typical developmental phases, sensorimotor exploration serves as a significant component for motivation and early learning.

CE assists the individual learning new movements to access and build on available motor patterns, and thus learn new actions. Nervous system damage will continue to interfere with the smoothness, speed, and efficiency of the movements produced, but these qualities are not necessarily required to perform a functional task.[8]

Understanding adaptive movement patterns

Individuals with neurologic challenges experience a wide variety of movement difficulties, including musculoskeletal weakness.[11] CE increases strength through the incorporation of special equipment and a variety of facilitations that promote repetitious practice of motor patterns against gravity. Movement against gravity using some level of manual and equipment for graded support is a facilitation used in CE. Graded supports may include environmental adaptations such as a horizontal handrail or the slatted plinths and stools used to help improve grasp, strength, and stability. The graded supports assist the individual in developing strength within a movement skill, allowing for purposeful practice.

Posture and balance may also be affected with a neurologic impairment, thus affecting the individual's ability to hold their body upright and move against gravity. Most individuals with neurologic impairments develop postural mechanisms using their muscles inappropriately in an attempt to compensate.[8,11]

Additionally, individuals may develop impairments in the muscles and joints secondary to the neurologic lesion. Atypical postures and movement patterns in sitting, standing, and walking often develop as a result of movement restrictions.[12] Loss of range of motion and subsequent contractures may result from spasticity and limited movement patterns. Habitual atypical pattern of movement, such as a crouched postural pattern during standing and walking, causes asymmetrical development of agonist and antagonist muscles, reinforcing the continued use of a habitual crouched posture.

CE affects muscle and joint function through the use of facilitations and special equipment that assist the individual in improving strength, posture, and balance through movement (table 1). CE facilitations include repeated practice, reinforcement of movements with corrected posture for the activity, and prompted initiation. This allows for individual achievement in performing particular tasks. These are similar to facilitations used in other therapeutic interventions but with intentional learning as the goal.

In the movement education process of CE, the conductor teachers and therapists help individuals develop a broad range of sensory and motor strategies effective in meeting the postural demands of the task.[4,5] These CE task series facilitate strategies through practiced movement activities such as sit-to-stand, developing balance in sitting, eating at the table, walking, toileting, and many of other functional movements (table 2).

Movement tasks are also graded to increase strength, efficiency, speed, and quality. RI enhances motor learning strategies for the individual to use cognition, language, and movement to accomplish functional skills and tasks. The use of language by the conductor teachers and therapists is key for the participant to link the RI to the cognitive processes driving the initiation of movement and motor learning. The conductors use and repeat the exact verbiage every session during the learning phase of the task series so participants can begin to predict the movements needed to complete the task.

Specifically, the 4 stages of skill acquisition and Vygotsky's ZPD link RI with cognition, language, and movement.[6] These concepts allow for the pathway of neural development and motor learning, which are directly related to the results of CE interventions.

Motor learning

Motor learning is defined as the study of the acquisition or modification of skilled action. Originally, the study of motor learning was developed for the purpose of enhancing athletic performance. From this body of knowledge, rehabilitation fields have generated an understanding of how movement is learned and the necessary elements in teaching new motor skills to individuals with an impaired nervous system.[8]

How does motor learning occur in CE?

CE is an exemplar of motor learning and CE professionals have an in-depth understanding of the cognitive aspects of learning movements. CE delivers learning explicitly through a declarative learning process. Declarative learning results in knowledge that can be consciously recalled. This type of learning requires awareness, attention, and reflection.[8]

Declarative learning is exemplified in the CE language: "First, I put my feet flat, then I lean forward, and I stand up." CE emphasizes this type of declarative learning to aid learners in functional skill acquisition. Specific task series teach sequences to the learner through constant repetition, transforming declarative learning into nondeclarative, procedural or automatic knowledge. Movement sequences can be practiced mentally, increasing the amount of practice available to the learner. The CE task series focuses on teaching abstract movement skills that can be further generalized and embedded, via problem solving, into everyday functional routines. Thus, movements and functions become habitual, reducing the need for conscious attention and monitoring.[13]

Many learners with disabilities experience limitations in some cognitive domains. Short-term memory is critical for the encoding and recall of long-term memory.[14] Conductors are able to appreciate how these cognitive domains influence ones' capacity to learn and the severity of the challenges learners experience. CE principles underscore

motivation, attention to task, and the ability to relate and integrate new information to already known information about a task.[2,4]

Additionally, learning is modified continuously and relies heavily on sensory feedback as a means of comparing and correcting movements. The individual compares a current experience or action to past situations and modifies the current action to the current demand. When we store movement skills in memory, many different components of the skill are coded. For example, the glass is slightly heavier than the previous glass, or the table is higher, and so forth.

Knowing the complexity of the conditions involved in learning is helpful, but practice and repetition is needed to remember movement for everyday tasks. These concepts are inherent in CE. A variety of contexts, environments, and experiences further contribute to these memories, expanding the movement repertoire as the person develops.

Ongoing feedback is essential for learning to take place. Many different types of feedback are needed to modify the learning process. Intrinsic feedback is information that comes to the person simply through the various sensory systems as a result of the normal production of movement. Extrinsic feedback supplements intrinsic feedback and is feedback from another person or outside source about the movement. Conductor teachers and therapists provide opportunities for the learner to practice movements while active problem solving by incorporating the individual, the task series, and the environment. This format allows the learner to problem solve novel motor tasks by incorporating internal and external feedback. CE is designed to produce permanent changes in behavior through learning experiences that incorporate both intrinsic and extrinsic forms of feedback.[8]

Movements introduced in a structured group setting provide specific verbal instruction to support the learner in thinking and planning movements. Ongoing verbal feedback and guidance is provided to support learning the "feel" of the new movements. The provision of verbal instruction taps into the linguistic and cognitive aspect of learning, allowing the individual to visualize where their body is located and how to move in the environment. This verbal guidance also provides motivation and energizes the individual to focus on the task at hand. These strategies specifically follow the principles of motor learning to enhance the rehabilitation of movement.

Practice, which is a part of the daily CE routine, is a critical feature of motor learning. Early in the practice of a new task, performance improves rapidly, whereas it improves more slowly after practice. It also shows that performance may improve for many years, although increments may be small.[8]

Neuroplasticity and recovery of function

Neuroplasticity is a property of the brain that enables it to modify its own structure and functioning in response to activity and mental practice.[15] In 2000, a Nobel Prize was awarded for demonstrating that as learning occurs, the connections among nerve cells increases. Since then, hundreds of studies have been produced to demonstrate that mental activity is not only a product of the brain but a shaper of it.[15]

Neuroplastic approaches in motor rehabilitation require the active involvement of the whole patient in his or her own care: mind, brain, and body. This is highly compatible with CE. Norman Doidge described how consciousness and active learning can change the brain structures of clients with Parkinson disease.[15] Parkinson disease is a frequent diagnosis that receives treatment in CE centers. Numerous studies have shown that the basal ganglia contributes to the formation of automatic programs responsible for the selection of and initiation of complex actions of everyday life.[11] When the dopamine system in the basal ganglia does not work, as in the case of Parkinson disease, it becomes difficult for the individual to perform complex motor sequences and to learn new cognitive sequences of thought. CE teaches the learner with Parkinson disease to use his or her cognition and consciousness to override the structures that are impaired to actively reengage in motor control.[3]

Movement and exercise help the brain to work more effectively despite injury. Research on humans now suggests that a combination of learning and exercise can help provide neuroprotection, promote brain plasticity, and even increase brain plasticity. It is suggested that the learning process activates genes that express more brain-derived neurotrophic factor.[15] Thus, the more people learn, the better they become at learning, and their healthier brains become primed for other functions. Despite the fact that there are no direct investigations of these brain changes as a result of CE, one can infer that these types of neuroplastic alterations may arise from and are supported by the principles and processes of CE.

Research examining the reorganization of neuronal circuits after injury has shown that the nervous system has amazing capacities for reorganization.[11,16] Injury to the brain and spinal cord can affect nerve cell function, either through direct damage to the neurons themselves or through disruption of nerve cell function from indirect injuries. Whether the trauma occurs through a direct or indirect means, the result may be nerve cell death.

New methods of evaluating brain function indicate that the brain has developed many strategies to support itself in times of crisis. The brain is adaptable and modifiable, altering its structure to adapt to the changing needs to function. Some parts of the brain may take over functions that were previously designated to other areas.[16] Multiple pathways innervate any given part of sensory or motor areas of the brain, with only the dominant pathway showing functional activity on a positron emission tomography scan. However, when damage occurs in one pathway, the less dominant pathway may immediately show functional connections.[16]

Experience, which can be achieved through learning, is very important in shaping new pathways. Training and practice influence the pathways and supports the development of new cortical areas to take over damaged ones. To enhance the components of neuroplasticity, a stimulus must have a sufficient degree of importance to the nervous system. Only salient experiences will induce plasticity. CE inherently capitalizes on these principles within the pedagogy of the approach through active learning, RI, and

repetition of the task series to promote the initiation of newly learned (or relearned) movements and the control of these movements. Through the combined understanding of how movement occurs, atypical movement patterns, and the development of new learning, CE supports the processes in the development of motor patterns that are functional and interactive with the environment.

The limitations involved in evaluating the effectiveness of such techniques lie in the challenges of measuring changes in quality of movement. Each individual with a neurologic impairment demonstrates a different underlying set of motor control challenges and environmental experiences.

Current research and evidence supporting CE

When evaluating the effectiveness of the therapeutic intervention, it is necessary to measure change within individuals. To date, limited empirical studies have been performed on therapeutic practices such as CE, as motor control models have only recently been devised.[17]

The effectiveness of CE has been primarily anecdotal. Although it is important to acknowledge that many individuals have benefited from the practices of CE, additional objective research is important to validate the CE approach. Herein lies a challenge: because the focus of CE is on teaching, learning, and well-being, rather than solely on objectively measurable functional outcomes, evaluation of the process itself can be difficult. There is still a general tendency to view CE as just a means to teach walking, quite missing is its central educational objective of transforming the whole cognitive and personality development of people with motor disorders.[18] This broader perspective encompasses a view of the whole person and the multitude of factors that affect daily function. Improved technology and importing of scientific inquiry have resulted in advanced measuring of CE's effect.

Evidence supporting CE

O'Shea et al demonstrated regional neural circuitry improvements after 20 hours of CE intervention over 10 weeks in adults with chronic cerebrovascular accident.[16,19] This study duplicated a study by Bek et al[20] and added a functional magnetic resonance imaging scan before and after intervention. Despite chronicity of stroke, the participants demonstrated improved neural activity in some brain areas on the postintervention scan that were inactive on the preintervention scan. The participants also reported improved function in their daily routines, with some being easier to complete without assistance (opening doors with involved hemi hand, dressing, stepping off a curb) and some tasks being completed faster (personal hygiene, walking across a street). Limitations of this study were a small sample size (n=4) and mixed stroke pathologies (2 brainstem level, 1 left cerebral hemisphere, 1 right cerebral hemisphere).

Another study by O'Shea and Pidcoe, compared the movement development of children with cerebral palsy (CP) enrolled in CE with children with CP receiving traditional therapy.[18] The researchers compared 10 children (Gross Motor Function Measure levels 3, 4, and 5) enrolled in CE with themselves over the course of a single year. Three children with CP (Gross Motor Function Measure levels 1 and 3) acted as a control series of case studies. The control cases received standard therapy school services. Data were collected via motion capture during performance of functional activities and were compared with like movements in typically developing children and children with CP without CE intervention. Movements were measured through motion analysis of static standing, sit-to-stand, hand-to-mouth, and ambulation (with assistive device of choice). The results showed a 47% improvement in speed from sitting-to-standing with full knee extension after 5 months of CE. Center of mass excursion during the task decreased 43% in a left-right direction and 70% in an anterior-posterior direction. These findings suggest improved motor control and potentially less energy expenditure during the sit-to-stand function in the CE group. Hand-to-mouth movement patterns appeared to become smoother with time. An observable marked decrease in cyclic trajectory deviation was noted, suggesting improved control of hand-to-mouth movements in the CE group. A shift from more ballistic movements to more controlled movements were observed in the CE group. During walking, the movement index (MI) was based on the center of mass during the total distance traveled over the linear distance. An index value of 1 is ideal. Children in the CE group demonstrated a decrease in MI from 4.5 to 1.25, indicating significant improvement. Children in the control group had an MI of 3. Overall, the children enrolled in the CE program demonstrated increased speed and control of their sit-to-stand and hand-to-mouth movements and a normalization of movement patterns when ambulating. Children who were not in the CE program did not show this improvement.

Additionally, kinematic improvements indicated that joint alignment and motion appeared more typical after the CE program versus traditional therapy.[18] According to the study, children with significant motor impairments required more intensive multidimensional services and intervention to make similar or better motor progress as their less involved peers. The authors concluded that if children with moderate to severe CP are not enrolled in intensive functionally based services, the children risk not developing to their full potential.[18]

A study by Bek et al evaluated CE intervention with adults after cerebrovascular accident.[20] The CE intervention group participated in a 10-week program, whereas the control participants were on a waiting list and did not experience any intervention. Within-group analyses showed statistically significant improvements in the intervention group for 4 of the 8 domains on the Stroke Impact Scale. These domains were activities of daily living, hand function, strength, and mobility. The results exhibited a definitive deterioration in functions of the control group, which was not anticipated in a nonprogressive condition. Additionally, the CE group showed a significant reduction in depression and anxiety. This study also demonstrated significant cost savings using a CE program for adults

poststroke when compared with a traditional rehabilitation model.[20]

It is critical to acquire data over time on the success of goal-directed movement education. As this data becomes available, increased evidence may guide conductors, therapists, and teachers toward using and implementing best practice models.

How is CE different from other motor rehabilitation approaches?

In the field of neurorehabilitation, many different professionals assist children and adults with the development of their movement skills. Physical therapists, occupational therapists, speech and language pathologists, kinesiologists, and conductors all share the role of instructing the process of movement. Each profession has a unique viewpoint, perceptions, and a specific set of tools necessary to evaluate and treat individuals with disability, while helping the individuals to acquire movement skills. Professional working theories guide therapists in their respective provisions of therapy. Most of the therapeutic techniques and theories are complementary and can be easily integrated in an approach to provide for the comprehensive needs of an individual with a disability. Traditional therapy techniques used by physical therapists, occupational therapists, speech and language pathologists, and kinesiologists do not necessarily focus on the holistic educational and self-development components of overall improvement. What makes the process of CE unique is the focus on learning, attention to the expression of the learner's personality and development of self-confidence, and holistic principles of education in the approach to movement, thus separating CE pedagogy from other rehabilitation techniques.

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