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Dance and Rehabilitation: A Systematic Search and Review of the Evidence for Cerebral Palsy.

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Abstract

This systematic search and review on the use of dance and movement with music (Rhythmic Auditory Stimulation-RAS) for neurorehabilitation of children and adults with cerebral palsy (CP) presents a quality appraisal of current research literature. The literature analysis links research outcomes to the International Classification of Function (ICF) framework, highlighting areas of research strengths and areas where increased rigor is desirable. Additionally, to facilitate translation of quantitative research outcomes to the clinical classification of the ICF, we provide a table that links traditional areas of quantitative rehabilitation research with the ICF categories.

What this Paper Adds

- Dance and movement to music benefit balance, gait, and walking in people in CP.
- Research gaps are evident across ICF domains, particularly participation and environment domains.

Individuals with cerebral palsy (CP) have limitations with posture and movement that reduce participation in physical and social activities (1). CP is diagnosed in childhood but, is a lifelong condition; with increasing life expectancy, most now live into adulthood. However, balance, strength, and endurance appear to decline with age, thereby reducing activity (2). Along with motor deficits, co-existing conditions commonly occur with CP including: sensory deficits, epilepsy, intellectual impairment, learning problems, attention deficit, autism, and musculoskeletal misalignment. These deficits impact the child over time (3). With age, children and adults with CP become increasingly sedentary further reducing social engagement and participation (4).

Activities and opportunities for therapeutic movement and rehabilitation such as physical therapy decline over time for children with CP (5). Community resources and accessibility vary, and often are limited within health care systems (6). Children with CP face shifts in priorities with increasing responsibility in school and greater importance placed on relationships and socializing as children become adolescents. Dance classes and moving to music provide individuals with CP opportunities to explore movement in environments that can address associated impairments. Dance, a creative and expressive art, generally involves the performance of movement to music. Incorporating dance as an art form into rehabilitation has capacity to transcend traditional barriers in therapy that differentially focus on impairments and limitations. Dance enables opportunities for engaging in a social activity while providing therapeutic benefit (7). Rhythmic Auditory Stimulation (RAS), which also includes movement and rhythm, has a greater emphasis on synchronization of gait to a steady external rhythm, that may include melody, and does not focus on the performative capacity of gait (8). Participation in artistic endeavours may not only provide

a motivating environment, but also contribute to enhanced recovery through opportunities for enjoyable creative expression (9).

For children with CP, emerging dance programs offer adjuncts to physical and occupational therapy to enhance enjoyment, motivation and participation in therapy (10, 11). Evidence shows that dance has potential to impact proprioception, balance, sensorimotor function, posture, motor timing, procedural and working memory, rehearsing, copying, mirroring, and aesthetic expression and appreciation (12). Discrete postures and gestures used in dance constitute the simplest elements of a movement vocabulary that can be used to compose sequences of meaningful movement. These movement sequences may transfer to everyday functional mobility, therefore providing potential rehabilitative benefit.

Dance may offer therapeutic benefit to individuals with CP across different therapeutic areas and health and education disciplines, as well as personal artistic development, within multiple contexts for participation; each providing differing perspectives and terminologies. There is thus a need for a consistent language and framework to consider the mechanisms and processes of dance within rehabilitation, as well as the outcomes that might be facilitated. The International Classification of Function–Children and Youth (ICF-CY) is a useful construct to organize this review as it provides a common language that considers characteristics of the individual, influences of the environment, and interactions with the intervention (13). The ICF framework is recommended to guide development of common data elements for clinical/research studies in CP.

The ICF-CY is consistent with recent models of participation as both a process and an outcome (14). A family of participation-related constructs defines intrinsic person-focused processes in interaction with extrinsic environment-focused processes to influence participation. Activity can then be measured as capacity and performance. Capacity reflects the highest level of skill performance that can be achieved in a supportive environment, performance reflects the level of skill demonstrated in a typical environment. It is important to consider this distinction with respect to the opportunities that dance has for not only developing skills, but also having the confidence to integrate and use these across daily activities and special events. Performance therefore takes on different dimensions; at one level having the confidence to execute a more discrete performance reflecting skills used in daily life, through to having the confidence to perform either solely or as part of a group in public. The ICF-CY has been applied to CP research; increasing understanding of the impact of impairments on participation.

This review considers the potential of dance and RAS within rehabilitation for infants, children, adolescents, and adults with CP. In view of the clinical and non-clinical contexts for inclusion of dance in rehabilitation, the evidence is mapped across the domains of the ICF-CY. We aim to provide a consistent language to consider the mechanisms by which dance and RAS may influence skill acquisition and participation, with participation considered as both process (e.g. engagement, motivational influences) and outcome.

Methods

A systematic search and review were employed to combine the strengths of a critical review with a comprehensive search process but not restrict the types of included studies (15). We aimed for

an exhaustive, comprehensive search to produce a best evidence synthesis mapped against the ICF.

Search Methods

This review includes searches in six academic databases: Academic Search Complete, PubMed, Scopus, CINAHL, Cochrane Database of Systematic Reviews, and SPORTDiscus; limiting searches to scholarly peer reviewed academic journals. Boolean search phrases were identified in consultation with a health sciences librarian. Search terms were: ‘art therapy’, ‘cerebral palsy’, ‘danc*’, and ‘rhythmic auditory stimulation’. MeSH terms were used in PubMed when applicable. All available years were included; however, language restrictions were applied to include only articles in English. All review articles were excluded. All searches were done electronically and the last day that searches were run was June 9th, 2017. The search strategy is described in Appendix A, along with Boolean search phrases, the number of relevant results, the number of relevant results, the citations of relevant articles, citations of excluded articles, and the reasons for exclusion.

Initially, two authors (SNM, RNM) screened titles, abstracts, and full texts of search results to reject studies that possessed any of the following characteristics: exercise studies with no performing arts aspects, studies regarding surgeries as treatment method, a focus on the status of accessibility to rehabilitation or on appropriate class structure or curricula or methods of analysis of therapy sessions, studies on virtual reality, video gaming, studies focussing on the experience of caregivers, parental competencies, or the interpersonal relationships of therapists and clients, and art therapy studies with no dance aspect involved. Within the criteria above, all

types of study designs were included and all ages were considered to ensure a broad review scope.

A table was created summarizing the study type, number of participants, age of participants, primary and secondary outcomes, measurement techniques, and results of each article. This table was independently reviewed by CLO, DGS, and DG to determine final eligibility for each article (Appendix B).

Quality Appraisal

This review employed rating criteria for quality appraisal of the articles. The Grading of Recommendations, Assessment, Development and Evaluations System, Physiotherapy Evidence Database Scale and Downs and Black Quality Checklist were not considered appropriate due to difficulties in determining ‘equivalence’ between different methodologies, or limits to randomized or non-randomized studies respectively.

One author (DG), created a modified scale based on various Critical Appraisal Skills Programme (CASP) checklists (16). The resultant Quality Appraisal Scale (Appendix C) ensured sufficient representation of items across case control, cohort, and randomized controlled trials and relevant variations from the CASP checklists: theoretical rationale for the study; appropriate methodological design; recruitment information; description and representativeness of participants; robustness of research, including control for bias; sufficiently appropriate and rigorous data analysis (including qualitative analyses where appropriate); control for confounders; and, clear discussion of implications of findings.

Articles were assessed on each quality listed in Appendix C with **1** meaning the article possessed the assessed quality, **0** meaning it did not, and **-1**, the given quality was not applicable. The extent to which the assessed quality **1** was a good, adequate, or less than adequate, it was subdivided into **1+**, **1**, and **1-** reflecting good, adequate, and less than adequate attributes respectively. CLO, DGS, and DG rated each included article independently. Meetings ensued to discuss disagreements until consensus was reached. In order to mitigate against a possible bias of authors assessing their own studies, in cases of disagreement, the rating by the author independent of the study was accepted as valid.

ICF-CY Coding and Linking Rules

The outcomes were coded using the ICF-CY to better understand and discuss dance within the rehabilitation and CP research community as well as provide a common language to communicate with other professionals of the dance community. The linking processes involved assigning codes of the ICF domains of Body Structure and Function, Activities and Participation, and Environmental Factors. Codes were further divided into chapters, and second, third, and fourth levels within the ICF-CY. The two dimensions of participation, presence and involvement, were separated in the linking process according to the recommendations of Augustine et al. (17) to capture Mental Health constructs involving interpersonal relations and subjective experiences. DG coded the outcomes initially. CLO and SNM, and DGS then independently verified ICF-CY assigned codes. Disagreements in coding allocation were re-examined by CLO, DG, and DGS and the most appropriate codes were agreed following the recently updated refinements to ICF linking rules (18, 19). This allowed for each meaningful concept to be linked to the most precise

ICF category and the methods for assigning concepts as either personal or health factors (or not-assignable) in an objective manner (18). This process resulted in several coding rules for responses that were initially ambiguous (e.g. 'cadence' was coded as b770-Gait pattern functions rather than d450-Walking because it reflects the rhythm associated with pattern of walking rather than the activity of walking) and or contained latent constructs (17).

Results

Search Results

The search yielded 66 articles. Once 25 duplicates were removed and articles were reviewed for inclusion or exclusion criteria, 17 remained. Six articles were excluded for the following reasons: the central topic of discussion was not truly dance or RAS related, but addressed components such as psychological measures or school counselling, or the RAS included no dance component, only stair-stepping, leaving 11 articles for review (8, 10, 11, 20-27) (Figure 1.)

[INSERT Figure 1 HERE]

Characteristics of the Studies

Six studies involved dance and five utilised RAS. Seven studies included adults with CP, two included children and adults with CP, and two included only children with CP. The number of participants in ranged from one to forty-four. Study design types included one case study, ten

clinical trials of which three were randomized control studies, and three were pilot studies. For details on methods and results of each study see Appendix B.

Quality Appraisal Results

The results are shown in Table 1.

[INSERT Table 1 HERE]

All studies included appropriate theoretical considerations, and only one (20) did not have a clearly designed research methodology, representing a qualitative phenomenological case study. This paper constitutes a posteriori presentation of mobility improvement in an adult professional actor with CP after dance training with a dance performance (public engagement) objective. The remainder of the studies utilized validated and or reliable methods for outcome measures. Data analysis was adequate in ten studies and not applicable in one. Eight papers included clear discussions of clinical implications of the results. Half of the studies did not include a priori power calculations. This might be explained by the lack of existing data in dance interventions applicable to studies.

Most studies did not directly address confounding factors resulting from the absence of blinding. Studies on physical interventions are unavoidably characterized by the impossibility of blinding the participant to the intervention. However, it is possible to blind assessors and no studies reported assessor blinding.

ICF-CY Coding and Linking Results

The reported outcomes were linked to ICF codes to provide a consistent language to discuss the articles. The results are shown in Table 2.

[INSERT Table 2 HERE]

All papers directly measured Body Functions, most prominently: b1-mental functions, b4-functions of the cardiovascular, haematological, immunological and respiratory systems, and b7-neuromusculoskeletal and movement-related functions. Additional areas were indicated as significant including categories within b1-mental functions, b4-functions of the cardiovascular, haematological, immunological and respiratory systems, and b5-functions of the digestive, metabolic, and endocrine systems (Supplementary File 1).

Subsections of the Body Functions domain were distributed as follows: 80% of papers reflect mental functions, 70% reflect neuromusculoskeletal and movement-related functions, 20% reflect cardiovascular and respiratory system functions. Aside from the papers by Terada, all papers included b1471-quality of psychomotor function under specific mental functions (b140-b189) of section b1-mental functions. Under neuromusculoskeletal and movement-related functions, several subsections were shared across papers: control of b760-voluntary and b765-involuntary movement functions, b770-gait pattern functions, and b720-mobility of bone functions. Finally, cardiovascular system and respiratory system functions are only explored by Terada et al. (26, 27). Detailed specifications of each paper with respect to their measured categories are included in Table 2.

Body Functions that were indicated within studies without being directly measured were apparent in two of the ten papers (20, 27) and listed in Supplementary File 1. Chaitow et al. (20) indicated attendance to a subsections of movement functions and specific mental functions: b1643-sensations related to muscles and movement functions and b1643-cognitive flexibility. Terada et al. 2017 indicated attendance to the cardiovascular system through the subsections of b429-blood pressure and b455-exercise tolerance functions, and to metabolic and digestive functions through b540-general metabolic functions and b530-weight maintenance functions.

Interpretation

This systematic search and review shows the need to investigate further the effects of dance-based interventions for rehabilitation in CP. Most importantly, detailed reporting on study protocols is recommended for effective replication and implementation of the interventions especially: a) Blinding b) Relationship between the experimenter, dance instructors, and participants c) Training level of individuals delivering the dance interventions d) Recruitment methods and population e) Dance teaching methodology and f) Intervention location and environment. Regarding research methods, there is a need to bridge the results of rigorous quantitative techniques to clinical outcomes to facilitate translation of research and adoption of successful interventions.

The mapping of dance research outcomes to ICF classifications bridges research to daily contexts (18). This endeavour is challenging as researchers have not typically designed

experiments based on the ICF. To promote such transition in further research on rehabilitation using dance, we created a table that lists the main attributes of dance skill training from the neurophysiological point of view and maps them into the most salient items of the ICF (Table 3).

[INSERT Table 3 HERE]

Considering the theoretical potential of dance to modulate health status, relatively few of the potential body structures and functions categories were addressed in the studies and even fewer ICF activity and participatory domains were directly addressed. Additionally, internal and external factors, which modify participation, were not measured. In contrast to the other articles, Chaitow et al. (20) do reference change in attitudes towards performance and disability. Attitudinal factors concerning disability are culturally complex and deeply engrained. Understanding attitudes is an important part of the biosocial framework of the ICF and has the potential to catalyse change in public policy (28). Literature reports greater participation when disability stigma decreases and attitudes toward disability improve; with dance supporting social integration for children with intellectual disability (7).

The role of dance, music, and arts more generally, in supporting emotional expression and facilitating well-being has been demonstrated across a number of public health projects (29). The ICF-CY is limited in its capacity to capture personal aspects related to self-esteem and mood which may form an important component of a dance program (21). There is an increased reported risk of mental health problems in young people with CP (30). It thus seems imperative to consider additional therapeutic interventions that target broader concepts of participation, health and well-

being than are currently evidenced in the literature. Engagement in creative movement coupled with music and rhythm, provides opportunities for nonverbal and emotional expression, activity competence, and participation engagement. The opportunity to use dance to influence societal attitudes about and towards disability has been hinted at by the work of Chaitow et al. (20). These areas of transdisciplinary research to understand the potential of dance have yet to be explored.

Dance with music and rhythm may be integrated into rehabilitation, physical and occupational therapy to increase participation in therapy and enjoyment (10, 11). Music may determine the dramatic or expressive quality of the dance and reciprocally, music may be written to match the requirements of the movement and/or narrative in a dance and provide a temporal template for movement composition.

Considering engagement in dance as both a process and as an outcome, only López-Ortiz et al. (10) asked participants about their feelings regarding their dance program. Given the potential of dance and creative movement to impact on a number of personal factors, including self-concept and self-efficacy, as well as social participation and environmental domains, it is noteworthy how few of the studies explored these aspects. The RAS studies of walking to prescribed music rhythms, did not consider social communication, environmental, or personal factors as outcomes.

There are limitations to this review, particularly with respect to the difficulty in extracting data across such varied methodologies and the small number of studies which have explored the role of dance and movement to music. However, over half of these studies used validated and

objective methods to assess outcomes. Additionally, it was unclear from the studies what prior exposure and experience participants may have had with dance. Further, there may be some inherent bias due to the professional interests and backgrounds of the authors. A strength of this review is the mapping of these outcomes against the ICF domains which has provided a framework for considering the mechanisms and processes of the performing arts within rehabilitation.

Conclusion

This systematic search and review identified 11 studies providing preliminary evidence of the benefits of dance and RAS on body functions, particularly those associated with balance, gait and walking for individuals with CP; with some indication for benefits to cardiorespiratory fitness for individuals with more movement restrictions. Utilising the ICF as a common language to define research outcomes across inter-disciplinary studies, highlighted research gaps particularly in the domains of participation and environment. The potential for dance and movement with music to have positive impacts on emotional expression, social participation, and attitudinal change are indicated areas for consideration in future research.

References

1. Beckung E, Hagberg G. Neuroimpairments, activity limitations, and participation restrictions in children with cerebral palsy. *Dev Med Child Neurol.* 2002;44(5):309-16.
2. Haak P, Lenski, M., Hidecker, M.J.C., Li, M., & Paneth, N. Cerebral Palsy and Aging. *Dev Med Child Neurol.* 2009;51(s4):16-23.

3. Claridge EA, McPhee PG, Timmons BW, Ginis KA, MacDonald MJ, Gorter JW.

Quantification of Physical Activity and Sedentary Time in Adults with Cerebral Palsy. *Medicine and science in sports and exercise*. 2014.

4. Fowler EG, Kolobe TH, Damiano DL, Thorpe DE, Morgan DW, Brunstrom JE, et al.

Promotion of physical fitness and prevention of secondary conditions for children with cerebral palsy: section on pediatrics research summit proceedings. *Phys Ther*. 2007;87(11):1495-510.

5. Coombe S, Moore F, Bower E. A national survey of the amount of physiotherapy intervention given to children with cerebral palsy in the UK in the NHS2012. 5-18 p.

6. Mihaylov SI, Jarvis SN, Colver AF, Beresford B. Identification and description of environmental factors that influence participation of children with cerebral palsy. *Dev Med Child Neurol*. 2004;46(5):299-304.

7. Green D, Ziviani, J. The Arts and Children's Occupational Opportunities. In: Roger S, Kennedy-Behr, A., editor. *Occupation-Centered Practice with Children: A Practical Guide for Occupational Therapists*: Wiley-Blackwell; 2017. p. 311-24.

8. Kim SJ, Kwak EE, Park ES, Cho SR. Differential effects of rhythmic auditory stimulation and neurodevelopmental treatment/Bobath on gait patterns in adults with cerebral palsy: a randomized controlled trial. *Clin Rehabil*. 2012;26(10):904-14.

9. Sarkamo T, Tervaniemi M, Laitinen S, Forsblom A, Soinila S, Mikkonen M, et al. Music listening enhances cognitive recovery and mood after middle cerebral artery stroke. *Brain*. 2008;131(Pt 3):866-76.

10. Lopez-Ortiz C, Gladden K, Deon L, Schmidt J, Girolami G, Gaebler-Spira D. Dance program for physical rehabilitation and participation in children with cerebral palsy. *Arts & health*. 2012;4(1):39-54.

11. Teixeira-Machado L, Azevedo-Santos I, DeSantana JM. Dance Improves Functionality and Psychosocial Adjustment in Cerebral Palsy: A Randomized Controlled Clinical Trial. *Am J Phys Med Rehabil*. 2016.
12. Blasing B, Calvo-Merino B, Cross ES, Jola C, Honisch J, Stevens CJ. Neurocognitive control in dance perception and performance. *Acta psychologica*. 2012;139(2):300-8.
13. International Classification of Functioning, Disability, and Health: Children and Youth Version: ICF-CY. Geneva, OH: World Health Organization; 2007.
14. Imms C, Adair B, Rosenbaum P, Keen D, Ullenhag A, Granlund M. 'Participation': A systematic review of language, definitions, and constructs used in intervention research with children with disabilities. *Dev Med Child Neurol*. 2016;58(1):29-38.
15. Grant MJ, Booth A. A typology of reviews: an analysis of 14 review types and associated methodologies. *Health Info Libr J*. 2009;26(2):91-108.
16. CASP. Critical Appraisal Skills Programme (CASP) Making Sense of Evidence Trial Checklists [Website]. Middle Way, Oxford, UK: CASP; 2017 [Available from: <http://www.casp-uk.net/casp-tools-checklists>].
17. Augustine L, Lyngnegard F, Granlund M, Adolfsson M. Linking youths' mental, psychosocial, and emotional functioning to ICF-CY: lessons learned. *Disability and rehabilitation*. 2017:1-7.
18. Cieza A, Bickenbach J, Prodinger B, Fayed N. Refinements of the ICF Linking Rules to strengthen their potential for establishing comparability of health information. *Disability and Rehabilitation*. 2016:1-10.
19. Ibragimova NK, Pless M, Adolfsson M, Granlund M, Bjorck-Akesson E. Using Content Analysis to Link Texts on Assessment and Intervention to the International Classification of

Functioning, Disability and Health - Version for Children and Youth (Icf-Cy). Journal of Rehabilitation Medicine. 2011;43(8):728-33.

20. Chaitow L, Rogoff T, Mozgala G, Chmelik S, Comeaux Z, Hannon J, et al. Modifying the effects of cerebral palsy: the Gregg Mozgala story. Journal of bodywork and movement therapies. 2010;14(2):108-18.

21. Efraimidou V, Tsimaras V, Proios M, Christoulas K, Giagazoglou P, Sidiropoulou M, et al. The effect of a music and movement program on gait, balance and psychological parameters of adults with cerebral palsy. Journal of Physical Education & Sport. 2016;16(4):1357-64.

22. Kim SJ, Kwak EE, Park ES, Lee DS, Kim KJ, Song JE, et al. Changes in gait patterns with rhythmic auditory stimulation in adults with cerebral palsy. NeuroRehabilitation. 2011;29(3):233-41.

23. Kwak EE. Effect of rhythmic auditory stimulation on gait performance in children with spastic cerebral palsy. J Music Ther. 2007;44(3):198-216.

24. Lopez-Ortiz C, Egan T, Gaebler-Spira DJ. Pilot study of a targeted dance class for physical rehabilitation in children with cerebral palsy. SAGE open medicine. 2016;4:2050312116670926.

25. Shin YK, Chong HJ, Kim SJ, Cho SR. Effect of Rhythmic Auditory Stimulation on Hemiplegic Gait Patterns. Yonsei medical journal. 2015;56(6):1703-13.

26. Terada K, Satonaka A, Suzuki N, Terada Y. Cardiorespiratory responses during wheelchair dance in bedridden individuals with severe athetospastic cerebral palsy. Gazzetta Medica Italiana Archivio per le Scienze Mediche. 2016;175(6):241-7.

27. Terada K, Satonaka A, Terada Y, Suzuki N. Training effects of wheelchair dance on aerobic fitness in bedridden individuals with severe athetospastic cerebral palsy rated to GMFCS level V. *European journal of physical and rehabilitation medicine*. 2017.
28. Garcia SF, Hahn EA, Magasi S, Lai JS, Semik P, Hammel J, et al. Development of self-report measures of social attitudes that act as environmental barriers and facilitators for people with disabilities. *Archives of physical medicine and rehabilitation*. 2015;96(4):596-603.
29. Howarth L. Creative health: the arts for health and wellbeing. *Perspectives in Public Health*. 2018;138(1):26-7.
30. Downs J, Blackmore AM, Epstein A, Skoss R, Langdon K, Jacoby P, et al. The prevalence of mental health disorders and symptoms in children and adolescents with cerebral palsy: a systematic review and meta-analysis. *Dev Med Child Neurol*. 2018;60(1):30-8.

Captions

Figure 1. PRISMA Flowchart

Table 1. Representation of the agreed upon ratings for the Modified CASP Quality Appraisal Scale. Black boxes represent a rating of 0, indicating the article did not address the domain assessed; grey boxes represent a rating of -1, indicating that the domain assessed was not applicable to the given article; and white boxes represent a rating of 1, indicating that the article did address the domain assessed. Within white boxes, a “+” or “-” represent a 1+ or 1- respectively, which are subsets of the 1 category with 1+ being an excellent example of the given domain and 1- being a less adequate example.

Table 2: Categories and linked codes for directly measured outcomes across all eleven studies.

Table 3. Main attributes of dance skill training from the neurophysiological point of view and mapped to the most salient items of the ICF.

Appendix A: Search Strategy

Appendix B: Summary of studies: country, type, number of participants, age of participants, domains assessed, measures used, results.

Appendix C: Modified CASP Quality Appraisal Scale

Figure 1 PRISMA Flowchart

Table 1. Representation of the agreed upon ratings for Modified CASP Quality Appraisal Scale

Studies	Modified CASP Categories															
	1	2	3	4a	4b	5a	5b	5c	5d	6	7a	7b	7c	8	9	10
Chaitow, L., et. al. (2010)						-				-						-
Efraimidou. V., et al. (2016)	-					-	-							-		
Kim, S.J., et al. (2011)				-		-	-							-		-
Kim, S. J., et al. (2012)						-	-							-	-	-
Kwak, E. E. (2007)				-	-									-		
López -Ortiz, C., et al. (2012)			-											-		-
López -Ortiz, C., et al. (2016)																
Shin, Y. K., et al. (2015)													-	-		
Teixeira-Machado, L., et al. (2016)						-									-	
Terada, K., et al. (2016)														-		
Terada, K., et al. (2017)																

Black boxes represent a rating of 0, indicating the article did not address the domain assessed; grey boxes represent a rating of -1, indicating that the domain assessed was not applicable to the given article; and white boxes represent a rating of 1, indicating that the article did address the domain assessed. Within white boxes, a “+” or “-” represent a 1+ or 1- respectively, which are subsets of the 1 category with 1+ being an excellent example of the given domain and 1- being a less adequate example.

Table 2: Categories and linked codes for directly measured outcomes across all eleven studies.

Body Functions (b)	
Mental functions (b1)	Neuromusculoskeletal and movement-related functions (b7)
Specific mental functions (b140-b189): Attention functions (b140) Teixeira-Machado et al. 2017 Memory functions (b144) Teixeira-Machado et al. 2017 Psychomotor functions (b147) Quality of psychomotor function (b1471) Chaitow et al. 2010 Efraimidou et al. 2016 Kim et al. 2011 Kim et al. 2012 Kwak 2007 López-Ortiz et al. 2012 López-Ortiz et al. 2016 Shin et al. 2015 Teixeira-Machado et al. 2017 Higher-level cognitive functions (b164) Teixeira-Machado et al. 2017	Functions of the joints and bones (b710-b729) Mobility of bone functions (b720) Mobility of pelvis (b7201) Kim et al. 2011 Kim et al. 2012 Shin et al. 2015 Mobility of bone functions, other specified (b7208) Kim et al. 2011 Kim et al. 2012 Shin et al. 2015 Movement functions (b750-b789) Vestibular functions (b235) Efraimidou et al. 2016 Motor reflex function (b750) Chaitow et al. 2010 Involuntary movement reaction functions (b755) López-Ortiz et al. 2016 Control of voluntary movement functions (b760) Chaitow et al. 2010 Efraimidou et al. 2016 López-Ortiz et al. 2016 Teixeira-Machado et al. 2017 Supportive functions of arm or leg (b7603) López-Ortiz et al. 2016 Involuntary movement functions (b765) Chaitow et al. 2010 Efraimidou et al. 2016 López-Ortiz et al. 2016 Teixeira-Machado et al. 2017 Gait pattern function (b770) Chaitow et al. 2010 Kim et al. 2011 Kim et al. 2012 Kwak 2007
Functions of the cardiovascular, haematological, immunological and respiratory systems (b4)	
Functions of the cardiovascular system (b410-b429) Heart functions (b410) Terada et al. 2016 Terada et al. 2017 Functions of the haematological and immunological systems (b430-b439) Haematological system functions (b430) Oxygen carrying capacity (b4301) Terada et al. 2016 Terada et al. 2017	
Activity and Participation (d)	
General tasks and demands (d2)	Mobility (d4)

Undertaking multiple tasks (d220) Undertaking multiple tasks independently (d2202) Teixeira-Machado et al. 2017	Changing and maintaining body position (d410-d429) Changing basic body position (d410) López-Ortiz et al. 2016 Teixeira-Machado et al. 2017 Sitting (d4103) López-Ortiz et al. 2016 Standing (d4104) López-Ortiz et al. 2016 Bending (d4105) López-Ortiz et al. 2016 Maintaining a body position (d415) López-Ortiz et al. 2016 Maintaining a standing position (d4145) López-Ortiz et al. 2016 Efraimidou et al. 2016 Transferring oneself (d420) López-Ortiz et al. 2016 Efraimidou et al. 2016 Changing and maintaining body position, other specified and unspecified (d429) López-Ortiz et al. 2016 Efraimidou et al. 2016 Carrying, moving and handling objects (d430-d449) Fine hand use (d440) López-Ortiz et al. 2016 Grasping (d4401) López-Ortiz et al. 2016 Releasing (d4403) López-Ortiz et al. 2016 Walking and moving (d450-d469) Walking (d4508) Efraimidou et al. 2016 Kim et al. 2012 Kwak 2007 Shin et al. 2015 Teixeira-Machado et al. 2017
Communication (d3) Communicating - receiving (d310-d329) Communicating - receiving, other specified and unspecified (d329) Teixeira-Machado et al. 2017 Communicating - producing (d330-d349) Communication - producing, other specified and unspecified (d349) Teixeira-Machado et al. 2017	
Self-care (d5) Self-care, other specified (d598) Teixeira-Machado et al. 2017 Self-care, unspecified (d599) Teixeira-Machado et al. 2017	
Interpersonal interactions and relationships (d7) Informal social relationships (d750) Informal relationships with peers (d7504) López-Ortiz et al. 2016	
Community, social and civic life (d9) Community life (d910) Teixeira-Machado et al. 2017 Recreation and leisure (d920) Teixeira-Machado et al. 2017 Arts and culture (d9202) López-Ortiz et al. 2012	
Environmental Factors (e)	
Attitudes (e4) Chaitow et al. 2010	Services, systems and policies (e5) Education and training services, systems and policies (e585) Chaitow et al. 2010

Table 3. Main attributes of dance skill training from the neurophysiological point of view and mapped to the most salient items of the ICF.

Dance Skill Training	ICF Body Structures and Functions	ICF Activities and Participation
Motor Control: Control of	Vestibular Function of Position (b2350) Vestibular Function of Balance (b2351)	Focusing Attention, other specified (d1608) Applying knowledge, other specified and unspecified (d179)

Equilibrium and Posture	Seeing Functions, other specified (b2109) Proprioceptive Function (b260) Stability of Joints Generalized (b7152) Structures Related to Movement, unspecified (s799)	Undertaking a Complex Task (d2101) Maintaining a Body Position, unspecified (d4159)
Motor Control: Control of Complex Movements	Supportive Functions of Arm and Leg (b7603) Vestibular Function of Determination of Movement (b2352) Proprioceptive Function (b260) Mobility of Joints Generalized (b7102) Power of all Muscles of the Body (b7306) Control of Complex Voluntary Movements (b7601) Structures Related to Movement, unspecified (s799)	Focusing Attention, other specified (d1608) Applying knowledge, other specified and unspecified (d179) Undertaking a Complex Task (d2101) Producing Body Language (d3350) Changing a Basic Body Position, unspecified (d4109) Moving around, other specified (d4558)
Timing and Synchronization in Dance Performance	Experience of Time (b1802) Visual Perception (b1561) Auditory Perception (b1560) Visuospatial Perception (b1565) Psychomotor Control (b1470) Basic Cognitive Functions (b163) Proprioceptive Function (b260) Coordination of Voluntary Movements (b7602) Structures Related to Movement, unspecified (s799)	Coordination of Voluntary Movements (d7602) Mental Function of Sequencing Complex Movements (d176) Focusing Attention, other specified (d1608) Purposeful Sensory Experience, other specified and unspecified (d129) Applying knowledge, other specified and unspecified (d179) Undertaking a Complex Task (d2101)
Motor Learning and Memory in Dance Perception and Performance	Motivation (b1301) Sustaining Attention (b1400) Short Term Memory (b1440) Long Term Memory (b1441) Retrieval and Processing of Memory (b1442) Visuospatial Perception (b1565) Basic Cognitive Functions (b163)	Rehearsing (d135) Acquiring complex skills (d1551) Acquiring skills, other specified (d1558) Directing Attention (d161) Purposeful Sensory Experience, other specified and unspecified (d129) Acquiring Information (d132) Applying knowledge, other specified and unspecified (d179) Undertaking a Complex Task (d2101)
Visuomotor and Spatial Transformations and Mental Imagery	Orientation to Space (b1144) Visuospatial Perception (b1565) Visual Perception (b1561) Basic Cognitive Functions (b163)	Rehearsing (d134) Focusing Attention to Changes in the Environment (d1601) Directing Attention (d161) Thinking, other specified (d1638) Visuospatial Perception (d1565) Undertaking a Complex Task (d2101)
Neural Substrates for Observation of Motor Actions	Short Term Memory (b1440) Sustaining Attention (b1400) Structure of Cortical Lobes (s1100) Parietal Lobe (s11002)	Watching (d110) Directing Attention (d161) Purposeful Sensory Experience, other specified and unspecified (d129) Acquiring complex skills (d1551)
Esthetics and Expression	Experience of Self (b1800) Openness to Experience (1264) Appropriateness of Emotion (b1520)	Communicating with-receiving- body gestures (d3150) Abstraction (d1640)

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		Watching (d110) Purposeful Sensory Experience, other specified and unspecified (d129) Producing Body Language (d3350)
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