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COMPLEXITY OF AN ATHLETIC FITNESS WITH RESPECT TO SELECTION AND TALENT PROGNOSIS FROM A PHYSIOLOGICAL POINT OF VIEW*

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Abstract

The level of an athletic fitness depends on a complex interaction of various performance-related factors. It is a common knowledge that these factors are different for each specific athletic discipline, and thus can be divided into categories that are measurable and not measurable by tests. Sport scientists often test the athletes' fitness level. It is necessary to admonish them: Careful monitoring the results with respect to the complexity of an athletic fitness is advised.

In soccer, applying the rating scale is more accurate than testing and testing scale works better than throwing a dice. While the "False negative and false positive" decision approach is hard to avoid, the percentage of false negative decisions should be minimal. With respect to the test criteria sensitivity and specificity this is only possible by accepting a high percentage of false positive decisions in searching for talented athletes.

When subjecting individuals to adjudicating, scoring or testing, the experience is a crucial factor. Carrying out the most accurate diagnosis and prognosis of an athletic fitness can be achieved through integration of objective and subjective parameters. Since the coach's view and experience plays a decisive role in recognizing the skills and talents of a teenage athlete, it is imperative that the coach be the judge.

Key words: fitness, coach's view, athletes, selection, talent prognosis, assessment, soccer

Introduction

Physical or athletic fitness are commonly used terms in the field of applied physiology and sport science. While a wide variety of tests exists, the question is how accurately these types of tests reflect on a true performance of top athlete performers (i.e., soccer players). So the amount of the transfer fees for soccer players is not ascertained by scientific tests (e. g. 1).

Athletic fitness is a complex phenomenon

An athletic fitness level of each individual is a complex phenomenon, consisting of multiple factors, among others, physical, psychic or social identity characters. Within each character category a sub-character group, relevant to each athletic fitness, exists (see Table 1). Naturally, top athletes' composition is not identical with their

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Table 1. *Identity characters, relevant for fitness, only exemplary*

physical	psychic	social	etc.
coordination	knowledge	team ability	
muscle force	tactics	competition driven thinking	
muscle endurance	motivation	etc.	
joint flexibility	etc.		
etc.			

relevant individual parameters of fitness. No two human beings are alike. And this is due to the compensation mechanisms that even in a high performance level athlete exist.

On another level the state of health is important in accessing an athletic fitness, e. g. with respect to joints, muscles, bones, heart, etc. This leads to the 1st conclusion: An athletic fitness, like a mosaic, is a composition of complex and multiple factors. Therefore, a general athletic or physical fitness does not exist; only a (specific) fitness tailored for a type of sports or a group of similar disciplines.

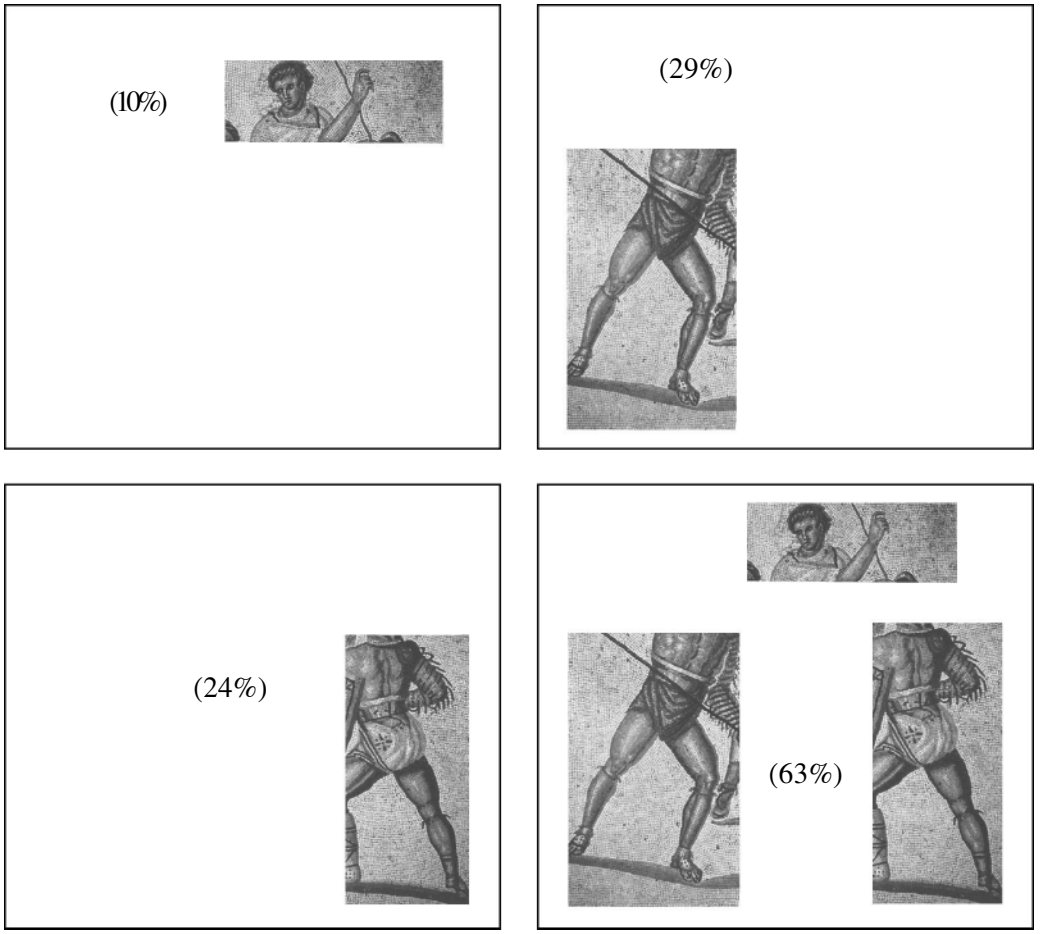

Fig. 1. *Analogically to the "pars pro toto" principle in applying tests, 3 single segments of a mosaic and the 3 segments all together. Percentages are related to the total area of the mosaic (cf. figure 2 [2]).*

Testing athletic fitness

With respect to this complexity, carrying out such tests resembles a *pars pro toto* principle, as each test result represents only the assessed part of the complex athletic fitness. Such testing leads in reductionism due to the following reasons: 1) they measure only a part of the whole unit and 2) the test results are to transfer to an ensemble: The athletic fitness. In principle, this type of transfer leads to a loss of transfer and entertains a high degree of speculation.

In figure 1 the *pars pro toto* principle is demonstrated. The sense of the mosaic cannot be recognized in the 3 detail pictures each or together. At least 3 different men can be identified, but only the complete mosaic (or nearly complete) makes it possible to recognize the sense of the picture (Fig. 2), unless the observer has known the picture before (effect of experience). This leads to the 2nd consequence: In testing an athletic fitness (i.e., for selection of players or talent searching) objective tests reduce the complex athletic fitness only to the tested ability. Transfer to reality is possible, but only in case of a high degree of affinity between test and reality; otherwise a relevant loss of transfer comes off.

Three categories in assessing an athletic fitness

To assess an athletic fitness 3 groups of categories exist (Table 2); therefore not all identity characters of a complex athletic fitness are measurable objectively. In addition to the complexity problem the question arises, how the multiple relevant abilities are to calculate one beneath the other, if more than one parameter is assessed. Are they to calculate additive, subtractive, multiplicative or by other procedures? This includes compensatory mechanisms, which should be regarded, too, in interpretating assessment results.

Fig. 2. *Total mosaic with elements of figure 1. Fight of Gladiators, Roman Villa in Nennig (Mosel, Germany) from 2nd Century A.D. (2)*

Table 2. *Three groups of categories of assessments*

1. categories which can be measured by objective physical or chemical procedures
2. categories which can be scored reliably by subjective scales by experts
3. categories which can be described only in qualitative terms (e. g. adjudication by expert's or coach's view)

If one or several objective parameters are tested, the assessment of a complex athletic fitness is reduced only to the measured variables. These measured variables represent a more or less small section of the total complex athletic fitness (problem of reductionism, cf. figure 1). This leads to the 3rd consequence: A complex athletic fitness cannot be tested by one or several tests. A great number of relevant categories only can be assessed by scores or qualitative terms.

Intraindividual variability

While a mosaic is based on a complex stable system, an athletic fitness represents a more complex and dynamic system. This complexity includes properties of non linear dynamic systems (Table 3).

Intraindividual variability also exists in nearly all quantitative and qualitative factors ("strong" and "soft" data) which are relevant for an athletic fitness. Variability will arise by training or by the principles of nonlinear dynamic systems (Table 3). This requires a high degree of experience by performing assessments and tests as well as by interpretating the results. This leads to the 4th consequence: In diagnosing athletic fitness, selection of players and talent searching be careful to the snap-shot effect!

Table 3. *Several properties of non linear dynamic systems (cf. 3)*

• Even small reasons can produce great effects
• Complex systems can react saltatorically
• Future behavior is only statistically, but not exactly in *individual case*, foreseeable

Table 4. *Four categories of yes/no decisions in testing*

1. right positive
2. right negative (separation between both as aim of testing)
but also
3. false positive
4. false negative (failure of tests)

Table 5. *Formula for sensitivity and specifity, RP = right positive, FP = false positive, RN = right negative, FN = false negative (e. g. 4)*

$$\text{Sensitvity} = \frac{\text{found right positive cases}}{\text{all de facto positive cases}} = \frac{RP}{RP + FN}$$

$$\text{Specitifity} = \frac{\text{found right negative cases}}{\text{all de facto negative cases}} = \frac{RN}{RN + FP}$$

Table 6. *Definitions of athletic fitness and talent*

– *Athletic fitness*: Ability to perform a special duty (a type of sport), an *actual fitness* with regard to a discipline of sport, intraindividual *variable* by training
– *Athletic talent*: Compound of individual identity characters, which are not (or no longer) trainable, intraindividual *invariant,* including a *prospective fitness*

Statistical aspects of testing

Testing athletes often includes yes/no decisions. By principal there exist 4 possibilities, however (Table 4).

The amount of right positive and right negative results can be described by the test criteria specificity and sensitivity (formula in Table 5), unknown for the most athletic tests, however.

From these formula results: Sensitivity and specifity are not independent one beneath the other. In praxis one can have only a high sensitivity or a high specifity, depending on the threshold for discrimination. This leads to the 5th consequence: For yes/no-decisions it is impossible to separate right positive from right negative athletes with absolute certainty.

Athletic fitness and talent

Athletic fitness is not the same as athletic talent (Table 6); this is to regard in talent searching. In both cases, fitness and talent are not valid in general categories but only in relation to a special discipline of sport.

So talent searching means: Creating prognoses from present to the future in a complex system, consistent of intraindividual *invariant* (e. g. talent) and *variable* (e.g., state of training) identity characters. Typical for this process is a stepwise reduction of the supported cadre athletes from youth to international championship level. This selection process can be schematically described in a pyramid-like principle with multiple stepwise reduction of the number of supported athletes (Fig. 3).

The statement "talent" for international level or highest league finally can be applied when the athlete has reached this level. Before this, in the strict sense one should speak about "potential talented athletes".

Each of the multiple stepwise reductions can be caused spontaneously and/or systematically in different ways:

1. Spontaneous dropout of the supported cadre athletes by their own decision. Many reasons are given: Loss of sense of achievement, loss of motivation for the intensive training, social problems with family, friends and job etc.
2. Systematic selection by interventions for example by scientific screening, qualifying heats or decision of the coach. By this way of selection each false negative decision is a relevant loss in the selection process, because real talented athletes are rare!

This leads to the 6th consequence: For stepwise reduction of supported cadre ath-

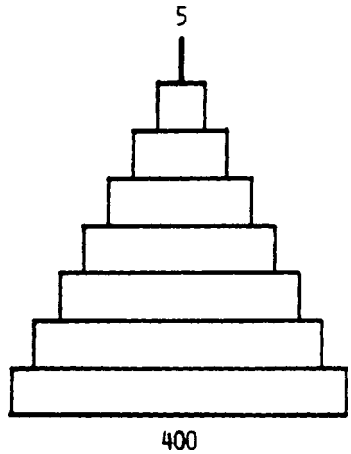

Figure 3. *Pyramid like principle of stepwise selection of supported cadre athletes in the talent searching process, starting with 400 athletes; 5 talented athletes remain at the top (5)*

letes it is necessary to accept a remarkable amount of false positive decisions and in extreme cases: To revise a negative decision, if it appears that it has been wrong.

Diagnosis of actual and future athletic fitness: An integrative procedure!

The diagnosis of actual athletic fitness *by competition results* brings a maximum of validity. A diagnosis *by tests* includes a loss of transfer from test to the real athletic fitness in competition.

In searching of potential talented athletes (future athletic fitness) one has to regard, that only few of talent factors can be measured directly. A talent factor has to represent a not or no longer trainable identity character (e. g. muscle fibre composition). As a useful alternative a selection by the following indirect procedure can be done:

The actual fitness can be seen as the result of talent and state of training, therefore potential talented athletes are those with high actual fitness and a lower state of training. For this indirect procedure, the coach's view seems to be a relevant method.

Therefore an integrative concept in diagnosis of athletic fitness and in prognosis of future fitness in talent searching offers the best chance to find those athletes, which are wanted. This way obviously will be better than using a dice. With regard to the described complexity the diagnoses and prognoses cannot be stated with 100% of certainty, however.

Integrative concept means to regard quantitative and qualitative parameters of the different topics and subtopics (Table 1). By this, coach's view is of high value, it needs experience as well as encouragement and acceptance of learning this integrative procedure. This leads to the 7th consequence: Coach's view plays a significant role in integrative assessment of actual and future fitness. It calls for experience and the readiness of learning of this integrative instrument.

Final conclusions

With respect to diagnosis, no general athletic fitness exists, only an athletic fitness in a specific sport discipline. Athletic fitness is a complex phenomenon, including measurable and not measurable identity characters. Therefore, the athletic fitness for a special discipline cannot be assessed through a couple of tests with adequate validity. Otherwise, testing is better than using a dice. As consequence the diagnostic of the athletic fitness has to be done by integrative procedures. By this the problem rises also, because this needs a great amount of time, however.

Coach's view plays an important part as an integrating procedure for diagnosis; but it calls for a high level of expertise, and on the other hand it saves time. The disadvantage of its subjectivity will mainly be compensated by the higher validity since a lot of non-measurable parameters can flow in.

The coach's mistakes are not only unique to this subjective procedure but they are inherent to all procedures: By testing objectively, by scoring, or by using coach's view as well; they all require experience. Therefore, it is necessary to be open to revisions of all decisions in context to assessments of athletic fitness.

Hence, coaches should formulate their negative decisions under reserve, i.e.: *At the moment* it does not reach for the further support in the talent support program. This keeps the possibility open to revise the decision, if an athlete makes a jump in his development or if the decision was false-negative.

In case of lack of a sufficient positive state of an athlete, coaches should not only decide negatively about "no further support", but encourage an athlete to move to another sport discipline - proposed by Bar Or (6). This option allows to regard not only one pyramid (see Fig. 3) but a "forest" of pyramids and the possibility to

change between the pyramids. At the base of each individual pyramid a change has a better chance to become successful than in higher levels.

With regard to prognoses, talent searching is more complex than the diagnosis of fitness. Long-range prognoses are complicated due to the prolonged time span. Talent searching has to integrate, measurable and not measurable variables, too. An efficient selection of talented athletes demands accepting a significant amount of wrong positive decisions to avoid a false negative decision. True talents are rare to find!

All together: Each process of talent support and selection is to be seen as an experiment in a single case. There exist no general valid rules or criteria. Selection of players (diagnostic of athletic fitness, selection and prognoses of talented athletes) needs a great amount of experience. In this case the coach's view is very important and the most experienced coaches should be engaged in talent searching in teenagers. This seems to be an artistry only assisted by scientific procedures. Experience in performing tests and coach's view is essential, experience in handling tests, scoring and adjudicating as well as in interpretating the assessed results. Overall, the coach's effort seems to be more of an artistic than of a scientific procedure.

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