A MATTER OF TIME: TIME IN MOVEMENT AS REPRESENTED IN CHILDREN'S SELF-GENERATED MOVEMENT NOTATIONS

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Abstract - In the framework of the concept of "movement literacy", which links the body's movement in space and time to its graphic-symbolic representation, the representation of time as a component of movement has been examined. Sixteen participants aged 9-10 joined 29 weekly sessions that included movement studies and a process of group generation and decipherment of original movement symbols. The findings indicate a great diversity in the representation of time, which is based on rich cultural knowledge, alongside original and creative thinking in the modes of time representation. In light of this experience, it is suggestedto combine learning that involves the body and the movement in the learning of different fields of knowledge, especially those involving abstract concepts such as time and space.

Keywords - Movement Literacy, Self -generated representations, Time.

I. INTRODUCTION

The creation ofgraphic symbolic representations for communicating information regarding body movements to others is challenging due to the different characteristics of each of these media– body movement and the graphic-symbolic representation. The field that studies these connections istermed"Movement Literacy",and some of itsfindings may have implications on the teaching and learning of movement and dance, as well as the development of teaching methods that incorporate the body and its movement in learning other fields of knowledge.

A special challenge lies in representing the abstract entity of "time"as a component of any movement. Current studies suggest that for generating and creating visual representations,children draw on cultural knowledge and past experiences. Such prior knowledge may include cultural norms of behavior, formally acquired knowledge regarding the use of symbolic languages for communicating information and symbolic systems, as well as accumulative experience in drawing.

Environments incorporating social interactions as well as explicit focused feedback regarding learning outcomes, may increase children's meta-cognitive awareness of their deliberations and the quality of learning products. Within this framework, this paper describes a study that examined the independent development of graphical-symbolic representations of movement by children, and focuses on representations developed to express and communicate the component of time in movement.

II. THEORETICAL BACKGROUND

A. Movement Literacy and Learning in Dance

The concept of Movement Literacy refers to a body of knowledge that integrates the practical (physical-motor) skills of movement with its theoretical understanding. In other words – the cognitive abilities that underline the knowledge of movement and its components: the body, space, and time, as well as aesthetic and emotional means of expression, and their connection to the actual movement performance [1]. The need for a definition and description of Movement Literacy as a basis for movement learning arose from years of familiarity with the accepted dance-movement teaching methods. These usually emphasize the physical-performance aspect, which is learned through either imitation, compliance with verbal instructions, or an independent creative process, and lack the cognitive-conceptual dimension as an integral part of the learning. The integration of the practical and theoretical aspects may provide an infrastructure for a deep understanding of the field and for various implications, such as elaborated physical performance, high-level analysis of observed movement, clever composition of dance-movement pieces, and proficient teaching methods. One of the significant challenges in conceptualizing the movement for the purpose of its representation is the component of "time", with its unique characteristics.

B. Representing Time

Representing the entity of "time" is inherently difficult due to its abstractness and the inability to directly observe or feel it. Therefore, the conceptualization of "time" evolves from individuals' daily embodied experiences, relative to experiences concerning moving and functioning in an environment. A sense of "time" is gained by comparing events or using successive iterations of specific events [2]. Hence, events' properties are projected onto "time", perceived as directional, irreversible, and continuous; an entity that may be segmented and therefore also measured. Constituting a factor organizing representations into events, time may carry only a secondary role regarding representation and interpretation [3]."Time" is referred to through the use of movement metaphors that map spatially conceptualized meanings onto their

temporal meaning of expressions [4]. Changes occurring in time may be represented by (a) a depicted series of objects or events at several time points, which enable inferences by comparisons, and (b) based on time-equal units, fluidity and directionality, translation of "time" features into graphical spaces and the use of graphical means like timelines and timetables [5].

C. Graphical Spaces –Spatial Organization of Symbols

Meaning of graphic-symbolic visual displays is conveyed by both the meaning of each of its symbols as well as all symbols spatial organization on the medium chosen for representing (e.g., a paper, a screen). The interpretation of such intended graphical outcomeis never easy or spontaneous, requiring the understanding of spatial relations among symbols as well as relations to relevant referents [6]. The spatial display may be presented as viewed from an external point or as viewed from an internalreferential point [7]. This consideration may affect interpretation, for example, by requiring the mental rotation of the scene (e.g., left and right) or drawing on aninternal reference point of view. An additional difficulty evolves from the need to represent 3D phenomena on the 2D spatial display [8]. Frequently, symbols of a spatial organization are used for emphasizing a specific idea, the outcome of which are inaccurate or inconsistent representations [9]. Therefore, everyday graphic-symbolic representations of spatial phenomena are designed to accommodate a particular purpose through emphasizing, deleting or changing relations among its symbols and their relations to referents,[10]suggesting that among other reasons, interpretation is possible in spite of these difficulties due to individuals' awareness of the following rules: (a) continuity –if a specific description of a starting point in a certain segment is not provided, one should continue from the endpoint of the previous segment, and (b) a forward progression – unless specified differently. Some of the described knowledge was evidenced in children's self-generated representations as is described next.

D. Children's Self-Generated Graphic Representations of Dynamic Events

Engaging learners in processes of generating their own representations of a phenomenon is a practice anchored in the Constructionist approach [11]. Studies demonstrated learners' difficulties to represent dynamic temporal events, and the relevant rich graphical solutions they come up with. Analyses of such solutions revealed learners' insight into the nature of representations and of issues related to representing "time". For example, Sherin [12]suggested that for representing motion, children draw on "constructive resources" like their accumulative experiences with drawing and with representation of temporal sequences (such as text), as well as the children's sensitivities to properties of figural elements (such as lines). Bamberger [13] reported that children applied Gestalt law of proximity for grouping dynamic events (sounds) perceived as being adjacent. She [14] described two styles of constructing meaning from musical events: "path-makers", constructing meanings regarding the unique function of contextually situated objects or events, and "map-makers", forming an outside, fixed reference structures, independent of the particular situation.Several studies have focused on the difficulty of representing complex phenomena concerning time,such asrepresenting motion occurring backward in a graph [15]. The authors suggested that in spite of individuals' natural awareness of "time" being irreversible and directional, the children's graph products exhibited their deficient understanding of the phenomenon. In a different study, these authors reported that children skipped a day of measuring a plant's growth due to a day off school. This resulted in not leaving a space for that day on the graph, suggesting "this day did not exist". From this, it can be concluded that for these children, the sense of continuity of time is lacking when they themselves are not present [16].It is important to emphasize that the studies mentioned and other studies that have been milestones in the development of the research concept that examines the independent development of representations as reflecting understanding and as a means of promoting learning [for example, 17] have been all carried out in the fields of natural sciences, and usually without embodied experience.

III. METHODS AND PROCEDURE

E. Objectives

Thestudy focuses on children's self-generated modes of representing the aspect of "time"in movement, as reflected in their symbols spatio-temporal organization.

F. Methods

Participants: Sixteen, medium SES, fourth-grade girls from a school in central Israel, with normal spatial abilities and no movement limitations. All participants volunteered to participate in a dance class and the study with parental consent. At this age (9-10 years old) all have already formally encountered symbolic languages (e.g., mathematics, music notation or Hebrew), as well as constructed other resources to draw on for generating representations.

The 16 girls were divided into fourstablegroups as per request,with two roles among members of each group:(a) being a "Developer", 2-3 girls collaboratively developing scripts of dance notation to a presented movement sequence, and (b) being a "Decipherer", one per developers' group, decoding the notation and performing its represented movement, thus providing "Developers" with feedback concerning notation efficiency.

G. Study Context and Procedure

The conceptual framework used for developing the girls' knowledge about movement and for examining

their representations included four aspects of movement knowledge: (a) the spatial aspect of **body directions** (e.g., forward, right), (b) the spatial aspect of the **absolute directions of space** (e.g., north, south, however, symbolized by numbers (0) – (7) instead of words), (c) an aspect related to the moving**body parts** (e.g., arm, head), and (d) the **temporal** aspect.

In order to challenge the development of representations relating to the time of movement – three levels of complexity regarding the time of movement were presented: (1) a **single** movement event within each timeunit, (2) **synchronous** movement event within the timeunit (meaning two different aspects of movement happening at the same time), and (3) **asynchronous** movement events across timeunits (meaning different aspects of movement happening without overlapping of time units).

This specially designed curriculum has been studied by all participantsthroughout the 29 intervention lessons. The girls acquired conceptual and practical knowledge through physically training, observing and analyzing the various aspects of movements, indicating the desired concepts. Following, the developers generated notations for a demonstrated (by teacher and video) short movement sequence (i.e., task: "put signs on the blank paper, so that your decipherer could understand the movements and perform the sentence"), while decipherers were outside the room. This process resulted in a "script", which was handed to the decipherer for decoding. The decipherer's performance after interpreting the script served as feedback for the accuracy and clarity of the symbols in the script. If needed, the "developers"improved the script by adding/deleting symbols, or even generating a new version.

H. Data Collection

Two types of data were collected from all groups: (a) video recordings, of all lesson parts (instruction, training, notation development and accompanying discourses, decipherer's feedback and script improvement). These recordings exposed learners' understanding, and (b) scripts, participants' self-generated notations. These were scanned after each round of production and returned to learners' group portfolios for continuous use.

I. Data Analysis

Video recordings were transcribed. The scripts, being polysemic sign systems, where the meaning of individual signs is driven from the relationship between the detailsand the context in which they are embedded, and are subjective and debatable [17]. Therefore, the interpretation and analysis of scripts were based on and constrained by:

(a) developers' recorded discourses, which revealed some of their considerations and deliberationsregarding the script generation; (b) knowledge of the acquired movement content (conceptual and training), which constrained interpretation possibilities; (c) knowledge of the presented movement sequence, which provided clues regarding the chosen symbols and their spatial organization; and (d) knowledge of the physical, social and cultural immediate context, as well as knowledge of local and universal conventions regarding representations, that may have influenced script development.

IV. RESULTS

The findings of the study comprise symbols, which refer to the various movement components. Regarding the component of time, which is the focus of this paper, several modes of representation were found. Examples to these modes of representations are presented belowaccording to thedefined level of time complexity and according to the symbols'spatial organization in the scripts.

J. First level:A single movement event within time-unit

Three models for representing the movement time were found at this initial level of a single-movement event within each timeunit: the "sequential", the "split-relational" and the "condensed" format of representation.

1) "Sequential linear" representation. This common form of representation consists of a series of successive symbols, placed one after the other in the order in which their corresponding movementhas occurred. However, as Hebrew writers are accustomed to both horizontal writing directions – right-to-left and left-to-right, this use of writing directions also appeared here, as can be seen in Figs. 1 and 2.



Fig. 1. A left-to-right successive linear representation. The arrow on the left, pointing the beginning of the reading direction, was added to the improved version of the script after the first decipherment failed.



Fig. 2. A right-to-left successive linear representation with indication (x) symbol indicating the beginning of the reading direction.

The symbolic representations for movement often lacked the cultural context that will bind the collection of symbols to any familiar "language" or systematic "laws". And since Israeli participants are accustomed to reading and writing in both directions – from right to left, which is the Hebrew language direction, and from left to right, for international languages (e.g., English, mathematics, music), both these directions have appeared in the scripts, as can be seen in Figs. 1 and 2 above. As a result, a clear indication markingthe starting point or the desired direction of reading was sometimes added, either in the original script (Fig. 2) or in the improved version (Fig. 1).

2) **A "split-relational"linear representation**. This

form of representation was recordedonly twice among all ofthe 60 scripts. An example is presented in Fig 3.

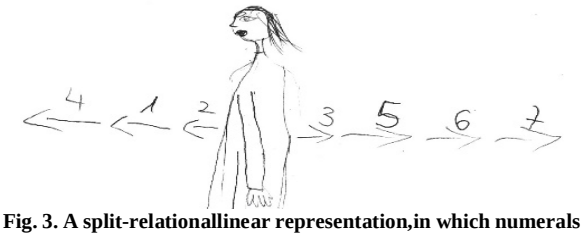


Fig. 3. A split-relationallinear representation,in which numerals display the order of successive movements.

The choice of such a unique form of representation that splits the sequential order of the symbols, as shown in Fig. 3 above, is intended to enable the representation of the body's directions **forward** and **back**. These spatial directions do not reallyexiston the two-dimensional page. To overcome this challenge, a figure inprofile was placed in the center of the page, and arrows pointing to the **left** and **right** were placed in front of and behind it. These arrows take on their directional meaning from their relation to the central figure and its position. This method allowed the developers to overcome the lack of the missing depth dimension, but resulted in the need to split the sequence of the movement instructions, while adding numbers to indicate the **order** of performance.

3) **A condensed format of representation**. The design of the condensedformat is based on the grouping of the identical movement instructions and their presentation by a single sign, together with a number indicating the **number** of repetitions required (with or without multiplication marks); somewhat similar to a mathematical formula. This mode of presentation disconnects the direct link between the sequential movement events to theirsymbolic representation, as can be seen in Fig. 4 a-b.

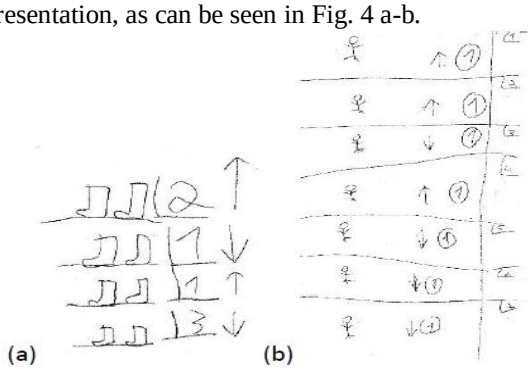


Fig. 4 a-b. Figure 4a presents acondensed representation,in which the identical symbols of seven, were grouped together, resulting in a total of four symbols. Numbers added near each symbol indicating the required number of repetitions (i.e., 2, 1, 1, 3). Since this script was not deciphered correctly, an improved version (4b) was created, in which all seven movement events are detailed from top to bottom.

B. Second level: Synchronous movement events within timeunit

Two models for representing thetime movement were found at this secondary level of more than one single-movement event within each timeunit: the "table" format, and the "compound" format.

1) A table format. The use of a table format to represent multiple layers of information were common at this level as well as in the third level of time complexity. Participants at the age of 9-10 are familiar with the table format both from within school curriculum and from their daily encounters with various kinds of information. Here, thecategories that comprise the table – whether in a column or in a row –are based on the **type of movement aspects**to be represented on one axis of the table,and on the **timeunits whichdivide the movement sequence** on the other axis.Examples arepresentedin Fig. 5a-b.

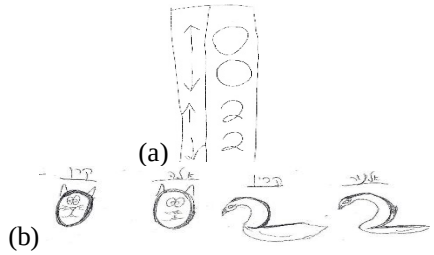


Fig. 5a-b. Two table format representations, each presents two layers of information: in Fig. 5a the movement aspects are displayed in columns while the simultaneous movement is represented in rows; in Fig. 5b the movement aspects are displayed in rows while the simultaneous movement is represented in columns.

Fig. 5displaystwotable format representations, in each, two layers of information regarding the components of the movement that are represented. In Fig. 5a – the movement of the body directions forward and back is represented in the left column by arrows, while the movement of the spatial directions is represented in the right column using the digits 0 and 2. Reading this table should be done row by row, combining the information from the two columns. Fig. 5b is a horizontal table-like representation, although missing the row lines. The spatial directions represented by the digits 0 and 2 are placed in the bottom row, while above each digit a Hebrew name was placed beginning with the same letter of the word Forward or Backward (anequivalent English example maybe writing the names "Fred" and "Barbara" as anindication for the directions Forward and Back). Reading this table should be done column by the column, combining the information from the two rows.

2) A "compound" format. This unique form of representation is apparently an original development of the participants, although it is based on accepted iconic representations of the body directions by presenting the face (forward) and the back of the head/hair (back), as seen in Fig. 6.

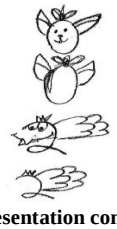


Fig. 6. A compounder presentation combining the two aspects of the movement in each symbol.

However, after analyzing each symbol and understanding its components, these compound symbols are read in a simplelinear sequential way.

*K. **Asynchronous**movement events across timeunits*

This most complicated level engaged (together with other elements) a "long" movement of the arm while the head moved twice,as presented in Table 1.

Movement of left arm			x	
Movement of head	x	x	x	x

Table I. Schematic representation of asynchronous movements of the left arm and the head

Two examples of representing this complexity were found, which according to Bamberger [14], maybelabeled as being generated by either"path-makers", which construct meaning regarding the unique function of events (see Fig. 7), or"map-makers", who form outside, fixed reference structures, like defined time units, as a basis for representation (see Fig 8).

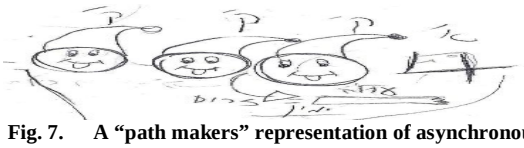


Fig. 7. A "path makers" representation of asynchronous movement events of the arm and the head. Note the arm movement depiction after two head symbols.

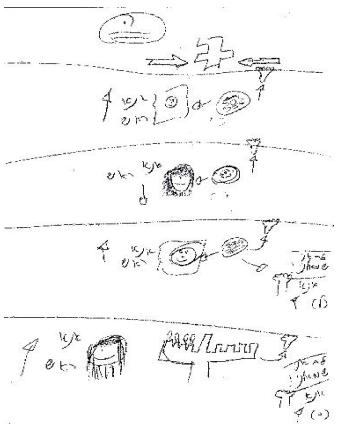


Fig. 8. A "map makers" representation of asynchronous movement events of the arm and the head. Note the clear structure of time units dividing the page as a basis for all other information.

V. CONCLUDING REMARKS

The variety of ways selected by the participants to represent the aspect of time may, first of all, attest to the wealth of possible modes of "time" representation which children are exposed to.

Yet, the learning outcomes presented here are not only original but mainly reflects the contribution of the unique method embedded.Due to its characteristics, the study of body movement enabled a processthat brought to a deep understanding of time as a component of a complex phenomenon. The methodology implemented in the Movement Literacy directive may in principle be applied to other disciplines and contribute to deep learning of other concepts;this is an idea that calls for further investigation.

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