NON-LINEAR PHENOMENA OF A DROP-JUMP-TEST ON CONDITION OF INCREASED LOAD

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INTRODUCTION

For some years, we have been studying the influence of increased loads on kinematical, dynamical, physiological and psycho-physiological parameters in our Movement Science Department in Magdeburg. We regard these parameters as indicators for stresses on the organism. We found out that there are changes between variable and stable states for these quantities with increased loads. It is not possible to sufficiently explain these results with traditional linear methods. For this reason we tested methods of non-linear dynamics for analysing these time series. Thus we attempted to answer the following question: In which way do continuous and discontinuous changes of chosen kinematical, dynamical, physiological and psycho-physiological parameters occur under the condition of increased load on a sport movement?

METHODS

For our investigations we developed a complex test on laboratory conditions, enabling the estimation of biomechanical, physiological and psycho-physiological parameters. The test person carried out a series of drop jumps from a stool (h = 0.40m) to a force plate and from the force plate to a stool and after a turn of 180 degrees the movement started again. The load increased by a step by step increased intensity. In a pre-test we investigated the maximum number of jumps in the interval of 2 minutes. We considered this number as 100% (as the maximum performance). The test was carried out with the load intensities of 80%, 85%, 90%, 95% and 100%. The six test persons jumped for 2 minutes per load intensity, the breaks lasting for 4 minutes.

In this paper we discuss the results of one test person using the following measurement methods: The velocity of the centre of gravity and the body angles at chosen phases of the movement were calculated by means of a picture anlaysis system. Additionally the characteristic time curve of the vertical ground reaction force was recorded by using a force plate. These curves were compared with each other at various times of the load.

As indicators for the physiological and psycho-physiological stress of the

organism we measured the cardiac rhythm (RR - interval) by means of a long-term-electrocardiogram and the reaction time (movement and initiation time) by means of a special reaction desk. For a quantitative analysis of time series we used the correlation dimension according to GRASSBERGER/PROCACCIA (1984).

RESULTS AND DISCUSSION

From the biomechanical point of view the phase of movement was investigated from the begunning to the end of the ground contact (force plate). The measured ground contact times varied around a mean value in the course of a test. SCHMIDTBLEICHER (1991) diagnosed either an increasing or a decreasing of the mean value of the ground contact time. We could not prove these trends. The computed vertical impulses reduced with an increased jump number in each level of load intensity. The decreased impulses result in decreased jump heights of the centre of gravity of the body. The test perso0n had to bend her legs much more during high stress to be able to jump onto the stool. This movement appears more economical.

We were interested in the question, in which way the reduced impulses on constant ground contact influenced the characteristic time curve of the vertical ground reaction force. Figure 1 shows a qualitative change of the characteristic curve at the beginning and at the end of the test. To quantify the variability of the successive characteristic curves the correlation dimensions were computed. The RR - intervals were estimated during the load steps and the load breaks. The correlation dimension turned out to be greater in the load steps than in the load breaks. This means the number of degrees of freedom of heart dynamics is higher during stress than in the recovery phases. We assume that other parameters also influence the heart rhythm.

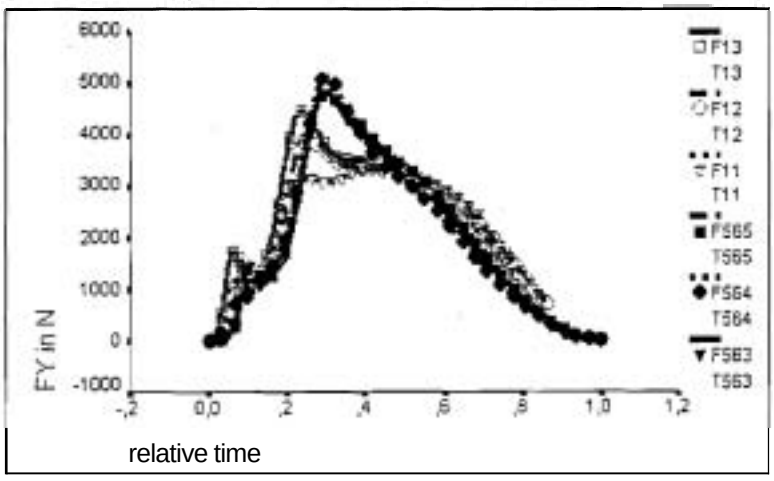

Figure 1: Vertical ground reaction force in dependence on the relative time of the ground contact.
F1..-T1..= the first three jumps of the total test.
F5..-T5..= the latest three jumps of the total test.

Nevertheless we calculated the reaction time relating to acoustical and optical stimuli. Results indicated that the correlation dimension of the movement time is increasing by higher stress.

CONCLUSION

The research question stated in which ways are continuous and discontinuous changes of chosen kinematical, dynamical, physiological and psycho - physiological parameters effected by conditions of increased load. These changes could be quantified by means of the correlation dimension. We analysed the time series of ground reaction forces, cardiac rhythms and reaction time.

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