CHAPTER 2

The Action Theory-Based Mental Test and Training System (MTTS)

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The application of sport psychology in elite sports requires (1) the search, identification, and selection of sporting talent; (2) performance enhancement through mental training, mental preparation, and learning strategies; and (3) consultations to ensure the athlete’s mental stability in competitive situations and ability to cope with conflicts and crises. These tasks demand a professional, systematic approach based on information derived from diagnostic tools. Modern diagnostic tools utilize computer systems for processing and analyzing data from written assessments, and, more frequently, for providing computerized tests with special features that check performance in various mental processes and domains. Although numerous tests and tools are available, a comprehensive framework is still lacking, and consequently, most of the tests and tools do not have a conceptual-based relation to the appropriate training programs.

The purpose of this chapter is to introduce and report on the development of a Mental Test and Training System (MTTS), which integrates computer-assisted tools with field setups for the testing and training of mental processes and skills deemed important in elite sports. A special emphasis is given to performance-oriented tasks. First, the theoretical background of the MTTS will be outlined.

Theoretical Background of the MTTS

The fundamental idea of the MTTS and the diagnostic and training program is to create a specific action situation—to coordinate the person, the task, and the environment (see Hackfort, 1986) and to modify this constellation for diagnostic or training purposes.

The constellation (see Figure 1) can be altered by referring to the person and modifying, for example, mood states, stress, and cognitive and motivational processes. The state of the person can be modified systematically by influencing existing mental or physical strain or by the announcement (anticipation) of an upcoming stressor. Mental tasks, such as detecting figures or signals, and motor tasks, such as tracking or aiming, can be presented individually or in combination. Reaction
time measurements are an example of a setup using such combinations. The environment can be modified with respect to, for example, light, noise, temperature, or the presence of (disturbing or facilitating) or absence of (supportive or debilitating) other people. The specific constellation can be used for testing purposes while varying combinations of the above influencing agents can be used for training purposes.

As mental and motor activities are closely interrelated, and the subjective perception and appraisal of the given (objective) circumstances and task at hand are decisive for the organization and regulation (control) of the actions needed to cope with the situation, a multi-method, multi-faceted approach is required for an appropriate strategy to analyze and modify actions. Following this understanding, we use the computer to present tasks, measure performance, and collect and analyze data. We also refer to observations and verbal reports to round off the information for appropriate interpretation of the action processes and results. Both information and the impression of the performance process, as well as the performance outcome, are considered in the test evaluation and the design of training strategies and/or recommendations for practice and competition.

**Technical Description of the MTTS**

The MTTS is an ongoing developing system that is composed of a mental test system and a mental training system. The main structure of the MTTS is presented in Figure 2.

Both the mental test and the mental training systems consist of a series of computerized/computer-assisted programs as well as field tests and training programs. Features and details of the MTTS will be introduced in the following paragraphs. We will also refer to strategies using a multi-method approach for data collection and for a multi-faceted approach to the interpretation and design of consequences (training, practice).

**Computerized Mental Test and Training Systems**

**Test System**

The platform and hardware of the computerized mental test system is based on the Vienna Test System (VTS), which was developed with a focus on clinical and traffic psychology according to the most advanced standards by the Dr. Schuhfried Company located in Vienna.
Austria. Figure 3 demonstrates the main devices of the system. It is composed of the control unit (for the test administrator) and the action unit (for the client). The control unit is a desktop or laptop computer containing programs of the system, which is manipulated by the test administrator to control the processes of various tests. The action unit includes (1) output devices such as client monitor, peripheral display, flicker and fusion device, and psycho-motor device, by which the instructions and tasks of various tests are presented to the client, and (2) input devices such as client panel, light pen, foot pedals, and so on, by which the client responds to the tasks in various tests.

The system includes various general psycho-motor tests, which are relevant to the performance tests (e.g., reaction time test, two-hand coordination test, peripheral perception test, etc.) and to personality, attitude/interest tests (e.g., Eysenck-Personality-Profiler-V6, Attitude Towards Work, etc.), as well as sport(s)-specific tests that are currently under development by the sport psychology team at ASPIRE Academy for Sports Excellence, Qatar. The Movement Detection Test (BDT) is an example of a sport-specific test aimed at measuring the ability to detect and differentiate movements—an ability that is quite important in a broad variety of sports. The task of the test is to react to the movement of...
a dot in the center of a square on the client monitor. The dot moves randomly from the center to one corner of the square, corresponding to the movement direction. A different button has to be pressed as quickly as possible when the client detects the movements (see Figure 4).

When running the test system, results (various performance indicators/data) can be presented immediately after the test is completed, and can be saved automatically in the database. By using the “find” function, the result of any test conducted on a client can be obtained from the database whenever it is required for individual diagnosis. The system also offers a “data export” function, by which the result of a test conducted on a group of clients can be converted into a SPSS file for research.

Training System
The organization of mental training, which includes developing training situations, is one of the two broad domains of mental training (Hackfort, 2001). The development of the mental training system in the frame of the MTTS is based on this understanding of and approach to mental training, and the fundamental idea of the system is to create various action situations for training purposes. The computerized mental training system is a combination of mental test system tasks and a specific setup to cope with the tasks, that is, the creation of special training situations. According to the action theory-based approach on mental training (e.g., Hackfort, 1986; Hackfort & Munzert, 2005; Nitsch & Hackfort, 1981), a training situation is a special action situation regarded as a person-environment-task constellation (see Figure 5). The person is related to the physical and/or mental state of the client during the training, the task is related to the format and/or complexity of task in the training, and the environment refers to training environment, which includes both material and social environments. Various training situations can be created by modifying this constellation.

Figure 6 is an illustration of two training situations created in the computerized mental training system. In Figure 6a, a bicycle is used to create a motion situation, which is integrated with a Peripheral Perception Test (PPT) for training purposes. In the training process, the client has to synchronously respond to the PPT and ride the bicycle under varying levels of physical load. Riding the bicycle creates a new training situation in which the client’s physical state is changed and the complexity of the task is increased. Training in such situations is designed to effectively improve the client’s peripheral perception. In Figure 6b, disturbing lights are used to modify the training environment, and these can be integrated with all the performance tests for training purposes. In addition to the cycle and the disturbing lights, CDs with various noises (e.g., white noise, noise of spectators in a sports competition) can also be used to create different training situations. These three training situations can be used separately, or the elements can be combined in different ways to create further training situations.

Another important element of the computerized mental training system is a wireless biofeedback system.

Figure 4. Illustration of the Movement Detection Test (BDT).
The hardware of the biofeedback system from the Dr. Schuhfried Company includes: (1) a desktop or laptop with biofeedback programs, (2) one client monitor connected to the desktop or laptop, and (3) three radio modules. The first module has three different sensors that record temperature feedback (TEMP), pulse amplitude and frequency feedback (PULS), and skin conductance (EDA) separately. The second module can be used to analyze the client’s breathing pattern and to compare abdominal and thoracic breathing, if it is connected with an add-on module for these purposes. The third module can be connected to two 2-pole and one 1-pole electrode cables in order to measure muscle tension. With wireless design, the long cables leading to a central unit for signal transmission are replaced by radio modules. Only very short sensor cables are needed to pass the signal from the sensors to the radio modules, which prevent the feeling of being wired. During the training session the client receives visual and acoustic feedback on his or her physiological reactions. Various feedback options are available in the system.

Biofeedback training in combination with cognitive strategies can be used to create a new training situation in order to learn how to monitor the psycho-physiological
state. The development of cognitive strategies for respiration control with the assistance of the biofeedback equipment is a good application of biofeedback tools in the computerized mental training system. The whole training program consists of three steps:

1. Introduction of the basic concept of deep abdominal breathing for relaxation purposes, as well as the basic method of deep abdominal breathing;

2. Elaboration on strategies and training of deep abdominal breathing with the biofeedback system. The respiration training program in the biofeedback system can be used specifically for abdominal breathing training. At the beginning of the training session, the client is asked to breathe deeply several times using the abdominal style. The computer then analyzes the client's breathing pattern and immediately calculates an ideal respiration curve and displays the curve on the screen. After that, the client is asked to start his or her breathing training and to determine an appropriate strategy resulting in a fit with the ideal respiration curve;

3. Mental training in the computerized system. The client is asked to start a training session assisted by the system, following the abdominal breathing training. It is assumed that the relaxed state after the breathing training will improve the subsequent training effectiveness.

In addition, the biofeedback can be linked to VTS-based training by a marker cable (see Figure 7). This connection makes it possible to record physiological data during the training period, and to determine the optimal physiological state corresponding to a peak performance.

For example, the EMG value of the client’s arm can be recorded during several training sessions and then analyzed to determine the optimal value for peak performance. This value can then be used as a threshold in future training sessions.

### Field Test and Training System

As with the computerized mental test and training systems, a field test and training system is also under ongoing development. At ASPIRE, the applied sport psychology staff strives to build on participants’ learning from the computerized testing and training by challenging participants in other areas. A setup and sequence of computerized MTTS → practical/virtual laboratory → field training has been established. Testing and training on the computerized MTTS and in the practical/virtual labs has proved to be a very enjoyable, efficient, and safe way of learning mental skills and strategies before attempting them in real sport. Virtual sports games and practical lab games such as motor slot racing are examples of fun yet challenging ways of transferring learning from the computerized MTTS, and can even lead to the development of additional mental strategies.

In addition to furthering mental training in a different environment, practical lab tests are ideal ways of validating tests done on the computerized MTTS. A good example of this is a lab tool (game), named Action-Check, created and designed by ASPIRE’s sport psychology team. The “game” is essentially a cross between several ball sports (e.g., football, bowling, basketball, golf-putting), and its purpose is to assess a combination of achievement motivation and risk-taking behavior. The link between achievement motivation and risk-taking (both of which can be assessed on the computerized MTTS and by the Action-Check) is significant. Reference will be given to the theories behind the tests and the subsequent development of the lab game.

Risk Choice, also known by the test label RISIKO, is a test on the computerized MTTS for assessment of general readiness to take risks. Readiness to take risks describes a global style of behavior in respect to which differences between individuals can be identified (Andresen, 1995; Schwenkmezger, 1988). Based on the Risk Choice Model (Atkinson, 1957), one’s overall readiness for risk-taking is assessed in RISIKO by examining achievement motivation, as exposure to real risk for experimental purposes cannot be ethically
Achievement motivation in general is the need that drives an individual to improve, succeed, or excel. The test itself consists of a moving ball on the screen, which undergoes unpredictable changes in direction. The participant’s task is to use a control lever to create a circle that encloses the ball and to keep the ball within the circle. Points are scored for keeping the ball within the circle. The aim is to score as many points as possible. The participant chooses the radius size before each run. A smaller radius can potentially lead to more points being scored but the risk is higher as the task becomes harder with a decrease in radius size. The test is made up of four phases, with different conditions in each phase: (a) ball moves slowly, (b) ball moves fast, (c) control of circle is rotated counter-clockwise by 90 degrees, and (d) conditions of the first three phases occur apparently at random.

The Risk Choice Model examines factors that influence the selection of the level of a challenge. Atkinson (1957) assumes that one acts in accordance with the probability of being able to cope with the selected level of difficulty. The easier the task, the greater is the probability of success. However, people also strive for challenges. The level of challenge describes what an individual intends to do (Rheinberg, 1997). Furthermore, difficulty of a task is always subjective (Rheinberg). An extremely difficult task has a very high incentive for success; however, realistically, achievement motivation is very low, as the probability of success is close to zero. Likewise, achievement motivation is equally low in the case of simplified tasks, where there is a 100% certainty of accomplishment.

In addition to having an intensity aspect, the Risk Choice Model also assumes that achievement motivation has a direction component; that is, whether a person anticipates and organizes his or her actions for probable success or to prevent failure when facing a task. Thus, individuals can be described as either “success-approaching oriented” or “failure-avoidance oriented.” In brief, success-approaching oriented individuals prefer moderately high goals. Therefore, they choose an open and undetermined outcome of which they have a high probability of being able to influence through the exercise of their skill (Otti, 1993). Their approach to goal setting is flexible and takes into account current performance and the associated prospects of success. In contrast, failure-avoidance oriented individuals set goals that are either so low that they are almost certain to be achieved, or so high that they would be unattainable for most people. Following failure, such people stick to pre-determined goals and do not take the current performance level and associated prospects of success into account. Their approach to goal setting, therefore, is rigid.

While achievement motivation is examined in RISIKO for the purpose of assessing readiness to take risks, another computerized MTTS test, the Objective Achievement Motivation Test (OLMT), examines achievement motivation in a different way. The OLMT provides information on the effort put into working the test under various significant motivating conditions. It consists of three subtests, each of which is built around a particular incentive or stimulus that is relevant to motivating respondents’ performance: incentives arising from the task itself, from setting one’s own goals, and from competition. The task in each subtest is simply to cover as much ground in a “route” as possible in ten seconds, by pressing appropriate buttons for moving left or right.

In both OLMT and RISIKO, there is an opportunity for the test administrator to observe the participant’s intentional organized behavior. Useful information can be gathered on the approaches to goal setting (see, e.g., Weinberg & Butt, 2005). It is also useful to observe tactical, physical, and mental strategies employed by participants for improving or for striving to reach a target. This information can later be used in making participants aware of their behavior, and when necessary, it can form the basis of advice recommending more efficient strategies. Moreover, the use of a DVD camcorder for immediate visual feedback has proven to be popular and informative among test participants for increasing their awareness of existing behavior and for the explanation of action organization, action control, and recommendations for modifications by the psychologist.

While RISIKO and OLMT provide valuable information on readiness to take risks and achievement motivation, respectively, Action-Check was specially developed for combining the best elements of both tests and to serve as a means of validating the results. As already mentioned, this lab task is designed to mimic several ball sports. The task is to kick (or throw, or roll) a ball into a hole. As illustrated in Figure 8, the hole is situated on a raised platform. The goal of successfully kicking the ball into the hole is attainable but challenging. The greater the distance is between ball and hole, the more difficult the task.

Action-Check is a tool under ongoing development,
with continual improvements being sought in regard to rules and interpretations of the concept of action (intentional organized behavior). At the time of writing this chapter, special rules are in place for assessing readiness to take risks and also for assessing the intensity and direction of achievement motivation. A set of rules for the “game” were agreed upon based on the Risk Choice Model (Atkinson, 1957). The objective of the task, as far as the participants are concerned, is to score as many points as possible. The participant has a choice of where to shoot from. As seen in Figure 8, there are eight white strips on the left side of the green carpet, each 45 centimeters apart. Shots must be taken from a point level with one of these strips. The strip closest to the hole provides a score of +1 for a successful shot or -1 for a miss. For each strip one moves away from the hole, one can score an extra point, but also potentially lose an extra point for a miss. Therefore, the strip farthest from the hole, which represents the greatest challenge or risk, provides scores of +8 or -8, depending on the success of the shot. To make the game more strategic and risk-laden, participants start with a 20-point credit. If they reach zero at any point, they are disqualified. So, for example, three consecutive misses from the start at the 7-point strip will cause disqualification. Therefore, the risk of going for higher points is tactically, as well as practically, greater.

In practice, Action-Check provides an excellent opportunity for observing intentional organized behavior (actions). Firstly, one can observe any changes in behavior, from a pre-task familiarization exercise to the exercise itself. Secondly, one can observe from the sequence in the strategy of selecting starting positions, along with the success of the shots (i.e., flexibility of goal-setting), whether their achievement motivation is high or low, whether they are success-approaching or failure-avoidance oriented, and whether their readiness to take risks is high or low. Furthermore, variety can be introduced into this lab game. For example, as with the OLMT, one can observe how participants intentionally behave under different motivating conditions. That is, one can compare or contrast the behavior of an individual when in a competitive situation with other participants when he or she is doing the task alone, and when setting his or her own goals. Additionally, if monitoring competitive behavior, it is worth asking participants in which order they would like to compete (e.g., first, second, last). Information gleaned from this may provide further indications about participants’ achievement motivation. For example, one could argue that by choosing to go first, the participant is not easily influenced by competitors’ actions. Instead, the participant chooses to focus on his or her own performance, a possible indicator of a success-approaching orientation. If, for example, a participant immediately chooses to go last, it might indicate the existence of strategic intentions that will focus specifically on observations of the competitors’ actions. Depending on the flexibility of goals in this scenario, one could make a case that the participant is either success-approaching- or failure-avoidance-oriented.

The link between the aforementioned computerized MTTS tests (RISIKO and OLMT) and the specially-built Action-Check is one example of the ASPIRE sport psychology team’s approach to transferring learning and training from one setting to another. The lab task also serves to validate the MTTS tests. Meanwhile, another example of a popular practical lab tool used for mental training purposes is an advanced motor slot racing game (see Figure 9). This will now be discussed briefly.

The motor slot racing game has proved to be an exciting addition to the ASPIRE sport psychology unit’s practical lab. The task of completing a lap on the race track in good time requires acute reaction times, concentration, and emotional control. Again, this tool fits in nicely in the environmental sequence: computerized MTTS → practical/virtual lab → field. In the first stage of this sequence, as mentioned previously, mental strategies are taught and trained depending on the situation. For example, participants may benefit from advice on mental and physical pre-task preparation, or perhaps from cognitive strategies for improving concentration and overcoming mistakes. It is strongly encouraged that lessons learned during the computer-assisted element of...
training be used in training on the motor slot racing (practical lab task).

The motor slot racing tool is also an excellent way of introducing imagery in a practical way (Hackfort & Munzert, 2005; Schack, 2004; Schack & Hackfort, 2007). In a training scenario, participants are required to build up a mental representation of the track and focus on the rhythm with the intention of being able to complete laps afterwards with their vision occluded. An example of a task on the slot racing track with vision occluded is ten timed trials to complete ten laps without crashing or stopping. When the visual sense is absent, the participant has to compensate by heightening other senses (e.g., hearing the car, touching the control) and blending this information with a sense of lap timing to create a perfect rhythm. Evidence from trials to date with this training approach suggests that such an internal-focused and process-oriented approach to training can produce sharpened performance outcomes when final testing (the same design as training) is done with the eyes open. While improved performance on a slot racing game is not the most important objective of mental training, the raw time figures from the lap counter serve to “convince” the participant of the success of their chosen mental strategies. The message from this lab training is then to take and apply this new learning in real-life sport (the final step in the sequence: computerized MTTS → practical/virtual lab → field).

Summary

At present, computer and other relevant technologies are playing an increasing role in sport diagnosis and training. The MTTS, based on an action-theory concept, includes a computerized mental test system and a computerized mental training system. The fundamental idea is to create specific person-task-environment constellations as action situations for testing and training purposes. In the computerized mental test system, the performance-oriented tests, which require the client to respond to various special tasks by pressing button(s) and/or foot pedal(s), can provide more accurate performance-relevant information than traditional paper-and-pencil inventories, and the utility of mental strategies (e.g., imagery, deep breathing, and muscle relaxation) can be observed directly during the test. The computerized mental training system, conceptually, is a combination of tasks of the mental test system and the creation of special training situations. By modifying the person-task-environment constellation, a series of highly individualized and sport(s)-specific training programs can be tailored. In the process of training, various mental skills such as imagery, relaxation, and self-talk, as well as mental preparation, are learned. This new learning is further tried and developed in the practical/virtual lab (e.g., slot racing), and then, ultimately, the field (i.e., real-life sport). This sequence of mental training is currently being used by the authors with student-athletes at the ASPIRE Academy for Sports Excellence in Doha, Qatar. Specially-tailored training programs in the framework of this approach have already been developed for some elite sports (e.g., Formula One racing and squash). Subjective feedback from participants on such programs reveals a feeling of a decrease in effort/energy for the same or improved performance. Objective test results from post-training testing support this positive feedback with evidence of improved performances on specific tests. Likewise, observation during final testing can confirm whether or not newly-learned mental strategies are employed.

MTTS is an ongoing developing system. At present, work on further tools for testing and training purposes is in progress.

References


