Effectiveness of Facilitation, Arrangement of Task and Situation, (Non-) verbal Communication, and Counseling of Caregivers in Children with Neuromotor Disorders: a Systematic Review

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Abstract

Objectives The techniques facilitation of activities, arrangement of task or situation, verbal and non-verbal communication, and counseling and empowerment of parents and caregivers are applied in different therapy approaches to improve motor function in children with neuromotor disorders. This review quantitatively examines the effectiveness of these four techniques allocated to pre-defined age groups and levels of disability.

Methods We followed the systematic review methodology proposed by the American Academy for Cerebral Palsy and Developmental Medicine (AAPDM). The search was conducted on PubMed, Scopus, EMBASE, PEDro, OT Seeker, ERIC, and CINAHL. The main outcomes of the included articles were allocated to the framework of the International Classification of Functioning, Disability, and Health (body functions, activities, and participation).

Results The search yielded eleven studies for facilitation, 22 for arrangement of task or situation, three for verbal and non-verbal communication, and three studies for counseling and empowerment. The effect sizes indicated strong evidence for body function and activity outcomes for the use of facilitation in newborns until the age of 2 years and the arrangement of tasks in children between 2 and 5 years with cerebral palsy.

Conclusions Thus, while some evidence exist for facilitation and arrangement of task or situation, further research is needed on the effectiveness of verbal and non-verbal communication and counseling and empowerment of parents and caregivers to improve motor function, activities, and participation.

Systematic review registration. PROSPERO CRD42017048583.

Keywords Rehabilitation · Cerebral palsy · Treatment techniques · Approach · Bobath

Therapeutic professionals (e.g., physiotherapists, occupational therapists, and speech and language therapists) apply treatment concepts and interventions within the rehabilitation of children with neuromotor disorders. A treatment concept usually consists of several techniques that compose the actual content of the therapy. A technique can be included

in different treatment concepts or interventions and applied by professionals with diverse therapeutic backgrounds (Mayston, 2012). While various systematic reviews identified the effectiveness of different treatment concepts and interventions (Anttila et al., 2008; Martin et al., 2010; Novak et al., 2020), systematic reviews evaluating techniques are scarce. One review assessed the effectiveness of stretching, massage, strengthening, electrical stimulation, weight-bearing, balance, treadmill, and endurance training targeting lower limb function in children with cerebral palsy (CP) (Franki et al., 2012). While these techniques could positively influence various body functions (according to the International Classification of Functioning, Disability, and Health – Children and Youth version (ICF-CY)), no change in the activity level was observed (Franki et al., 2012).

In line with this review, we aimed to determine the evidence concerning the effectiveness of four techniques

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applied within the management of children with neuromotor disorders to improve motor function, activities, or participation (Munsch et al., 2010). These techniques were chosen for the following reasons: facilitation as a process to enable the child to be active in an efficient way and to reach their own goals; the use of an arrangement of the task or situation that can be applied to facilitate and enable the child to be active and enhance self-regulation; the use of verbal and non-verbal communication to affect alertness, activity, and participation, counseling, and empowerment of parents and caregivers to set goals and enhance integration and quality of life (Munsch et al., 2010). In addition, for appropriate therapeutic management, it is essential to consider the child's age and the severity of the disability. Therefore, it is relevant to look at and evaluate the evidence in different age groups and disability severity levels.

Facilitation is defined as guiding, accompanying, and reducing the manual sensory-motor input during a meaningful task chosen by the child (Capelovitch, 2017; Munsch et al., 2010). Furthermore, facilitation includes manual or bodily support of positioning in alignment to enable activity and participation, place and clarify the base of support, and provide a sensory input due to movement and activity (Capelovitch, 2017; Munsch et al., 2010). Arrangement of task or situation includes tasks with a specific level of action, difficulty, and motivation. In the current study, we allocated environmental and situational adaptations such as specifically adapted objects (e.g., toys), adaptation of the location or room, specific positioning of the child, therapist, caregiver, and objects (e.g., toys). Verbal and non-verbal communication includes gestures, facial expressions, body posture, and aid-supported communication; verbal communication includes melody, rhythm, timbre, volume, and focus of attention to enable the child's activity. Finally, counseling and empowerment of parents, caregivers, and the child or adolescent with neuromotor disorder itself includes the dialogical process to enable these persons to understand and to act in a supporting way to enable the child or young person to gain more independence and quality of life.

We formulated the following research question: How effective are (a) facilitation of activities and movements, (b) arrangement of task or situation, (c) verbal and non-verbal communication, and (d) counseling and empowerment of parents and caregivers on improving outcomes classified on the levels body function, activities, or participation according to the ICF-CY in children and youths with neuromotor disorders? We consider this review of interest for a broad group of rehabilitation professionals as these techniques are applied within various disciplines. Furthermore, by summarizing the evidence, we hope to identify techniques that improve motor function and independence in children with neuromotor disorders.

Methods

Study Eligibility

This systematic review followed the methodological approach recommended by the American Academy for Cerebral Palsy and Developmental Medicine (AAPDM) (Darrah et al., 2008). This is a step-by-step process to develop, conduct, and present a systematic review.

Studies were included if participants were diagnosed with neuromotor disorders such as CP, acquired brain injuries (ABI), and others (e.g., high risk for developmental disorders, myelomeningocele with hydrocephalus, syndromes with movement disorders); the participants' age was between 0 and 20 years; the study was written in English or German; the level of evidence was I–IV (where I is the highest level; see Supplementary information S1) for the group and single-subject study designs; the effectiveness of one of the four techniques was investigated. In addition, peer-reviewed articles published between January 2000 and November 2020 were included, as with the introduction of the ICF in 2001, research became more focused on specific groups of children with CP. Furthermore, more attention was paid to using assessments with known psychometric properties (Damiano, 2014).

Exclusion criteria were defined for (1) facilitation: studies applying facilitation as “inhibitory technique,” or “in a passive way,” “to normalize movement,” “to manipulate” were excluded according to the definition of facilitation used in this study; (2) arrangement of task or situation: studies were excluded if they used solely virtually adapted environments or tasks; (3) non-verbal or verbal communication: studies with specific programs to enhance solely articulation were excluded, as this aspect was included in previous reviews (Morgan & Vogel, 2008; Pennington et al., 2016); (4) counseling and empowerment of caregivers and parents: studies which investigated solely the perception of the parents were excluded.

Literature Search

The literature search was conducted in the following electronic databases: PubMed, Scopus, EMBASE, PEDro, OT Seeker, ERIC, and CINAHL (via EBSCOhost). The search was performed for each of the four techniques individually, according to the framework describing the techniques provided by Munsch et al. (2010) and in each database. Figure 1 shows the contents belonging to the four techniques (Munsch et al., 2010).

Search strategies were built with search terms according to the categories: (1) participants (e.g., cerebral palsy,

Fig. 1 Therapeutic approach with the four techniques applied in the Bobath/NDT concept (translated and adapted with permission of Karolina Munsch (6))

neuromotor impairment, sensorimotor impairment), (2) techniques (e.g., facilitation, guiding movement, support position), and (3) professions (e.g., physiotherapy, occupational therapy, speech, and language therapy). See Supplementary information S2 for the complete search strategies for the PubMed database. The original search was conducted in July 2018, and a follow-up search in all databases was performed in November 2020.

The first and second authors read the abstracts and independently decided whether an article was included by following the pre-defined inclusion/exclusion algorithm (Supplementary information S3). If there was no abstract available or if a decision could not be made based on reading the abstract only, the full text was screened. In case of disagreement, the authors discussed until consensus was met.

Search Results

After excluding duplicates and including records from an additional search of the references, we found (a) 700 papers about facilitation, (b) 547 papers about arrangement of task or situation, (c) 2290 papers about the use of verbal and non-verbal communication, and (d) 72 articles about counseling and empowerment of parents and caregivers. Figure 2 displays the flowchart of the search, including reasons for exclusion. After screening the full texts, (a) eleven papers were included for facilitation, (b) 22 papers for the arrangement of task or situation, (c) three papers for the use of verbal and non-verbal communication, and (d) three for counseling and empowerment.

Fig. 2 Flowchart of the literature search for all four techniques

Data Extraction

The main outcomes were allocated to the ICF-CY framework. On the body function level, outcomes such as muscle strength, range of motion, or surface electromyography (sEMG), on the activity level, e.g., the gross motor function measure (GMFM), timed walking tests, or hand activity tests, and on the participation level, e.g., the pediatric evaluation of disability inventory (PEDI) or Canadian occupational performance measure (COPM). For the evidence

synthesis, the studies including children with CP were allocated for the level of disability with the gross motor function classification system (GMFCS), and for four age groups: 0–2 years, 2–5 years, 5–12 years, and 12–20 years (Mayston, 2012).

Risk of Bias Assessments

Two raters independently rated the level of evidence and the quality of the studies with evidence level I, II, and III, using

the AACPD risk of bias assessment. Level IV studies will be described in Table 1 and not rated with the risk of bias assessments (Supplementary information S4).

Statistical Analysis

For the quantitative analysis, effect sizes (ES), including the 95% confidence intervals (CI), were calculated according to Hedges' g , using the mean group differences ($x_1; x_2$) and the pooled standard deviation (SD) of the differences (S_{within}) (Cooper et al., 2009). To calculate ES from ordinal data, the means and the SDs were calculated as follows: mean $x \sim \frac{q^1 + m + q^3}{3}$, where q is the quartile (first or third) and m is the median, and SD $S \sim \frac{q^3 - q^1}{\eta(n)}$, where η is a function of n , and n is the sample size (Wan et al., 2014). The ES should be interpreted in the context of similar research, i.e., the magnitude of effectiveness based on the context, and practical or clinical value of the research (Durlak, 2009). Therefore, the mean differences (pre–post measurements), also known as raw (unstandardized) mean differences, can be discussed in relation to the minimal detectable change (MDC) or the minimal clinically important difference (MCID), if available. To interpret the magnitude of the ES, we used the benchmark for ES suggested by Cohen: small ≤ 0.20 ; medium $0.21–0.79$; large ≥ 0.80 (Cohen, 1988). The standard mean difference (SMD) of all baseline and intervention measurement time points (SMD_{all}) was calculated for single-subject design studies (Olive & Smith, 2005).

With a random effect model, using the DerSimonian and Laird method, ES of comparable outcomes were calculated separately for (1) function and activities or (2) participation (Borenstein et al., 2011). Statistical calculations and forest plots were calculated with RStudio (250 Northern Ave, Boston, MA 02,210) using the “meta,” “metacont,” and “forest” packages.

Results

Study Characteristics: Interventions and Participants

Facilitation of Activities and Movements

Eleven studies of the category facilitation of activities and movements were included. Six of these studies were evidence levels I–III, and five studies evidence level IV. For the contents of the studies, see Table 1. The majority of the participants were diagnosed with CP ($n=695$), and all GMFCS levels were represented. In two studies, children with a high risk to develop CP (born very preterm, with

very low birth weight) were included (Cameron et al., 2005; Dirks et al., 2011). One study also included children with other neuromotor conditions in addition to children with CP (Evans-Rogers et al., 2015).

In two studies, the technique of facilitation was applied in the control group, while the COPing with and CARing for Infants with Special Needs (COPCA) approach was applied in the intervention group (Blauw-Hospers et al., 2011; Hielkema et al., 2019). The authors named the approach for treating the control group traditional infant physiotherapy (TIP), which was based on neurodevelopmental treatment (NDT). These two studies were included in two categories of techniques, one facilitation (control group) and one caregiver counseling and empowerment (experimental group).

The quality rating of the studies evidence level I–III is presented in Supplementary information S4a. All rated studies were group design studies of weak-to-strong quality, including 10 to 487 children per study. The purposes of the studies were increasing motor strength, enhancing motor development and function, or improving gait.

Arrangement of Task or Situation

Twenty-two studies investigated the arrangement of task or situation. In Table 1, we present these studies separately for arrangement of task ($n=9$ studies) and arrangement of situation ($n=13$ studies). The studies investigated the effectiveness of goal setting, task-oriented training, context-focused training (arrangement of task), and adaptation of positioning (arrangement of situation).

Three case–control level-IV studies evaluated the effectiveness of task-oriented training on the transfer of a reach-to-grasp task in daily life and the effectiveness of a functional goal approach (Knox & Evans, 2002; Robert et al., 2013; Schneiberg et al., 2010). Ten level IV studies investigated specific adaptations of seating equipment in wheelchairs, and one study evaluated the effectiveness of night-time positioning on sleep quality (Cimolin et al., 2009; Hill et al., 2009; Holmes et al., 2003; McDonald & Surtees, 2007; Rigby et al., 2001, 2009; Ryan et al., 2005, 2009; Sarmad et al., 2019; Vekerd, 2007).

Seven of the nine studies targeting arrangement of task and two of the studies targeting arrangement of situation had evidence levels I–III. For the specific content of the studies, see Table 1. The majority of participants were diagnosed with CP ($n=523$), and all GMFCS levels were represented. The quality synthesis was performed for nine evidence level I to III studies ($n=7$ studies arrangement of task; $n=2$ studies arrangement of situation, one of them was a single-subject design study). The quality of these studies was weak to moderate (Supplementary information S4). A total of 267 children participated, the majority of them were

Table 1 Summary of studies – interventions and participants

	Group studies	Purpose	Level of evidence, conduct rating, ** and research design	Participants
1a. Facilitation of activities or movements	Jadhav et al., 2020	To find the effect of ankle dorsiflexors facilitation on gait	IV Pre–post design	CP
	Sah et al., 2019	To examine the effects of task-oriented activities based on neurodevelopmental therapy (TOA-NDT) principles on trunk control, balance, and gross motor function in children with spastic diplegic cerebral palsy	II-moderate Randomized controlled trial	CP GMFCS I–II
	*Hielkema et al., 2019	To compare outcome in infants at very high risk of CP after receiving the family-centered program COPCA or typical infant physiotherapy	II-weak Randomized controlled trial	Children at high risk of CP: n=22 did develop CP GMFCS I n=3; II n=7; III n=4; IV n=3; V n=4, n=19 ND, n=2 unknown
	Evans-Rogers et al., 2015	To examine functional changes following an intensive NDT program	IV Case series Mixed method design Pre–post design	n=13 CP GMFCS I–V n=2 developmental delay n=1 chromosome abnormality
	Yonetsu et al., 2015	To provide a better understanding of the effectiveness of a single NDT session on sit-to-stand movements	IV Single-group re-post design (pilot study)	Spastic diplegic CP, GMFCS III (typically developing children)
	Baghbadorani et al., 2014	To evaluate the effect of oral sensorimotor stimulation on feeding performance	IV Case series Interventional and semi-empirical study	CP, moderate-to-severe spasticity
	*Blauw-Hospers et al., 2011	To investigate the effect of COPCA on the development of the participants	II-moderate (4/7) Randomized controlled trial	Children with high risk for developmental disorders, n=10 did develop CP, n=28 complex MND, n=5 ND, n=1 unknown, n=29 minor neurological dysfunctions, n=3 normal
	Cameron et al., 2005	To investigate the effectiveness of physical therapy on motor outcome of infants born very preterm with very low birth weight	II-strong (7/7) Randomized controlled trial	Infants born very preterm with very low birth weight (< 1500 g) n=6 mild CP n=2 moderate CP n=4 severe CP
	Tsoralakis et al., 2004	To examine the effectiveness of (intensive) NDT on gross motor function	III-strong (6/7) Cohort study with concurrent control (quasi randomization)	CP, GMCS I–III
	Kerem & Livanelioglu, 2002	To investigate the effectiveness of early and late exercise programs based on NDT on motor development	III-weak (1/7) Cohort study with concurrent control	CP All types
	Adams et al., 2000	To investigate the effectiveness of NDT on gait characteristics	IV Case series	CP

Table 1 (continued)

	Group studies	Purpose	Level of evidence, conduct rating,** and research design	Participants
1b. Arrangement of task	Group studies	Purpose	Level of evidence and conduct rating	Participants
	Ko et al., 2020	To determine the effects of group-task-oriented training on gross and fine motor function	II-moderate Randomized controlled trial	CP GMFCS I n=4; II n=10; III n=4
	Ogwumike et al., 2019	To investigate the effect of task-oriented training on motor function and balance	II-weak Randomized controlled trial	CP GMFCS I n=14; II n=13; III n=12
	Vroland-Nordstrand et al., 2016	To investigate the effectiveness of two goal-setting approaches	II-moderate (4/7) Randomized controlled trial	Any type of disability
	Robert et al., 2013	To determine if improved upper limb kinematics in a reach-to-grasp task could be retained and transferred to a similar task	IV Case-control, quasi-randomized trial	Spastic unilateral CP
	Choi et al., 2011	To investigate in the effectiveness of task-oriented training and NDT on the sitting posture	III-weak (0/7) Cohort study with concurrent control	Spastic bilateral CP
	Law et al., 2011	To evaluate the effectiveness of context-focused vs. child-focused therapy	I-strong (5/7) Cluster randomized controlled trial	CP GMFCS I n=37, II n=23, III n=21, IV n=21, V n=26
	Schneiberg et al., 2010	To investigate the effectiveness of task-oriented training with and without the restriction of trunk movement	III-moderate (4/7) Randomized controlled N-of-1 design with the matched control group	Spastic CP
	Salem & Godwin, 2009	To examine the effectiveness of task-oriented strength training on mobility function	II-weak (3/7) Randomized controlled trial	CP GMFCS level I–III
	Knox & Evans, 2002	To evaluate the functional effectiveness of Bobath therapy	IV Repeated-measures design	CP
1b. Arrangement of situation	Sarmad et al., 2019	To evaluate the effect of positioning on motor function	IV Quasi-experimental study	Spastic and athetoid CP GMFCS level IV
	Hill et al., 2009	To investigate the influence of NTPE on sleep quality and respiratory function	IV Case-control study	Severe CP
	Cimolin et al., 2009	To investigate the effectiveness of a dynamic versus a rigid seat system	IV Case-series experimental design	Spastic and dystonia CP GMFCS V
	Hahn et al., 2009	To determine the initial effectiveness of a dynamic seating system	III-weak (0/7) Two-factor repeated-measures design	CP GMFCS II–V
	Rigby et al., 2009	To evaluate the short-term impact of two adaptive seating devices on the activity performance	IV Test-retest design	CP GMFCS III–IV
	Ryan et al., 2009	To determine the parent-perceived effectiveness of adaptive seating devices on the lives of the children	IV Quasi-experimental design	CP GMFCS III–IV

Table 1 (continued)

	Group studies	Purpose	Level of evidence, conduct rating, ** and research design	Participants
	McDonalds & Surtees, 2007	To evaluate the effectiveness of an adaptive seating system using sacral pads and knee blocks	IV Longitudinal study	Bilateral dystonic or spastic CP GMFCS level V
	McDonalds & Surtees, 2007	To investigate the effectiveness of postural management of one particular type of seating systems	IV Longitudinal study	Bilateral dystonic or spastic CP GMFCS level V
	Vekerdy, 2007	To investigate the effect of a special seating device: thoracic-lumbar-sacral orthosis SIDO®	IV Cohort study	CP
	Ryan et al., 2005	To investigate the effect of a prototype of pelvic stabilization device	IV Quasi-experimental design	CP
	Holmes et al., 2003	To investigate the effectiveness of special seating on lateral spinal curvature	IV Case series	Spastic CP with neuromuscular scoliosis
	Rigby et al., 2001	To evaluate the impact of a rigid pelvic stabilizer	IV Case-control study	CP
	Single-subject studies	Purpose	Level of evidence and conduct rating research design	Participants
	Washington et al., 2002	To examine the effectiveness of a contoured foam seat on the ability of postural alignment, and engagement with a toy	II-moderate (9/14) Single-subject time series	Spastic CP (bilateral n = 2), Down syndrome n = 1, congenital hypotonia n = 1
1c. Communication	Group studies	Purpose	Level of evidence and conduct rating	Participants
	Pennington & James, 2009	To investigate whether a Takes Two to Talk program for parents is associated with a change in the interaction between the children and their parents	IV Cohort study without a control group	CP
	Puyuelo & Rondal, 2006	To investigate the effectiveness of a 2-year oral praxis training	IV Longitudinal study design	Athetoid, spastic, ataxia CP
	Single-subject Studies	Purpose	Level of evidence and conduct rating research design	Participants
	Kent-Walsh et al., 2015	To investigate the effectiveness of a direct intervention program involving aided modeling and the presentation of contrastive targets on the aided production of inverted yes/no questions	IV Single-case, multiple-probe, experimental design	Childhood apraxia of speech in children with un-defined developmental delay (n = 2) and down syndrome (n = 1)
1d. Counseling and empowerment	Group studies	Purpose	Level of evidence and conduct rating	Participants
	*Hielkema et al., 2019	To compare outcome in infants at very high risk of CP after receiving the family-centered program COPCA or typical infant physiotherapy	II-moderate Randomized controlled trial	Children at high risk of CP: n = 22 did develop CP GMFCS I n = 3; II n = 7; III n = 4; IV n = 3; V n = 4, n = 19 ND, n = 2 unknown

Table 1 (continued)

Group studies	Purpose	Level of evidence, conduct rating, ** and research design	Participants
*Blauw-Hospers et al., 2011	To investigate the effectiveness of COPCA	II-moderate (4/7) Randomized controlled trial	Children with high risk for developmental disorders, n=10 did develop CP, n=28 complex MND, n=5 ND, n=1 unknown CP
Dalvand et al., 2009	To compare the effectiveness of Bobath techniques, conductive education, and education of parents in activities of daily life	IV Quasi-experimental clinical trial	CP
-Total n	-Age	-Intervention Control intervention	
-1a. Facilitation of activities or movements	n = 25	5–15 years	Facilitatory techniques to ankle dorsiflexors, which included joint positioning, joint compression, stretch, and exteroceptive applications, 3 times a 40-min session over a 6-week period of time
	N = 44	7–15 years	Activity-based task-oriented therapy, including facilitation techniques for 60 min 6 days a week over 6 weeks in the experimental group The comparison group had the same amount of therapy consisting of passive stretching, and active balance exercises on a balance board
	n = 43	0–0.75 years	The children received either 1 year of COPCA or 1-year typical infant physiotherapy. The therapies were provided at home, once a week, 30–60 min per session
	n = 16	1–17 years	Intensive NDT program according to a specific protocol (2 to 4 h a day) on 5 consecutive days per week of 1 to 2 weeks No control group
	n = 8	4–6 years	A single 40-min NDT session including handling techniques that aimed to alter muscle tone during movement and to facilitate antigravity, weight-shifting, and postural control No control group
	n = 10	2–7 years	Oral sensorimotor stimulation (tongue lateralization, lip control, and vigor of chewing, target movements extracted with food stimuli) for a period of 8 weeks, 15 min on each of 3 days per week
	n = 44	0.25–0.5 years	COPCA, consisting of parent coaching, challenging infants to produce motor behavior by themselves, was applied in an intervention period between 3 and 6 months, twice a week for 1 h in the home situation TIP: implementation of NDT principles, focusing on the sensorimotor functional problems of the infant with the incorporation of a more functional approach (e.g., motor learning is finding solutions for new tasks) setting unclear
	n = 60	Birth preterm between 24 and 32 weeks, until 4 months	Neonatal problem-orientated developmental interventions including handling and positioning techniques and movement using postural support and facilitation techniques, from birth to 4 months on a daily basis (week-days), length of the treatment depend on the infant's medical stability and behavioral state, with a max. treatment duration of 10 min Control group: no physiotherapy
	n = 34	3–14 years	High-dose NDT of five sessions per week, 50 min per session, for 16 weeks Low-dose NDT for two sessions per week, 50 min per session, for 16 weeks
	n = 487	Birth–10 years	Exercise program of 18 months based on NDT including appropriate handling, positioning, stimulation techniques, facilitation, with additional strengthening exercises, and appropriate devices on a regular basis The group of children younger than 1 year at the onset of the study was defined as the early treatment group The group of children older than 1 year at the onset of the study was defined as the late treatment group

Table 1 (continued)

	-Total n	-Age	-Intervention Control intervention
	n = 40	2–11 years	NDT transdisciplinary treatment, individualized for each child, during a 6-week treatment practicum of an NDT course, 1 h per session, twice a week
1b. Arrangement of task	Total n	Age	Intervention Control intervention
	n = 18	4–8 years	1 h session twice a week of group activity (2–4 children) over an 8-week period of time for the experimental group. The comparison group received 30 min of physical, and 30 min of occupational therapy, twice a week over the same time period
	n = 39		Experimental group, an individualized task-oriented training of the trunk and lower limbs was performed over 12 weeks of 40-min session, 5-times a week The children in the control group received 40-min conventional therapy consists of passive and active range of motion exercises, rolling exercises, sit-ups from the supine position, assisted-resisted lower limbs strengthening exercises over 12 weeks, 5 times a week
	n = 34	5–12 years	8-week goal-directed, task-oriented intervention once a week, plus a home program, one group with children's self-identified goals in comparison to a group with goals identified by parents
	n = 16	6–11 years	60-min session (3-min stretching, 20-min activities in a physical and a virtual environment each, 7-min rest, the 10-min practice of a functional activity (chosen by child/family) with trunk restraint, one session per week for 6 weeks Control group received the same training but without trunk restraint
	n = 10	2–10 years	Task-oriented training, 30 min per session, 5 times per week for 6 weeks NDT, 30 min per session, 5 times per week for 6 weeks
	n = 128	1–5 years	Context-focused therapy for 6 months (18–24 sessions) Child-focused therapy for 6 months (18–24 sessions)
	n = 12	6–11 years	Task-oriented training: three 1-h sessions per week for 5 weeks with trunk restraint The control group followed the same procedure but without trunk restraint
	n = 10	4–12 years	Task-oriented training focusing on strengthening of the lower limbs and practicing functional tasks Conventional physical therapy focused on improving walking and balance through normalization of movement patterns
	n = 15	2–12 years	Bobath therapy, 75 min per session, 3 sessions per week for 6 weeks (two sessions were assessment sessions) No control group; participants served as their own controls
1b. Arrangement of situation	n = 30	0.5–3 years	Positioning in a hammock for 10 h; time duration of the intervention is unknown
	n = 10	5–17 years	Two nights in a pediatric research laboratory, one night with NTPE, one night without NTPE (randomized order), separated by at least three nights of recuperative sleep at home No control group; participants served as their own controls
	n = 10	6–10 years	Two short sessions (< 1 min) of sitting in a dynamic and in a rigid system, respectively. During both sessions, at least 3 external perturbations to produce dystonic movements (sudden noise simulation of constant intensity) were induced. A break of 5 min separated the 2 sessions
	n = 12	4–13 years	Sitting in a custom-fit wheelchair with the hip and knee allowed to move within the limits of the chair's design (35° and 30° for the hip and knee, respectively) for 6 months The control group received a custom-fit wheelchair identical to the experimental group except with the components locked into a static design (representing a typical wheelchair) for 6 months

Table 1 (continued)

	-Total n	-Age	-Intervention Control intervention
	n = 30	2–7 years	Flip2Sit® activity seat for floor sitting and table level activities and Aquanaut® for toileting and grooming in the bathroom were adapted for the children and used for 6 weeks at their homes No control group
	n = 30	2–7 years	Flip2Sit® activity seat for floor sitting and table level activities and Aquanaut® for toileting and grooming in the bathroom were adapted for the children and used for 6 weeks at their homes No control group
	n = 23	7–14 years	Sitting without sacral pads and knee blocks (for 4 weeks), then sitting with sacral pads and knee blocks (for 4 weeks) in their own wheelchairs No control group
	n = 23	7–14 years	Force exerted through knee blocks was measured in different positions, with fixation and without fixation of the knee blocks within six measurement time points
	n = 42	1–7 years	Measurements within the individually modeled SIDO®
	n = 30	2–7 years	Individually adapted seating device used in their own wheelchair between 12 and 14 days
	n = 16 n = 1 with Duchenne	6–21 years	CAPS II modular seating system with three different arrangement of lateral support pads; each child was placed in each of the three different arrangements for the measurements No control group
	n = 6	8–12 years	The children wore a lap belt during 3 weeks, followed by 5 weeks using the rigid pelvis stabilizer (intervention period), followed again by 3 weeks with the lap belt No control group; the participants served as their own controls
	Total n	Age	Intervention
	n = 4	0.75–1.5 years	Sitting on a foam liner and a contoured foam seat for 5 min each, daily, for 8 days No control group
1c. Communication	Total n	Age	Intervention Control intervention
	n = 11	1.2–3 years	Parents applied what they had learned in the interaction training in their home setting Participants acted as their own controls
	n = 10	3–3.5 years	Two times 30 min a week for 12 months: a) year one and two: oral praxis (improving sensitivity and mobility of articulatory organs, food mastication, and expiratory control) b) years three and four: phonation and prosody All the children received additional NDT The participants acted as their own controls
1d. Counseling and empowerment	Total n	Age	Intervention
	n = 3	5–10 years	Specific instructional program for children using augmentative and alternative communication on an individualized basis
	Total n	Age	Intervention Control intervention
	n = 43	0–0.75 years	The children received either 1 year of COPCA or 1-year typical infant physiotherapy. The therapies were provided at home, once a week, 30–60 min per session
	n = 44	0.25–0.5 years	COPCA consists of parent coaching, challenging infants to produce motor behavior by themselves, was applied in an intervention period lasting 3 to 6 months, twice a week for 1 h in the home setting NDT/Bobath focused on the sensorimotor functional problems of the infant, setting unclear

Table 1 (continued)

-Total n	-Age	-Intervention Control intervention
n = 45	4–8 years	Children get therapy in the form of either Bobath technique, Conductive Education or education of parents for 3 months, four sessions per week of 3 h each

*Studies which are included in two categories of techniques

**Rating for studies with evidence level I–III

GMFCS, gross motor function classification system; CP, cerebral palsy; MND, minor neurological dysfunction; ND, no neurological dysfunction; NFDR, neurofacilitation of developmental reaction; NDT, neurodevelopmental treatment; FES, functional electrical stimulation; COPCA, coping and caring for infants with special needs; TIP, traditional infant physiotherapy; GA, gestation age; NTPE, night-time postural equipment

diagnosed with CP ($n = 233$), and all GMFCS levels were represented.

Verbal and Non-verbal Communication

Three studies included communication as a specifically defined technique and were rated at evidence level IV. Two studies had a group design and one a single-subject design (Table 1). A total of 24 children were included, 21 with CP, two with undefined developmental delays, and one with Trisomy 21. The age ranged from 19 months to 10 years. One study investigated the effectiveness of training of parents and children to enhance the interaction between the children and their parents (Pennington & James, 2009). Another study, which lasted 2 years, compared a voice training that included a functional approach for postural control with the oral praxis approach (Puyuelo & Rondal, 2005). The third study investigated the use of an expression of the children and augmented communication on an individualized basis (Kent-Walsh et al., 2015). No study investigated the influence of verbal or non-verbal communication (such as feedback or interactive dialogue) on motor function, activities, or participation in children or youths with neuromotor disorders.

Counseling and Empowerment of Parents and Caregivers

Three studies applying counseling and empowerment of parents and caregivers were included; two level II studies of moderate quality and one level IV study. The level II studies evaluated the effectiveness of COPCA (Blauw-Hospers et al., 2011; Hielkema et al., 2019). Both studies were already described in the paragraph about the facilitation technique since the control group received facilitation. In total, 144 children were included, of whom 77 were diagnosed with CP. The level IV study investigated the effectiveness of three different treatment approaches: Bobath

concept, conductive education, and education of parents (Dalvand et al., 2009).

Study Outcomes, Measures, Results, and Effect Sizes

Table 2 presents the outcomes, measures, and results of the group design studies; Table 3 shows the ES. For one study, the ES could not be calculated as the results of the children with neuromotor disorders were not separately listed (Hielkema et al., 2019).

The evidence of the studies with evidence levels I–III is displayed in Fig. 3. We grouped the evidence for each of the four techniques, the defined age group, and the GMFCS level. In three studies, the GMFCS levels were not reported. Based on the descriptions, we classified the children as follows: (a) children with very low birth weight (12 developed moderate-to-severe CP and we classified them as GMFCS level III–V) (Cameron et al., 2005); (b) two of the four children were diagnosed with moderate bilateral CP, and we classified them as GMFCS level III (Washington et al., 2002); and (c) children with complex minor neurological dysfunctions ($n = 15$) and CP ($n = 10$) with GMFCS level I–IV (Blauw-Hospers et al., 2011).

Facilitation of Activities and Movements

Two studies investigated participation and applied the Alberta infant motor scale (AIMS) (Blauw-Hospers et al., 2011; Cameron et al., 2005). One study also applied the PEDI (Blauw-Hospers et al., 2011). Two other studies investigated motor activities using the GMFM as an outcome measure (Kerem & Livanelioglu, 2002; Tsorlakis et al., 2004).

The study with the strongest level of evidence included 60 preterm babies with very low birth weight, of whom 12 developed CP (Cameron et al., 2005). In the group of children with CP, a non-significant improvement with a small ES

Table 2 Summary of studies: outcomes, measures, and results (group studies, level I–III)

	Study	Outcome of interest	ICF comp	Measure	Results	Statistical significance	Level of evidence	Profession
2a. Facilitation	Sah et al., 2019	Motor activity	A	GMFM-88	+	$p < 0.001$	II-M	PT
		Motor activity	A	Postural Assessment Scale	+	$p < 0.05$		
		Motor activity	A	Pediatric Balance Scale	+	$p < 0.001$		
		Motor activity	A	Trunk Impairment Scale	+	$p < 0.05$		
	Hielkema et al., 2019	Motor performance	P	PEDI	=	ns	II-W	PT
		Motor performance	A/P	Infant Motor Profile	=	ns		
	Blauw-Hospers et al., 2011	Motor performance	A/P	AIMS	=	ns	II-M	PT
		Motor performance	P	PEDI	=	ns		
	Cameron et al., 2005	Motor performance	A/P	AIMS	=	ns	II-S	PT
	Tsorlakis et al., 2004	Motor activity	A	GMFM-88	=	ns	III-S	PT
		Motor activity	A	GMFM-66	+	$p < 0.05$		
	Kerem & Livanelioglu, 2002	Motor activity	A	GMFM-66	+	$p < 0.05$	III-W	PT
2b. Arrangement of task or situation	Ko et al., 2020	Motor activity	A	GMFM D	+	ns	II-M	PT & OT
		Motor activity	A	GMFM E	+	ns		
		Motor activity	A	BOT-2 Manual Dexterity	+	ns		
	Ogwumike et al., 2019	Motor performance	P	PEDI – Mobility	=	ns	II-W	PT
		Motor activity	A	Timed up and go test	+	$p < 0.05$		
	Vroland-Nordstrand et al., 2016	Motor activity	A	GMFM D, E	+	$p < 0.05$	II-M	OT
		Motor performance	P	COPM – Performance (P)	=	ns		
	Choi et al., 2011	Individual task performance	P	Goal Attainment Scale	=	ns	III-W	PT
		Motor activity	A	GMFM B	=	ns		
		Muscle activity	BF	Surface Electromyography	=	ns		
	Law et al., 2011	Motor performance	P	PEDI	=	ns	I-S	PT & OT
		Motor activity	A	GMFM-66	=	ns		
		Voluntary daily activity	P	APCP	=	ns		
		Empowerment	P	Family Empowerment Scale	=	ns		
	Schneiberg et al., 2010	Motor activity	BF	Melbourne Assessment	=	ns	III-M	OT
		Motor activity	BF	Upper limb movement kinematic	=	ns		
	Salem & Godwin, 2009	Motor activity	A	Timed up and go test	+	$p < 0.05$	II-W	PT
	Hahn et al., 2009	Motor activity	A	GMFM D & E	+	$p < 0.05$	III-W	OT
		Motor activity	A	GMFM B	=	ns		
		Motor performance	P	PEDI	=	ns		
		Spasticity	BF	Modified Ashworth Scale	=	ns		
	Washington et al., 2002	Range of Motion	BF	Range of motion	=	ns	II-M	OT/PT
		Postural alignment	BF	Percentage of time out of videotape	+	ns		
		Hand activity	A	Engagement with a toy out of videotape	+	ns		

Table 2 (continued)

	Study	Outcome of interest	ICF comp	Measure	Results	Statistical significance	Level of evidence	Profession
2d	Hielkema et al., 2019	Motor performance	P	PEDI	=	ns	II-M	PT
		Motor performance	P	Infant Motor Profile	=	ns		
	Blauw-Hospers et al., 2011	Motor performance	P	AIMS	=	ns	II-M	PT
		Motor performance	P	PEDI	=	ns		

Classification system: “=” means the same effectiveness as the control group; “+” means bigger effectiveness of the technique (facilitation, arrangement of task or situation, counseling, and empowerment) as the control group; “=” means that the results were not significantly different between the control and the experimental group

A/P, activity or participation; *BF*, body function; *nr*, not reported; *ns*, not significant; *PT*, physical therapy; *OT*, occupational therapy; *CAPS*, Chailey adjustable postural support; *PEDI*, pediatric evaluation of disability inventory; *GMFM*, gross motor function measure; *AIMS*, Alberta infant motor scale; *COPM*, Canadian occupational performance measure; *BOT-2*, Bruininks–Oseretsky test of motor proficiency, 2nd edition; *APCP*, assessment of preschool children’s participation

of 0.15 (95% CI: –1.05 to 1.35; Table 3) was found (Cameron et al., 2005). Blauw-Hospers et al. (2011) found minimal differences between COPCA and TIP. These changes did not influence the developmental outcome of the children at high risk for developmental disabilities. In one study with evidence level III (40), children with CP ($n=24$) improved significantly in the GMFM-66 after intensive high-dose facilitation (NDT) during 16 weeks ($ES=0.78$ (95% CI: 0.08 to 1.48). The mean pre–post difference (2.37 points) exceeded the MCID (1.58 points for GMFM-66) (42).

The pooled ES of the three studies investigating the effectiveness of facilitation on activity level, using the GMFM as an outcome, was large but not significant ($ES=3.78$, 95% CI [–6.73–14.28]), as shown in the forest plot, Fig. 4a (Kerem

& Livanelioglu, 2002; Sah et al., 2019; Tsorlakis et al., 2004). The pooled ES of the studies reporting outcomes with the PEDI for participation (Blauw-Hospers et al., 2011; Cameron et al., 2005) was medium ($ES=0.26$, 95% CI –1.32 to 1.84; Fig. 4a).

Arrangement of Task or Situation

The study with the largest numbers of participants ($n=128$) found improvements in the intervention (context-focused therapy approach) as well as in the control group (child-focused therapy approach) (Law et al., 2011). The PEDI, the GMFM-66, family empowerment scale (FES), and the assessment of preschool children’s participation were assessed. The raw ES (mean differences) of both groups

Table 3 Effect sizes of the mean differences (group design studies, level I–III)

	Study/level of evidence	Measure	Intervention group			Control group			Effect size: Hedges’ g (95% CI)
			Sample size	Mean diff (raw non-stand ES)	SD of the diff pooled	Sample size	Mean diff (raw non-stand ES)	SD of the diff pooled	
3a. Facilitation	Sah et al., 2019/ II-M	GMFM-88	22	12.28	6.07	22	3.74	1.51	1.90 (1.17 to 2.62)
		Postural assessment scale	22	1.86	1.04	22	0.95	0.49	1.10 (0.48 to 1.72)
		Pediatric balance scale	22	7.73	4.15	22	2.86	1.7	1.51 (0.85 to 2.17)
		Trunk impairment scale	22	3.77	2.2	22	2.31	1.49	0.76 (0.16 to 1.36)
	Blauw-Hospers et al., 2011/ II-M	AIMS (3 to 6 months)	25	8.67	2.30	21	7.67	2.68	0.40 (–0.19 to 0.98)
		AIMS (6 to 18 months)	23	28.00	6.88	21	26.33	8.32	0.22 (–0.37 to 0.80)
		PEDI (6 to 18 months)	23	60.17	10.42	21	69.00	11.54	–0.79 (–1.39 to –0.19)
	Cameron et al., 2005/ II-S	AIMS	8	60*	46.4*	4	51.2*	69.40*	0.15 (–1.05 to 1.35) *
	Tsorlakis et al., 2004/ III-S	GMFM-88	17	2.63	5.61	17	1.69	5.09	0.17 (–0.50 to 0.85)
		GMFM-66	17	2.37	1.79	17	1.19	1.09	0.78 (0.08 to 1.48)
	Kerem & Livanelioglu, 2002/ III-W**	GMFM-66	75	22.50	2.03	412	11.60	1.08	8.56 (7.96 to 9.15)

Table 3 (continued)

	Study/level of evidence	Measure	Intervention group			Control group			Effect size: Hedges' <i>g</i> (95% CI)
			Sample size	Mean diff (raw non-stand ES)	SD of the diff pooled	Sample size	Mean diff (raw non-stand ES)	SD of the diff pooled	
3b. Arrangement of task or situation	Ko et al., 2020/ II-M	GMFM D	9	3.4	7.27	9	1.40	7.59	0.26 (−0.65 to 1.16)
		GMFM E	9	4.8	7.34	9	3.1	7.14	0.22 (−0.71 to 1.15)
		BOT-2 manual dexterity	9	2.4	2.98	9	1.8	3.22	0.18 (−0.70 to 1.07)
		PEDI mobility	9	3.80	3.82	9	2.5	4.03	0.32 (−0.62 to 1.20)
	Ogwumike et al., 2019/ II-W	Time up and go test	20	5.70	2.17	19	1.1	2.86	1.66 (0.95 to 2.37)
		GMFM D & E	20	17.5	6.67	19	13.0	6.66	0.66 (0.01 to 1.31)
	Vroland-Nordstrand et al., 2016/ II-M	Goal attainment scale	17	27.84	10.34	15	21.24	10.38	0.62 (−0.09 to 1.33)
		PEDI performance	17	2.77	1.95	15	2.74	2.05	0.01 (−0.68 to 0.71)
	Choi et al., 2011/ III-W	GMFM B	5	9.40	9.45	5	1.80	2.36	1.00 (−0.36 to 2.36)
	Law et al., 2011/ I-S	PEDI total	57	2.96	2.79	71	4.2	4.38	−0.33 (−0.68 to 0.02)
		GMFM-66	57	2.12	2.24	71	2.51	2.62	−0.16 (−0.51 to 0.19)
		Family empowerment scale (family)	57	0.09	0.10	71	−0.01	0.06	1.24 (0.86 to 1.61)
		APCP: intensity scores (active physical activities)	57	0.28	0.23	10	0.33	0.17	−0.22 (−0.89 to 0.45)
	Schneiberg et al., 2010/ III-M	Melbourne assessment of unilateral arm function	6	1.83	4.91	6	−1.50	6.78	0.52 (−0.64 to 1.68)
	Salem & Godwin, 2009/ II-W	GMFM D	5	11.18	15.90	5	5.10	16.14	0.34 (−0.91 to 1.60)
		GMFM E	5	9.04	18.13	5	3.98	16.14	0.27 (−0.98 to 1.51)
		Timed up and go test	5	4.13	7.01	5	1.80	8.37	0.27 (−0.98 to 1.52)
	Hahn et al., 2009/ III-W	GMFM B	8	3.40	16.88	4	13.30	24.91	−0.47 (−1.69 to 0.76)
		PEDI mobility	8	4.20	5.48	4	3.80	14.59	0.04 (−1.16 to 1.24)
		MAS (knee extensors)	8	0.20	0.73	4	−0.30	0.69	0.64 (−0.59 to 1.88)
3d	Blauw-Hospers et al., 2011/ II-M	AIMS (3 to 6 months)	21	7.67	2.68	25	8.67	2.30	−0.40 (−0.63 to −0.16)
		AIMS (6 to 18 months)	21	26.33	8.32	23	28.00	6.88	−0.22 (−0.34 to −0.09)
		PEDI (6 to 18 months)	21	69.00	11.54	23	60.17	10.42	0.79 (0.30 to 1.28)

Interpretation: recommended: effect size over 0.8 and statistically significant (green); not recommended: effect size smaller as −0.8 and statistically significant (red); other: unclear (yellow)

ES, effect size; M, moderate study quality; S, strong study quality; W, weak study quality; CI, confidence interval; GMFM, gross motor function measure; AIMS, Alberta infant motor scale; APCP, assessment of preschool children's participation; PEDI, pediatric evaluation of disability inventory; MAS, modified Ashworth scale

Comments: 3d. Counseling and empowerment

*Calculated from ordinal data

**In the original paper, both groups are listed as “intervention groups”

Fig. 3 Evidence chart. Evidence of the four techniques (facilitation, arrangement of task or situation, counseling and empowerment of parents or caregivers, and communication) was obtained from the included studies with evidence levels I–III. The studies are grouped according to the GMFCS levels of the children (second inner ring),

the age groups (third inner ring), and body function or activities level, or participation (outer ring). One study was not included in the evidence chart since the level of disability of the participants could not be estimated due to lack of a description (Vroland-Nordstrand et al., 2016)

exceeded the MCID of the GMFM-66. The control group showed greater improvement in the GMFM-66 and PEDI. The raw ES values obtained from the assessment of pre-school children's participation were small in both groups and did not exceed the MCID of 0.8 points (Table 3). For the FES, a large ES was found, favoring the context-focused therapy approach (Law et al., 2011).

A significant effect (medium ES) of task-oriented strength training of the lower limbs in five children aged 4 to 12 years was measured with the GMFM dimensions D and E and the timed up and go test (TUG) (Salem & Godwin, 2009). While five children with spastic bilateral CP attending a 6-week task-oriented intervention improved, five children receiving NDT improved as well, but improvements did not differ between the groups (Choi

Fig. 4 Forest plots. Evidence of the four techniques (facilitation, arrangement of task or situation, counseling and empowerment of parents or caregivers, and communication) was obtained from the included studies with evidence levels I–III. The studies are grouped according to the GMFCS levels of the children (second inner ring),

et al., 2011). Two of the five children of the NDT control group reached the maximum of the GMFM B (60 points) already before the intervention (Choi et al., 2011). Therefore, no improvement could be measured with this assessment due to the ceiling effect (Choi et al., 2011; Hahn et al., 2009; Ko et al., 2020; Law et al., 2011; Ogumike et al., 2019; Salem & Godwin, 2009).

The pooled ES of the six studies reporting motor activity outcomes assessed with the GMFM was low ($ES = 0.20$, 95% CI -0.20 to 0.71), i.e., similar outcomes in both the experimental and control intervention groups (Choi et al., 2011; Hahn et al., 2009; Ko et al., 2020; Law et al., 2011; Ogumike et al., 2019; Salem & Godwin, 2009). The pooled ES of the studies reporting outcomes with the PEDI for participation were negative ($ES = -0.18$, 95% CI -0.59 to 0.23 ; Fig. 4b) (Hahn et al., 2009; Ko et al., 2020; Law et al., 2011; Vroland-Nordstrand et al., 2016). These results suggest that arrangement of the task resulted in comparable improvements to those of the control intervention.

Verbal and Non-verbal Communication

The body of evidence of the technique verbal and non-verbal communication improving motor function, activities, or participation is weak. The studies showed some effects. Children interacted more with other children and their parents after functional communication therapy (Pennington & James, 2009). Children with severe CP showed an increase in oral praxis after a functional approach with voice training (Puyuelo & Rondal, 2005). Three children with apraxia and developmental delays interacted better after receiving specific instructions for children using augmentative and alternative communication (Kent-Walsh et al., 2015).

the age groups (third inner ring), and body function or activities level, or participation (outer ring). One study was not included in the evidence chart since the level of disability of the participants could not be estimated due to lack of a description (Vroland-Nordstrand et al., 2016).

Counseling and Empowerment of Parents and Caregivers

Only three studies assessed the effectiveness of counseling and empowerment of parents and caregivers on participation. The study by Blauw-Hospers et al. (2011) was already included in this review in the category of facilitation (control group). Despite some weaknesses described before, the study highlighted a positive effect of parental coaching when compared to passive handling of the children (Blauw-Hospers et al., 2011). This effect was higher in children who had mothers with a low level of education compared to children whose mothers had a middle or high education level (Blauw-Hospers et al., 2011). The second study investigating COPCA found a similar neurodevelopmental outcome in infants at high risk of CP for both groups (COPCA and TIP) (Hielkema et al., 2019). However, because only the results of the total group of both of these studies (children with and without a neurological diagnosis) were presented, we could not calculate the ES of the group of children with CP.

The third study (evidence level IV) found a positive impact of parental education in activities of daily living, as well as positive aspects of conductive education and NDT Bobath (Dalvand et al., 2009). However, there was no significant difference between the three approaches (Dalvand et al., 2009).

Discussion

The aim of this systematic review was to summarize the evidence of the effectiveness of four techniques on motor function, activities, and participation applied in the treatment of children and youths with neuromotor disorders. Secondly,

we wanted to allocate the evidence to different age groups and levels of disability.

The majority of the studies examined effects on the levels of body function or activities rather than participation, as shown in the evidence diagram in Fig. 3. Also striking is the lack of evidence for verbal and non-verbal communication and counseling and empowerment techniques to improve activities or participation. Although communication and counseling are usually techniques used in each therapeutic intervention, there is a lack of (particularly longitudinal) studies that examine their effect. While longitudinal randomized controlled trials would be difficult and costly to conduct, multiple *n*-of-1 single-subject studies could be a way to investigate these two important aspects of therapy.

Today, context-focused, goal-oriented therapies, as part of the arrangement of task or situation, count as evidence-based approaches (Law et al., 2011; Novak & Honan, 2019). However, evidence about the effectiveness of motor function, activities, and participation is missing, or, as it has been shown in this systematic review, ES is small. One reason could be the low contrast between the intervention and control treatment. While comparing an intervention group with a control group undergoing no therapy would increase the contrast, therapists are reluctant to withhold treatment. Another, more speculative, reason could be that children profited from the inclusion of different techniques in their therapy program. This assumption was verified by the results of Law et al. (2011), who investigated the effectiveness of context- and child-focused therapy and found a positive effect for both therapy approaches.

Evidence for the age group 12–20 years, and within this group, especially for the children with GMFCS levels IV and V, is lacking. As the GMFCS development curves show, children and adolescents with CP who belong to this age group often lose function (Hanna et al., 2009). In the sensitive phase of adolescence, body function greatly influences the development of independence in daily life and thus on integration into the community (Strauss et al., 2004). Therefore, research to evaluate the effect of therapy on the maintenance of function, well-being, and integration into the community should be promoted.

One major limitation of most studies included in this review is the poor description of the exact therapeutic content. While underlying principles, methods, and theories were explained in many studies, the description of the therapy sessions was such that treatments could not be replicated in clinical practice. Authors are advised to report their intervention and control protocols in line with the TIDieR guidelines (Hoffmann et al., 2014). Why not share a detailed program with the readers? This would help to transfer the valuable findings into clinical

practice. Some studies gave broad conclusions without reporting the specific age groups or disability levels. Research reports should be specific, and these points should be taken into account. These are steps toward thorough knowledge translation from evidence to practice and vice versa.

Methodological limitations

Our approach was explicitly designed to search for studies using the four defined techniques rather than concepts or approaches, which are usually mentioned. As we searched with pre-defined terms, we could have missed studies that used certain techniques but did not include terms describing the techniques.

Only a few studies applied identical or comparable assessments, which allowed us to pool data and create forest plots. For example, the two studies on facilitation of activity both had positive significant ESs. However, since there was a large difference between their ESs, the pooled 95% CI crossed the zero line.

This study focused on studies investigating the effectiveness of four techniques, which are applied in the treatment of children with neuromotor disorders. Strong evidence was found for the use of facilitation in newborns until the age of 2 years and for the arrangement of tasks in children aged 2 to 5 years. No study with evidence level I–III reported the effectiveness of verbal or non-verbal communication techniques applied in therapy. To date, there is a lack of evidence (studies with an evidence level IV and V) for children aged 12 to 20 years with a more severe level of motor disability. Studies about the effectiveness of communication and counseling and the empowerment of parents and caregivers are scarce.

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Author Contribution PM designed and executed the study and the data analyses and wrote the paper. JG collaborated with the design and writing of the study, the selection and rating of the studies. HvH supported the data analyses and collaborated with the design and writing of the study.

Declarations

Ethics Approval This article does not contain any studies with human participants or animals performed by any of the authors. This work was supported by the Mäxi foundation, Switzerland.

Conflict of Interest PM has, besides her work as a PhD student and physiotherapist at the Swiss Children's Rehab of the University Children's Hospital Zurich, the position as head of the Master of Advanced Studies (MAS) Entwicklungsneurologische Therapie (i.e., Neurodevelopmental Treatment) in Switzerland. She is a Bobath-trained pediatric physiotherapist. JVG is also a Bobath-trained pediatric physi-

otherapist. She currently works in research and in a clinical position. She is teaching motor learning and scientific writing at the DAS and the MAS Entwicklungsneurologische Therapie, respectively. HvH has no conflict of interest to declare.

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