

Effects of Conductive Education Intervention for Children with a Diagnosis of Cerebral Palsy: An AACPDM Evidence Report

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Objective

The objective of the American Academy for Cerebral Palsy and Developmental Medicine (AACPDM) evidence reports is to provide the biomedical research and clinical practice communities with the current state of evidence about various interventions for the management of developmental disabilities. AACPDM evidence reports aggregate all that has been published about outcomes of an intervention for a medical condition, gauge the credibility (i.e. strength of the internal validity) of that evidence, and identify gaps in our scientific knowledge.

The AACPDM reviews are not evidence-based 'practice guidelines'. As yet, the bodies of evidence in many areas of developmental medicine are neither robust nor comprehensive enough to allow confident generalization to populations-at-large, a prerequisite for evidence-based guidelines. Moreover, absence of evidence of effectiveness in an evidence report should not be construed as proof that a treatment is not effective; rather, it may reflect areas in which more meaningful research is needed. In the meanwhile, clinicians must be circumspect about their treatment recommendations, relying on current 'best evidence' to inform individual choice.^a

^a 'Best evidence' is represented by the study (or studies) in the evidence report that most closely approximates the patient characteristics that are of interest to the clinician, that uses a therapeutic regime most like the one the clinician can provide, that investigates outcomes of greatest concern to the patient, and that provides the most credible or internally valid results.

Disclosure

Every effort has been made to assure that AACPDMD evidence reports are free from any real or perceived bias. The Academy's editorial review panel is a multidisciplinary group comprised of the current members of the AACPDMD Treatment Outcomes Committee who serve 3-year rotating terms. This Committee may invite up to two additional reviewers to encourage substantive input by knowledgeable proponents of all points of view. Potential conflicts of interest of authors and reviewers have been disclosed and are documented in the 'AACPDMD Database of Evidence Reports'. The Treatment Outcomes Committee is charged and overseen by the AACPDMD board of directors and operates under an approved methodology of systematic review of the scientific literature and approved procedures^{1,2}. The Board grants final sanction for each report.

Consensus Process

The review authors organize intervention outcomes in a predefined manner and answer predefined questions to describe the scientific evidence. Members of the review panel give their input and resolve any differing opinions to reach agreement about statements made therein on behalf of the Academy. Nevertheless, the data in an AACPDMD evidence report can be interpreted differently, depending on people's perspectives. Please consider the statements presented carefully.

Conductive Education

HISTORICAL PERSPECTIVE

Dr. Andreas Petö conceived the concept known as conductive education (CE) in Hungary in the 1940's to assist children with motor dysfunction to attain 'orthofunction', enabling them to attend school with maximum independence³. CE was based on an educational rather than a medical model of intervention, and integrated education and rehabilitation goals into one program.⁴ Orthofunction has been defined as 'the capacity of individuals to respond to biological and social demands made upon him'(p. 140)⁵. Reddihough describes it as the ability of the child 'to participate and function in society despite his or her disability'(p. 141).⁶ CE addresses all aspects of a child's development and personality⁷. The philosophy of orthofunction resonates with contemporary thinking because it advocates a variety of ways to achieve functional goals, dependent on the abilities of the child and the environmental context.⁵

In traditional CE programs in Hungary, conductors plan and supervise the program, incorporating both teacher and therapist roles. Conductors have four years of university education with an emphasis on special education. Conductors typically are responsible for the selection of appropriate children for the program and all curriculum development.

In programs modeled on the traditional model, CE is provided in a group. The children work collectively to monitor and to encourage each other. Conductors lead the group and provide a motivating and supportive environment. Educational goals are determined by the general ability level of the group and by the performance of each individual⁵. Group activities are highly structured and are broken down by task series into a series of steps. Each step represents an intentional activity rather than an isolated exercise. Task series are built on the premise that the tasks start within the child's ability level and then progress in difficulty culminating in a functional independent goal. Rhyme and song are used in a technique labeled 'rhythmical intention'. Through rhyme and song a background rhythm is provided for the motor action and facilitates learning, motivation, control, and initiation of functional movements. Rhythmical intentions are verbal instructions incorporated into the task series. The children use

wooden slatted beds and ladder-back chairs to assist with their movements. Other adaptive equipment such as splints, walkers and wheelchairs are not encouraged, although some programs now allow assistive devices and adaptive equipment.

As CE has spread from Hungary to other countries, it has been packaged in an array of delivery models, making it difficult to ascertain specific criteria that define CE as a program. Therapists, teachers and sometimes parents assumed the role of conductor. Sometimes conductors act as consultants to a CE program but do not deliver the intervention. Traditionally CE was offered in a residential setting, but outside Hungary it has been offered in formats as diverse as one-week camps, school day programs, baby programs and residential programs. The diagnoses and physical severity level of children eligible for programs also vary by program.

As a result many different permutations of CE are appearing in different countries and in different geographical locations in the same country. One of the challenges in reviewing the research literature evaluating CE is that the intervention differed, at least slightly, in each study. Nevertheless, the common features to the intervention defined as CE were: 1) group work using a highly structured framework; 2) the use of task series; 3) the use of rhythmical intention; and 4) the use of specific equipment.

Method of review

INCLUSION CRITERIA

This review is limited to research studies in which the intervention was labeled as conductive education in the study. Studies were limited to those evaluating children and to those published in the English language.

LITERATURE SEARCH

The literature search included the following electronic databases: MEDLINE (1966 to December 2001), HealthSTAR (1975 to December 2000), CINAHL (1982 to September 2001), EMBASE (1988 to September 2001), ERIC (1966 to October 2001), AMED (1985 to November 2001), and Psychinfo (1984 to October 2001). The electronic search term was 'conductive education'. Reference lists in studies and review articles were also examined for appropriate articles. Eighty-eight citations were examined. Of that number, 68 articles were excluded because they were commentaries or review articles. Of the 20 remaining articles, two were excluded because they evaluated children with diagnoses other than CP, or the diagnoses could not be determined^{8,9}. One other article was a survey of health professionals' knowledge of CE¹⁰. Another article¹¹ reported the results of a program evaluation and the majority of outcome measures did not address changes in the child. Finally, another study¹² used qualitative methodology and thus did not fit into the methodology of this systematic review. Fifteen articles¹³⁻²⁷ met the inclusion criteria. All of the articles had samples with more than 90% of the children identified as having CP except one²⁵, which had a sample comprised of 75% (9/12) of children with a diagnosis of CP.

Three of the included articles report the results of research conducted by an independent research team from Birmingham University²⁰⁻²² commissioned by the Department for Education in Britain to evaluate the Birmingham Institute of Conductive Education. The full results are documented in a large report to the Department for Education published by Her Majesty's Stationary Office (HMSO) in 1993²⁸. For the purposes of this systematic review, the three articles were used instead of the large report because the three articles are published in peer-reviewed journals and thus more accessible to the general reader. The authors of this review

obtained the complete report and were satisfied that the three articles referenced captured the major findings.

Two articles^{18, 19} were retrieved as reports on microfiche rather than published articles. They were included in the review because they met the inclusion criteria, and they were referenced in other articles.

CLASSIFICATION OF THE RESULTS

All reported results of CE were classified on the basis of 1) dimensions of disablement (i.e., what kind of evidence there is) and 2) levels of evidence (i.e., how strong the evidence is).^b

Dimensions of disablement (Table 1) is a classification system that facilitates the measurement, management, and research of rehabilitation outcomes and minimizes the barriers between medical and social models of rehabilitation. It describes the effects of disablement (and interventions) in five dimensions: cellular and molecular physiology; body parts and systems; human activities; fulfillment of gender and societal roles; and in the dimension outside the individual including the family circumstances, prevalent societal attitudes, social policies, architectural barriers. The dimensions of disablement used in these reviews reflect the terminology used in two classification systems, the 1997 revision draft of the 1980 World Health Organization International Classification of Impairment, Disability and Handicap (ICIDH-2)²⁹ and the National Center for Medical Rehabilitation Research (NCMRR) model³⁰. The World Health Organization has recently published the final draft of their revisions, International Classification of Functioning, Disability and Health (ICF)³¹. The Treatment Outcomes Committee intends to revise the levels of disablement currently used in the review methodology to reflect the terms of the new ICF.

Table I: Dimensions of disability

<i>Dimension</i>	<i>Description</i>
Pathophysiology	Interruption or interference of normal physiology and developmental processes or structures
Impairment	Loss or abnormality of body structure or function
Functional Limitation/Activity	Restriction of ability to perform activities
Disability/Participation	Restricted participation in typical societal roles
Societal Limitations/Context factors	Barriers to full participation imposed by societal attitudes, architectural barriers, social policies and other external factors

Levels of evidence classifications and other quality-rating schemes are based on: 1) a hierarchy of research designs that range from the greatest to least according to ability to reduce bias, and/or 2) a means of assessing the scientific rigor of the conduct of the particular research

^b The rationale and specific guidelines for classifying the treatment outcomes are available on the Academy's Internet web site at www.aacpdm.org in the document titled "AACPDM methodology for Developing Evidence Tables and Reviewing Treatment Outcomes Research".

study.^c Generally speaking, Level I research designs contain the most scientifically rigorous methods, can produce the strongest evidence, and thus, can yield the most definitive results³². Level II designs are less scientifically rigorous so can produce, at best, less convincing evidence; thus their results must be regarded as only tentative. Levels III and IV can produce still less persuasive evidence with results that can merely suggest causation. No conclusions regarding treatment effectiveness can be drawn from Level V evidence as it contains no before and after documentation or control of other variables that may account for the outcomes observed. Even though a study may employ a Level I design, the actual conduct of the study may have flaws (e.g. incorrect statistics, poor test reliability etc.), thus weakening the rigor of the study. Thus, evaluation of both the level of evidence of the study design and the conduct of the study are important.

The AACPDM levels of evidence classification (Table II on next page) rates each study on the basis of its research design (Part A) plus a study quality indicator that reflects how well threats to validity appeared to be controlled within the parameters of the research design used (Part B).

Unlike some other classifications, the AACPDM levels of evidence evaluation is limited to gauging only the internal validity of a study, i.e., its ability to attribute the observed outcomes to the intervention in that study. External validity, or the confidence with which a finding might be expected to generalize, is believed to be more appropriately determined by individual users of the evidence reports who will focus on only the specific aspects of similarity between a patient of interest and the people who have been studied (e.g., their age, type and severity of cerebral palsy, conditions of treatment etc.).

^c The concept of a 'quality determination' for articles used in systematic reviews is a matter of some debate. The science of critical appraisal of research, initially developed in internal medicine, is an on-going process. It is additionally difficult to apply this concept to research about disabling conditions in developing children. Despite the considerable challenge, there is agreement that teams developing systematic reviews can take certain steps to ensure that their approaches to grading the quality of research results meet current scientific standards.

Table II: AACPDMD Levels of evidence. This designation is in two parts, indicating the highest level of evidence the research design provided (Level I-V, Part A) plus an evaluation of the conduct of the actual study (Strong, Moderate, Weak control of threats to internal validity, Part B).

Part A: Type of Research Design

<i>Level</i>	<i>Non-empirical</i>	<i>Group Research</i>	<i>Outcomes Research</i>	<i>Single Subject Research</i>
I		Randomized controlled trial. All or none case series		N-of-1 randomized controlled trial
II		Nonrandomized controlled trial. Prospective cohort study with concurrent control group	Analytic research	ABABA design Alternating treatments Multiple baseline across subjects
III		Case control study Cohort study with historical control group		ABA design
IV		Before and after case series without control group		AB design
V	Descriptive case series/case reports Anecdote Expert opinion Theory based on physiology, bench, or animal research Common sense/first principles			

Part B. Conduct of Study

Conduct of the study is judged as Strong ('yes' score of 6 or 7), Moderate (score 5), or Weak (score ≤ 4)

1. Were inclusion and exclusion criteria of the study population well described and followed?
2. Was the intervention well described and was there adherence to the intervention assignment? (for 2-group designs, was the control exposure also well described?)
3. Were the measures used clearly described, valid and reliable for measuring the outcomes of interest?
4. Was the outcome assessor unaware of the intervention status of the participants (i.e. was there blind assessment)?
5. Did the authors conduct and report appropriate statistical evaluation including power calculations?
6. Were dropout/loss to follow-up reported and less than 20%? For 2-group designs, was dropout balanced?
7. Considering the potential within the study design, were appropriate methods for controlling confounding variables and limiting potential biases used?

Summary tables

INTERVENTIONS AND PARTICIPANTS

Table III summarizes the interventions and participants in the 15 studies included in the review.

Table III: Summary of studies – interventions and participants

<i>Study</i>	<i>CE intervention</i>	<i>Control Intervention</i>	<i>Population</i>	<i>Total n</i>	<i>Ages</i>
1972a Heal ¹⁸	CE by 2-4 professionally trained 'therapist-teachers' and institutional aides in a residential school; 13 ½ hr/day	3 training programs in orthopedic residential schools	CP, non-ambulatory, IQ<70, able to understand simple instructions Children in treatment and control groups matched on mental age, chronological age, type of CP and motor ability	25	5-13 y
1972b Heal ¹⁹	CE by conductors at Peto Institute in Budapest; Discharged between 1950-1965	None	866 (626 with CP) {ataxia (28), diplegia (219), hemiplegia (137), double hemiplegia (29), athetosis(213)}	626 ^a	Not given
1973 Clarke ¹⁵	Rhythmical Intention (not specified by whom) at the Spastic Centre; 5 mornings/wk	None	Athetosis CP, average intelligence	6	6½-7½ y
1974 Cotton ¹⁷	CE by 2 nursery nurses with assistance of a PT and some house-mothers in a residential school for CP children; frequency not specified	None	Case A – CP (type unspecified), IQ 70 Case B – CP (spastic quadriplegia and probable bulbar palsy), IQ 65 Both in the 'educationally subnormal' range of intelligence'	2	A=11 y B=9 y
1983 Titchener ²⁷	CE (not specified by whom) in a school for the physically handicapped; 1 hr/day	None	CP (8) {spastic tetraplegia (1), athetosis (3), spastic quadriplegia (2), dystonic tetraplegia (1), road traffic accident (1)} Educational level: ESN(severe) (3), ESN(moderate) (3), 1 below average, 1 average	8	8-13 y
1989 Shields ²⁵	CE-based program by PT, OT, teacher, caregivers / nurse-aides, with input from speech therapist at a long term residential institution and special school for physically and intellectually disabled children; 3 task	None	CP (9) {spastic quadriplegia (7), athetosis (2)}, spina bifida + CP (1), chromosome anomalies (1), Lesch Nyhar syndrome (1) Cognitive level: not specified	12	3-6 y

1993 Sigafoos ²⁶	series/wk, each 45 min long.					
	<i>Younger group:</i> CE by 1 Hungarian conductor at a primary school; 3 hr/day 5dy/wk	None		CP (4) {nonambulatory (3), Intellectual disability: mild (2), not specified (2)}	4	22-48 mo
	<i>Older group:</i> CE by 2 Hungarian conductors in a.m. / 3 Hungarian conductors in p.m. in a separate classroom at a primary school; 6 hr/day, 5 dy/wk	None		CP (5) {nonambulatory (3) walks with assistance (2) Intellectual disability: moderate (1), severe (1), not specified (3)}	5	63-127 mo
1995 Coleman ¹⁶	5 CE-based programmes, (4 with Hungarian conductor and therapists, 1 with only therapists); ½ dy 5dy/wk to ½ dy 5/14 dy	4 centre-based early intervention programs using traditional approaches to therapy and special education; frequency not specified		CP (20) {spastic diplegia (7), hemiplegia (1), spastic quadriplegia (11), athetosis (1)} Cognitive level: not specified	20	19-69 mo
1995 Catanese ¹⁴	General statement that CE based programmes staffed by Hungarian conductors, Australian trained therapists and teachers; frequency not specified	Individual physiotherapy programmes; frequency not specified		CE: CP (17) {mild (5), moderate (11), severe (1)} Control: CP (17) {mild (5), moderate (7), severe (5)} Associated intellectual disability: CE: mild (6), moderate (7), severe (4) Control: mild (6), moderate (7), severe (4)	34	4-7 y
1995a Hur ²¹	CE by British school teachers trained as conductors in the Birmingham Institute for Conductive Education; 'physical' programme = 14.0 hr/wk (average), 'academic' programme = 4.0 hr/wk (average) ^b	Special education programs at special schools for children with physical handicaps; 'physical' programme = 3.3 hr/wk (average), 'academic' programme = 8.0 hr/wk (average)		CE: CP (19) {mild (5), moderate (4), severe (10)} Control: CP (17) {mild (5), moderate (6), severe (6)} Cognitive level: CE: mean IQ = 83.5 Control: mean IQ = 85.1	36	5-6½ y
1995b Hur ²²	CE by British school teachers trained as conductors in the Birmingham Institute for Conductive Education; 'physical' programme = 14.0 hr/wk (average), 'academic' programme = 4.0 hr/wk (average)	Special education programs at special schools for children with physical handicaps; 'physical' programme = 3.3 hr/wk (average), 'academic' programme = 8.0 hr/wk (average)		Mothers of 36 children with cerebral palsy (as described in 1995a Hur and 1997 Hur) CE: 19 mothers Control: 17 mothers	36	Not given

1997 Hur ²⁰	CE by British school teachers trained as conductors in the Birmingham Institute for Conductive Education; 'physical' programme =14.0 hr/wk (average), 'academic' programme = 4.0 hr/wk (average)	Special education programs at special schools for children with physical handicaps; 'physical' programme =3.3 hr/wk (average), 'academic' programme = 8.0 hr/wk (average)	CE: CP (19) {mild (5), moderate (4), severe(10)} Control: CP (17) {mild (5), moderate (6), severe (6)} Cognitive level: CE: mean IQ = 83.5 Control: mean IQ = 85.1	36	3½–4½ y.	
1998 Reddihough ²⁴	R: CE-based programme with input from a Hungarian conductor at a children's hospital, mean frequency 2.8 hr/wk NR: CE-based programmes (not specified by whom); programmes staffed by Australian therapists and teachers with consultation provided by Hungarian conductors; mean frequency 3.2 hr/wk	R: Individual therapy and playgroup with additional hours of therapy to match CE group; mean frequency 2.9 hr/wk NR: traditional therapy programmes; mean frequency 2.2 hr/wk	R CE (17) <u>mild</u> diplegia 3 <u>moderate</u> diplegia 2 quadriplegia. 5 <u>severe</u> diplegia 1 quadriplegia. 5 <u>not specified</u> ataxia 1 Cog. level <u>normal</u> 11 <u>impaired</u> 5 <u>unknown</u> 1 NR CE (15) <u>mild</u> diplegia 0 hemiplegia 2 quadriplegia 1 <u>moderate</u> diplegia 1 quadriplegia 2 <u>severe</u> diplegia 0 quadriplegia. 9 Cog. level <u>normal</u> 6 <u>impaired</u> 9	R Control (17) <u>mild</u> diplegia 3 <u>moderate</u> diplegia 2 quadriplegia. 5 <u>severe</u> diplegia 1 quadriplegia 5 <u>not specified</u> ataxia 1 Cog. level <u>normal</u> 11 <u>impaired</u> 5 <u>unknown</u> 1 NR Control (17) <u>mild</u> diplegia 3 hemiplegia 2 quadriplegia 1 <u>moderate</u> diplegia 1 quadriplegia 2 <u>severe</u> diplegia 1 quadriplegia 7 Cog. level <u>normal</u> 10 <u>impaired</u> 7	R: 34 NR: 32	12-36 mo. 12–36 mo
1999 Bochner ¹³	Part I: School Project CE by 2 Hungarian conductors, 1 teacher, 1 aide, 2-3 volunteers 4 - 4.5 hr/day Part II: Preschool Project CE by 2 Hungarian conductors in a special	None None	CP Varying degrees of physical and intellectual impairment CP Varying degrees of physical impairment Cognitive level: not specified	6 ^c 7	12 y (n=5) 6 y (n=1) 3–6 y	

2000 Lind ²³	school; 5.75 hr/day CE by 4 Hungarian conductors at the Move and Walk Institute, children and families stayed at the institute the whole time	None	109 total respondents, CP (103), {spastic diplegia (55), spastic quadriplegia (14), hemiplegia (8), ataxia (5), unspecified (21)}, Others (6) {muscular diseases, spilitomia, and brain damage following surgery} Cognitive level: not specified	109	2-12 y
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CE, conductive education; CP, cerebral palsy; ESN, educationally subnormal; y, year; wk, weeks; dy, days; PT, physical therapist; OT, occupational therapist; hr, hours; mo, months; min, minutes; R, randomly assigned; NR, non-randomly assigned; Cog level, cognitive level; n, number.

^a The 626 clients all have CP

^b information about treatment frequency in Hur 1995a²¹, Hur 1995b²², and Hur 1997²⁰ derived from HMSO report²⁸

^c only 4 of the 6 children remained in the study for the full 2 years – the other 2 children were replaced in the second year.

RESEARCH METHODS

Table IV (on this page and next) summarizes the research methods used in the 15 studies. Levels of evidence were determined by the type of research design (Level I-V) plus a judgment about the degree to which the particular study controlled threats to internal validity within its design parameters (S for Strong, M for Moderate, W for Weak)^d. Level V studies are not subjected to judgment about how well they controlled for threats to validity because there are no controls.

Table IV: Summary of studies – research methods

<i>Study</i>	<i>Research design</i>	<i>Level of evidence/ quality</i>	<i>Treatment duration</i>	<i>CE Rx n</i>	<i>Control Rx n</i>
1972a Heal ¹⁸	Cohort study with concurrent control group	II-W (2/7) ^a	12 mo	10	15
1972b Heal ¹⁹	Descriptive case series	IV- W (0/7)	>1 mo range unknown	626	None
1973 Clarke ¹⁵	Case series without controls	IV-W (2/7)	16 mo	6	None
1974 Cotton ¹⁷	Descriptive case series	V	Not specified	2	None
1983 Titchener ²⁷	Case series without controls	IV-W (2/7)	7 mo	8	None
1989 Shields ²⁵	Case series without controls	IV-W (1/7)	1 y	12	None

^d THE AACPDm methodology is based on current scientific standards for analyzing and weighting studies for bias and error and for judging study methods. Nevertheless, this type of critical appraisal is a new endeavor in medicine, in general and within the Academy, in particular. The AACPDm methodology will continue to evolve both with experience and as the science of critical appraisal improves. Therefore, the assigned level of evidence should be regarded as an estimate, and relative to other studies, rather than an absolute.

1993 Sigafoos ²⁶	Case series without controls	IV-W (1/7)	6 wk	9	None
1995 Coleman ¹⁶	Cohort study with concurrent control group	II-W (4/7)	26 wk	11	9
1995 Catanese ¹⁴	Cohort study with concurrent control group	II-W (4/7)	26 wk	17	17
1995a Hur ²¹	Cohort study with historical control group	III-W (2/7)	2 y	19	17
1995b Hur ²²	Cohort study with historical control group	III-W (2/7)	2 y	19	17
1997 Hur ²⁰	Cohort study with historical control group	III-W (2/7)	2 y	19	17
1998 Reddihough ²⁴	Randomized controlled trial	I-S (6/7)	6 mo	R=17	R=17
	Non-randomized controlled trial	II-M(5/7)	6 mo	NR=15	NR=17
1999 Bochner ¹³	Part I: Case Series	V	2 y	6	None
	Part II: Case Series Without Controls	IV-W (1/7)	1 y	7	None
2000 Lind ²³	Descriptive case series	V	4 wk	109	None

CE, conductive education; Rx Treatment; R, random assignment; NR, non-random assignment

^a This fraction represents the number of conduct questions that received a 'yes' response

OUTCOMES, MEASURES, AND RESULTS

Table V, in three parts, summarizes 185 results from the 15 studies¹³⁻²⁷. Table V, Part A and Part B, show the coding of each result for the dimension of disability and level of evidence it represented.

Some studies reported the results as group data that reflect the average effect of CE in a group when its pre-and post- CE status was compared. Other studies reported results according to the uniformity of effect within the group, i.e. the change of status of individuals. Part A of the table includes 142 results that reflect comparisons of group averages; Part B includes 43 results that reflect uniformity of effect within the group. Clinical importance or relevance was not stated explicitly in any of the studies examined. Statistical information is specified to the extent provided. No study in this review reported power calculations. Each result is assigned the level of evidence of the study that produced it (see Table IV).

Table V: Summary of studies: outcomes, measures, and results.

Part A Average of group comparison effect These results reflect effects of CE when compared to another condition or to status before treatment.

<i>Study</i>	<i>Outcome of interest</i>	<i>Measure</i>	<i>Dimension of Disability</i>	<i>Result¹</i>	<i>CI</i>	<i>Statistics² No Power reported</i>	<i>Level</i>
Heal ¹⁸	Mat tasks	ECFAT	I	a		<i>ns</i>	II
1972a	Sitting	ECFAT	FL/A	a		<i>ns</i>	II
	Standing	ECFAT	FL/A	e		<i>ns</i>	II
	Sitting down	ECFAT	FL/A	e		<i>ns</i>	II
	Walking	ECFAT	FL/A	a		<i>ns</i>	II
	Eating	ECFAT	FL/A	e		<i>p<.05 Ctl</i>	II
	Chewing	ECFAT	FL/A	a		<i>ns</i>	II
	Drinking	ECFAT	FL/A	e		<i>p<.05 Ctl</i>	II
	Hand skills	ECFAT	FL/A	a		<i>ns</i>	II
	Writing	ECFAT	FL/A	d		<i>ns</i>	II

	Dressing	ECFAT	FL/A	d	<i>ns</i>	II
	Total ECFAT score	ECFAT	FL/A	e	<i>p</i> <.05 Ctl	II
	Self-care	WBSI	FL/A	b	<i>p</i> <.05	II
	Environmental orientation	WBSI	FL/A	a	<i>ns</i>	II
	Independence	WBSI	FL/A	a	<i>ns</i>	II
	Communication	WBSI	FL/A	a	<i>p</i> <.05 CE	II
	Emotional Maturity	WBSI	FL/A	a	<i>ns</i>	II
	Group interaction	WBSI	FL/A	a	<i>ns</i>	II
	Intellectual growth	WBSI	FL/A	a	<i>ns</i>	II
	Total WBSI Score	WBSI	FL/A	a	<i>ns</i>	II
	Expressive language	VLDS	I	a	<i>ns</i>	II
	Receptive language	PPVT	I	a	<i>ns</i>	II
	Math Abilities	PIAT	I	e	<i>ns</i>	II
	Reading recognition	PIAT	I	a	<i>ns</i>	II
	Reading comprehension	PIAT	I	d	<i>ns</i>	II
	Spelling	PIAT	I	a	<i>ns</i>	II
	General Info	PIAT	I	a	<i>ns</i>	II
	Total	PIAT	I	a	<i>ns</i>	II
Heal ¹⁹ 1972b	Level of independence	Rating scale	FL/A	a (no Ctl)	<i>None</i>	IV
Shields ²⁵ 1989	Lying	Task series	I ³	Unknown ⁴		IV
	Sitting	Task series	I ³	Unknown ⁴		IV
Catanese ¹⁴ 1995	Gross motor	VAB-BR-Video	FL/A	c	<i>p</i> <.01 CE	II
		Video Ratings	FL/A	c	<i>p</i> <.03 CE	II
	Fine Motor	VAB-BR-Video	FL/A	a	<i>ns</i>	II
		Video Ratings	FL/A	c	<i>p</i> <.01 CE	II
	Receptive language	VAB-BR-Video	FL/A	a	<i>ns</i>	II
		Video Ratings	FL/A	f	<i>ns</i>	II
		VAB-CR	FL/A	a	<i>ns</i>	II
	Expressive language	VAB-BR-Video	FL/A	a	<i>ns</i>	II
		Video Ratings	FL/A	a	<i>ns</i>	II
		VAB-CR	FL/A	a	<i>ns</i>	II
	Grooming	VAB-BR-Video	FL/A	a	<i>ns</i>	II
		VAB-CR	FL/A	a	<i>ns</i>	II
	Feeding	VAB-BR-Video	FL/A	a	<i>ns</i>	II
		VAB-CR	FL/A	a	<i>ns</i>	II
	Dressing	VAB-CR	FL/A	a	<i>ns</i>	II
	Social Interaction	VAB-CR	FL/A	a	<i>p</i> <.001 Ctl	II
	Play	VAB-CR	FL/A	a	<i>p</i> =.05 Ctl	II
	Toileting	VAB-CR	FL/A	a	<i>p</i> <.02 CE	II
	Parent/Family Problems	QRS-F modified	SL/Context	c	<i>p</i> <.05 CE	II
	Pessimism	QRS-F modified	SL/Context	c	<i>ns</i>	II
	Child Characteristics	QRS-F modified	FL/A	c	<i>ns</i>	II
	ADL	Video Ratings	FL/A	c	<i>p</i> =.01 CE	II
	Compliance	Video Ratings)	FL/A	c	<i>ns</i>	II
	Cognitive Ability	CMMS	I	a	<i>p</i> =.005 Ctl	II
		RDLS	I	a	<i>ns</i>	II
		PPVT	I	a	<i>ns</i>	II
	Cognitive and Physical Skills	WPPSI(drawing and maze subtests)	I	a	<i>p</i> <.03 Ctl	II
	Numeracy skills	SB subtest	I	a	<i>ns</i>	II

Coleman ¹⁶ 1995		DMT	I	a	<i>ns</i>	II
	Gross motor	VAB-BR-Video	FL/A	c	<i>ns</i>	II
	Fine motor	VAB-BR-Video	FL/A	a	<i>ns</i>	II
	Receptive language	VAB-BR-Video	FL/A	c	<i>ns</i>	II
		VAB CR	FL/A	a	<i>ns</i>	II
	Expressive language	VAB-BR-Video	FL/A	a	<i>ns</i>	II
		VAB CR	FL/A	f	<i>ns</i>	II
	Grooming	VAB-BR-Video	FL/A	c	<i>ns</i>	II
		VAB CR	FL/A	c	<i>ns</i>	II
	Feeding	VAB-BR-Video	FL/A	c	<i>ns</i>	II
		VAB CR	FL/A	a	<i>ns</i>	II
	Organizational behavior	VAB CR	Unknown ⁵	a	<i>ns</i>	II
	Dressing	VAB CR	FL/A	a	<i>ns</i>	II
	Social Interaction	VAB CR	FL/A	a	<i>p=.004 CE</i>	II
	Play	VAB CR	FL/A	a	<i>ns</i>	II
	Toileting	VAB CR	FL/A	a	<i>ns</i>	II
	Parent/Family Problems	QRS-F	SL/Context	c	<i>ns</i>	II
Pessimism	QRS-F	SL/Context	f	<i>ns</i>	II	
Child Characteristics	QRS-F	FL/A	f	<i>ns</i>	II	
Hur ²¹ 1995a	Reading performance	CRT	FL/A	a	<i>ns</i>	III
	Math performance	Basic Math test	FL/A	a	<i>ns</i>	III
Hur ²² 1995b	Maternal stress	MI	SL/Context	a	<i>ns</i>	III
	Child behavior	Checklist	FL/A	unknown	<i>ns</i>	III
	Maternal satisfaction with help given to child	9-pt Likert scale	SL/Context	f	<i>ns</i> ⁶	III
	Maternal satisfaction with child's progress	9-pt Likert scale	SL/Context	f	<i>ns</i>	III
Hur ²⁰ 1997	Gross motor	VABS IE	I	a	<i>ns</i>	III
	Interpersonal relationships	VABS CE	I	a	<i>ns</i>	III
		DP 2 SAS	I	a	<i>ns</i>	III
	Play and leisure Time	VABS CE	I	a	<i>ns</i>	III
	ADL	VABS CE	I	a	<i>ns</i>	III
		DP 2 SHAS	I	a	<i>ns</i>	III
	Receptive, expressive and non-verbal communication	DP2 - CAS	I	a	<i>ns</i>	III
	Physical strength, coordination (fine and gross motor), stamina and flexibility	DP2 PAS	I	a	<i>ns</i>	III
Reddihough ²⁴ 1998	Cognitive	VAB-BR-Video	I	e	<i>ns</i>	I
		VAB CR	I	a	<i>ns</i>	I
	Feeding	VAB-BR-Video	FL/A	a	<i>ns</i>	I
		VAB CR	FL/A	a	<i>ns</i>	I
	Play	VAB-BR-Video	FL/A	a	<i>ns</i>	I
		VAB CR	FL/A	a	<i>ns</i>	I
	Expressive Language	VAB-BR-Video	FL/A	a	<i>ns</i>	I
		VAB CR	FL/A	a	<i>ns</i>	I
	Receptive Language	VAB-BR-Video	FL/A	a	<i>ns</i>	I
		VAB CR	FL/A	a	<i>ns</i>	I
	Gross Motor	VAB-BR-Video	FL/A	f	<i>ns</i>	I
GMFM: L&R		FL/A	a	<i>ns</i>	I (n=22)	

	Sitting	FL/A	a	<i>ns</i>	I (n=22)
	C&K	FL/A	a	<i>ns</i>	I (n=22)
	Standing	FL/A	a	<i>ns</i>	I (n=22)
	W&R	FL/A	a	<i>ns</i>	I (n=22)
	Total score	FL/A	a	<i>ns</i>	I (n=22)
Fine motor	VAB-BR-Video	FL/A	e	<i>ns</i>	I
Organizational behavior	VAB-BR-Video	Unknown ⁵	e	<i>p</i> <.05 Ctl	I
	VAB CR	Unknown ⁵	a	<i>ns</i>	I
Dressing	VAB CR	FL/A	a	<i>p</i> <.05 CE	I
Grooming	VAB CR	FL/A	a	<i>ns</i>	I
Social	VAB CR	FL/A	a	<i>ns</i>	I
Toileting	VAB-BR-Video	FL/A	a	<i>ns</i>	I
Parent perceptions of coping	QRS-F modified	SL/Context	a	<i>ns</i>	I
Cognitive	VAB-BR-Video	I	c	<i>ns</i>	II
	RDLS	I	a	<i>ns</i>	II
Feeding	VAB-BR-Video	FL/A	c	<i>ns</i>	II
	VAB CR	FL/A	a	<i>ns</i>	II
Play	VAB-BR-Video	FL/A	c	<i>ns</i>	II
	VAB CR	FL/A	e	<i>ns</i>	II
Expressive Language	VAB-BR-Video	FL/A	a	<i>ns</i>	II
	VAB CR	FL/A	a	<i>ns</i>	II
Receptive Language	VAB-BR-Video	FL/A	a	<i>ns</i>	II
	VAB CR	FL/A	a	<i>ns</i>	II
Gross Motor	VAB BR (video)	FL/A	a	<i>ns</i>	II
	GMFM: L&R	FL/A	a	<i>p</i> <.05 Ctl	II (n=19)
	Sitting	FL/A	a	<i>ns</i>	II (n=19)
	C&K	FL/A	a	<i>ns</i>	II (n=19)
	Standing	FL/A	a	<i>p</i> <.05 Ctl	II (n=19)
	W&R	FL/A	a	<i>ns</i>	II (n=19)
	Total score	FL/A	a	<i>p</i> <.05 Ctl	II (n=19)
Fine motor	VAB-BR-Video	FL/A	f	<i>ns</i>	II
Organizational behavior	VAB-BR-Video	Unknown ⁵	c	<i>ns</i>	II
	VAB CR	Unknown ⁵	a	<i>ns</i>	II
Dressing	VAB CR	FL/A	a	<i>ns</i>	II
Grooming	VAB CR	FL/A	a	<i>ns</i>	II
Social	VAB CR	FL/A	a	<i>ns</i>	II
Toileting	VAB CR	FL/A	a	<i>ns</i>	II
Parent perceptions of coping	QRS-F modified	SL/Context	c	<i>ns</i>	II

Abbreviations: CI, Clinical Improvement; I, Impairment; *ns*, not significant; ECFAT, Eau-Claire Functional Abilities Test; FL/A, Functional limitation/ Activity; WBSI, Wolfe-Bleuel Socialization Inventory; VLDS, Verbal Language Developmental Scale; PPVT, Peabody Picture Vocabulary Test; PIAT, Peabody Individual Achievement Test; VAB BR (video), Vulpe Assessment Battery – Behavior Rating (modified); VAB CR, Vulpe Assessment Battery – Caregiver Rating (modified); SL/Context, Societal limitations/contextual factors; ADL, Activities of Daily Living; QRS-F Questionnaire on Resources and Stress (short form); CMMS, Columbia Mental Maturity Scale; RDLS, Reynell Developmental Language Scale, WPPSI, Weschler Pre-school Scale of Intelligence (revised); SB, Stanford Binet; DMT, Diagnostic Mathematical Task; CRT, Comprehensive Reading Test; MI, Malaise Inventory; VABS IE, Vineland Adaptive Behavior Scales Interview edition; VABS CE, Vineland Adaptive Behavior Scales Classroom edition; DP2 SHAS, Developmental Profile 2 Self-help Age scale; DP2 CAS, Developmental Profile 2 Communication Age scale; DP2 PAS, Developmental Profile 2 Physical Age scale; DP2 SAS, Developmental Profile 2 Social Age scale; GMFM, Gross Motor Function Measure; L&R, Lying and Rolling; C&K, Crawling and Kneeling; W&R, Walking and Running

¹ The direction of improvement in each group is graded using the following legend. Statistical significance between group status is given by the p value.

- a both groups improved
- b Conductive Education (CE) group improved, no change in Control group (Ctl)
- c CE group improved, Ctl deteriorated
- d no change in CE group, Ctl improved
- e CE group deteriorated, Ctl improved
- f both groups deteriorated

² CE and Ctl indicate the group with significantly significant result

³ Activities not described in enough detail to determine level of disablement, thus reduced to lower level of impairment

⁴ Statistics cannot be interpreted – incorrect assumption and use of Spearman's correlation coefficient

⁵ Outcome of interest not described in enough detail to assign a level of disablement

⁶ Mothers of children in CE group had significantly higher levels of satisfaction at baseline, end of yr 1 and end of yr 2 ($p < .01$). Authors' attributed significant difference at baseline to mothers' 'initial faith' in CE program

Table V: Uniformity of effect with a treatment group results

Part B These results reflect the amount of change within a group receiving conductive education. For outcomes with more than one item measured independently, the first proportion represents the item for which the minimum number of children improved and the second proportion represent the item for which the maximum number of children improved.

<i>Study</i>	<i>Outcome of interest</i>	<i>Measure</i>	<i>Dimension of Disability</i>	<i>Improved Result n, %</i>	<i>Better before CE</i>	<i>No change result</i>	<i>Level</i>		
Clarke ¹⁵ 1973	Prone (3 items)	Observation	FL/A	3/6, 50%			IV		
	Rolling (1 item)	Observation	FL/A	5/6, 84%					
	Supine (7 items)	Observation	FL/A	2/6, 33%					
	Getting on & off tables alone	Observation	FL/A	4/6, 67%					
	Sitting (3 items)	Observation	FL/A	4/6, 67%					
	Arm and hand function (13 items)	Observation	FL/A	3/6, 50%	5/6, 84%				
	Sit-Stand-Walking (5 items)	Observation	FL/A	2/6, 33%	4/6, 67%				
	Feeding (6 items)	Observation	FL/A	2/6, 33%	4/6, 67%				
	Undressing (3 items)	Observation	FL/A	3/6, 59%	5/6, 84%				
	Toileting (2items)	Observation	FL/A	2/6, 33%	4/6, 67%				
	Titchner ²⁷ 1983	Activities in lying (16 items)	Task analysis	FL/A	2/8, 25%				IV
		Activities in Sitting (8 items)	Task analysis	FL/A	6/8, 75%				
		Activities with hands (30 items)	Task analysis	FL/A	1/8, 13%	6/8, 75%			
				0/8, 0%	4/8, 50%				

	Transfer skills (19 items)	Task analysis	FL/A	0/8, 0%		
	Self-help activities (23 items)	Task analysis	FL/A	5/8, 63%		
	Relationship within Group (4 items)	Task analysis	FL/A	0/8, 0%		
				6/8, 75%		
				2/8, 25%		
				5/8, 63%		
Bochner ¹³ 1999	Eating	Task analysis	FL/A	3/4, 75%	1/4, 25%	V
Part 1:	Standing	Task analysis	FL/A	4/4, 100%		
	Match objects to sample	Task analysis	FL/A		2/2, 100%	IV
Part 2:	Potty skills	Task analysis	FL/A	6/7, 86%		
	Rolling	Task analysis	FL/A	4/7, 57%		
	Eating	Task analysis	FL/A	1/7, 14%	6/7, 86%	
	Pre-academic skills	DSI	FL/A	UK ¹		
Sigafoos ²⁶ 1993	Awareness of Left arm	All outcomes measured by parent perception of goal achievement	I	1/1, 100%		IV
	Improve balance		I	1/1, 100%		
	Standing independence		FL/A	1/1, 100%		
	Increase confidence in walking		FL/A	1/1, 100%		
	Increase confidence in hand function		FL/A	1/1, 100%		
	Improve walking		FL/A	1/1, 100%		
	Improve communication		FL/A	1/1, 100%		
	Improve hand function		FL/A	2/2, 100%		
	Improve trunk control		I	1/1, 100%		
	Independent stepping		I	1/1, 100%		
	Muscle flexibility		I	2/2, 100%		
	Cognition		FL/A	1/1, 100%		
	Stepping		I	2/2, 100%		
	Walking	Videotape	FL/A		4/4, 100%	
	Eating	Videotape	FL/A	1/5, 20%	4/5, 80%	
Cotton ¹⁷ 1974	Patterns of movement	Observation	I	2/2, 100%		V
Lind ²³ 2000	Sitting, standing. Walking abilities (17 items)	Mail out survey to parents	FL/A	1/109, 1%		V
	Gross motor (13 items)	Mail out survey to parents	I	22/109, 20%		
	Fine motor (9 items)	Mail out survey to parents	FL/A	1/109, 1%		
	Eating and Special activities (8 items)	Mail out survey to parents	FL/A	13/109, 12%		
				1/109, 1%		
				11/109, 10%		

Abbreviations: I, Impairment; FL/A, Functional Limitation/Activity; DSI, Developmental Skills Inventor; UK, Unknown

¹ 'only minor improvements' – cannot determine number of children

Evidence table

ORGANIZATION AND INTERPRETATION

The evidence table (Table VI) must also be displayed in two parts to accommodate the two different types of results. Interpretation can be made visually with this table or more in-depth interpretation is possible by referring back to the summary tables.

Part A of the table aggregates 137 group average results^e produced by nine of the studies. Each outcome is indicated by a superscript representing the citation number of each study that produced this result associated with a level of evidence (coded I-V for type of research design and S, M or W for strong, moderate or weak control to threats of validity). By rows, one can see which dimensions of disability have been targeted for investigation and which types and how often outcomes have been measured. For example, a variety of motor activities have been evaluated using group comparison 27 times at the level of Functional limitation/Activity in four different studies over a 26-year period. Only three results (from the same study) found significant changes in favor of CE. The confidence with which one can regard these findings is moderate since all four studies were at least at a Level II with conduct ratings ranging from strong to weak.

Part B aggregates the 42 uniformity of effect results^f by level of evidence and a citation for the study that produced the result. For example, cognition was evaluated by only one study²⁶ in this portion of the table. Examination of Table V Part B reveals that it was measured by parent perception of achieving a goal and that evaluation was done on only one child. The strength of the evidence gathered from the uniformity of effect studies regarding the change in cognition of children in CE programs is very weak, despite the positive result.

The evidence reported in Part A of Tables V and VI is methodologically stronger than the information reported from the studies listed in Part B of both tables. The studies in Part B are all at Level IV or V. The sample sizes are small and no statistical analyses were performed. The results are presented as proportions of children reported to have improved.

^e All 141 results from Table V Part A are not included because the 5 'organizational behaviors',^{16,24} outcomes could not be classified by level of disablement.

^f One measure of interest in Table V, Part B, pre-academic skills¹³, could not be assigned an outcome in Table VI, Part B.

Table VI: Evidence table – outcomes of CE for CP.

Part A Average of group comparison results. Each outcome is indicated by a superscript that is the citation number of each study that produced this result associated with a level of evidence (coded I-V for type of research design and S, M, or W for strong, moderate or weak control to threats of validity in conducting the study). Each entry reflects whether the group-average outcome was better after CE compared to either a pre-CE group average or a control group average. Multiple results appear when a study investigated the same outcome of interest in different ways. Two studies reviewed are not included in this table; the outcomes in Hill's study could not be classified by levels of disablement and the methodology used by Cooper was qualitative and thus could not be assigned a level of evidence.

<i>Outcomes by dimension of disability</i>	<i>Results favoring CE statistical significance</i>	<i>Results favoring Ctl statistical significance</i>	<i>Results favoring CE but not evaluated for statistical significance</i>	<i>Results statistically evaluated and reporting no statistical significance between groups</i>
Pathophysiology				
Impairment <u>Motor actions:</u> mat activities, lying, sitting, gross motor skills, physical coordination, strength, stamina, flexibility			IV-W ^{25, 25}	II-W ¹⁸ III-W ^{20, 20}
<u>Cognitive abilities and Social Behaviors:</u> cognitive ability, interpersonal relationships, play and leisure time		II-W ^{14 14}		I-S ^{24, 24} II-M ^{24, 24} II-W ^{14, 14} III-W ^{20, 20, 20}
<u>School performance skills:</u> Reading recognition, math abilities, reading comprehension, spelling, numeracy skills, general information, total PIAT score				II-W ^{18, 18, 18, 18, 18, 18, 14, 14}
<u>Activities of Daily Living</u>				III-W ^{20, 20}
<u>Language:</u> receptive, expressive and non-verbal communication				II-W ^{18, 18} III-W ²⁰
Functional Limitation/ Activity				
<u>Level of independence</u>			IV ¹⁹	
<u>Motor activities:</u> Sitting, standing, walking & running, running, crawling and kneeling, lying and rolling, gross motor, fine motor, hand skills, total GMFM scores	II-W ^{14, 14, 14}	II-M ^{24, 24, 24}		I-S ^{24, 24, 24, 24, 24, 24, 24, 24,} II-M ^{24, 24, 24, 24, 24,} II-W ^{18, 18, 18, 18, 18, 14, 16, 16}
<u>Activities of Daily Living:</u> Eating, chewing, drinking, feeding, dressing, self-care, independence, grooming, toileting, ADL, functional behaviors, total ECFAT score	I-S ²⁴ II-W ^{14, 18, 14}	II-W ^{18, 18, 18}		I-S ^{24, 24, 24, 24} II-M ^{24, 24, 24, 24, 24} II-W ^{14, 14, 14, 14, 14, 16, 16, 16, 16, 18, 18, 18} III-W ²²

<u>Social Interactions and behaviors</u> Play, environmental interaction, social interaction child characteristics, compliance, emotional maturity, intellectual growth, group interaction, total WBSI	II-W ¹⁶	II-W ^{14, 14}		I-S ^{24, 24, 24} II-M ^{24, 24, 24} II-W ^{16, 16, 18, 18, 18, 18, 14, 14}
<u>Communication</u> Communication, expressive language, receptive language	II-W ¹⁸			I-S ^{24, 24, 24, 24} II-M ^{24, 24, 24, 24} II-W ^{16, 16, 16, 16, 14, 14, 14, 14, 14}
<u>Academic Skills</u> writing skills, reading performance, math performance				II-W ¹⁸ III-W ^{21, 21}
Disability Participation No outcome measures at this level				
Societal Limitations Contextual Factors <i>Parental Attitudes/Perceptions</i> parent/family problems, pessimism, coping, maternal stress, maternal satisfaction	II-W ¹⁴			I-S ²⁴ II-M ²⁴ II-W ^{16, 16, 14} III-W ^{22, 22, 22}

CE, Conductive education; Ctl, Control group

Table VI: Evidence table – outcomes of CE for CP.

Part B Uniformity of results within a treated group. Some studies report improved and unchanged groups while some only report the improved results. Refer to Table Vb for number proportion of children for each study.

<i>Outcomes by dimension of disability</i>	<i>Some Improved result for CE. (Proportion of sample that improved). Refer to Table V Part B for specific sample sizes)</i>	<i>Better before CE</i>	<i>No change (Proportion of sample that did not change) Refer to Table V Part B for specific sample sizes)</i>
Pathophysiology			
Impairment <u>Motor responses:</u> awareness of L arm, balance, trunk control, stepping, muscle flexibility, patterns of movement, gross motor skills	IV-W ^{26, 26, 26, 26, 26, 23} V ¹⁷ (23% to 100%)		
Functional Limitation/Activity <u>Motor Activities:</u> prone, rolling, supine, getting on and off tables, sitting, walking, lying, standing, hand activities, transfer skills, fine motor	IV-W ^{15, 15, 15, 15, 15, 15, 27, 27, 27, 13, 13, 26, 26, 26, 26, 23, 23} (12% to 100%)		IV-W ²⁶ (100%)
<u>Activities of Daily Living:</u> feeding/eating, dressing/undressing, toileting, self-help activities, potty skills	IV-W ^{15, 15, 15, 27} V ^{13, 13, 23} (10% to 86%)		IV-W ²⁶ V ¹³ (25% to 80%)
<u>Social Interactions and Behaviors:</u> relationships in group	IV-W ²⁷ (63%)		
<u>Language and communication skills</u>	IV-W ²⁶ (100%)		
<u>Pre-academic and Academic skills:</u> match objects			V ¹³ (86%)
<u>Cognition</u>	IV-W ²⁶ (100%)		
Disability/Participation no outcomes			
Societal Limitations Contextual Factors no outcomes			

CE, Conductive education; Ctl, Control group

GREATER ELABORATION OF THE EVIDENCE

Any data in Table VI can be examined in more detail by using the superscript citations and referring back to the summary tables. For example, in the row in Table VI Part A that shows the

effects of CE on motor activities in the Functional limitation/Activity dimension of disability, there is a single study¹⁴ that indicates three outcomes in favor of CE. The summary of studies (Tables III and IV) reveals that this evidence came from a study in 1995 with a sample of 34 children aged 4 to 7 years who had mild to moderate severity of CP. All had some degree of intellectual disability. The children in the experimental group attended a CE based program (n=17). The control group (n=17) received individual physiotherapy sessions of varying and unknown intensities and frequencies. Both groups received intervention for 26 weeks.

From the summary of research methods (Table IV) it can be determined that this level II-W evidence came from a cohort study with a concurrent control group, a relatively strong research design. However, the quality of the study was rated as 4/7, indicating some limitations in the study methods.

Final elaboration of the summary of results (see Table V Part A) reveals that motor activities at the level of Functional limitation/Activity were measured in this study by two gross motor and two fine motor measures. In both domains, the two measures entailed the use of video ratings, one from the behavior ratings from a standardized measure and the other using retrospective video ratings done by independent raters of the child's entire videotaped performance. Statistical analyses of the measures revealed a significant interaction effect in favor of the CE group in three of these four measures, the two gross motor measures and the overall video ratings of fine motor performance.

TARGETING EVIDENCE OF PARTICULAR INTEREST

Readers can also use the evidence tables to focus on a specific aspect of the data included within them. For example, a family of a 13-year old child with severe spastic quadriplegia may be considering a CE intervention program and seeks advice from a therapist regarding evidence that CE is beneficial for an older child with severe involvement. Starting at Table III, the therapist could identify two studies^{18,27} that included children 13 years of age. All children in the Heal study were non-ambulatory with an IQ less than 70 and seven of the eight children in the Titchner sample had involvement of all four limbs. Highlighting the results in Table VI Part A from the Heal study reveals 28 outcomes of interest, nine at the level of impairment, and 19 at the level of functional limitations/activity. Referring back to the measures in Table V Part A the therapist could identify that of these measures, two (self-care and communication), were statistically significant in favor of the CE group and three (eating, drinking and the total Eau-Claire Functional Abilities Test (ECFAT) score), were significant in favor of the control group. The CE group in this study received intensive intervention.

Highlighting the Titchner results in Table VI Part B reveals six outcomes all at the level of functional limitations/activity that were measured by task analysis. The greatest proportion of improvement in the eight children occurred in activities of lying sitting and self-help with 75% of the children improving in at least one item of these outcomes.

Referring back to Tables III and IV the therapist would realize that the results from Heal represent Level II evidence compared to Titchner graded as Level IV, suggesting that more confidence can be placed on the results from Heal. However, the therapist must also note that the conduct of the Heal article was rated 2/7, indicating major concerns about the research methods. The therapist must exercise caution in forming any strong conclusions from the literature available. However, by using the evidence tables, information given to the parents is based on an understanding of the available literature rather than personal opinion.

CAUTION INTERPRETING RESULTS

Caution is advised concerning the correct interpretation of results that are not statistically significant. This is not necessarily due to the fact that the treatment has no clinically important effect. Instead, results may be not significant because of lack of adequate power in the study sample and design. The power of a study is the probability that the study, given its design and sample size, can detect a true difference of a pre-determined magnitude (effect size). In the absence of a reported power calculation, there is always the possibility that a true difference existed between the two treatments being compared, but that there was inadequate power to detect the difference. However, if a power calculation is reported and the sample size needed to produce the power is obtained, then a non-significant result statistically supports the conclusion that there is no difference between the two treatments compared. Unfortunately, no study in this review reported power calculations and small sample sizes raise concerns about adequate power.

Analyses of the evidence about CE

1. WHAT KIND OF EVIDENCE IS THERE ABOUT EFFECTS ON MOTOR IMPAIRMENT OR ABOUT IMPAIRMENT IN OTHER DOMAINS OF DEVELOPMENT?

Outcomes that measured body functions or structures (e.g. range of motion, flexibility etc.) or norm-referenced measures that reported results as a developmental age score or quotient are included in this domain. Thus norm-referenced measures of motor abilities are placed in this category, even though they may measure the same skills as some tests categorized under Functional limitation/Activity heading.

Motor actions

There are 13 measures in six studies. Part A of Table VI, shows five measures from three studies (II-W¹⁸, III-W²⁰, IV-W²⁵). Part B of Table VI shows eight measures from three studies (IV-W²³,²⁶, V¹⁷). Two measures from the same study²⁵ in Part A and all measures in Part B show an improvement for CE. Shields²⁵ measured components of lying and sitting in task series and reported positive correlation coefficients across three consecutive assessments. She interpreted a significant positive correlation across time as indicating improved performance when in fact this result could also indicate unchanged or overall decrease in performance. The three Part B studies all had low levels of evidence. The two studies that tested the children's performance¹⁷,²⁶ had a combined sample size of 11 while Lind⁴ had a sample size of 109 but used a mail out survey to parents to gather information regarding the children's gross motor skills. Of 13 items on the gross motor list, the maximum number of parents reporting improvement on any one item was 25/109 (23%). Examining the two Part A studies that showed no difference in motor activities, one²⁰ used two norm-referenced tests to evaluate gross motor skills and physical coordination, strength, stamina and flexibility, while Heal¹⁸ used a standardized test to measure change in mat activities performed by the children.

Cognitive Abilities and Social Behaviors

At the level of impairment, three studies in Part A (I-S and II-M²⁴; II-W¹⁴, III-W²⁰) reported 11 norm-referenced standardized measures evaluating cognitive abilities, interpersonal relationships and play and leisure time; nine results reported no difference and two results reported a significant difference in favor of the control group. This study¹⁴, evaluating 34 children for 26 weeks, 17 of whom received CE, used four standardized measures to evaluate cognitive ability.

School Performance Skills

Two studies (II-W^{14, 18}) reported eight measures evaluating school performance skills in the areas of reading recognition and comprehension, spelling, numeracy skills, math abilities and general information. All results reported no statistically significant group differences.

Activities of Daily Living

One study (III-W²⁰), used two norm-referenced measures to document activities of daily living and both measures yielded no difference between the groups.

Language

Three measures of language and communication abilities from two studies (II-W¹⁸, III-W²⁰) reported no difference between the control and intervention groups of children.

2. WHAT EVIDENCE IS THERE ABOUT EFFECTS IN DIMENSIONS OF DISABILITY OTHER THAN IMPAIRMENT?

Pathophysiology

There is no evidence regarding effects on cellular or molecular structure or function in individuals as a result of CE.

Functional limitation/Activity

The Functional limitation/Activity dimension is concerned with common functional activities such as sitting, walking, dressing and interacting with other people. In keeping with the tenet of orthofunction that is central to CE philosophy, it is at this functional level that CE theoretically should have the biggest influence. While other treatments may have an impairment-based rationale, CE is directly aimed at improving the independence of children in their specific environment. Seven categories of skills were identified at the level of Functional limitation/Activity: level of independence, motor activities, activities of daily living, cognition, social interactions and behaviors, communication and academic/pre-academic skills.

Level of Independence

The study¹⁹ reporting this outcome of interest is important since it is a report out of Budapest that evaluated the results of the Institute program with 626 participants discharged between 1950 and 1965. The outcome 'level of independence' represents an array of functional abilities including eating, moving, manual dexterity and aural understanding. Unfortunately the low level of evidence of the study (IV) and the lack of clear descriptions of the outcome measure severely limit the applicability of the results. Improvement was noted in all areas evaluated; the minimum proportion of participants with an improvement was 2.2% in the area of aural understanding and comprehension of directions.

Motor Activities

In total there were 48 measures of motor activities in nine studies. Part A of Table VI reveals 27 measures gathered from four studies (I-S & II-M²⁴, II-W^{14, 16, 18}). Two gross motor measures and one fine motor measure from Catanese study¹⁴, which did not match treatment intensity across groups, revealed statistically significant improvements in the CE group. In contrast, the non-randomized portion of the Reddihough study²⁴, which did match intensity, reported significantly higher scores for the control group on three sections of the GMFM (lying and rolling, standing and the total score). All other results reported no significant differences between the groups. In

the Part B studies, there were 21 measures reported in five studies, all level IV-W^{13, 15, 23, 26, 27}. All but one measure resulted in some improvement for the children in the CE group.

Activities of Daily Living (ADL)

In total 10 studies, five in Part A^{14, 16, 18, 22, 24} and five in Part B^{13, 15, 23, 26, 27} of Table VI reported a total of 40 measures of various areas of ADL. In Part A, four outcomes, dressing (I-S²⁴), self-care (II-W¹⁸), toileting (II-W¹⁴), and overall ADL (II-W¹⁴) demonstrated a significant difference between the groups in favor of CE. Three outcomes, eating, drinking and the total score of the ECFAT, all from the same study (II-W¹⁸) reported significant improvement in favor of the control group. In Part B, seven of the nine measures reported improvement while two measures of eating from two separate studies (IV-W²⁶, V¹³) reported no change in the eating abilities of children in CE programs.

Social Interactions and Behaviors

A total of 19 measures from five studies evaluated a variety of measures categorized as social interactions and behaviors. In Part A of Table VI four studies (I-S & II-M²⁴, II-W^{14, 16, 18}) reported on 18 measures. Social interaction in one study (II-W¹⁶), was significantly better for the CE group and two outcomes, social interaction and play, were significantly improved for the control group in the Catanese study¹⁴. All three of these outcomes were measured using the caregiver ratings on the Vulpe Assessment Battery. The assessors reviewed children's progress retrospectively by viewing videotapes taken before and after intervention. One study in Part B of Table VI (IV-W²⁷) reported improvement on four items evaluating relationships within a group.

Communication

Five studies, four in Part A (I-S & II-M²⁴, II-W^{14, 16, 18} and one in Part B (IV²⁶) included measures of communication and language abilities. Three studies in Part A reported no significant difference between the group scores while the fourth study¹⁸ reported a significant interaction effect in favor of the CE group. In Part B, the Sigafos study, using parental perceptions of goal achievement, reported an improvement for the one child studied.

Cognition

One study (IV-W²⁶) reported a cognitive measure using parent perception of improvement of goals, and indicated that the one child evaluated improved in the area of cognition.

Academic and Pre-academic Skills

In this category, reading, writing, math or matching abilities were measured in three studies by a total of four measures. All three studies reported no difference either between groups (II-W^{18, 21}) or in children changing within a group over time. (V¹³).

Disability and Participation

No outcomes were reported at this level of disablement

Societal Limitations/Contextual Factors

Given the emphasis on independence in different community settings in the CE approach, it could be hypothesized that positive changes would be detected in parents' satisfaction of their child's abilities, parental stress and family relationships. Four studies in Part A (I-S & II-M²⁴, II-W^{14, 16}, III-W²²) of table VI evaluated nine measures classified at this level. Only one outcome, parent/family problems, reported in the Catanese article¹⁴, reported a significant improvement in favor of the CE group. This outcome was measured on the short form of the Questionnaire of Resources and Stress (QRS-F), a standardized measure of stress.

3. WHAT LINKAGES EXIST FOR TREATMENT EFFECTS ACROSS THESE DIMENSIONS?

No linkages have been reported or can be determined from this literature.

4. WHAT KINDS AND MAGNITUDE OF MEDICAL COMPLICATION HAVE BEEN DOCUMENTED?

No medical complications were reported for either the CE groups or the control groups in this body of literature.

5. ARE THERE SUBGROUPS FOR WHOM CE MAY BE MORE OR LESS EFFECTIVE?

The heterogeneous samples reported in this body of literature make it difficult to identify outcomes for specific subgroups of children. Historically CE was targeted at children who had the potential to walk independently, but no research study examined ambulatory children in isolation or reported results by ambulatory status. Given the information and the measures used, there appeared to be no discernable effect of age of the child at intervention, cognitive ability or the presence or absence of a conductor.

6. WHAT IS THE STRENGTH OF THE EVIDENCE?

The confidence the reader can place in the collective findings from a body of literature depends on various factors: the strength of the internal validity of the results (i.e. the level of evidence and the conduct of the study); how extensively the population has been sampled (i.e. number of different studies and number of participants); and the consistency of results across the studies.

The level of evidence reflects the methodological strength of a study. Stronger levels of evidence (Levels I and II) suggest that there are fewer sources of error present in the study design and more confidence can be placed in the results than less rigorous studies. The conduct of the study serves as a second gauge to a study's rigor, since even Level I studies can contain flaws that decrease the confidence that the reader can place in the results. In this review of 15 studies, one study²⁴ was assigned a combination level of I-S and II-M, three were Level II-W studies^{14, 16, 18}, three were Level III-W studies²⁰⁻²², five were Level IV-W studies^{15, 19, 25-27}, one study had a combined rating of IV-W and V¹³ and two were Level V studies^{17, 23}. Since only four of the studies were at Level I or II, the conclusions drawn from the results must be done with caution. Small sample sizes, poor descriptions of the interventions and/or measures used, and lack of power calculations led to many studies being rated as weak in conduct.

Sample: Often the inclusion/exclusion criteria were inadequately described. Most studies had small sample sizes, increasing the probability of a Type II error, that is, reporting a non-significant difference when a true difference is present. Finally, most studies reported samples with children of varied cognitive and motor abilities, decreasing the likelihood of detecting a treatment effect for a specific type of client.

Interventions: The interventions were usually poorly described, with no clear indication of the content of the program. In four studies it was unclear who provided the intervention, in seven studies the intensity and frequency were not described. Most interventions could not be replicated, given the information provided.

Measures: Although standardized measures were often used, 'in-house' measures fabricated for the study, or rating scales with no report of reliability or validity were also used. In addition parts of measures were used in isolation, or modified slightly for the study. Since the aim of CE is directed towards functional independence in all domains of development, an array of measures at the levels of Functional limitations/Activity and Participation/Societal Limitations, validated

for this population, could feasibly be used to capture change in motor, social, communication and educational skills.

Power calculation: No study reported a power calculation, making it impossible to estimate the probability of a Type II error.

This body of evidence represents 966 different individuals. This number of study participants is misleading because 626 participants come from the descriptive level IV study¹⁹ from the Budapest Institute. Another 109 children are from a Level V study²³ that used a mail out survey. With these two studies removed, the number of participants represented in this reviewed literature is 231. This modest total sample coupled with the lack of description of the study population and the heterogeneity of many study populations, make it difficult to discern if a specific treatment works for a specific type of child.

Part A of Table V and VI represents the strongest studies in the review both in research design and conduct of the study. The majority of the results in this table reveal no difference in outcome between the CE intervention group and the control group or pre-post CE group results. Of the 20 statistically significant outcomes, ten were in favor of the CE and 10 favored the control group. No one outcome of interest consistently showed improvement in the CE group across the studies. Although the majority of outcomes of interest in Table VI Part B showed some improvement for the CE group, it must be restated that substantial threats to internal validity were identified in the majority of these studies. In the absence of statistical analysis, proportional improvement of any item across the children in each study was placed in the improvement column, regardless of clinical or statistical significance.

Summary and directions for future research

Implementation of conventional (i.e. Hungarian) CE is difficult because of limited written information to guide practice. Dr. Hári's book⁵ provided the best description of the original program of CE. However, persons working with children with motor dysfunction need to reflect on whether the program described is 'transplantable', or whether it should be modified to accommodate different cultural and educational models. For example, original CE programs did not advocate the use of any assistive devices except specified CE equipment. This restriction made sense when schools were not wheelchair accessible, and a child could attend school only if he or she walked independently. This situation differs from the contemporary model that assumes school accessibility and encourages the use of assistive technology. If an intervention strategy is adapted to cultural norms, the researchers have a responsibility to clearly describe the similarities and differences of the new program to traditional CE programs. What are the essential characteristics of a CE program – supervision by a conductor trained in Hungary, group work, the use of task series and rhythmical intention? A standardized definition of the parameters of CE is needed, as well as research that analyzes each of these components individually. Unfortunately, most of the studies in this review did not describe their intervention in enough detail to identify whether there were common characteristics across studies. The intensity of programs varied considerably, and a conductor was not involved in the implementation of all programs. A clear understanding of the minimum parameters of CE-based intervention would standardize the techniques used across studies.

Just as important as standardization of intervention is the need for well-defined samples of children with similar abilities. Traditionally, studies of therapeutic interventions have used small samples with varied abilities, ages and co-morbidities. While such a heterogenic sample

approach increases the generalizability of positive results, it confounds the results of studies that report no significant differences. There may have been specific children in the sample for whom the treatment was very effective, but the effect was lost in the group data. It is now commonly accepted that cerebral palsy is merely an umbrella term for children with brain damage in the developmental period from multiple and different etiologies and with varying degrees of abilities, but investigators continue to study intervention for children with CP 'en masse', grouping different types of children together. Research needs to be focused on identifying optimal intervention strategies for a very clearly defined clinical profile, that is, the best fit between a child and a specific intervention.

In summary, the present literature base does not provide conclusive evidence either in support of or against CE as an intervention strategy. The limited number of studies and their weak quality makes it impossible for the literature alone to guide decision-making regarding CE. At first glance a review with inconclusive results can be frustrating because it does not provide one definitive answer. However, even an inconclusive review serves two important purposes. First, it helps families make better informed decisions regarding CE intervention as a choice for their child. In the absence of strong evidence of its effectiveness, parents must consider other important aspects of intervention such as cost, accessibility, time and the effect of the intervention on family dynamics. The focus of CE intervention on education, function and activities of daily living may fit with the needs of many families. Second, a review of the literature assists researchers to identify what is needed in future research studies. If well-designed and methodologically sound studies of CE are to be attempted, clear definitions of the intervention and standardized outcome measures with evidence and validity need to be used.

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