Journal of Movement Arts Literacy

Volume 5 | Number 1 Article 2

2019

Enhancing Motor Coordination: An Eshkol-Wachman Movement Notation (EWMN) Perspective

Dr. Nira Al-dor
nira.aldor@gmail.com
Author Credentials
Nira Al-Dor, PhD.
Hakibbutzim College of Education

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Abstract

The article integrates multi-layered learning and its potential for human development in parallel domains—psycho-motor, cognitive and social-emotional—while focusing on the complex motor coordination that is involved in mastering literacy skills. It presents Eshkol-Wachman Movement Notation (EWMN) and the coordination phenomena that are based on this method and supported by pilot study on the impact of learning EWMN on the development of coordination. The present pilot study provides proof of concept both for its assessment tools and the idea that EWMN may facilitate coordination. *Objectives*: to examine improvement in coordination during an intervention program. *Participants*: 45 dance department students, 12 to 14 years old, in 3 separate age groups. *Procedure*: A five-month intervention based on learning EWMN was executed. Pre- and post-tests were given to 15 randomly chosen dance students from the research group (5 participants from each age group, every 3rd student in an alphabetized list of names). *Results*: The before and after assessments of the intervention program indicate that there was significant improvement in level of coordination among the participants (range—in the first variable: -3.57, $p < .01$ to the second variable: -10.58, $p < .01$). All participants significantly improved their coordination. *Recommendation*s: (I) Increasing the number of subjects in future studies in order to obtain more significant conclusions, using relevant parametric statistics and check for normally distributed data using Shapiro-Wilk test or a Kruskal-Wallis test. (II) Employment of scientific tools such as inertial sensors in order to investigate the potential for enhancing coordination using large spaces of movement and time dependency against a gold standard and enable testing the sensitivity of the research tool during an intervention program. (III) Employment of retention test after a non-practicing period in order to assess change in motor learning patterns.

Keywords

dance notation, dance literacy, Eshkol-Wachman Movement Notation, motor coordination

During my career as a dance educator, I have met many students who believed that they lacked coordination and could never acquire it. Yet, enhancing coordination is like any kind of learning that involves a process of dynamic change.[1] I consistently argue that anyone can improve coordination if they learn, practice, and persevere.

A considerable part of the learning is tied to consolidation of physical-cognitive-emotional and social skills, that allow us to express the knowledge that has been accumulated.[2] Todd Rose, Samantha Daley, and David Rose explain that when building these skills, we use our body muscles and establish both nerve-muscle paths and their paths' connection to cognitive paths.[3]

Consultants Dean Aslinia, Rasheed Masuma, and Chris Simpson express that every human being has the cognitive ability to change perception and behaviors as a result of learning.[4] Karl Newell describes learning as the coordination of perceptual environment with the action environment in a way consistent with the task constrains.[5] As described by neuroscientists, while the dynamics of general learning process entail re-organizing, and de-stabilizing patterns that were adopted in previous learning, motor learning aims to change the spatial trajectories and dynamics of moving body limbs.[6] As motor learning enhances the human ability to adapt to new coordination patterns, it can affect the entire behavioral repertoire, including the social and emotional domains, as noted by Rose et al. who emphasized the value of the interdisciplinary approach in Mind, Brain and Education (MBE).[7] When the relationship between motor coordination, recognition of emotions, and social behavior was examined in children, Ariane Cummins, Jan Piek, and Murray Dyck found that a child`s motor ability is a significant predictor of social behavior.[8] The researchers Viviane Kostrubiec, Pier-Georgio Zanone, Armin Fuchs, and Scott Kelso

1. The dynamics of general learning process include pattern formation or pattern change over time.

2. Hanna, Lynne Judith. *Dancing to learn, the brain`s cognition, emotion, and movement*. (Lanham: Rowman and Littlefield Publishing Group, Inc., 2015)40.

3. Todd L. Rose, Samantha G. Daley, and David H. Rose, "Let the Questions Be Your Guide: MBE as Interdisciplinary Science," *Mind Brain and Education 5, no.* 4 (2011): 153–162.

4. Deans S. Aslinia, Rasheed Masuma, and Chris Simpson. "Individual Psychology (Adlerian) Applied to International Collectivist Cultures: Compatibility, Effectiveness, and Impact," *Journal for International Counselor Education 3,* (2011): 1–12.

5. Karl, M. Newell, K. M. "Motor skill acquisition." *Annual Review of Psychology, 42,* (1991): 225.

6. Scott J. Kelso, Dan L. Southard and David Goodman, "On the Coordination of Two-handed Movements," *Journal of Experimental Psychology: Human Perception and Performance 5* (1979): 229–238; Viviane Kostrubiec, Pier-Georgio Zanone, Armin Fuchs, and Scott J. Kelso, "Beyond the Blank Slate: Routes to Learning New Coordination Patterns Depend on the Intrinsic Dynamics of the Learner—Experimental Evidence and Theoretical Model," *Frontiers in Human Neuroscience 6,* (2012): 222. doi: 10.3389/fnhum.2012.00222.

7. Rose, Samantha G. Daley, and David H. Rose, "Let the Questions Be Your Guide," 153–162.

8. Ariane Cummins, Jan P. Piek, and Murray J. Dyck, "Motor Coordination, Empathy, and Social Behavior in School-aged Children," *Developmental Medicine and Child Neurology 47* (2005): 437–442.

express that motor ability is optimally modified by the acquisition of new patterns. Their "dynamical approach," which refers to changes in structures of movement,[9] implies that there can be a positive transfer between newly learned coordination patterns and other patterns that had not been previously acquired. Moreover, the anthropologist Judith Hanna suggests that the relationship between cognitive, emotional, and psychomotor development might strengthen deficiencies in one area by training in a related area.[10]

Shawn Yi-Ching Peh, Jia Yi Chow, and Keith David, sports medicine researchers, found that some coordination tasks may benefit from the use of internal focus instruction, especially when learners need to display specific forms of movement in specific performance context like dance. This may also prove efficacious in tasks where the form of movement required to produce a distinct outcome is highly stable.[11] These findings are different from those presented by the sports researcher, Gabriele Wulf, who found that external focus causes much better achievements than internal focus.[12] The difference may derive from the differences of targets between the sports action and the coordination exercise based on EWMN which is very similar to dance. Thus, the outcomes of a sports action such as tennis and soccer are clear and external, while the outcomes of the movement based on EWMN are internal and deals, as the scientists Tamar Flash and Nevile Hogan found, with the gracefulness of the movement[13] without external outcomes, differently from athletic or game plays.

Motor learning and motor coordination can be also executed in a group. In joint action, where several individuals are contributing parts of a broader learning system, researchers found that performance accuracy, and stability were higher as compared to individual learning. In a study by Viviane Kostrubiec, Raoul Huys, and Pier-Georgio Zanone, this phenomenon became even stronger while examining error corrections.[14] Health scientists John van der Kamp, Joop Duivenvoorden, Marjan Kok, and Ivo van Hilvoorde found that motor learning in groups contributes, by observing its members, to learn from

9. Viviane Kostrubiec, Pier-Georgio Zanone, Armin Fuchs, and Scott J. Kelso, "Beyond the Blank Slate: Routes to Learning New Coordination Patterns Depend on the Intrinsic Dynamics of the Learner—Experimental Evidence and Theoretical Model." *Frontiers in Human Neuroscience 6*, (2012): 222. doi: 10.3389/ fnhum.2012.00222.

10. Judith L. Hanna, *Dancing to Learn, the Brain`s Cognition, Emotion, and Movement* (Rowman and Littlefield Publishing Group, Inc., 2015), 42, 67, 70.

11. Shawn Yi-Ching Peh, Jia Yi Chow, and Keith David, "Focus of attention and its impact on movement behavior," *Journal of Science and Medicine in Sport 14*, no.1 (2011):70–78. doi:10.1016/j.jsams.2010.07.002

12. Gabriele Wulf, "Attentional Focus and Motor Learning: A review of 10 Years of Research," *E-Journal Bewegung und Training, 1* (2007): 4–14.

13. Tamar Flash, and Neville J. Hogan, "The Coordination of Arm Movements: An Experimentally Confirmed Mathematical Model," *The Journal of Neuroscience 5*, no. 7 (July 1985): 1688–1703.

14. Viviane Kostrubiec, Raoul Huys, and Pier-Georgio Zanone. "Joint Dyadic Action: Error Correction by Two Persons Works Better than by One Alone," *Human Movement Science 61*, (2018): 1–18.

each other's and to adopt problems solving strategies. It also involves interactions between the group members that promote implicit and explicit motor learning, increasing motor skills, self-efficacy and self-controlled feedback.[15]

Recent empirical studies of motor learning support the viewpoint that learning is nonlinear, dynamical process, such as emergence, dynamic inter-relations, multi-stability and phase transitions. Skill acquisition is conceived by sudden changes in skill capability and coordination dynamic stability. Movement variability allow the learner to search, find and refine appropriate solution manifolds for different performance contexts.[16]

In this article, I aim to demonstrate an integrated multi-layered group learning and its contribution for human development. I will focus on complex motor coordination based on Eshkol-Wachman Movement Notation (EWMN), which mostly combines literacy skills, and I also will address, theoretically, to emotional and social skills. The following research aims to be a pilot study that provides proof of concept for both their assessment tools and the idea that EWMN may facilitate coordination. The learning model which was used in this study partly based on known motor learning models which were developed by Antoinette Gentile,[17] Bryant Cratty,[18] Karl Newell,[19] and Paul Fitts and Michael Posner.[20]

Coordination

Motor coordination has been described as the capacity to efficiently control the degrees of freedom of the different body segments that are involved in the motion.[21] It also determines to what extent and during what time span someone can fully learn a skill. In physical activity and sports performance domain,

15. John van der Kamp, Joop Duivenvoorden, Marjan Kok, and Ivo van Hilvoorde. "Motor Skill Learning in Groups: Some Proposals for Applying Implicit Learning and Self-controlled Feedback," *RICYDE. Revista Internacional de Ciencias del Deporte*, *39,* no.11 (2015): 33–47. http://dx.doi.org/10.5232/ricyde2015.03903.

16. Chris, Button, Chi-Mei Lee, Dutt A. Mazumder, Clara W. K. Tan, and Jia Yi Chow. "Empirical Investigations of Nonlinear Motor Learning." *The Open Sports Science Journal 5* (2012): 56–57.

17. Antoinette M. Gentile, *A Working Model of Skill Acquisition with Application to Teaching* (August 2012): 3–23. http://doi.org/10.1080/00336297.1972.10519717.

18. Bryant J. Cratty, the Three Level Theory of Perceptual-Motor Behavior. *Quest 6,* (1966): 1-9. DOI: 10.1080/00336297.1966.10519605.

19. Newell, "Motor skill acquisition," 213–237.

20. Caitlin Tenison, and John R. Anderson. "Modeling the Distinct Phases of Skill Acquisition," *Journal of Experimental Psychology: Learning, Memory, and Cognition 42,* no. 5 (2016): 749–767.

21. Joric B. Vandendriessch, Barbara Vandorpe, Manuel J. Coelho-e-Silva, Roel Vaeyns, Matthieu Lenoir, Johan Lefevre, and Renaat M. Philippaerts, "Multivariate Association Among Morphology, Fitness, and Motor Coordination Characteristics in Boys Age 7 to 11." *Pediatric Exercise Science, 23* (2011): 504–520.

motor coordination, alongside strength and power, plays an important role in the cooperative interaction between nervous system and the skeletal muscles.

Professor of Kinesiology and Applied Physiology Nancy Getchell express that as a psychomotor skill, coordination is crucial for daily functioning. It must occur not only within the body, but between the body and the environment (physical and personal environment), through the dynamic coupling of perceptual information with appropriate units of action. The process of integrating perception and action to produce adaptive, coordination behaviors, develops and becomes refined throughout the early years of life.[22]

Lilach Shalit and Jacob Hantiu explain that coordination is considered to be a complicated ability and it has an elusive quality[23], but is generally agreed to possess qualities such as efficiency and homogeneity. Sportis Goran et al. assert that it develops in varying conditions and demands a subjective time span for learning to adapt to new patterns. Varying conditions include movement spatial trajectories, movement time, unique and new combinations of body limb movement and balancing challenges.[24]

Shawn Yi-Ching Peh et al. share insights into the relative efficacy of different attentional foci for instructions and feedback while developing movement coordination—internal focus is focusing on the movement form and external focus is focusing on the movement effect. They indicated that conscious processing of information while learning a new coordination task can disrupt automatic control processes that putatively regulate execution, thus they asserted that there is a need to clarify whether an internal focus of attention may benefit the acquisition of movement coordination. They also indicated that the use of novel tasks is needed in order to minimize the impact of a learner`s past experience on the acquisition of a skill.[25]

Karl Newell`s model of motor learning that divided learning into three stages (Coordination, Control and Skill) can provide a general framework how movement coordination and control are acquired with practice and time and found applicable to express the complexity process of improving coordination based on EWMN. In early learning (Coordination) learners seek to use the stable movement patterns that are present within their existing preferred coordination tendencies to find movement solutions to specific motor tasks. At the next stage (Control) learners are able to perform with consistency in changing performance environments and they will better associate higher-order derivatives such as, varying tempo of movement, varying force exerted, changing body front and posture (from standing to sitting to lying) involved in movement performance

22. Nancy Getchell. "Developmental Aspects of Perception-action Coupling in Multi-limb Coordination: Rhythmic Sensorimotor Synchronization." *Motor Control 11* (2007): 1–15.

23. Lilach Shalit, and Iacob Hantiu. "The impact of exercise based on the Eshkol-Wachman movement notation on general coordination." *Palestrica of the third millennium—Civilization and Sport 15,* no. 1 (2014): 16–21.

24. Sportis Goran, Tomac Zvonimir, Darija Omrcen, Mario Baic, and Drazen Hrasin. "Motor Learning without External Feedback when Testing Motor Coordination." *Sports Science 4,* no. 1 (2011): 84–88.

25. Yi-Ching Peh, et al., 70–78.

to effectively accomplish the task goals. As learning progresses and the control principles are assimilated, the learner begins to assign optimal organization of the variables controlling at the Skill stage, uses the reactive forces from the limb or from the environment to produce the coordination movement.[26] Newell also classified constrains into three categories for understanding how movement patterns emerge during task performance: performance constrain, environment constrain and task constrain.[27] Both models of Newell can be a significant infrastructure for discussion of the results in this study, as they reflect the spiral learning used in EWMN for developing coordination.[28] Furthermore, Yi-Ching Peh et al. relate attentional foci to Newell`s Control stage by switching of focus conditions (from internal to external) that can be provided as the learners' progress.[29]

Coordination can be characterized by qualitative components such as flow and harmony; quantitative components such as accuracy of movement, spatial trajectories, synchronizing timing of movements; involvement of cognitive and motor units of the neural system;[30] the body limbs participating in the dance; levels of complexity;[31] and varying classifications such as fine, gross, spatial, inter-personal, and polyrhythmic.

Using Eshkol-Wachman Movement Notation (EWMN) as a Platform for Improving Coordination

Motor coordination can be improved through learning EWMN, which was invented in Israel by the dancer-choreographer Prof. Noa Eshkol, together with the architect Prof. Abraham Wachman, and was first published in 1958.[32] It is considered one of the four movement notation methods accepted in the world today. The other methods are Benesh Notation,[33] Labanotation/Kinetography,[34] and Coordinate Method of Dance Notation (CMDN),[35] which was developed in

26. Newell, "Motor skill acquisition," 213–237.

27. Ian Renshaw, Jia Yi Chow, Keith Davids, and John Hammond, "A constraints-led perspective to understanding skill acquisition and game play: A basis for integration of motor learning theory and physical education praxis?" *Physical Education and Sport Pedagogy*, 15 no.2 (2010): 117–137.

28. See figure 9 (SMCD learning model—one of the study tools) which integrates principles of general learning and motor learning models as a basis for the intervention in this study and were suited to learning new coordination exercise based on EWMN.

29. Yi-Ching Peh, et al..70–78.

30. Flash, and Hogan, "The Coordination of Arm Movements," 1688–1703.

31. Scott J. Kelso, Dan L. Southard and David Goodman, (1979): 229–238.

32. Noa Eshkol, and Abraham Wachman, *Movement Notation.* **(**London: Weidenfeld and Nicolson, 1958), VII–IX.

33. Rudolf Benesh, and Joan Benesh. *An Introduction to Benesh Dance Notation.* **(**London: Adam and Charles Black, 1956).

34. Rudolf, Laban, *Laban`s Principles of Dance and Movement Notation.* **(**Boston: Plays, 1956).

35. Mei Wu Ji and Gao Chun Lin. *CMDN—Dance Notation*. (Tel Aviv: The Center for Movement Notation Exploring, The Art Faculty, Tel Aviv University, 1991).

China. EWMN refers to visible elements of the human body and proposes a limited system of symbols that represent basic values, through which the movement of the human body can be described in space and time (Eshkol and Wachman, 1958).[36]

EWMN has been employed for movement and dance style analysis, documentation, composition and also as the basis for philosophical discussions regarding phenomena and structures of movement and general behavior.[37] A unique application of reading and writing EW MN involves refining structured coordination processes in dance performance and composition.[38]

As a visual method, EWMN uses numeric-graphic symbols (see table 1) on a netted manuscript page that represent body limb movement, spatial orientaion and time (see figures 7 and 8). Dancing through reading and writing the EWMN score involves a two-way relationship between written and spoken language and movement. Shlomit Ofer, an EWMN expert, deconstructed the term "Movement Literacy" into four non-linear components[39]: *Conceptualization* is the possibility of thinking and objectively verbalizing movement, defining its elements (deconstructing the movement phenomena) and creating new movement compositions (constructing new entities); *Symbolization* is the possibility of symbolizing concrete movement[40] and encoding it graphically (coding, symbolizing and creating a score). The level of symbolization depends on the level of knowledge in EWMN and the composer's intentions, ranging from a general description of actions (running, walking, turning around) to a multiple-item and precise symbolization of the limbs in action, their direction and range in space and the time of their movement; *Decoding*, the third component, is the ability to read graphic symbols and understand their meaning. "Movement Literacy" refers to the process that begins with the given score to be read and decoded and from which the movement information (stemming from understanding the conceptual system) will be derived. This process might occur through analyzing the continuity of movement that requires the application of the learned concepts. The process of reading can either precede or follow writing, while the conceptual foundation is constructed during the movement experience through reading and writing the learned movement materials. *Performance*, the fourth component of "Movement Literacy," constitutes implementing the information obtained by reading in the form of movement. At this stage, a performance of the actions should occur, based on realizing, coordinating and combining the separate movement elements and consolidating them into one homogeneous movement (reconstruction). The body is simultaneously the performer and the

36. Eshkol, and Wachman, *Movement Notation,* VII–IX.

37. These include classical ballet, gymnastics, swimming, animals' movement, Tai chi, Eshkol dance suits, etc.

38. Eshkol, and Wachman, *Movement Notation,* VII–IX.

39. Shlomit, Ofer. "*Movement Literacy*: Development of the Concept and its Implications for Curriculum." (Unpublished Master`s Thesis, University of Haifa, 2001), 40–51.

40. EWMN can only symbolize movement whose axis can be observed by human eye.

performance tool (unlike the musician and his instrument), so they cannot be separated from one another.[41]

A method such as EWMN is able to cope with a multiply-detailed description of body movement. Although movement is temporary and occurs in three-dimensional space, it is represented on a two-dimensional, static manuscript page.

Following is a description of the basic principles of EWMN and the potential to improve coordination, based on its unique form of literacy:

I. *The human body is built as a chain of limbs*, which are connected to one another by joints. In order to notate a movement, an imaginary longitudinal axis of a body limb, outlines its direction in space. This linked body structure defines the hierarchical relationship between movements of limbs (see figure 1).[42,43]

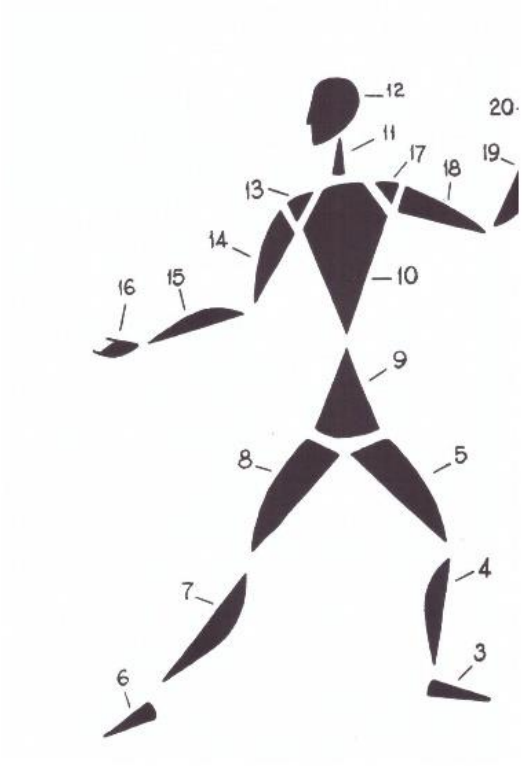

Figure 1. The human body is built as a chain of limbs.[44]

41. Ofer, "*Movement Literacy*," 40–51; Al-Dor, Nira. "The Impact of Learning Eshkol-Wachman Movement Notation on the Development of Coordination." Unpublished PhD Dissertation, ELTE University of Budapest, 2004), 49–57.

42. Noa Eshkol, and John Harries, *Eshkol-Wachman Movement Notation: A Survey*. **(**Israel: The Movement Notation Society, 1998), 11–19.

43. All figures and illustrations in this article are used with permission.

44. Eshkol, and Wachman, *Movement Notation*, 4.

II. *The movement of the limbs is always circular* and creates a spherical movement, with the joint at its center (see figure 2. the spherical object reffers to each joint).

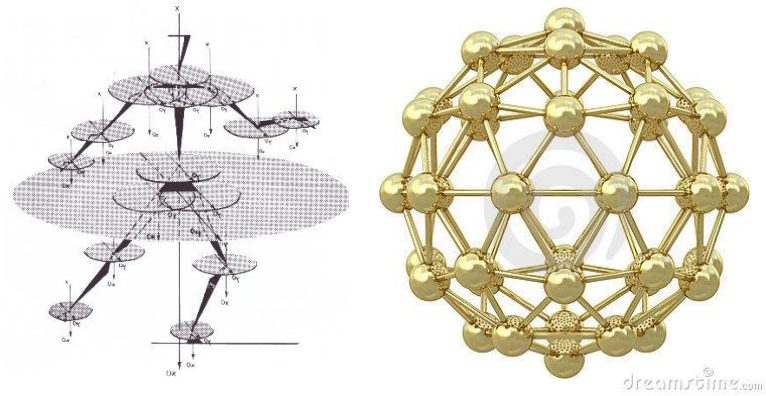

Figure 2. Private system of reference.[45]

III. Through observing the angular relationships created between the longitudinal axis of the limb and the axis of movement, it is possible to classify the movements of the human body into *three distinct types*:

Plane movement occurs when the longitudinal axis of the moving limb delineates the surface of the horizontal, vertical and diagonal plane in space (see figure 3).

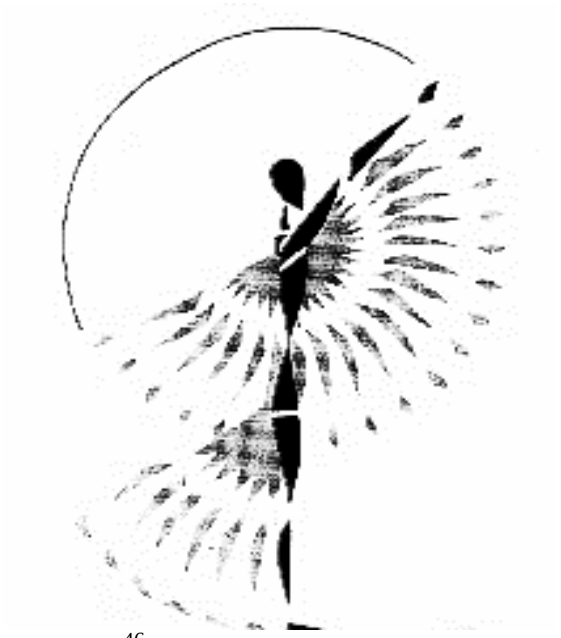

Figure 3. Plane movement.[46]

45. Eshkol and Harries, *Eshkol-Wachman Movement Notation: A Survey*, 27.
46. Eshkol and Harries, *Eshkol-Wachman*, 21.

Conical (curved) movement in which the longitudinal axis of the limb delineates a 3D envelope of a cone (see figure 4).

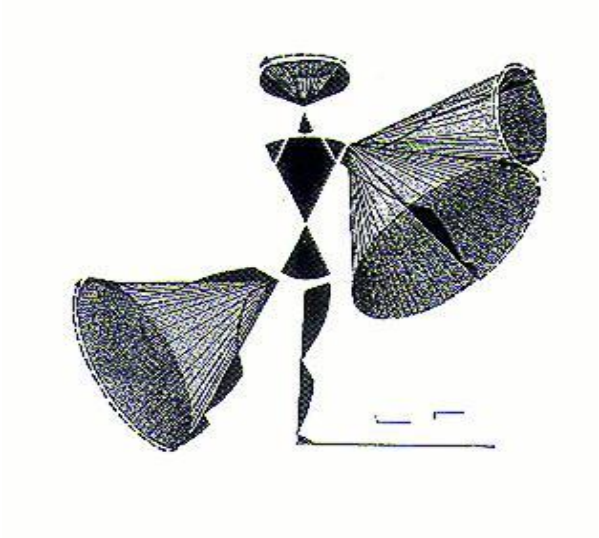

Figure 4. Conical movement.[47]

Rotatory movement occurs when the longitudinal axis of the limb that moves around itself unites with the axis of the movement, without changing its location in space (see figure 5).

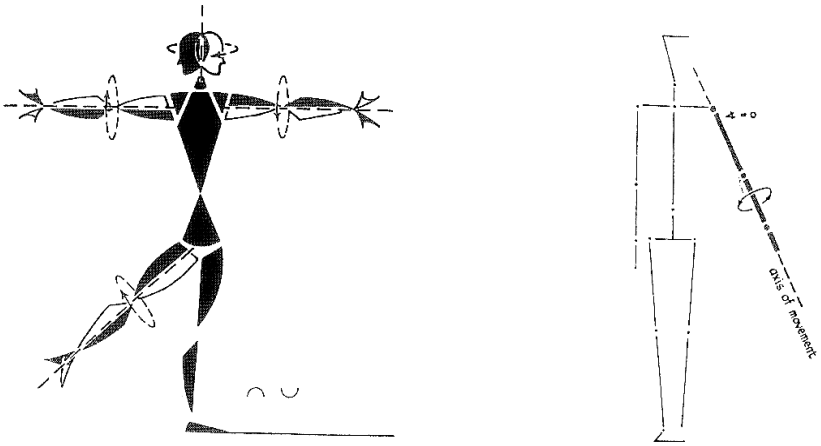

Figure 5. Rotatory movement.[48]

IV. The space of movement is organized through a *spherical system of reference*, which is used to define the starting and ending position of the limbs' circular movement (see figure 6). This system is generally constructed by dividing 45-degree units. This division allows the

47. Eshkol and Harries, *Eshkol-Wachman*, 21.
48. Eshkol and Harries, *Eshkol-Wachman*, 20.

presentation of 26 basic directions that are defined as *positions*. Every joint constitutes the center of the *private system of reference*, which is attributed to each limb separately, so that their spatial direction can be defined (see figure 2).

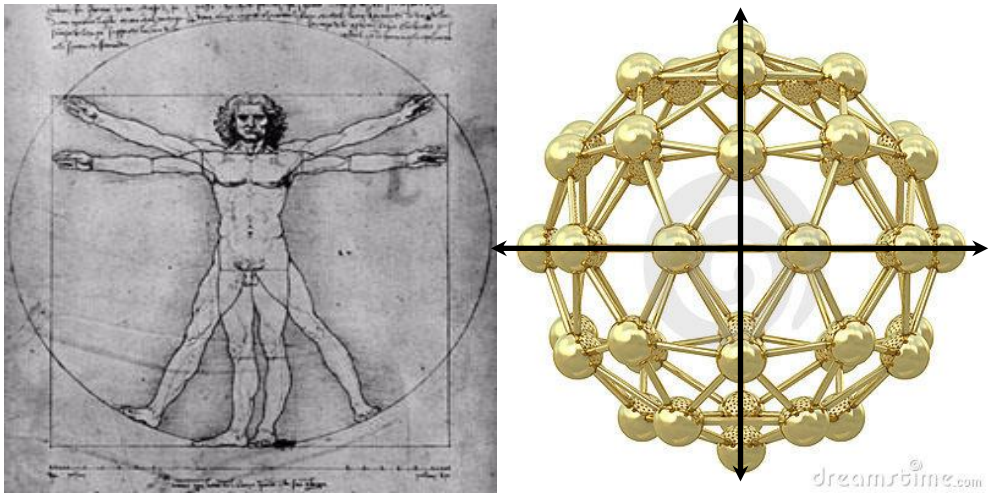

Figure 6. The position of the limbs and the spherical globe (fair use images retrieved from the dreamstime.com).

V. Table 1. The *numeric-graphic symbol* classification[49]

Digits (the core of the method)	0 1 2 3 4 5 6 7 8 9		
Types of movement symbols	Rotation ∩ ∪	Plane ← → ↓ ↑	Cone ∧ ∨
Parentheses (characteristics)	( ) [ ] ⊥ _		
Symbols of contact and alienation	L = T		
Letters (abbreviations)	W P S R M m f		

EWMN is considered an objective method that is independent of any style of dance or movement. Thinking and composing through EWMN provides a variety of options and unexpected movement combinations. This is illustrated by the following score (see figure 7):

49. Al-Dor, "The Impact of Learning Eshkol-Wachman Movement Notation," 20.

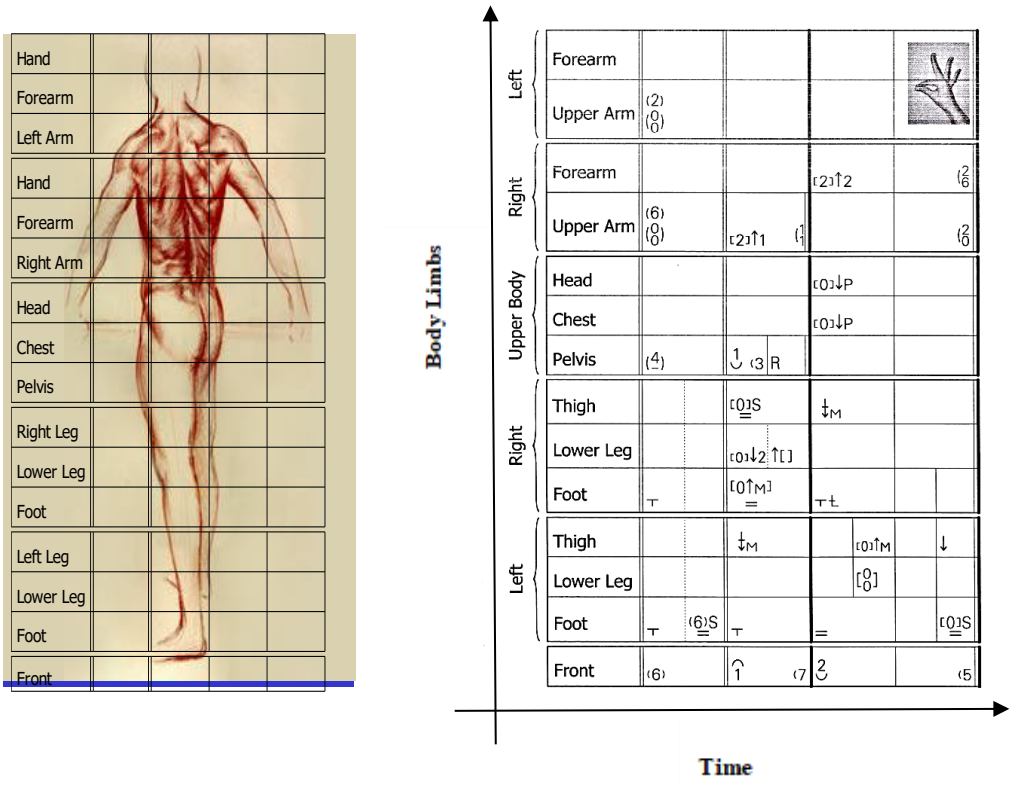

Figure 7. An example of EWMN dance score, *A Woman's Prayer*.[50,51]

Due to the structure of the manuscript page, the two dimensions of the reading process are performed parallel to one another. The horizontal reading presents the sequence of movement events performed by each limb, as described in each separate row, while the vertical reading (each column) presents multiple limb movements in a single time unit—similarly to a musical chord.[52] The possibility to read the score for each separate limb, practice the movement, and later combine the different roles together has potential for learning that affects coordination and improvement. Try to imagine, within one brain (body), a cello, a saxophone and a piano playing polyphonic music that was rehearsed separately beforehand. When the human body performs a dance based on EWMN, each hand, for example, usually plays an independent, separate role from one another and from the legs and the head, while performing rotations of the body front. When these roles are later combined, they resemble an orchestra that is assembled and conducted by a conductor—the human body.

50. Nira Al-Dor, *A Woman's Prayer: A Dance Score in Eshkol-Wachman Movement Notation*. (Unpublished Notebook. Tel-Aviv, 2010).

51. A dance score composed, annotated, and illustrated by the author.

52. Nira Al-Dor, "How Learning and Practicing Eshkol-Wachman Movement Notation Improves Coordination." Athens CID 37th Congress, 2014, http://cid-portal.org/cdr/athens2014/index.php/program.

Performing movement based on EWMN is usually accompanied by the fixed tempo of a metronome, which frames time and demands that the moving body be adaptive, contrary to its natural subjective time. The EWMN compositions are mostly based on unexpected serial orders of time units. Counting the time is an integral challenge while performing EWMN dance. Nancy Getchell points out the contribution to improved coordination of using a fixed external tempo and confronting the increasing coordinative complexity involved in external tempo.[53]

Method

A coordination dance performance implementing EWMN score was tested through a pilot study investigating participants` coordination improvement using a rubric defining the variables of the coordination phenomenon that are typical of EWMN dances. Those variables were not present in previous research tools, which chiefly quantified sports performance.[54] Some of the variables appeared in research studies investigating new coordination patterns indicating behavioral change through brain activity observed in brain imaging.[55]

Objectives. (I) To examine the impact of an intervention program on improving coordination, based on the Spiral Model for the Development of Coordination (SMDC).[56]

Main hypothesis. A relationship will be found between the learning of a new coordination exercise through Movement Notation Eshkol-Wachman and the development of the coordination. Thus, a coordination improvement is expected after participating a structured intervention program.

Participants. The research group consisted of 45 dance department students (ages 12 to14) studying at an Israeli art school. For the youngest group (7th grade) it was the first year of studying EWMN, For the second group (8th grade) it was the third year of studying EWMN and for the third group (9th grade) it was the 5th year of studying EWMN; 15 students were randomly chosen (every 3rd student from an alphabetized list of names), 5 from each age group, who underwent a coordination assessment before and after the intervention program (pre- and post-tests). For a five-month period, all 45 students participated in a weekly 90-minute EWMN lesson, which was an integral part of their curriculum.

Research tools. (I) Rubric for assessing coordination improvement was especially constructed for the pilot study by five EWMN authorities (having seniority and expertise of 10 to 40 years). It was found to be reliable, valid and sensitive after three stages of a pilot. The criteria indicated the variables that

53. Getchell, "Developmental Aspects of Perception-action," 12–13.

54. Button et al., "Empirical Investigations," 49–58.

55. Kostrubiec et al., "Beyond the blank slate," 222; Flash, and Hogan, "The Coordination of Arm Movements," 1985, 1688–1703.

56. For this pilot study, a learning model was especially designed: SMDC—the Spiral Model for the Development of Coordination, see figure 9.

were defined as a result of deconstructing the coordination phenomenon to its basic elements and analyzing it.[57] (II) A learning model was constructed, named the Spiral Model for the Development of Coordination (SMDC) that formed the infrastructure for the intervention program, integrated motor learning and general learning models that are known from the literature with the uniqueness of learning coordination dance based on EWMN.

Procedure. An intervention program was implemented, in which coordination assessment was performed before and after the program (pre- and post-test) on random samples drawn from the research group (N=15). It aimed at examining the impact of the intervention program on coordination development. The assessment included four basic coordination exercises that addressed coordination types, which had been identified in the *Light and Fire* dance, focused in spatial, gross, fine, polyrhythmic and inter-personal coordination.[58] The dance was taught during the intervention program using basic EWMN verbal instructions (see figure 8).

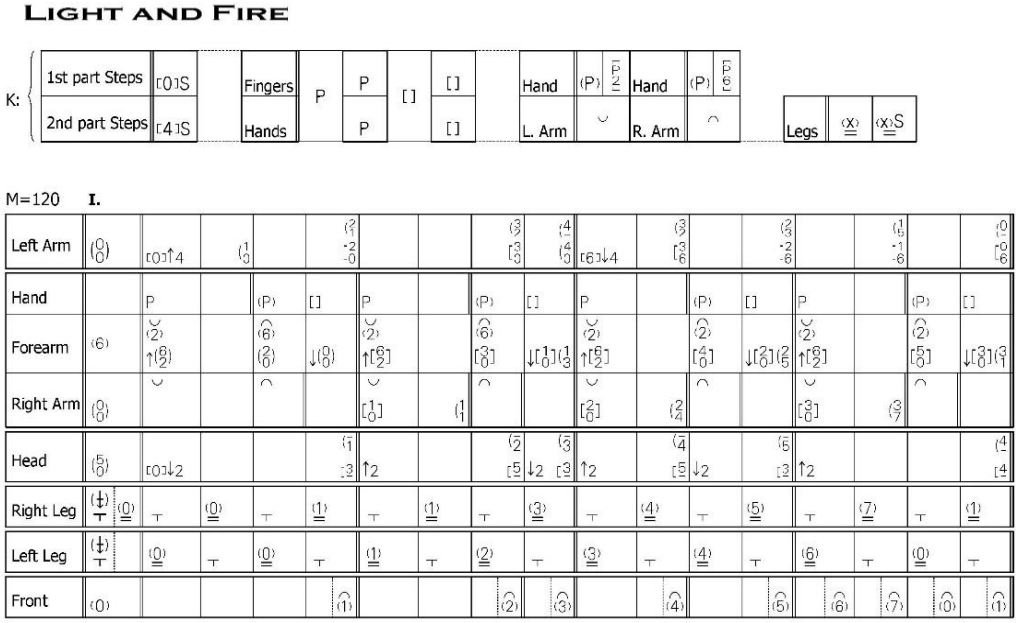

Figure 8. An example from the *Light and Fire* dance.[59]

The intervention program was conducted separately for each age group, according to the principles of Spiral Model of the Development of Coordination (SMDC) (see figure 9), which detailed the stages of learning a new coordination

57. See Appendix 1, The Research Instrument (rubric) for assessing "coordination" according to the *Light and Fire* dance.

58. Link for the exercises of the coordination assessment: https://youtu.be/VH-62sQ2V4g and for Sapir's *Light and Fire* dance https://www.youtube.com/watch?v=U7XKKiJrL4A&feature=youtu.be.

59. Al-Dor, Nira, and Tirza Sapir. *Dancing Fire*. (Tel-Aviv: The Research Center for Movement and Dance Notations at the Kibbutzim College of Education, Technology and Arts, 2013), 40.

dance, layer by layer. The participants first read the EWMN score for each layer (a movement role of a limb or a group of limbs, such as legs, head and hands), practiced the limbs' movements separately for few weeks and gradually combined the layers; at first, combined two layers, then after a few weeks of training combined three layers and finally after more few weeks combined four layers of the dance, in spiral learning.[60] The juncture at which coordination was assessed was named the *stage of coordination*. At that stage, participants' performances were documented by a video camera in order to be assessed by five EWMN experts, using the rubric they had constructed for the pilot of this study. From that point on, the learning process became more complicated and proceeded towards the next *stage of coordination*, until the entire multi-layered dance was performed.

Data analysis: 61 Paired t-test analyses were performed to examine the differences in the rate of coordination improvement between pre-test to post-test in the research group.

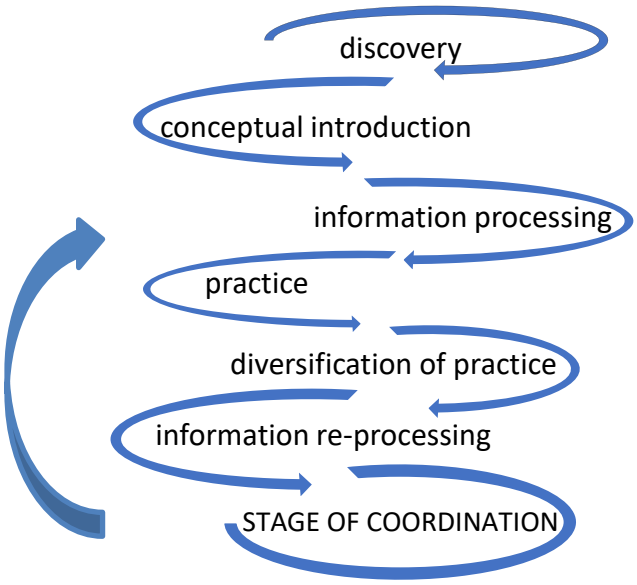

Figure 9. The Spiral Model for the Development of Coordination—SMDC.[62,63]

60. The spiral form represents the learning loop according to the SMCD model—after reaching the 1st stage of coordination, the learner returns to previous stages in the model, in order to deepen learning and progress in the coordination process through the stages of the learning model.

61. As aforementioned, the accuracy of the outcomes drops as a result of the limited sample, but it serves as a pilot to capture a model for a future study.

62. Illustrated by the author for this article.

63. SMDC was based on several motor learning and general learning models: "The Circle of Learning Model" of Atkin and Karplus, (1962); The Model of Gentile (1972); The Three-Stage Model by Cratty (1966); The Three-Stage Model by Fitts and Posner, (1967); The Model of Coordination and Control of Newell (1985); "Schema Theory" of Schmidt (1975); and the "Information Processing" approach of Welford (1976).

In order to describe the variables that defined the criteria for the rubric and were tested during the program, it is necessary to describe the multi-layered structure of the dance in detail. This dance combines a few types of coordination: fine (head and bending hand), gross (legs and straight hand), spatial (rotation of the body front and changing eyes glance), polyrhythmic (with a different time division for each "voice") (see table 2 and the video https://youtu.be/UcAVph-_p0M).

Table 2. The *Light and Fire* dance and its four different "voices"[64]

Legs and front	step forward and backward during rotations of the body front, clockwise and counterclockwise
One hand	moves straight in various vertical circles
Second-hand	bends and straightens, while rising up and down on a frontal vertical plane
Head	moves forward and backward
Time division Each "voice" has its own time division, differs from the other "voices." For example, the time division of the body front rotation (reading from left to right, the numbers represent time counting, each column is equal to a single time unit)	

Referring to Gentile`s taxonomy of motor skills,[65] this dance combines environmental context and action function in a high level of difficulty (without object manipulation). Moreover, the dance performance was accompanied by metronome beats and each individual "voice" was observed under the lens of *precision* for each separate coordination variable, as detailed below:

1. Time of movement.
2. Placement of a limb in relation to the adjacent one (body-wise).
3. Placement of a limb in relation to space (space-wise).
4. Simultaneous movement of limbs in space (3-dimentional paths in synchronized timing).
5. Knowledge of polyphony (multiplicity of roles, wholeness) and its expression in the dance performance.

64. Similarly to a choir's singing, a solo "voice" is a single role of movement for a limb or a group of limbs. EWMN score (figures 7 and 8) shows each limb role in the relevant row.

65. Seline Wuest, Rolf van de Langenberg, and Eling D. de Bruin, "Design Considerations for a Theory-Driven Exergame-Based Rehabilitation Program to Improve Walking of Persons with Stroke," *European Review Aging Physical Activity 11*, (2014): 119–129.

The first three basic variables that were defined for the rubric (time, body-wise and space-wise) were derived directly from the dance score, affords some insights regarding coordination based on EWMN and helps to explain the complexity of developing coordination[66]. At the same time, the variables, which are defined for the rubric, provide a systematic way of analyzing and understanding why EWMN is a unique method for the development of complex coordination.

Deconstruction of the coordination phenomenon is based on bodily structure—a chain of limbs—and as a result the structure of the EWMN manuscript page allocates a row to each individual limb (Eshkol and Wachman, 1958).[67] The other two variables (4 and 5) were conditioned by the participants` achievements according to the three basic variables. They did not derive from the score but were byproducts of its movement implementation.

Results. The assessment before and after the intervention program indicated that there was a significant improvement among the participants in the level of coordination (range—in the first variable: -3.57, p< .01 to the second variable: -10.58, p< .01 (see table 3).

Table 3. Coordination improvement rate according to the rubric`s variables—the results of the pre- and post-test

		Research group sample (n=15)			
Variable	**Exercise**	Pre-test	Post-test	Diff.	T(14)
Precision in time	**A**	3.13	-.20	- .67	-3.57**
	B	2.93	-.07	-1.47	-7.64**
	C	3.13	.00	-1.07	-5.87**
	D	2.40	.13	-1.33	-7.14**
Limb in relation to the adjacent limb (body-wise)	**A**	2.87	-.13	- .80	-5.53**
	B	2.67	.20	-1.33	-10.58**
	C	2.80	.33	-1.13	-5.91**
	D	2.53	-.07	-1.40	-5.50**
Limb in relation to space (space-wise)	**A**	2.93	-.20	-1.07	-3.76**
	B	3.27	-.07	-1.60	-9.80**
	C	3.27	.07	-1.27	-6.97**
	D	2.80	-.40	-1.67	-6.61**

(**) p< .01

66. According to Newell`s model, the first 2 variables are matching to the Coordination stage, the 3rd variable is matching to the Control stage and the 4th and 5th variables are matching to the Skill stage. The 4th and 5th variables especially represent high-order thinking, understanding and implementing of motor and literacy skills, as seen in Newell`s model.

67. Eshkol, and Wachman, *Movement Notation,* 4.

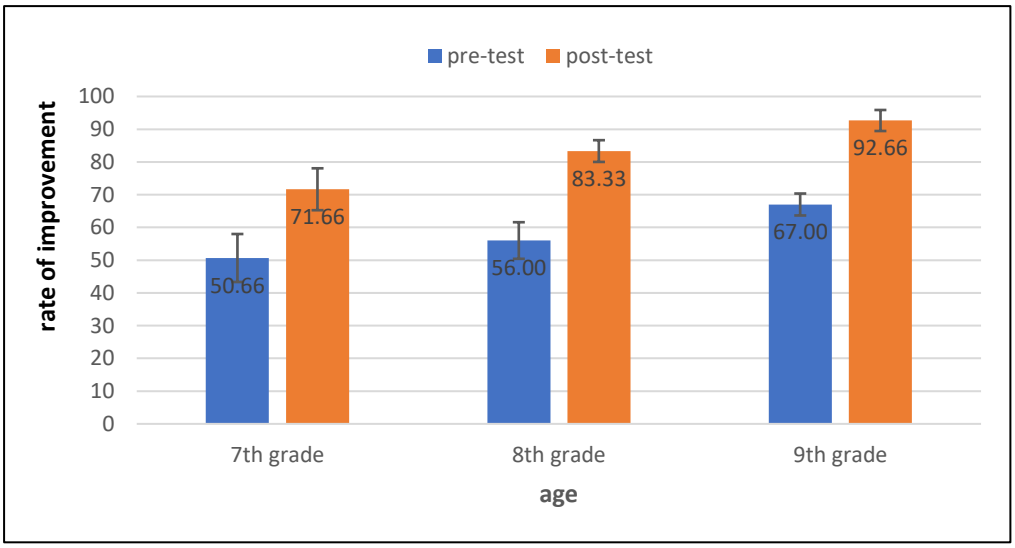

Figure 10. Coordination improvement rate according to age—the results of the pre- and post-tests.

Regarding the findings of the intervention program, there was a significant improvement of coordination in each age group. Figure 10 shows the improvement by age and the differences between the age groups from pre- to post-test.

Discussion

The objective of the pilot study was to examine the impact of an intervention program on the improvement of coordination using the research tools that had been constructed.

The integration between models of motor learning, general learning with EWMN principles constituted the basis for the SMDC learning model. The significant improvement of coordination supported by SMDC throughout the program could be explained parallel to the progress of the learning process. During the five-month program, the information was processed by the participants in a structured way, so that every layer built upon its predecessor and the learning moved "back and forth" (the Information Processing approach of Welford).[68] This spiral learning (which is a characteristic of learning EWMN according to the approach presented in this article) allowed the storage of knowledge in long-term memory and thus a recall mechanism was also implemented as described by "Schema Theory."[69] This had a significant impact on the learning during the intervention program, when the teacher added

68. Terry McMorris, *Acquisition and Performance of Sports Skills* (Chichester: John Wiley & Sons Ltd, 2004), 13–17.

69. Richard A. Schmidt, "A Schema Theory of Discrete Motor Skill Learning." *Psychological Review 82*, no. 4, (1975): 225–260.

diversification in practice to the learning process,[70] such as performing the limb roles movement during turning on blind eyes or imagining the movement without performing it. Practicing the dance under changing conditions, such as changing the tempo of the metronome or changing body front and spacing, until the participants had completely coded it into their memory and the effective repetitions (verbal, physical, or mental) performed throughout the entire program indicated improvement in both short- and long-term memory (relatively new learning and previous learning) and enable progressing from the Coordination stage to the Control stage according to Newell`s Model.[71]

During the program, diverse and long-term learning occurred under changing conditions, while learning was constructed step-by-step (from the movement of a single limb role to a combination of four different roles). The participants acquired considerable skill in functioning under changing conditions, thus helping them to internalize the movement material, improve attention to small details, sharpen memory, and draw attention to learning at a higher level of complexity than previously experienced.[72]

An additional insight was revealed concerning the stability of a coordination pattern.[73] A new coordination mode was learned by transferring from a stable coordination pattern acquired by the participants by previous learning to the creation of a new stable pattern through acquiring new skills.[74] The stability of the learning patterns extended the possible coordination patterns for the participants' use. It also helped them adapt coordination patterns to changing conditions as they practiced the limb roles of the dance in various conditions, such as changing tempo and spacing, switching the left arm role with the right arm role. It also improved their skills in other domains – cognitive and emotional.[75,76] In addition, the participants had access to number of patterns and could apply different solutions to achieving the same task,[77] thus acquiring the ability to choose any of the behaviors for coordination activities of a similar type. Furthermore, the entire learning process was strengthened and the whole coordination system was put in action through involving processes of deconstruction and reconstruction of learning and coordination patterns.[78]

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70. Richard A. Schmidt, Young, E. Douglas, Stephan Swinnen and Diane C. Shapiro. "Summary Knowledge of Results for Skill Acquisition: Support for the Guidance Hypothesis." *Journal of Experimental Psychology: Learning, Memory and Cognition 2,* (1989): 358–359.

71. Yi-Ching Peh, et al., "Focus of attention," 70–78.

72. Kostrubiec et al., "Beyond the Blank Slate," 1–18. Yi-Ching Peh, et al., "Focus of attention," 70–78.

73 "Coordination pattern" refers to a new combination of movements that gives an opportunity for each participant to develop a new motor pattern to be stamped in the brain.

74. Yi-Ching Peh, et al., "Focus of attention," 70–78.

75. Hanna, *Dancing to Learn,*70, 127; Kostrubiec et al., "Beyond the Blank Slate," 1–18.

76. See reflective notes given by the participants in Appendix 2.

77. Cummins et al., "Motor Coordination, Empathy." 437–442.

78. Aslinia, et al. "Individual Psychology (Adlerian)," 1–12; Rose, et al. "Let the Questions," 153–162.

Some researchers indicate several factors that influence the time and manner of preparing a performance involving a motor skill. These include the necessity of being precise in movement, understanding complexity of movement, being concentrated while performing, practicing, rehearsing and understanding the musical implications of the skill.[79] The preparation for coping with the contents, movement score and movement performance, acquired during the intervention program, was multi-disciplinary and thus very significant.[80] The first discipline was linguistic in nature: the participants read the movement score, understood it in depth, distinguished a myriad of details and integrated them as the program progressed ("Movement Literacy,"[81] the Verbal-Cognitive stage of Fitts and Posner).[82] The second discipline involved motor learning at a number of stages (as indicated by SMDC): the first stage refers to the single-role performance (the legs and front rotations, the straight arm, the bending and straightening arm and the role of the head). It includes the awareness of the trajectories created in space that depended on precise timing of movement, the precise directions of the limbs, posture, and the correct movement of the limbs as detailed in Newell`s model and requires recruiting internal and external foci.[83] The second stage refers to the performance of a combination of two roles (the 1st *Stage of Coordination*), in which all the aforementioned variables referring to the single role became more complex in the context of polyphony movement and were recalled by the earlier learning. The advanced stages refer to the performance of a combination of three and four roles (the Intermediate Stage in the "Model of Fitts and Posner," 1967: the transition from information perceived visually and verbally to the experience of movement). At these stages, emphasis was placed on learning from one's mistakes as a constructive and essential process, in which the participants learned what should be performed and what should be avoided, this process becomes stronger in group learning.[84] At the *stage of coordination* (as in the automatic stage in the "Model of Fitts and Posner),"[85] the participants could automatically combine roles and be aware of additional details that must be attended to during the performance, only if they performed the movement roles fluently and effectively.

The second research tool was a rubric for assessing coordination through breaking down the coordination phenomena into their components (deconstruction) as defined by the rubric criteria. As aforementioned, during the intervention program, the rubric served to assess the participants' improvement of coordination through the lens of each separated criterion. The performance of each participant was ranked by five EWMN experts, using the rubric (see

79. Button et al., "Empirical Investigations," 49–58.
80. Rose, et al., "Let the Questions," 153–162.
81. Ofer, "Movement Literacy,"40–51.
82. Tenison, and Anderson, "Modeling the Distinct Phases," 749–767.
83. Yi-Ching Peh, et al., "Focus of attention," 70–78.
84. Kostrubiec et al., "Beyond the Blank Slate," 1–18.
85. Tenison, and Anderson, "Modeling the Distinct Phases," 749–767.

rubric in appendix (1). Each participant was ranked by all five experts when the participants reached the *stage of coordination* (total of three stages of coordination). The ranking was executed according to the designated rubric that was constructed by them and was tested in the pilot stage of this study.

The first variable defined as the *precision in time*—when the time division required for the movement of different limbs is not identical for all of them, a polyrhythmic movement is created that varies in quality and time. The time frame is provided by the score and paced by the metronome as an external fixed tempo. It demands of the moving body to go against its natural sense of time, a complexity that creates a coordination challenge.[86] Thus, the performance of combined roles (reconstruction) demands an awareness of at least four different rhythms to be performed simultaneously.

Quality of movement is primarily expressed by precision in time, which is elusive.[87] Thus, it is more difficult to differentiate and quantify it precisely while observing. In the abovementioned study, assessing coordination was implemented through watching video documentation of the dance performances, while the experts knew by heart, specifically, the dance`s requirements. Focusing on a role of one limb at a time revealed movement that the observers could have missed if they had not been "forced" to isolate it while observing (deconstruction). Thus, observing at a role of one limb at a time through the lens of a criterion forces the observer to seek a refined phenomenon.

This variable is also about polyrhythmic coordination and inter-personal coordination. Improvement in this variable means that the participants could feel and execute the musicality of each limb role and also could perform the movement in unison, synchronized with 15 group members. Typically, learning is understood and studied as a process taking place uniquely within the confines of a single person. Yet, learning may often develop inside a broader learning unit. These learning groups may exhibit coherent and purposeful patterns of inter-individual behaviors in which each individual's behavior may be meaningless for each member functioning alone. Human endeavors that involve social coordination do their acquisition and improvement collective learning situations, where all partners contribute, symmetrically or not, to co-produce a shared motor outcome.[88] In other words, the development of coordination in a learning group (inter-personal coordination) is a meaningful factor in the whole learning process. Moreover, group performance that is dependent on an external metronome beats requires involving of internal and external foci. When both foci types are involved, it indicates that the level of performance is higher.[89]

The second variable—*Placement of a limb in relation to the adjacent limb (body-wise)*—Distinguishing the angled relations between adjacent limbs is made possible by reading the score, which details the direction of each limb during the dance, as well as deepening understanding of the body in relation to

86. Getchell, "Developmental Aspects of Perception-action," 12–13.
87. Shalit and Hantiu, "The impact of exercise," 16–21.
88. Kostrubiec et al. "Joint Dyadic Action," 1–18.
89. Yi-Ching Peh et al. "Focus of attention," 70–78.

space. Improvement in this variable can also be observed as a gradual (muscle) "softening," which contributes to a sense of gracefulness and harmony in the movement performance.[90] It expresses both *precision in body-wise directions* and improved *precision in time*.

The third variable—*placement of a limb in relation to space (space-wise)*—The score distinguishes between types of movement by following the limbs' spatial trajectories. Observing the dance score in figure 8, column 10: ↑ for plane movement and ⌒ for rotatory movement, can demonstrate the directions[91] and trajectories complexity in relation to space by all limbs that participate the movement. This observation differentiates angled relations between adjacent limbs and between the limbs and spherical space. It is unique to EWMN and enables the performer to be simultaneously aware of parallel spatial concepts (internal and external foci).[92] Moreover, spatial coordination is linked to visual-motor coordination, which requires activating various motor units (for example, the hands and legs together with the head) and visual focus on the performance of these movements (for example, stepping in space by rotating the front of the body, together with the movements of each hand and the head, along different paths). Coordination is necessary both between groups of limbs and between those limbs and the visual system (especially when the head moves while stepping in space, as is true of the dance shown in figure 8. It allows the visual stimulus to be absorbed by the visual system in order to be translated and decoded by the perceptual system.[93] Improvement in this variable can be observed as enhanced spatial and visual-motor coordination, as well as improved precision in the change of angle between the moving limbs and space (body-wise).[94]

Summary

Motor coordination enhances multi-layered learning and various skills. It is sensitive to environmental changes and involves a combination of an ability to make choices and a readiness to cope with re-organization and de-stabilization, which can modify behavior that is reflected in motor behavior and in other domains.

Enhancing coordination based on EWMN mainly combines motor learning and "Movement Literacy" and also develop emotional and social learning (see reflective notes given by the participants in appendix 2).[95] This integration refers to the whole human being and takes into consideration pre-

90. Flash and Hogan, "The Coordination of Arm Movements," 1688–1703.

91. In general, numbers in brackets are symbols for directions in EWMN.

92. Yi-Ching Peh et al., "Focus of attention," 70–78.

93. Vandendriessch et al. "Multivariate Association Among Morphology," 504–520.

94. Flash and Hogan, "The Coordination of Arm Movements," 1688–1703.

95. As aforementioned, this article the emotional and social components were not discussed but are subjects to further research. Some insights of the participant are described in the appendix that were taken during the reflective discussion at the end of the research.

existing learning and experiences, which challenged by uncertainty, difficulties, frustration, and ambiguity while learning at the same time individually and as a part of a group. In order to change behavior (in other words—to learn and to develop), the strategy of deconstruction and reconstruction in the coordination process has an added value. Taking into consideration the social component, that was present as an interpersonal coordination, was necessary in order to enable learning, cope with complicated challenges and dancing in a group while performing the dance in unison. The entire group's improvement had a strong impact which was expressed by the positive improvement trend of each age group and by the reflective summary conversation that took place at the end of the intervention program.

The results of this pilot study indicated that all participants had improved their coordination significantly while gradually combining the roles of limbs the dance into a whole and homogeneous performance. These findings support the argument I raised to my students that everyone is capable of improving coordination through an in-depth learning experience.

The coordination addressed by the study was at a high level of complexity that is rarely encountered in the research literature. Since EWMN allows the combination of many criteria into one coordination performance, the created dance composition will necessarily be of a higher motor and cognitive level. The development of this ability lies at the foundation of the teaching and learning method that some of which was presented in the article. It also hints at the first limitation of the research, namely, the level of expertise required of teachers and learners of EWMN. In order to develop coordination based on EWMN, it is necessary to be able to implement it effectively; this resembles the acquisition of any new language, while being complicated by the need to apply it to the learner`s moving body. The second limitation is the limited number of students presently learning EWMN. In order to reach significant conclusions about the impact of learning EWMN on developing coordination, it would be necessary to increase the number of learners. The third limitation involves the necessity of a retention test after a period without practicing the dance in order to make conclusions about the permanent change to a motor learning pattern. Otherwise as in this study, the observed improvement was in motor performances only. The fourth limitation involves quantifying coordination phenomena by means of video documentation. This method is necessarily based on relatively subjective assessment. It is thus recommended to employ scientific tools such as inertial sensors in order to investigate the potential for enhancing coordination using large spaces of movement and time dependency. Moreover, this gold standard (inertial sensors) will enable testing the sensitivity of the research tool during an intervention program. My assumption is that findings based on inertial sensors may open up a reliable path towards coordination improvement, while also reinforcing other domains, including emotional and social learning, and also learning deficiencies. All of the aforementioned are recommended to be investigated in future research studies.

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Appendix 1: The Research Instrument (Rubric) for Assessing "Coordination" of the *Light and Fire* Dance (Al-Dor, 2014).

The *Light and Fire* Dance				
Weight	**Variable**	**Stage**	**Elements of the Variable**	**Elements of the Ranking**
1	**Degree of precision in time**	A1	The contact of the foot at the end of the transfer of the weight is performed on the beat. The rotation in the front is performed on time.	To a very slight degree—not knowing the sequence; confusion in the sequence frequently and consistently; stopping the movement before the dance is ended (ranking 1).
		A2	The hand moves in time, without emphases and without stops and at an equal speed throughout the entire movement. There is no emphasis when the direction is changed.	To a basic degree—knowledge of the sequence of movements; beginning the sentence on time and ending on time (ranking 2).
		A3	The arm, the forearm, and the hand move according to their time, without stops or emphases (primarily when straightening).	To a moderate degree—some of the movements are performed on time (about 50%); the degree of consistency of precision in time is moderate; the rotation of the front is sometimes performed on time (ranking 3).
		A4	The head moves in time, without emphases in the change of direction.	To a good level—most of the movements are performed in time; the degree of consistency in time is high; the rotation of the front is for the most part performed on time (ranking 4). To a very good level—there are almost no errors (ranking 5).

Appendix 1: The Research Instrument (Rubric) for Assessing "Coordination" of the *Light and Fire* Dance (Al-Dor, 2014), continued.

The *Light and Fire* Dance				
Weight	**Variable**	**Stage**	**Elements of the Variable**	**Elements of the Ranking**
1	**Degree of precision in placement of limb in relation to adjacent limb (body)**	A1	Directional relation between the legs and the upper body; directional relation between the upper body and the legs; relation between one foot and the other; direction of the foot.	To a very slight degree—not knowing the sequence; confusion in the sequence frequently and consistently; stopping the movement before the dance is ended (ranking 1).
		A2	The relation of the arm to the upper body.	To a basic degree—the direction of the foot is not identical to the direction of the upper leg and the legs are sometimes not precise in relation to the upper body; the direction of the arm is frequently not precise in relation to the upper body; the direction of the forearm is frequently not precise in relation to the arm; the hand is not precise in relation to the forearm (ranking 2).
		A3	The relation of the arm to the upper body; the relation of the forearm to the arm; the degree of release of the hand and its straightening.	To a moderate degree—some of the movements are performed precisely in direction and in size; the degree of consistency is moderate (ranking 3).
		A4	The relation of the head to the upper body.	To a good level—most of the movements are precise in relation to the adjacent limb; the degree of consistency in time is high (ranking 4). To a very good level—there are almost no errors (ranking 5).

Appendix 1: The Research Instrument (Rubric) for Assessing "Coordination" of the *Light and Fire* Dance (Al-Dor, 2014), continued.

The *Light and Fire* Dance				
Weight	**Variable**	**Stage**	**Elements of the Variable**	**Elements of the Ranking**
1	**Degree of precision placement of the limb in space (absolute)**	A1	The spatial direction of the transfer of weight between the feet.	To a very slight degree—not knowing the sequence; confusion the sequence frequently and consistently; stopping the movement before the dance is ended (ranking 1).
		A2	The spatial direction of the arm from the elbow to the shoulder.	To a basic degree—the spatial direction of the limb is sometimes precise, primarily at the beginning and the end of the sentence; there is frequently imprecision and there is no consistency (ranking 2).
		A3	The angle between the forearm and the arm; the rotational situation; direction of the released hand.	To a moderate degree—the spatial direction of the limbs is sometimes precise during every sentence; the degree of consistency is moderate (ranking 3).
		A4	The spatial direction of the head from the neck.	To a good level—the spatial direction for the most part is precise and the degree of consistency is high (ranking 4). To a very good level—there are almost no errors (ranking 5).

Appendix 1: The Research Instrument (Rubric) for Assessing "Coordination" of the *Light and Fire* Dance (Al-Dor, 2014), continued.

The *Light and Fire* Dance				
Weight	**Variable**	**Stage**	**Elements of the Variable**	**Elements of the Ranking**
2	**Degree of precision in simultaneous movement (movement timing of adjacent limbs moving in space)**	A1	Changes in the height of the upper body; rotation in the front of the upper body; movement of the lower leg to the upper legs and to the feet.	To a very slight degree—not knowing the sequence; stopping the movement before the dance is ended; inability to be precise in the previous variables (ranking 1).
		A2	The drawing of the cover of the arms in three dimensional space; drawing of the end of the limb in space.	To a basic degree—a path in the places that are physically comfortable begins to be created (when there are a number of steps to the same direction; when the arm moves to the front or the side); low consistency (ranking 2).
		A3	The influence of the rotation of the arm; the straightening and bending of the forearm and the hand.	To a moderate degree—sometimes a path is created; moderate consistency (ranking 3).
		A4	The drawing of the cover of the head in the three dimensional space; the drawing of the top of the head in space.	To a good level—for the most part a path is created; high consistency (ranking 4). To a very good level—there are almost no errors (ranking 5).

Appendix 1: The Research Instrument (Rubric) for Assessing "Coordination" of the *Light and Fire* Dance (Al-Dor, 2014), continued.

The *Light and Fire* Dance				
Weight	**Variable**	**Stage**	**Elements of the Variable**	**Elements of the Ranking**
3	**Degree of knowledge of "polyphony" and its expressions in dance**		Knowing the structure of the dance; knowing the spatial relations in dance; knowing the relations between the different limbs in the dance; coordination between the understanding of the dance and the movement performance (wholeness).	To a very slight degree—not knowing the sequence; stopping the movement before the dance is ended; inability to be precise in the previous variables (ranking 1). To a basic degree—there is a certain understanding, but it does not affect the performance (ranking 2). To a moderate degree—sometimes there is coordination between the understanding and the performance; moderate consistency (ranking 3). To a good level—for the most part there is coordination between the understanding and the performance; high consistency (ranking 4). To a very good level—there are almost no errors (ranking 5).

Appendix 2: Notes Taken During Reflective Conversation

Here is a sample of anecdotal comments that were noted during the reflective conversation at the end of the research. Comments are related to social, emotional, cognitive, and psycho-motor experiences.

- I learned from watching other students and I understood my mistakes as well.
- I feel that my coordination has developed.
- I had a fear that I was not excellent in coordination, I saw that suddenly I managed to do things I had not succeeded before.
- I felt that coordination also developed in other dance classes because of the research.
- I liked to enter into commitment and practice at home. My hands (the hands movements of the dance) helped me to orient myself in the dance. The connection of the roles (role of the limbs in the dance) was more logical and made me connect and be intrigued.
- I connected to the concentration and it calmed me down. The metronome helped. I learned to concentrate on myself and not to strain myself. The motivation came from the way you taught us, and you gave us time to train and you did not insist on succeeding do it on time.
- I do not know if it has to do with coordination or memory, I needed time to understand what each body limb should do separately, and it helped me overcome the difficulty. If you get wrong find yourself lost.
- The combination of the limb roles helped me to become more familiar with the sequence (the relationship between the roles). Working in groups helps me to express myself because I was less exposed than doing alone.
- It was all complicated for me, it's hard for me to concentrate. I'm used to looking at others and in coordination I cannot rely on anyone else. The imitation pushes me. I learned to rely on myself and trust myself. I made a lot of progress with myself. I realized that I did not need to compare my progress with others.
- I had a good feeling that you could not succeed, and you could be wrong. And that there is time for the process and that motivated me to succeed even more.