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Monitoring work and rest during performance and life-style: A study case with a principal ballet dancer

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Traditionally, dance training is based on day-to-day technical routines: the class. Studies in dance physiology started in the 1980s have shown that there are significant differences between the effort made during performance and that made in classes. The challenge for researchers and for those in the field (dancers, teachers, choreographers) is to find out training methodologies that allow improved performance, reducing the high number of injuries and prolonging careers. In this paper, we present a research methodology that can help to improve dance training by changing the starting point: past or future. Planning based on the past is to continue to repeat the same routines as always has been. Planning based on the future requires an analysis of the future task (dancing a particular role)—technical, energy, informational, psychological, and artistic—so that the preparation takes into account these different demands; what is known today as nonlinear periodization. This training must be specific and individualized.

Keywords: energy expenditure; work-to-rest ratio; dance training; elite ballet dancer; performance science

The prevalence of injuries in dance, mainly for professional dancers, is extremely high. Literature suggests that 80% of dancers get injured during their carrier (Hamilton 1989). The most frequent type of injury is normally named as overuse, a minor injury that gets worst by overload; micro traumatisms caused by the exhaustive repetition of the same technical exercises in order to achieve artistic perfection. This kind of injury, according to Garrick's (2008) studies, varies between 60-90% of total injuries, and the remaining are considered acute injuries that result from macro traumatisms (sprain, collision/impact, overstretch, etc.).

There are many factors that contribute to the occurrence of injuries: fatigue, excessive exercise/overtraining, inappropriate warm-up and cool-down, continuing to work when injured, deficient physical condition, hypo- or hypermobility, postural problems, alignment deficits, inadequate en-dehors, poor nutrition, disordered eating, menstrual irregularity, osteoporosis, psychological factors (sleeping problems, anxiety, depression), and factors related to equipment use (point shoes, floor type, wardrobe).

It seems to be consensual that injury happens when some of these factors occur together, with it being impossible to consider the injury occurrence the result of just one factor. However the *training* factors have a great contribution: 90% of the injuries happen when the dancer is fatigued (Liederbach 1997). Used to training over and over, it is common for dancers to hide the injuries and to keep working. Hamilton (1998) was responsible for an inquiry that collected the following results: 66% of dancers had continued to work with a chronic injury, 52% with tendinitis, and 27% with stress fracture and with arthritis.

One of the central problems of training consists of the specific choice of the balance between work and rest. To find the adequate amount of load and the adequate duration of recovery is important to improve performance and to prevent injuries. An insufficient load does not improve performance. On the other hand, loads too high or with a lack of time to recover are negative for health and performance maintains or decreases.

The aim of the study is to quantify the energy expenditure of high level performance in dance in order to characterize the dance task requirements and energetic costs in different time periods, and also to understand the balance between load and recovery.

METHOD

Participants

A 31 year old principal ballet male dancer was studied for eight days. For this study, the subject wore a multiple physiological sensor (*SenseWear Pro Armband*) during a week of performing *Coppélia*.

Materials

The arm band provided the following measures: total energy expenditure and active energy expenditure (at 3.0 METS or higher), physical activity duration, intensity (sedentary, moderate, vigorous, and very vigorous), and sleep duration. All the stage performances, individual and company rehearsals, and

classes were filmed and submitted to a specific observation system. The movement analysis is centered on the kind of motor actions, and other variables, to calculate the movement density and the work-to-rest ratio.

Procedure

The subject wore the *SenseWear Pro Armband* on the right arm, and energy expenditure was estimated using proprietary equations developed by the manufacturer. The measurement periods were continuous for several days (until 14 days). Time ranges were selected according to the desired analyses work periods: week and day, including class, rehearsal, and performance. The collected data were analyzed in research software. The classes, rehearsals, and performances were filmed and recorded in digital base for posterior analysis with the observational system.

Estimated energy expenditure from the *SenseWear Pro Armband* is broadly validated in the literature, namely with standard indirect calorimetry. The sensewear data should be accompanied with information obtained through the completion of a simple diary. The different data were integrated over time. The equipment proved to be reliable and easy to use for all levels of dancers, and even during performance. A brief instruction period to the subjects is enough to achieve reliable results.

For the observation of the motor actions, the "system of observation of motor behavior in dance" created and developed by Rodrigues (1992, 1999) was utilized in this study. Through the systematic observation of motor behavior in dance we have identified nine motor actions: *steps*, *jumps*, *turns*, *gestures*, *falls*, *displacements*, *postures*, *balances,* and *contacts*. The list of motor actions proposed is limited and their definition based on two criteria: the support (link to the ground) and the group of specific features of each action. The observational system was validated in 1999.

RESULTS

Energy expenditure

On average the total energy expenditure was of 2933 Kcal, oscillating between 2300 on days-off and 3500 on performance days. During the eight days observed, the dancer had three performances of 2 hours and 20 mins (including intervals) and lost on average 600 Kcal in each one. For 50 mins he was in sedentary activity and about 90 mins in physical activity. The physical activity was distributed in 74 mins of *moderate* (3.0-6.0 METS), 14 mins of *vigorous*

(6.0-9.0 METS), and 3 mins in *very vigorous* (9.0 METS and higher). The sleep period was on average 8 hours.

The analysis of movement allows us to identify the relation between energy expenditure and density of movement: there is an increase of energy expenditure when the number of actions per min. also increases and mainly when those actions are moveable (jumps, displacements, and steps). However, some differences in the content are found between the classes (individual or collective) and the specificities of performance because classes are more like a routine without a direct relationship with the different requirements of choreographies.

Another characteristic that is important is the difference between what the subject does in his individual trainings before the performance and what he does during the company class. The expenditure (about 400 Kcal) is higher during his individual trainings of 1 hour and 15 mins (on average 4.0 METS) than during group classes (270 Kcal, 3.0 METS) with the same time. This last activity presents a sedentary and moderate activity, while the first situation has periods of vigorous activity like in the performance.

Work-to-rest ratio

One of the most interesting observations in this study concerns the comparison of the collective training with individual training. Typically, on performance day the company (with about 70 dancers) usually does a class similar to the other days. But on performance days our subject (principal dancer) holds his individual preparation/training just immediately before performance, instead of the collective class that occurs two hours before performance. What are the differences between these two classes?

In terms of content the differences are not much (at the end of the individual training there is some specific work/preparation with passages of the choreography, but only in the last 5 mins), but differences arise at the level of work-to-rest ratio: for a similar duration of 73 and 71 mins, in the collective class there was a total of 28-45 mins from work to rest, while in the individual training 32-39 mins of work to rest. The average time of the barre exercises is, respectively, 90 and 70 s, with similar values (33 s, 32 s) of rest.

In the centre the differences increase, with values of work of 28 s and 30 s, but with periods of rest significantly different from 180 s and 45 s, respectively. The organization of the exercises in small groups can explain this difference; in a class where there are on average 40 dancers, the rest time of each dancer will at least triple. The problem is that the physiological effects are quite different—e.g. if one waits 3 mins to work about 30 s, or if one just

waits 45 s to do the same 30 s. The more experienced dancers are aware of this, and when they work individually they work more (39 versus 28 mins) and better.

DISCUSSION

The results shows that physical activity is mainly moderate (91%): on average, the eight days observed presented 3 daily hours of moderate physical activity, about 15 mins of vigorous, and 2 mins of very vigorous activity. The complexity of the tasks, which demands high coordination, may justify these results.

Another aspect that we must enhance is the importance of individual training for success. In the individual training periods, we found a work-to-rest-ratio more similar to performance than in the group class company.

The underlying question that arises in this study (in our line of research) is how to assist the performers to reach the peak level of performance at the right moment? Planning and monitoring are key words to achieve these objectives. If we continue to train only based on tradition, with a routine daily lesson for all the elements of the company, probably the same high rate of injuries will continue and the individual's potential is not developed: at the highest professional level, a lesson for all is a lesson for anyone. We need to individualize the training, planning well to find a balance between work periods and rest periods and to avoid overuse injuries.

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