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# THE ESTIMATION OF THE TECHNIQUE OF DOWNHILL CONTROL BY THE SPECIFIC INDEXES OF THE ALPINE-SKIER'S SENSOMOTORICS

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**Abstract:** In the article, the possibilities of qualitative estimates of the technique of downhill control by the values and dynamics of the indexes of the time sense as well as the musculoarticular and tactile senses are considered. The presence of the relationship between level and dynamics of these indexes and values of skiing loads is shown. It is ascertained an indubitable advantage of sportsmen-students by the musculoarticular and tactile senses over students covered lesser distances with slower speeds. It is drawn a conclusion that the qualitative estimates and control over the level of the implementation of the technical methods by the mountain-skiers are possible.

**Key words:** biomechanics in sports, mountain-skiing, sensomotorics, dynamics of indexes

## Introduction

In the mountain-skiing, one of the most important aspects of the success in the downhill during training and competitions is the information on the accomplishment and results of motive activities (the specific technical methods) of a sportsman. The information is received by the afferent nervous tracts of the tested sensomotoric systems, i.e. the musculoarticular and tactile senses. The feeling of the time intervals in the process of downhill is defined by the activity of the central nervous system of the mountain-skier. The genetic level of efficiency and accuracy of such information in children is one of the criteria for selection to train the future masters of mountain-skiing. It follows that the perfection of technical skill of mountain-skiers can be estimated by the level of the mentioned organism systems functioning, but the literature data on this issue are extremely little.

In this study, a problem of the usage of information received by the canals of the musculoarticular and tactile senses, and time sense of mountain-skiers to estimate the quality of the downhill control (i. e. accomplishment of specific motive activities to change a movement trajectory of «skier-ski» system as well as its speed and acceleration) is investigated. We proposed that the receiving of the information on the level of motive activities of mountain-skiers is possible by registrations of the specific indexes of functioning of the sensomotoric systems and the time sense in dynamics. The data of our works on the significance of the time sense and the musculoarticular sense of mountain-skiers at different ages for getting good competition results served as a guide for such a proposition [5, 6]. It was found that the reproduction exactness indexes of temporal, forced and space components of the elementary motion of body parts have the reliable correlation with the sport results of mountain-skiers. Therefore one can set and solve the task to estimate the dynamics of such indexes in the process of perfection of sport and technical skills of mountain-skiers.

## Methods of research

The group involving 12 mountain-skiing students at the age of 18 to 22 was observed, their sporting qualification being the candidate-masters of sport and sportsmen of the first to

third grade. The indexes of time sense and functioning of the organism sensomotoric systems were registered in the competition weekly from November to April. The duration of observation was two years. The distance (in kilometres) covered by a mountain-skier during one week was chosen as a characteristic of sportsman's activity. The main method was the study of the level and dynamics of indexes of activity of some organism systems of different qualification mountain-skiers.

To register the time sense the following technique was used.

1. The ability to remember and reproduce short time intervals (two seconds) and its estimation by measuring a difference between a set interval and an averaged result of reproduction series (STI) [8]. Such duration of temporal interval was chosen since during approximately 2 seconds mountain-skiers pass two slalom turns or one giant slalom turn. For the setting and registration of temporal intervals an electronic equipment on the base of impulse meter was used. Each tested student had three test attempts and then six control ones; the final result was determined as an averaged one. The relative error of the technique was no more 2.5 %.

To register the musculoarticular sense the following techniques were used.

2. The estimation of the muscular sense (proprioception) of the tested students was carried out by analysing of accuracy of effort on a hand dynamometer (SD). The efforts close to the maximum, minimum values and an appropriate one for the tested students were specified [2, 3]. The procedure was the same as it was in the technique 1 according to the methodical instructions published in [8]. The total error of this technique was no more 6 %.

3. The level of the exactness of sensibilities of space shifts of body parts (kinestesia) was estimated by analysing remembrance and reproduction of the specific movement, namely the putting of hip on the special equipment "Edge" designed by the author [5]. This equipment was made as the imitator of a ski and allows to reproduce the setting of a ski to the rib («turning over») by sportsman doing turns. The maximum, minimum and comfortable angles of imitator turn in the range from 5 to 30 degrees were given to the students. The total error of this technique was 1.5-5.5 % depending on the turn-over angle. The abbreviating for the methods is «SA».

4. The tactile sense was determined by the Weber method [7]. It was estimated the possibility to differ the distance between the compass legs placed at those parts of the tested student skin that are in contact with the sport equipment (differential threshold of sense). It is the zone of contact of shin with the upper flank of the mountain-ski boot (SS); the zone on the sole at the foundation of the thumb (STH) and the zone at the dorsal surface of the palm where the sportsman leans on the handle of the mountain-ski stick (SH). The total error of this technique was no more 5 %.

## Results and discussion

The measured indexes presented above are shown in Table 1. For more clearness of the results the tested group was divided into two parts. The first subgroup was formed by the sportsmen which were the members of the combined team of the Tchaikovsky State Institute of Physical Culture. For the winter sport season they took part in 12-14 competitions and realized the considerable number of downhills (average distance was 350-400 km). The second subgroup consisted of the students (average distance was 150-200 km; the levels of their sport qualification are the second and third grades).

The estimates of certainty of group observation results were made by two ways. It was determined the certainty of group average values on the stages of the sport season by the van der Waerden criterion (the reliability of conclusions is 95 %); and also it was made the single-factor dispersion analysis [4] that allows estimating the quantity of the influence factor on the

investigated process. The downhill distance covered during the sport season was considered as an influence factor.

According to the data presented in Table 1 one can note that the reproduction of the temporal interval STI is reliably improved for both groups (the account value of criterion is higher than its value in the table of Van der Waerden (VTVW)). A considerable influence of training on the index of the time sense in the second sub-group is accounted for a poor quality of an initial technique. The sportsmen did not experience such difficulties because of their higher level of technical training.

The dynamics and level of proprioception (D) and kinestesia (SA5 and SA30) indexes have more clearly demonstrated the advantage of the first sub-group by the quality of realization of technical skills. The reliable improvements of the indexes were noted during the winter season; the factor of training influence was about 30 %. In the second sub-group, such improvements did not take place (the group changes are not reliable). From this analysis it is apparent that the students from the second sub-group did not have enough level of sense of force and moving of body parts that does not allow them to realize them qualitatively and develop a high downhill speed at the same time.

The indexes of the tactile sense (SS, STH, SH) have reliable improvements just for the first sub-group; the changes of indexes and influence factor for sportsmen are found to be greatest. It allows to attribute these features to higher level of the technical preparation in the first sub-group. In spite of the presence of essential influence factor in the second group, the common results are nevertheless negative, i.e. the changes are not reliable. It should be noted that the greatest factor of ski training influence appeares to be in both sub-groups for the sense of the skin strip on the arm (SS). These data confirm a wide spread opinion on importance of arm activity during accomplishment of specific methods [3].

On the whole, the group data showed the following features of the tested indexes dynamics by the degree of their influence on the quality of accomplishment of the specific methods. The time sense by the influence of training is improving for all the mountain-skiers and therefore it is the necessary condition for the accomplishment of technical preparation. The improvement of the specific indexes of the musculoarticular and tactile senses depends on covered distance (an average of 350-400 km) with relatively high speed and is typical for mountain-skiing sportsmen.

Table 1. The group indexes of sensomotorics

| Indexes | Subgroups | Stage of observation | | Criterions | Factor, % |
|---|---|---|---|---|---|
| | | December | March | | |
| STI, s | Sportsmen | 0.23 | 0.10 | > VTVW | 16.4 |
| | Students | 0.23 | 0.03 | > VTVW | 42.0 |
| SD, N | Sportsmen | 26.2 | 12.7 | > VTVW | 20.5 |
| | Students | 45.5 | 27.7 | < VTVW | 3.9 |
| SA5, degrees | Sportsmen | 0.23 | 0.08 | > VTVW | 23.3 |
| | Students | 0.57 | 0.32 | < VTVW | 2.4 |
| SA30, degrees | Sportsmen | 0.61 | 0.23 | > VTVW | 23.1 |
| | Students | 0.41 | 0.25 | < VTVW | 2.7 |
| SS, mm | Sportsmen | 0.89 | 0.25 | > VTVW | 71.1 |
| | Students | 1.30 | 0.56 | < VTVW | 14.4 |
| STH, mm | Sportsmen | 0.65 | 0.20 | > VTVW | 54.0 |
| | Students | 0.80 | 0.45 | < VTVW | 18.0 |
| SH, mm | Sportsmen | 0.50 | 0.18 | > VTVW | 62.2 |
| | Students | 0.86 | 0.50 | < VTVW | 28.5 |

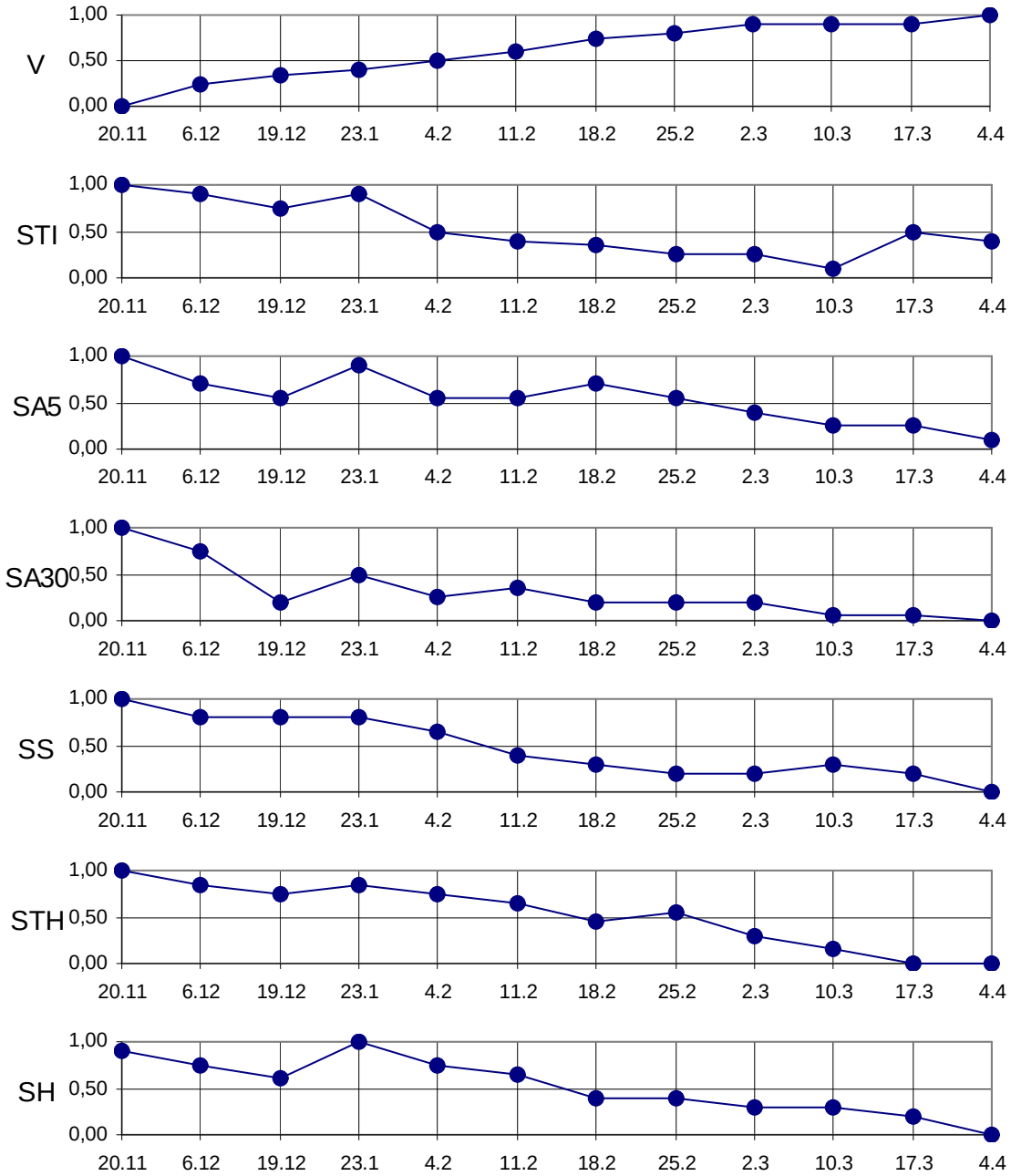


Fig. 1. The group dynamics of sensomotoric indexes of mountain-skiers for the winter competition period.

Besides the data of the stage control, the dynamics of indexes during all the sport season is of interest. Such dynamics of results measured every week for the first sub-group (indexes of the time, musculoarticular and tactile senses) is shown in Fig. 1. For the sake of convenience to compare, all the indexes are presented as relative quantities versus the measurement dates.

On the first diagram it is shown the covered distance (V). The greatest individual value was 376 km. Decreasing other indexes allows to conclude that the level of implementation of the specific methods in the process of mountain-skiing training and competitions was improved. All the diagrams increase in the period December-January; it is because the majority of students are out of intensive training during the winter exams.

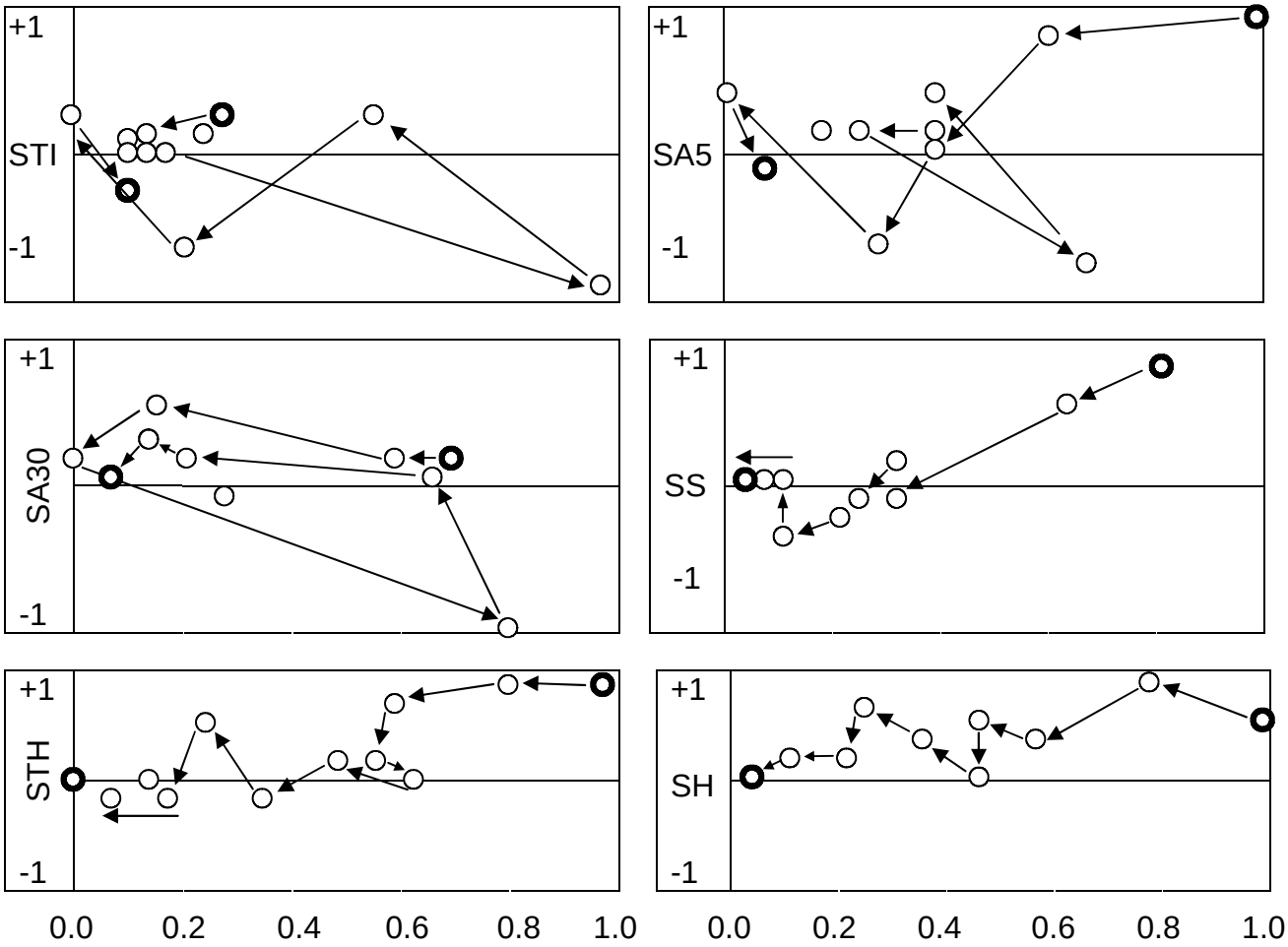


Fig. 2. The phase portraits of sensomotoric indexes of the best mountain-skier for the competition period. The start and finish of the process are marked by darker circles.

Since it is also necessary to take into account the results of preparing process of every sportsmen, the study of individual indexes is of interest. In this case, their dynamics can be considered as the adaptation process of mountain-skier's systems of downhill control to the specific loads and presented as phase portraits [1]. Fig. 2 shows such portraits for one of the mountain-skiing sportsmen. All the indexes and the speeds are presented as dimensionless quantities.

One can see on the phase portraits that the process of indexes adaptation (and accordingly the process of downhill control) has the quality differences. As for the tactile sense index, it is characterized as practically transitional process, whereas for the indexes of the time sense and kinestesia one can find considerable differences. Here, for example, there are the areas of relatively stable improvement of indexes as well as the breaks in adaptation with the variations of their values and speeds of changing and also with considerable improvements of attractor fields. These features are in good agreement with the theory of sport training provided for qualitative changes in the level of technical skill of sportsmen as an effect of different changes during the training process.

## Conclusions

The obtained data allowed us to make a conclusion that by the indexes of the time sense and sensomotorics of mountain-skiers one can estimate the quality of their specific motive activities as the technical methods of mountain-skiing and use them as the means of stage and current control of their special preparation. The foundation for all this is the presence of logical connection between the intensive competition exercise of mountain-skiing sportsmen as considerable covered distance and higher speed during the winter sport season and its separate stages.

For the mountain-skiers of lower level these connections have not been found, nevertheless dynamics of the index of reproduction of temporal intervals during the mountain-skiing has been determined. These data allow to account this index useful for estimates of the beginners or poorly prepared mountain-skiers.

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# ОЦЕНКА ТЕХНИКИ УПРАВЛЕНИЯ СПУСКОМ НА ЛЫЖАХ ПО СПЕЦИФИЧЕСКИМ ПОКАЗАТЕЛЯМ СЕНСОМОТОРИКИ У СПОРТСМЕНОВ-ГОРНОЛЫЖНИКОВ

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Для горнолыжного спорта важнейшим условием успешности спусков на лыжах в процессе тренировок и соревнований является получение информации о выполнении и результатах двигательных действий спортсмена (специфических технических приемов), получаемой по афферентным нервным путям исследуемых систем сенсомоторики: мышечно-суставной и тактильной чувствительности. Тонкое чувство интервалов времени в процессе спуска на лыжах определяется деятельностью центральной нервной системы горнолыжника. Генетически обусловленный уровень оперативности и точности такой информации у детей является одним из критериев отбора для подготовки будущих мастеров горнолыжного спорта. Отсюда следует, что

по уровню функционирования указанных систем организма можно производить оценки совершенства технического мастерства горнолыжников. Однако литературных данных по этому вопросу крайне мало.

В данной работе решалась проблема использования информации, получаемой по каналам мышечно-суставной, тактильной чувствительности и чувства времени у горнолыжников для оценки качества управления ими спуска на лыжах. В качестве объекта исследований использована группа из 19 студентов-горнолыжников в возрасте 18 лет-22 года, спортивная квалификация - кандидаты в мастера спорта и спортсмены первого-третьего разрядов. Уровень показателей чувства времени и функционирования сенсомоторных систем организма регистрировался в соревновательном периоде еженедельно с ноября по апрель. Продолжительность наблюдений - два года. В качестве характеристики специфической деятельности спортсменов регистрировался недельный объем спусков на лыжах в километрах.

Для регистрации чувства времени изучалась способность к запоминанию и воспроизведению коротких (две секунды) интервалов времени. Оценка точности мышечного чувства производилась по точности воспроизведения усилия сжатия кистевым динамометром. Уровень точности ощущений пространственных перемещений частей тела оценивался по запоминанию и воспроизведению специфического движения горнолыжника в виде приведения бедра на специальном устройстве. Тактильная чувствительность определялась по способности различать расстояние между острыми концами ножек циркуля на коже.

Описанные исследования показали наличие логической связи между уровнем и динамикой показателей горнолыжника, с одной стороны, и величиной выполненной нагрузки на лыжах, с другой. Установлено несомненное преимущество студентов-спортсменов по мышечно-суставной и тактильной чувствительности перед студентами, имеющими меньший объем спусков и спускающихся с небольшой скоростью.

Результаты работы позволяют сделать вывод о возможности качественных оценок и контроля за уровнем выполнения технических приемов у горнолыжников. Библ. 8.

Ключевые слова: биомеханика спорта, горнолыжный спорт, сенсомоторика, динамика показателей

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