TIME CONTINUOUS VS. TIME DISCRETE ANALYSIS OF THE TAKE OFF TECHNIQUE IN LONG JUMP

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Long jump trials of specialist long jumpers, decathlete and sports students were filmed two-dimensional with one high speed camera. Performance during Take-Off (TO) was analyzed based on time continuous data. All trials were compared for similarity and classified by cluster analysis (Schöllhorn, 1999). Additional cluster analyses considered time discrete variables only. For both data sets, no classification according to jumping performance was found. The results indicate that different TO strategies may result in comparable jumping performance. Consequences on the analysis and training of sports techniques are discussed.

KEY WORDS: pattern recognition, cluster analysis, long jump

INTRODUCTION:

High performance in long jumping can be achieved with different take off techniques that result e.g. in different vertical and horizontal velocities (Fukashiro & Wakayama, 1992). Therefore, an analysis of the long jump should not be based on single parameters but on a whole set of variables. In most studies (e.g. Hay, Miller, & Canterna, 1987), time discrete variables are considered that describe the performance at a given time (such as the take off) but lack on information about how the movement was processed. Process oriented data have been analyzed successfully to identify individual movement styles (Schöllhorn & Bauer, 1998a) or different techniques (Jaitner, Mendoza, & Schöllhorn, 2001). Especially for athletes on a high level of performance no relationship between movement patterns and performance could be found (Schöllhorn & Bauer, 1998b). While these previous studies were mainly based on homogeneous samples (such as finalists of an international championship) the focus in this study is on the comparison of movement patterns that result in very different performances. Further, two different kinds of movement patterns were considered: The first is described by performance related time discrete variables whereas the second is based on process oriented time continuous variables.

METHOD:

Data Collection:

20 Long Jump trials of 7 elite athletes, 6 decathletes und 7 students were filmed with one high speed film camera (Locam) at 150-200 Hz. The data of the long jumpers and decathletes were collected at international competitions whereas the students performed on a local competition. Subjects and performances are listen in table 1.

Table 1: subjects, groups, and the corresponding range of performance

Group	Subjects	Performance
Specialists (SP)	MP, CL, LM, AC, LS, NB, LV	8.41 – 7.97m
Decathletes (DC)	RZ, EN, MS, GK, FB, RS	8.02 -7.71 m
Students (ST)	CT, DK , SB, PM, TB, DI, MA	6.90 – 6.15 m

Data Processing:

Biomechanical parameters were determined that are typical for the analysis of the long jump such as take off velocities, angles and length of the three last steps of the approach (Nixdorf & Brüggemann, 1990). Altogether, 15 variables describe a time discrete movement pattern. Data processing of these patterns included a z-transformation and a hierarchical cluster analysis. Time continuous movement patterns were characterized by the time courses of the angles of both ankles, knees, hips, shoulders, elbows and the orientation angle of the trunk were calculated. The corresponding velocities were considered as well. Afterwards, the distances between single variables as well as groups of variables were determined and the resultant distance matrix was analysed by means of a cluster analysis (Schöllhorn, 1999).

RESULTS:

Figure 1 shows the results for the cluster analysis of the time discrete data.

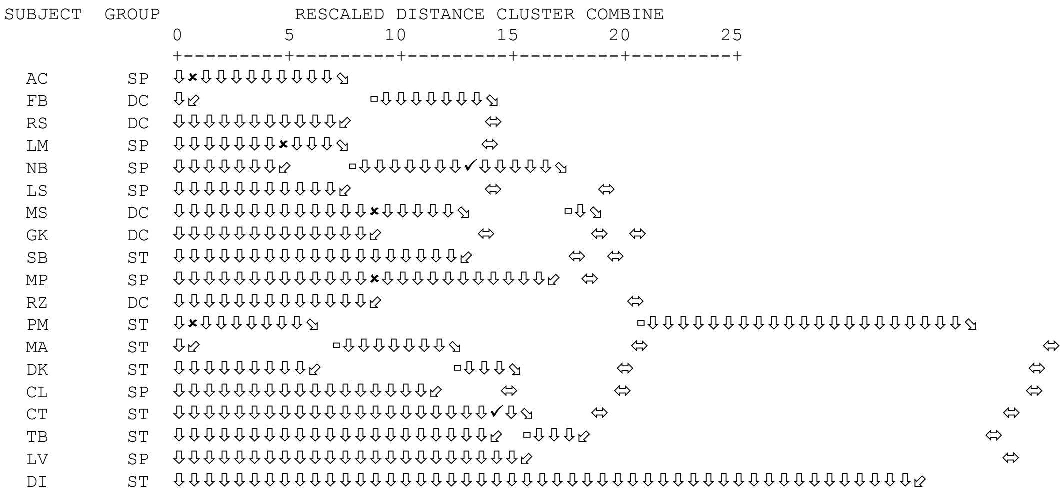

Figure 1: cluster analysis of time discrete data

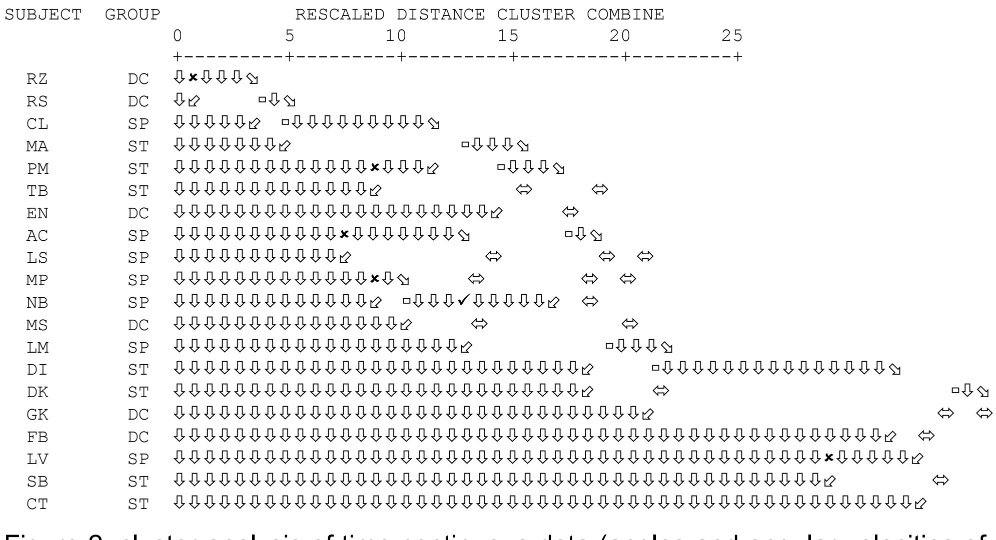

Figure 2: cluster analysis of time continuous data (angles and angular velocities of ankles, knees, hips, shoulders, elbows and trunk)

The dendrogram displays the grouping of all trials by distance. Trials that are grouped on a lower distance are considered more similar than trials grouped on a higher distance. Overall, long jump trials are roughly separated into two main clusters. The first cluster contains long jump trials of the subjects AC, FB, RS, LM, NB, LS, MS, GK, SB, MP, RZ. On a more detailed level, a further subdivision into several clusters can be found. The second cluster consists of the trials of all remaining subjects except for subject DI, which is clearly separated from all other trials.
The cluster analysis of the time courses of all angles and angular velocities (figure 2) shows at first two clusters that consists of trials of the subjects RZ, RS, CL, MA, PM, TB, EN (first cluster), respectively AC, LS, MP, NB, MS, LM (second cluster). All remaining trials are added successively.

DISCUSSION AND CONCLUSIONS:

Based on the analysis of performance related time discrete variables a classification related to performance can be recognized for some trials (LM, NB, LS). More often, long jump trials on different levels of performance (e.g. students and specialist) are grouped. Further, the long jump trial with highest performance (CL, 8,41m) is located in a cluster that contains also one trial of a student with minor performance (MA/ 6,15m).
Similar results are shown if time continuous variables are analyzed. The main clusters consist of long jump trials on different levels of performance. As for the previous analysis, the trials of subjects CL and MA were grouped in one cluster at a low distance which indicates a high similarity of movement patterns.
Overall, a classification of long jump trials according to performance can be found neither for the time discrete nor for the time continuous analysis. According to Schöllhorn and Bauer (1998) this can now also be stated not only for a homogenous population within a small range of performance but also for subjects of a quite wide range of performance. Remarkably, trials on a very different level of performance (e.g. specialist CL and student MA) show a higher similarity as trials on the same level of performance (e.g. specialists CL and LM).
Considering the movement processing, the results indicate that high performances in long jump can be achieved with different movement techniques. On the other, hand, subjects on a minor level of performance might perform with similar techniques. These subjects may have deficits concerning, e.g., movement amplitude or intensities. Further investigations are necessary that deal with such aspects in detail. Considering the time discrete variables, varying intensity of different variables might have an compensatory effect, which might explain the results. From a methodological view, it should be stated that our analyses were based on the relative differences between the variables. Therefore, especially the results of the process oriented analyses might differ, if absolute values were considered.

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