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Memory span in dance: Influence of age and experience

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The retention and recovery of movements are capacities that characterize and determine the life of dancers and dance students. The application of certain memory strategies is necessary and leads to an improvement in motor performance. Usually, the lowest levels of retention are associated with younger dancers when their performances are compared with the oldest and more experienced in dance. We aim in this study to evaluate capacity of the short-term motor memory of children and adults, with and without experience in dance, when asked to reproduce immediately (after presentation) sequences of movements. Results show that experience is crucial when comparing the maximal number of actions and sequences recalled in the correct order. For these same variables, children show lower results than adults, but these differences are not significant when we compare children with experience with adults without experience.

Keywords: motor memory; memory span; retention capacity; experience in dance; motor actions

The quantification of the capacity to retain information is a topic of interest since the 1950s, especially after the famous Miller's article of 1956. The first studies used exclusively words (Longstaff 1998), but after the end of the century, motor memory started to be studied as movements were used as stimuli. In the research of learning and motor control, motor memory is one of the crucial topics of study.

In dance, the capacity to memorize is very important, particularly in its artistic dimension which is very selective and in which professionals have to perform huge sequences of motor actions, sometimes for more than an hour. As actors have to retain/memorize a text, dancers are distinguished in many cases for their good ability to memorize long passages of movement.

The amount of information and the time available for its retention are two important aspects when we talk about memorization. According to several authors (Marteniuk 1976, Perlmutter and Hall 1992, Weiss 1995) Miller's work has established a referential: the short-term memory has an overall capacity of 7±2 items. The recovery of more information is dependent on the use of the long-term memory.

The short-term memory increases considerably with age, so the capacity to memorize is generally lower in children when compared with adults. This difference is due to the lack of knowledge and strategies of memory that children present (Ille and Cadopi 1999). As children grow older they acquire a repertoire of strategies that will help to solve problems: from age seven they begin to use strategies of rehearsal/memorization spontaneously, and until age eleven, a rapid increase in the number and quality of strategies is evident (Bouffard and Dun 1993, Weiss and Klint 1987). The acquisition of the *labeling*, *repetition,* and *cluster* strategies increases progressively up to eleven years old, and during the next two years children acquire other strategies.

One problem that arises when studying motor memory is how to measure it—that is, to find an appropriate unit of measurement to quantify this capacity. It may be easier to identify the number of words in a spoken or written discourse than the number of movements of a person who is dancing. The tests that are used to measure the capacity of short-term memory are called memory span. This type of testing identifies the longest sequence of non-related items that can be recalled immediately in the same order as they were presented.

The measure established by Miller (7±2 chunks of information to the short term memory capacity) means that the amount of information per chunk varies. This leads the author to conclude that capacity of short-term memory is a matter of organization of material to remember in units of meaningful information, so that maximum information is retained (Marteniuk 1976). But can the amount of recalled words be applied to, or similar to, the ability to remember movements?

According to Bavelier *et al.* (2006) the capacity of the short-term memory depends on the nature of the information, for example 7±2 items for language and 4±1 for visual-spatial items. Furthermore, the ability to organize information into chunks seems to depend more on familiarity and experience that the individual has with the skill or knowledge area, than their pre-existing capacity to store more information in memory (Rose 1997). This study tries to identify the largest number of motor actions that subjects with and without experience in dance are able to recall after the presentation of various sequences of motor actions in dance. We wanted to compare children with

adults, so participants were organized in four groups: children and adults with and without experience.

METHOD

Participants

The "children" group consisted of 10 female subjects with experience in dance and 6 female subjects without experience in dance. They were randomly chosen from the following criteria: age, experience, and availability. Both groups have an average age of 11 years. We considered that subjects have experience in dance when they dance for more than a year in a regular, formal, and systematic way, as is the case in vocational teaching. Children with experience had on average 6 years of experience, with 3 hours per day. The "adult" group consisted of 12 female subjects, 6 with experience in dance, and 6 without experience, mostly university students. They had on average 12 years of experience with 3 hours per day.

Materials

In the present study we have applied the *memory span test*. This is a test of presentation/reproduction of items (motor actions) in which subjects are classified/categorized by the number of items that they can identify and recall in the correct order (Bouffard and Dunn 1993). The material to be reproduced by subjects (motor actions and movement phrases), developed by the authors, was created for this study taking into account the degree of difficulty of the motor actions and movement phrases. We aimed to use sequences of motor actions *without complexity,* considering that a task with more relationships between the parts that compose it is more complex than a task with fewer relationships. For example, a jump with a rotation during the aerial phase is more complex than a vertical jump from two to two feet.

We created twelve sequences of non-related motor actions and eleven sequences of related motor actions. The transition between each sequence is characterized by adding a motor action. Structure units were taken to be the motor actions of the classification of movement in dance presented by Rodrigues (1999). The motor actions were our unit of measurement: posture, balance, gesture, turns, steps, displacement, jumps, and falls.

Procedure

The memory span test was done individually; only the participant and the researcher, responsible for projecting the images and recording the partici-

pant performance, were in the studio. The test started with the projection of the first group of non-related motor actions. The subject observed the sequence twice and then was asked to repeat it immediately once. The test followed the same procedure until the last sequence (12 motor actions). Subjects were asked to reproduce exactly what they saw, maintaining the overall form and also keeping the order of the presented movements. Subjects were not allowed to reproduce/rehearse the film during its projection. After a break of 10-15 minutes the second test was applied. The procedure was the same as the first, but this time subjects were asked to recall eleven movement phrases (related motor actions) of 2-12 actions per phrase.

RESULTS

The two types of sequences of our study (non-related and related motor actions) were studied according to the following variables: maximum number of motor actions recalled in the correct order, number of sequences recalled in the correct order, number of sequences recalled independently of order, total actions recalled in the correct order, and total actions recalled independently of order.

The m*aximum number of motor actions recalled in the correct order* ranges from 2-11 and seems to be the most interesting variable in quantifying the number of actions per sequence either in future studies or in learning applications. The results range from 3.50 actions in the children group without experience, to 8.00 actions in the group of adults with experience. The other two groups realized almost 5.00 actions sequentially in the correct order. For this variable, the approximate values obtained for the group of children with experience and the group of adults with no experience is consistent.

The *number of sequences recalled in the correct order* ranges from 0-5, with values of 3.67 actions for adults with experience, and 2.00 actions in adults with no experience. This variable focuses on the sequence; the number of actions executed correctly before the first error. This means that there were some subjects (2 adults without experience and 1 child with experience) who failed the first sequence of 2 related motor actions and that there were some (2 adults and 1 child with experience) who continued accurately until the fifth motor action sequence, after having also correctly completed the earlier sequences. In this variable, children with experience presented results slightly higher than adults with no experience.

The results obtained from the analysis of the *number of sequences recalled independently of order*—that is 12 and 11 sequences (related and unrelated, respectively)—consider all of the sequences that were executed

without error because one subject can correctly complete 4 actions, not complete 5 actions, and correctly complete 6 actions, etc. For this variable, the values are between 1 and 6 activities, with averages ranging from 1.17 for children with no experience to 4.17 for adults with experience. The other two groups have similar values with a slight advantage for children with experience (3.20-2.20 actions) compared with adults without experience (3.17-2.17 actions).

The *total of actions recalled in the correct order* varies from 15.58% in children without experience to 76.62% in adults with experience, which is the equivalent to 12 and 59 actions from the 77 actions presented by the model. The average values range from 33.76%-69.26%, with the highest values belonging to adults with experience and the lowest to children with no experience. Analysis of the *total of actions recalled independently of order* showed mean values generally higher than the values of the previous variable, with values ranging from 34.19%-70.30%. To study further the age and experience independent variables—and because of sample size and according the type of dependent variables—we used the nonparametric Mann-Whitney-Wilcoxon or the t-Student test. To compare the related and non-related data we used the Wilcoxon test and, for the paired data, the t-Student test. We considered a result significant if $p \leq 0.05$.

DISCUSSION

The results indicate that there are significant differences when comparing the groups with respect to experience. The n*umber of sequences recalled in the correct order* depends on this factor as it appears in all possible comparisons and cross-comparisons. The other four variables in the study also appear often, which reinforces the idea that years of practice in a particular activity influence the ability to recall movement, which despite being generic (not specific to a particular dance technique) have dance as frame of reference of the motor repertoire. With regard to age, it is confirmed that for the variables under study (which appear to have consensus in the literature) children are less able than adults to memorize movements; this disadvantage is more apparent if the sequences are particularly long (more than 5 motor actions), common in many situations of dance learning. When we associated age and experience, we found an aspect that seems worthy of development in future study: that the group of children with experience have similar or sometimes slightly higher scores than the group of adults without experience. This, and the size of the sample for different age groups, should be considered in future studies.

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