STRENGTH TRAINING PERIODIZATION BY MEANS OF INDIVIDUAL FACTOR SCORES IN SPRINT START TAKE-OFF

Christophe Delecluse, R. Diels, M. Goris,
Katholieke Universiteit, Leuven, Belgium

INTRODUCTION: Most coaches agree that strength training is one of the key elements in a sprinter's training schedule. However, the exact content of an appropriate strength training program is still open to discussion. As it is a sprinter's aim to improve his power, the fastest motor units must be activated in the most specific way, and a variety of training methods can be used to enhance dynamic performance. Some aim for hypertrophy and others for specific adaptations of the nervous system. The strength training program for a sprinter will always be a mixture of different methods, influencing strength/power/speed in a sprint-specific or nonspecific way. Because there are so many variables determining training effects, it is impossible to produce a general 'instant' training program. This means that the coach observes the quality of the training performances of his athletes and tries to recognize when recovery and progressive loading are out of balance. When working with top level athletes this necessitates an individualized strength training approach (Delecluse, 1997).
It was the purpose of this study to develop a test procedure for the follow-up of specific strength abilities of elite sprinters at selected moments in their training periodization. This test should be a sprint-specific test in which the factor 'strength' can be evaluated. Therefore the sprint start was selected as a standardized test condition, as it is very specific and because of the high test-retest reliability within a group of experienced sprinters.

METHODS AND PROCEDURES: Load cells mounted on the back of each starting block enable a continuous recording of the horizontal force-time characteristics of each foot on the blocks during the entire start action. These data were reduced to 11 start variables:

* for the total start action:

horizontal start velocity: horizontal speed on leaving the blocks
start time: duration of push-off, without reaction time.
horizontal start acceleration: start velocity divided by start time

* for each block separately: *maximum force (horizontal), forward impulse, duration of take-off, reaction time*

The group of subjects consisted of 20 male and 17 female national and international level sprinters.
These athletes were free to participate in three test sessions each year for three consecutive years, 1995-1997. The sessions were planned in January, April and June, six weeks before important competition periods: indoor championships, qualification period for outdoor championships, outdoor championships. The

athletes only participated if they were free of injuries. Over this three year period a total of 127 and 119 starts was recorded for the male and female sprinters respectively.
A principal component analysis was performed on the 11 start variables. The factors were extracted and rotated orthogonally to the varimax criterion. The number of components was determined by a Scree test (Kline, 1994).

RESULTS AND DISCUSSION: The principal component analysis on the 11 start parameters resulted in the extraction of four factors for the males, as well as for the females. These factors were uncorrelated as they were rotated orthogonally. The loadings of the start variables on the factors are presented in Table 1 and Table 2 for the male and female groups respectively. These factors explained 30%, 24%, 18% and 18% respectively of the total variance in the start variables of the female sprinters. These percentages differ only slightly in the male group: 22%, 24%, 24% and 18% respectively.

Table 1: Factor loadings of 11 start variables on the four selected factors and percentage of variance explained by each factor in the group of *male sprinters*

		factor 1	***factor 2***	***factor 3***	***factor 4***
Parameter	***block***	**TIME**	**STRENGTH**	**TECHNIQUE**	**REACTION**
Acceleration	**total**	-.61	.53	.45	-.17
Velocity	**total**	.15	**.61**	**.67**	-.17
Duration	**total**	**.97**	.00	.15	.03
Duration	**front**	**.94**	-.10	.05	-.03
	rear	**.51**	-.40	**.61**	-.05
Impulse	**front**	.00	**.95**	.06	-.04
	rear	.25	-.01	**.94**	-.08
max. force	**front**	-.25	**.89**	.07	-.08
	rear	-.27	.28	**.69**	-.06
Reaction	**front**	.02	-.03	-.03	**.97**
	rear	.00	-.11	-.15	**.95**
Explained	***variance***	***24.3%***	***23.7%***	***22.2%***	***17.6%***

Table 2: Factor loadings of 11 start variables on the four selected factors and percentage of variance explained by each factor in the group of *female sprinters*

Parameter	*block*	*factor 1* TECHNIQUE	*factor 2* TIME	*factor 3* STRENGTH	*factor 4* REACTION
Acceleration	**total**	.72	-.59	.17	-.15
Velocity	**total**	**.90**	.09	.16	-.03
Duration	**total**	.08	**.97**	-.04	.17
Duration	**front**	-.08	**.95**	.06	.09
	rear	**.70**	.46	-.46	-.06
Impulse	**front**	-.11	.20	**.95**	-.05
	rear	**.89**	.07	-.20	-.29
max. force	**front**	.11	-.20	**.90**	-.16
	rear	**.80**	-.38	.02	-.25
Reaction	**front**	-.09	.16	-.16	**.95**
	rear	-.32	-.12	-.04	**.91**
Explained	***variance***	***30.8%***	***24.4***	***18.6%***	***17.9%***

In the male group the first factor to be extracted, is a 'time' factor that refers to the duration of the take-off action on the front and rear blocks. The second factor is highly correlated with the impulse and maximum force on the front block. As the front leg is the only take-off leg in the final part of the start action, these force-values are an indication of the specific 'strength' of the athlete. Previous research (Delecluse, Van Coppenolle, Goris, Diels, & Didden, 1990) indicated that the ability to produce high forces on the rear block is rather a matter of technique (factor 3). The fourth factor is only correlated to both reaction times. Several studies have shown that reaction time is totally independent of strength and speed characteristics (Henry, & Trafton, 1951; Mero, Komi, & Gregor, 1992). The principal component analysis of the data of the female sprinters results in four identical factors: time, strength, technique and reaction, only the order of selection is different (Table 2). This means that the variance within the female start performances is determined first by technique, followed by time, strength and reaction.

As start acceleration is considered a good indication of the quality of a dynamic start action (Delecluse, Diels, Goris, & Van Coppenolle, 1996), a correlation analysis between this parameter and the four factors was performed. In the female group start acceleration was correlated to the technique- (.72) and the time-factor (-.59) only. In the group of male sprinters start acceleration was correlated to the time- (-.61), the strength- (.53), and the technique-factor (.45). This indicates that reaction time is not a performance determining factor in these groups of sprinters. More surprising was the fact that the strength factor was not correlated to the horizontal start acceleration in the female group.

CONCLUSIONS: In planning strength training, the coach must find a delicate balance between maximum strength, explosive strength, rate of force development and the transmutation of the acquired motor potential into athletic performance. When entering the final weeks of training preparation before major competitions coaches try to evaluate to what extent their athlete is prepared for the specific demands of his event. The reduction of the horizontal force-time data of the start action in four factor scores offers valuable information concerning the competition preparedness of his athlete. By means of the individual follow-up of these factor scores at standardized moments in the periodization, the coach can determine more accurately the content of the final training preparation.

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