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ELABORATION AND APPLICATION OF A MENTAL TEST AND TRAINING SYSTEM (MTTS) TOOL IN THE FRAME OF ACTION-THEORY-BASED MENTAL ASSESSMENT AND TRAINING APPROACH

Dissertation
zur Erlangung des Grades
Doktor der Philosophie

vorgelegt von

HAO LIU

Guangzhou, China

Tag der mündlichen Prüfung: 22. 02. 2012

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ABSTRACT

Mental testing and mental training have long remained dominant domains in the work of applied sport psychologists. As a consequence of their work in the domains, numerous tests and tools for mental diagnosis and mental training have been developed.

The MTTS (designed and developed by Hackfort; see Hackfort, Kilgallen, and Liu, 2009) is an action-theory-based mental test and training system, in which tests can be used individually or in combination with other setups for mental testing and/or training purposes. The main purposes of the present paper are to elaborate on a MTTS tool and to present and examine a practical application of that tool in the frame of an action-theory-based mental assessment and training approach. The paper was composed of seven sections:

1. Foreword.

2. A recapitulatory overview of mental assessment and training in sport. In this section, definitions of some basic terms, the framework for understanding mental assessment and mental training, the objectives and methods of mental assessment in sport, as well as the phases of mental skills training programs and the key steps for conducting mental training in sport are summarized from various literature.

3. Elaboration of the MTTS tool in the frame of action-theory-based mental assessment and training approach. In this section, the framework of action-theory-based mental assessment and training approach are presented firstly, and then the report is given about the elaboration of the MTTS tool.

4. Examination of the Movement Detection Test (MDT) in a sample of Chinese elite athletes. The MDT includes three test forms, i.e., MDT-S1, MDT-S2, and MDT-S3. The MDT-S1 was designed to detect the occurrence of movement only; the MDT-S2 was designed to detect the occurrence of movement and identify the direction of the movement; and the MDT-S3 was designed to detect the occurrence of movement and identify the movement direction that is determined by changing color coding. In this section, the reliability and validity of the MDT-S2 and MDT-S3 have been examined in a sample of Chinese elite athletes. The results suggested that the MDT-S2 has sound reliability and validity. Regarding the MDT-S3, although the results indicated it has good reliability, its validity was not proved. The most likely reason for this is that, strictly speaking, the usage of MDT-S3 is predominantly to train movement detection ability.

5. The practical application of the MTTS tool in the frame of action-theory-based mental assessment and training approach. In this section, a mental assessment and training intervention for elite athletes have been implemented and examined. The purposes of the intervention were to assess and train athletes' ability to optimize action situations, as well as the mental skills that was involved in the process of optimization of action situations. The ability to optimize action situations was evaluated from three aspects: (a) performance in the motor-performance test, (b) perceived effort in the testing, and (c) flow experience during the testing. The results indicated: (a) experimental group significantly improved ability to optimized action situations, while no significant change was identified in the control group; (b) significant improvements in the mental skills including imagery and thought-stopping were identified after a five-session mental training intervention; (c) compared with the use of self-talk in the pre-intervention assessment, the participants in

the experimental group increased the usage of positive self-talk and decreased negative self-talking in the post-intervention assessment.

6. Overall discussion on both an experimental study and an intervention study.

7. Summary and perspectives including some critical reflections and ideas for future research and improvements.

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1 FOREWORD

Research in sport science disciplines over the past decades have indicated that peak performance in sport is no longer simply concerned with an athlete's physical abilities, physiological states, and technical ability, but also with his or her mental superiority. The contribution of mental aspects to sport excellence is extremely noticeable to top-level athletes because they exhibit minimal differences in technical ability and physical fitness, and thereby those who possess mental edge skills are often believed to have greater chance of success than their counterparts who lack of such skills (e.g., Jones, Hanton, & Connaughton, 2002). It is even believed that "although sport is played with body, it is won in the mind" (Moran, 2004, p. 4).

Nowadays the importance of mental edge to sport success has been widely recognized by athletes, coaches, and sports administrators, and an increasing number of sport psychologists have been invited to contribute their expert applied work to athletes in both individual and team sports (see Dosil, 2006). Hackfort, Kilgallen and Liu (2009) argued that sport psychology was often applied in elite sport for (a) identifying and selecting sporting talent, (b) enhancing athletic performance through mental training, mental preparation, and learning strategies, and (c) ensuring athletes maintaining mental stability and coping conflicts and crises successfully in competitive situations. Apparently, in order to fulfill these tasks, it is necessary to conduct a variety of psychological assessment as well as elaborately tailored mental training interventions that base on the information derived from the previous assessment.

At present, mental assessment and mental training tools as well as the assessment and training programs designed on the basis of the tools have been ubiquitous in sport psychology literature. The development and application of these tools and programs allow the scientificity of the applied sport psychology service to be taken seriously, and increase the effectiveness and credibility of the service. Although the great majority of the assessment tools are paper-and-pencil based (see *Advances in Sport and Exercise Psychology Measurement*, Duda, 1998; *Directory of Psychological Tests in the Sport and Exercise Sciences*, Ostrow, 1996), more and more computer-based modern tools are adopted in sport psychology. In these modern tools, computer system are often used 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” (Hackfort et al., 2009, p. 15).

Hackfort et al. (2009) argued that “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” (p. 15). As a consequende, Hackfort took the initiative and (see Hackfort et al., 2009) developed with his research group an approach for the development of an action-theory based Mental Test and Training System (MTTS), which include a mental test system and a mental training system. In the current paper, a report is given focusing on the elaboration of a MTTS tool and the examination of a practical application of the tool in the frame of an action-theory based mental assessment and training approach. The MTTS tool was discussed from mental assessment rather than mental test standpoint because, when clients responded to tasks provided by the tool other methods (e.g., behavior observation, and interview) in addition to tests could be used to collect more performance-relevant information (e.g., the change of behavior, the utility of mental strategies or mental skills) for diagnostic purpose and, conceptually, an evaluation process is termed as mental assessment rather than mental test or mental testing, if several methods are involved in the process.

2 A RECAPITULATORY OVERVIEW OF MENTAL ASSESSMENT AND TRAINING IN SPORT

2.1 MENTAL ASSESSMENT IN SPORT

Mental assessment is one of the central tasks in applied sport psychology. Practitioners conducted mental assessment for various purposes, for instance, identifying and selecting talented athletes, monitoring overtraining or burnout in the training, understanding athletes' psychological states prior to a competition, designing individualized psychological training interventions, etc. At here a brief overview of mental assessment in sport psychology is given. Specifically, firstly the term mental assessment and two related terms – mental test and mental testing, as well as the distinctions among these terms are defined and clarified, then a framework for understanding mental assessment in applied sport psychology offered by Vealey and Garner-Holman (1998) is introduced, next the main objectives of mental assessment in sport are identified, and finally the common methods of mental assessment in sport are discussed.

2.1.1 Defining and Differentiating Mental Assessment and Related Terms

> For reasons that are mostly related to the marketing of tests, some test authors and publishers have begun to use the word *assessment* in the titles of their tests. Thus, in the mind of the general public the terms *assessment* and *testing* are often seen as synonymous. This is an unfortunate development. (Urbina, 2004, p. 23)

The same phenomenon exists in the field of sport psychology as well. The term assessment was also used by some authors in the title of their tests (e.g., The Ottawa Mental Skills Assessment Tool; Durand-Bush, Salmela, & Green-Demers, 2001), or in the title of the books pertaining to psychological testing (at least parts of the books are related to psychological testing) (e.g., *Assessment in Sport Psychology*, Nideffer & Sagal, 2001). Therefore, prior to a discussion in more detail of mental assessment in sport psychology, it seems to be necessary to clarify the definitions of mental assessment, mental test and mental testing, as well as the distinctions between the terms.

2.1.1.1 Defining mental test

The first and most general interpretation of the term *test* listed in *The Penguin Dictionary of Psychology* (Reber & Reber, 2001) is "any procedure used to measure a factor or assess some ability . . . To prevent confusion amid this plethora of assessment devices, it is usual to append a qualifier to denote the type and form of test under consideration" (p. 743). Based on the interpretation of test, a definition of *mental test* was offered in the same dictionary as well: it refers to, "generally, any test that is designed to evaluate a particular mental ability or performance" (p. 431).

Mental test was also defined by many authors in their publications. For example, the definition offered by Anastasi (1988), one of the best known experts in the field of psychological testing, is one widely adopted even at present. According to Anastasi, a *psychological test* is an objective and standardized measure of a sample of behavior. On the basis of this interpretation, a more comprehensive definition of psychological test was given by Urbina (2004). In the light of Urbina's definition, "a psychological test is a systematic procedure for obtaining samples of behavior, relevant to cognitive or affective functioning, and for scoring and evaluating those samples according to standards" (p. 1). Following the definition, Urbina elaborated on the basic elements of the definition of psychological test (Table 1).

Table 1. Basic elements of the definition of psychological tests (Urbina, 2004, p. 2).

Defining Element	Explanation	Rationale
Psychological tests are systematic procedures.	They are characterized by planning, uniformity, and thoroughness.	Test *must* be demonstrably objective and fair to be of use.
Psychological tests are sample of behavior.	They are small subsets of a much larger whole.	Sampling behavior is efficient because the time available is usually limited.
The behaviors sampled by tests are relevant to cognitive or affective functioning or both.	The samples are selected for their empirical or practical psychological significance.	Tests, unlike mental games, exist to be of use; they are tools.
Test results are evaluated and scored.	Some numerical or category system is applied to test results, according to preestablished rules.	There should be no question about what the results of tests are.
To evaluate test results it is necessary to have standards based on empirical data.	There has to be a way of applying a common yardstick or criterion to test results.	The standards used to evaluate test results lend the only meaning those results have.

In summary, the definition given in the dictionary provides a most general interpretation of mental test. In terms of this interpretation, even the general public have no difficult to identify a psychological test. The other two examples of definitions, however, provide a more academic interpretation of psychological test for the professionals in the field. Academically, a procedure cannot accurately be called a psychological test unless it meets requirements listed above. It is these requirements that psychological tests are allowed to be take seriously as "scientific" tools. Besides the elements listed in the Table 1, there are two points need further clarification to help understanding psychological test. The first point concerns how to understand "psychological tests are samples of behavior". In science of psychology, the constructs to be researched cannot be observed directly, which makes them are not able to be measured directly. To measure a psychological construct, researchers have to operationally define it in terms of a sample of behavior believed to represent it, and then measure it through the sample of behavior. From this point of view, a psychological is a sample of behavior. It deserves to be noted that the term *behavior* is used here in a very broad sense to include performance of some tasks or activities, as well as self-reported attitude, feelings, and perceptions, etc. The second point concerns with how to understanding the term *procedure*. It is used here to refer to any technique manipulated to obtain samples of behavior. It usually includes paper-and-pencil or computerized questionnaires, as well as various devices.

2.1.1.2 Defining mental testing

The term *psychological testing* has been defined by authors in some measurement textbooks. For instance, Cohen and Swerdlik (2002) defined psychological testing as "the process of measuring psychological-related variables by means of devices or procedures designed to obtain a sample of behavior" (p. 4). Domino and Domino (2006) defined psychological testing as "the psychometric aspects of a test (the technical information about the test), the actual administration and scoring of the test, and the interpretation made of the scores" (p. 2).

Summarizing various definitions of psychological testing, the following standpoints of psychological testing can be concluded: (a) Psychological testing is a professional activity in which only tests are used as tools. (b) A completed psychological testing is a process including administration, scoring, and interpretation of data from tests. (c) In the process of psychological testing, objectivity and standardization of administration, scoring, and interpretation are emphasized. (d) The interpretation in psychological testing mainly concerns magnitude of the constructs being tested, as well as the comparison with norms, but concerns not making diagnosis, predictions, and decisions. In addition, with the development of IT technique, more and more professionals begin to adopt computer-assisted testing in their research and practical work. With the internet and computer, testing can even be conducted when the administrators are absent. It is interesting to note that the objectiveness and standardization will be improved when computer-assisted testing is adopted.

2.1.1.3 Defining mental assessment

In the early measurement textbooks, authors (e.g., Maloney & Ward, 1976; Sundberg, 1977) began to define the term *psychological assessment* and to use it instead of psychological testing to describe assessment-related activities. According to Sundberg, psychological assessment refers to a complicated process with the purpose of "developing impressions and images, making decisions and checking hypotheses about another person's pattern of characteristics that determines his or her behavior in interaction with environment" (p. 21). Cohen and Swerdlik (2002), on the bases of comparing with the definition of psychological testing, defined psychological assessment as "the gathering and integration of psychology-related data for the purpose of making a psychological evaluation, accomplished through the use of tools such as tests, interviews, case studies, behavioral observation, and specially designed apparatuses and measurement procedures" (p. 4).

Reviewing various definitions of psychological testing, two standpoints are to be highlighted: (a) Psychological assessment is a professional activity in which various tools including psychological tests, interview, behavior observation, etc, are involved. (b) Psychological assessment is a complicated process. According to Urbina (2004), psychological assessment starts with identifying assessment goals and usually ends with written reporting or verbal communication with the person or persons who requested assessment, in between the two points, selecting of appropriate instruments, administrating of instrument and scoring, interpreting data, making diagnosis/predictions/decisions are included.

2.1.1.4 Differentiating mental test, mental testing, and mental assessment

The distinctions between mental test and mental testing, mental assessment are obvious. As defined in the above, tests are merely tools. They are the only type of tool in mental testing, while in mental assessment, they are merely one of the types of tools used.

Mental testing and mental assessment, however, differ from each other in many ways. The following is highlighting three main distinctions between them:

1. The scope of processes. Although psychological testing and psychological assessment are both processes, the scope of each process is different. Psychological testing is a narrower process including only administration, scoring, and interpretation of psychological tests. However, psychological assessment is a complex process including identification of assessment goals, selection of tools, administration, scoring, and interpretation of the outcomes, making inference, and reporting/communicating assessment conclusions.

2. The tools. In psychological testing, tests are the only type of tool used, while in psychological assessment, different types of tools including various tests are used. Of course, psychological assessment can be conducted only with psychological tests as tools.

3. The objectives. The ultimate objective of psychological testing is to obtain magnitude of the constructs measured, and to compare the magnitude with norms; while the ultimate objectives of psychological assessment is to make diagnosis, predictions, and decisions.

In addition, psychological testing can be seen as a part of psychological assessment when tests are used as a type of tool in the psychological assessment.

The distinction between psychological testing and psychological assessment was also discussed by Urbina (2004) in her book *Essential of Psychological Testing*. According to Urbina, psychological assessment differs from psychological testing in 10 typical dimensions (Table 2)

Table 2. Difference between psychological testing and assessment (Urbina, 2004, p. 25).

Basis	Psychological Testing	Psychological Assessment
Degree of complexity	Simpler; involves one uniform procedure, frequently unidimensional.	More complex; each assessment involves various procedures (interviewing, observation, testing, etc.) and dimensions.
Duration	Shorter, lasting from a few minutes to a few hours.	Longer, lasting from a few hours to a few days or more.
Sources of data	One person, the test taker.	Often collateral sources, such as relatives or teachers, are used in addition to the subject of the assessment.
Focus	How one person or group compares with others (nomothetic).	The uniqueness of a given individual, group, or situation (idiographic).
Qualifications for use	Knowledge of tests and testing procedures.	Knowledge of testing and other assessment methods as well as of the area assessed.
Procedural basis	Objectivity required; quantification is critical.	Subjectivity, in the form of clinical judgment, required; quantification rarely possible.
Cost	Inexpensive, especially when testing is done in groups.	Very expensive; requires intensive use of highly qualified professionals.
Purpose	Obtaining data for use in making decisions.	Arriving at a decision concerning the referral question or problem.
Degree of structure	Highly structured.	Entails both structured and unstructured aspects.
Evaluation of results	Relatively simple investigation of reliability and validity based on group results.	Very difficult due to variability of methods, assessors, nature of presenting questions, etc.

2.1.2 A Framework for Understanding Mental Assessment in Applied Sport Psychology

The assessment approach in the field of applied sport psychology is diverse, since the education and training backgrounds of the assessment professionals are different. Of course, contentious issues arose along with the establishment of diverse assessment approach, e.g. professional boundary, perceptions of assessment effectiveness.

Vealey and Garner-Holman (1998) argued that the assessment in applied sport psychology concerned with two broad categories of issues. The first category concerned with practical issues such as "what approaches to or methods of assessment are most effective at what times for which athletes" (p. 434), and the other category concerned with ethical issues such as "who is qualified to use which assessments as well as how these assessments should or should not be used (such as for team selection or retention)" (p. 434). To illustrate the organizational scheme for issues surrounding assessment in applied sport psychology, Vealey and Garner-Holman presented a multidomain assessment framework for applied sport psychology (see Figure 1).

As shown in Figure 1, there are four essential domains should be taken into account when conducting assessment and subsequent intervention with athletes. The first domain concerns with individual characteristics of the athletes, e.g., age, level, goals and personality; the second to be considered is with regard to the contextual characteristics such as coaches, teammates, family, and time of competitive season; the third is pertinent to the organizational culture of sport based on the type and level of sport and goals of the organization; the last domain includes the characteristics of consultant, e.g., training, competency, philosophy, and style. Vealey and Garner-Holman (1998) stated that practical and ethical issues related to mental assessment would emerge if any domain was ignored (e.g. practical and ethical issues arise when a professional conducting assessment misperception his or her expertise), or if incongruency occurs between these domains (e.g. practical and ethical issues arise when the philosophy of a professional are opposite to the characteristic of an athletes for assessment.

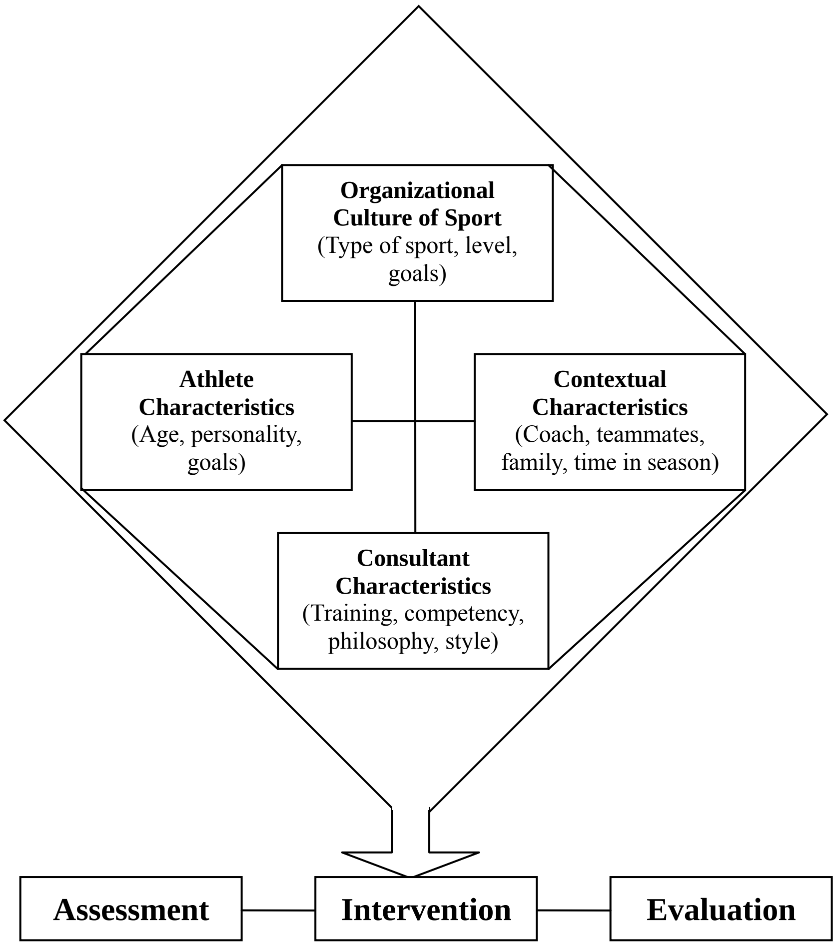


Figure 1. The multidomain assessment framework for applied sport psychology (Vealey & Garner-Holman, 1998, p. 434).

Without question, the framework is valued for its comprehensive. In the framework, various practical and ethical issues surrounding assessment in applied sport psychology are discussed from four domains, namely, athlete characteristics, contextual characteristics, organizational culture of sport, and consultant characteristics. Vealey and Garner-Holman (1998) advocated that, although the assessment approaches are diverse, all assessment should take into account these four domains.

However, there is a serious lack of dynamic systematic approach based insight into the issues surrounding the assessment. That is, although four domains are presented and suggested to assessment, the dynamic interrelationships among these domains are not illustrated, and where to start and end an assessment is also not discussed. In addition, although in the multidomain framework it emphasizes assessing individual and contextual characteristics, the other key aspect, *task*, is ignored in the framework. In most cases, the athlete's interpretations of contextual characteristics as well as the fit between individual and contextual characteristics vary with different tasks. Thus to assess individual and contextual characteristics without regard to specific tasks is inappropriate. Taking these disadvantages into account, an action-theory based mental assessment framework will be presented in the following section of this paper.

2.1.3 The Objectives of Mental Assessment in Applied Sport Psychology

As stated at the beginning of this section, mental assessment is widely used by practitioners in applied sport psychology with varying purposes. In some literature, the objectives or uses of mental assessment have been identified and classified by authors. Following are some examples of this.

Vealey and Garner-Holman (1998) stated that applied work in sport psychology includes both professional practice (e.g. intervention and mental training) and applied intervention research, and the uses or objectives of mental assessment in each were different. There are two common uses of mental assessment in professional practice: (a) pre-intervention assessment, which serves as an examination and analysis of the athlete's thoughts, feelings, and behaviors within his or her specific sport context prior to designing and implementing an intervention, as well as the basis line for evaluating intervention effects; (b) intervention assessment, which is conducted to "provide feedback to athletes regarding their specific thoughts, feelings, and behaviors and also to encourage them to engage in critical self-reflection and self-assessment" (p. 438). In the applied intervention research, mental assessment is conducted with three objectives: (a) to predict outcomes of importance (e.g., performance, flow, success, injury vulnerability) through measuring some psychological constructs (e.g., arousal, motivation, stress and coping, cognitive and somatic anxiety), (b) to assess the change or changes of one or several psychological constructs over time in response to some types of treatment, and (c) to evaluate interventions.

McCann, Jowdy, and Van Raalte (2002) summarized six common uses of assessment in applied sport psychology: (a) establish a baseline of mental skills, (b) monitor overtraining in athletes effort to obtain peak performance, (c) determine the role of anxiety in an athlete’s performance, (d) as part of team-building intervention, (e) diagnose clinical issues, and (f) neuropsychology testing.

Sagal, Sagal, and Miller (2004) stated that the uses of mental assessment depended on “what exactly does a sport psychology professional need to understand about an individual to help” (p. 178). Some professionals think that a clinical understanding is necessary, but most professionals believe that a performance-related understanding is the most important. Therefore, Sagal et al argued that there are four primary applications of assessment in applied sport psychology: (a) performance enhancement (individual or team), (b) athlete selection and screening, (c) injury recovery, and (d) sport enjoyment.

Of the three examples given above, McCann et al.’s (2002) summarization is only a list of some but not all of uses of mental assessment in applied sport psychology. For example, the assessment of environment (social and physical) in which athletes live, train, and compete is not mentioned. Sagal et al.’s (2004) summarization, on the contrary, is too brief and general to instruct the assessment work in practice. Vealey and Garner-Holman’s (1998) summarization is relatively comprehensive, in which the objectives of mental assessment in both professional practice and applied research have been elaborated. However, a systematic approach based insight into this issue is still lacked. In the next section, the objectives of mental assessment will be presented when discussing an action-theory based mental assessment frame. According to this frame, person, environment, and task are three essential components within a system. The objectives of mental assessment are to assess these components separately, or to assess the fit between person and environment with specific tasks.

2.1.4 The Methods of Mental Assessment in Sport Psychology

In sport psychology, practitioners adopt different methods or instruments in their assessment work. The common employed methods include psychological testing, inventories, surveys, questionnaires, psychophysiological measures, interview, behavioral observation, videotape review, and third-party anecdotal data collection (from parents, coaches, teammates, etc.) (McCann, Jowdy, & Van Raalte, 2002; Sagal, Sagal, & Miller, 2004; Vealey & Garner-Holman, 1998).

From current literature available in sport psychology, several basic conclusions on mental assessment methods can be highlighted/ emphasized:

1. The common assessment methods that have been adopted in sport psychology literatures can be classified into three categories: (a) test, which includes both paper-and-pencil and computerized inventory/survey questionnaire for measuring mental traits and states, as well as increasing computer-assisted tools for measuring psychophysiological response and mental performance; (b) behavioral observation, which includes on-site observation, watching TV, videotape review, and athletes' self-monitoring; (c) interview, which includes interviewing with athletes as well as other related person such as coaches, teammates, family members.

2. In the applied work, a sport psychology practitioner may prefer to adopt one or several methods, depending on the practitioner's theoretical orientation (for example, a behavioral sport psychologist may prefer to use behavior observation in his or her assessment work), the client-athletes' personal information (e.g., athletes' age, education level, gender, etc), the objectives of mental assessment, the conditions under which mental assessment occurs, and so forth. Vealey and Garner-Holman (1998) administered a survey to 68 consultants in North America, Europe, and Austria to investigate the percentage of times they used inventories/questionnaires, interviews, and observations in the assessment of athletes. The results indicated that interview was the mostly used method and accounted for 57.2%, which was followed by behavioral observation accounting for 21.2% and various tests accounting for 17.3%. Sagal et al. (2004) also regarded interview as the most common used assessment method in sport psychology.

3. In applied sport psychology, many practitioners adopt several types of assessment methods simultaneously to achieve a single objective, or to evaluate a person from multi-aspect. Gardner (1995) advocated the multiple usages of assessment methods to develop a full understanding of athletes. McCann et al. (2002) also suggested using several methods to get a comprehensive understanding of an athlete.

4. Mental test, especially paper-and-pencil test, is the assessment method used by most of sport psychology practitioners. Gould, Tammen, Murphy, and May's (1989) investigation indicated that 63% sport psychology consultants regularly use inventories and/or questionnaires in their intervention work with athletes. Vealey and Garner-Holman's (1998) investigation also indicated that 75% investigated sport psychology consultants in North America, Europe, and

Australia reported that they had used inventories or questionnaires in their work.

2.2 Mental Training in Sport

Mental training is another essential topic being extensively investigated and applied in sport psychology. Vealey (2007) pointed out that the published literature have indicated that systematic application of mental training in sport was first emerged in the former USSR in 1950s (Ryba, Stambulova, & Wrisberg, 2005; J. M. Williams & Straub, 2006). After that mental training for athletes has gradually become a major focus for research and practice in sport psychology worldwide. Within multifarious study and practice pertaining to mental training, different philosophies, models, techniques and strategies are utilized and the effectiveness of mental training are investigated by sport psychology practitioners.

On the background of the discussed literature a brief overview of mental training in sport can be given now: firstly, mental training and mental skills training are defined; secondly, a framework for understanding mental skills training in sport psychology (Vealey, 2007) is introduced; thirdly, the popular fallacies for mental training in sport are presented; and finally, key steps for conducting mental training programs in sport are given.

2.2.1 Defining Mental Training and Mental Skills Training

2.2.1.1 Defining mental training

The term *mental training* refers to different concepts and ideas when it was discussed in different contexts by various authors. According to Hackfort and Munzert (2005), this frequently used term allowed of three typical interpretations namely, training mental processes, mental practice, and mental preparation. The details of the three interpretations offered by Hackfort and Munzert were as follows:

1. Training of mental processes. Mental training is interpreted as *training of mental processes* when it is conducted with objective of improving mental functioning. Mental training with this interpretation concerns about training of three fundamental processes: (a) training of cognitive processes, which can be realized by techniques such as attentional control and concentration; (b) training of affective processes, which can be realized by such as emotional and anxiety control strategies; (c) training of motivational processes, which can be realized by strategies and techniques such as goal-setting and control volition.

2. Mental practice. Mental training is interpreted as *mental practic*e when it is implemented to facilitating learning process (acquisition) or to improving the execution of motor skills (performance). Basically, the mental practice in sport psychology is realized by putting its emphasis upon one of three different orientations: (a) visual-oriented mental practice. Imagery is the prototype of this kind of mental practice; (b) verbal-oriented mental practice. The characteristic forms of this kind of mental practice include self-talk with the strategies of self-argumentation, self-instructions, and self-suggestions, which have different meaning in influencing psychic processes; (c) kinaesthetic-oriented mental practice. This kind of mental practice always puts its focus on self-movement feelings.

3. Mental preparation. Mental training is interpreted as *mental preparation* when it is connected with idea of improving attitude, motivation, mood, etc before a competition. As the athletes toward competition and sees the problem, mental preparation is also viewed as one of "tuning" for performance. Generally, mental preparation is realized by three different strategies: (a) simulation of the

situation. This strategy is situation-oriented and focuses on the environment, and is characterized as “inner theater”; (b) control of the psychophysiological activation. This strategy is arousal-oriented and focuses on the person, and is characterized as “psyching up” and “psyching down”; (c) simulation of the action. This strategy is skill- or movement-oriented, and focuses on the task at hand. It can be viewed as a psychic warming up.

A compact overview provided by Gabler, Janssen, and Nitsch (1990) can help to get a more deep understanding on mental training in sport psychology. In the paper, Gabler et al discussed the goals, methods, and subjects of mental training. In Table 3, a summary of Gabler et al’s work was presented by Schuijers (2009).

Table 3. A summary of Gabler, Janssen, and Nitsch’s (1990) overview of mental training in sport (Schuijers, 2009, p. 106).

<table>
<tr><td rowspan="2">Intention</td><td>Goals</td><td colspan="2">Increasing action competency
Keeping (stabilizing) action competency
Minimal deterioration of action competency
Recovery of action competency
Controlled dismantlement (career ending) of action competency</td></tr>
<tr><td>usefulness</td><td colspan="2">Performance (training in sport)
Health (training through sport)
Quality of life (self-experience, self-realization, pleasure of life)</td></tr>
<tr><td rowspan="5">Subject</td><td>Basic accents – individual, and team</td><td colspan="2">Optimalization of action competency
Optimalization of self-influencing and other-influencing action competency
Optimalization of movement behavior under conditional, technical, and tactical aspects and/or social behavior (communication and interaction training)</td></tr>
<tr><td rowspan="2">Components of action competency</td><td>Performance skills</td><td>Performance potential
Stress resistance
Relaxation skills
Recovery skills</td></tr>
<tr><td>Performance readiness</td><td>Motivational qualities
Volitional qualities (willpower)</td></tr>
<tr><td rowspan="2">Psychological basis of regulation of sports actions</td><td>Psychological structures</td><td>Internal situation/ action representations
Claims, expectations, prejudices</td></tr>
<tr><td>Psychological skills for analysis/ coping</td><td>Optimalization of self-control
Optimalization of problem solving</td></tr>
<tr><td rowspan="4">Methods</td><td>Methodological point of view</td><td colspan="2">Etiological and/or symptomatical related processes
Motor, psychovegetative, and/or cognitive related processes</td></tr>
<tr><td>Intervention way</td><td colspan="2">(Self)-stimulation, -argumentation, -suggestion, -instruction, -knowledge
Active doing, observing, visualizing, thinking, (inner) speaking</td></tr>
<tr><td>Effectiveness principles</td><td colspan="2">Classic conditioning
Operant conditioning
Learning through insight</td></tr>
<tr><td>Execution form</td><td colspan="2">Individual and/or group training
Complete and/or partial training
Standardized training and/or adapted training</td></tr>
</table>

2.2.1.2 Defining mental skills training

In sport psychology, the term *mental skills training*, or *psychological skills training*, has often been used to substitute for the term mental training when it was discussed. Gould and Damarjian (1998) defined mental skills training as “the systematic employment of procedures that enhance an athlete’s ability to use his or her mind effectively and readily in the execution of sport-related goals” (p. 70). Weinberg and Gould (2007) defined mental skills training as “systematic and consistent practice of mental or psychological skills for the purpose of enhancing performance, increasing enjoyment, or achieving greater sport and physical activity self-satisfaction” (p. 250).

There are two critical points implied in Gould and Damarjian (1998) definition of mental skills training: (a) mental skills are understood as “procedures that enhance an athlete’s ability to use or her mind effectively and readily”; and (b) mental skills training is understood as systematic employment of mental skills in the execution of sport-related goals. In other words, the idea of training mental skills through systematic application/use (i.e. “employment”) in the execution of a task is advocated and emphasized. Such an understanding coincides with the idea of mental skills training presented in this paper, that is, to understand mental skills training from an action-theory approach. This idea will be elaborated in the following sections.

Weinberg and Gould’s (2007) definition, however, focuses on describing the purposes of mental skills training, these purposes include enhance performance, increase enjoyment, or achieving greater sport and physical activity self-satisfaction. With regard to the purpose of mental skills training, Gould and Carson (2007) also stated that, traditionally, mental skills training in sport was typically aimed at teaching athletes skills and techniques to enhance their sport-related performance, however, in recently years some practitioners have began to teach mental skills as life skills to athletes, especially to young athletes, through sport participation so that the skills could be used in other situations beyond sport (see Danish & Nellen, 1997; Hellison, 1995).

2.2.2 A Framework for Understanding Mental Skills Training in Sport Psychology

Mental skills training in sport does not merely mean teaching mental skills, it is a complex process. A framework for understanding mental skills training in sport (Figure 2) presented by Vealey (2007) can help to understand this complicated process.

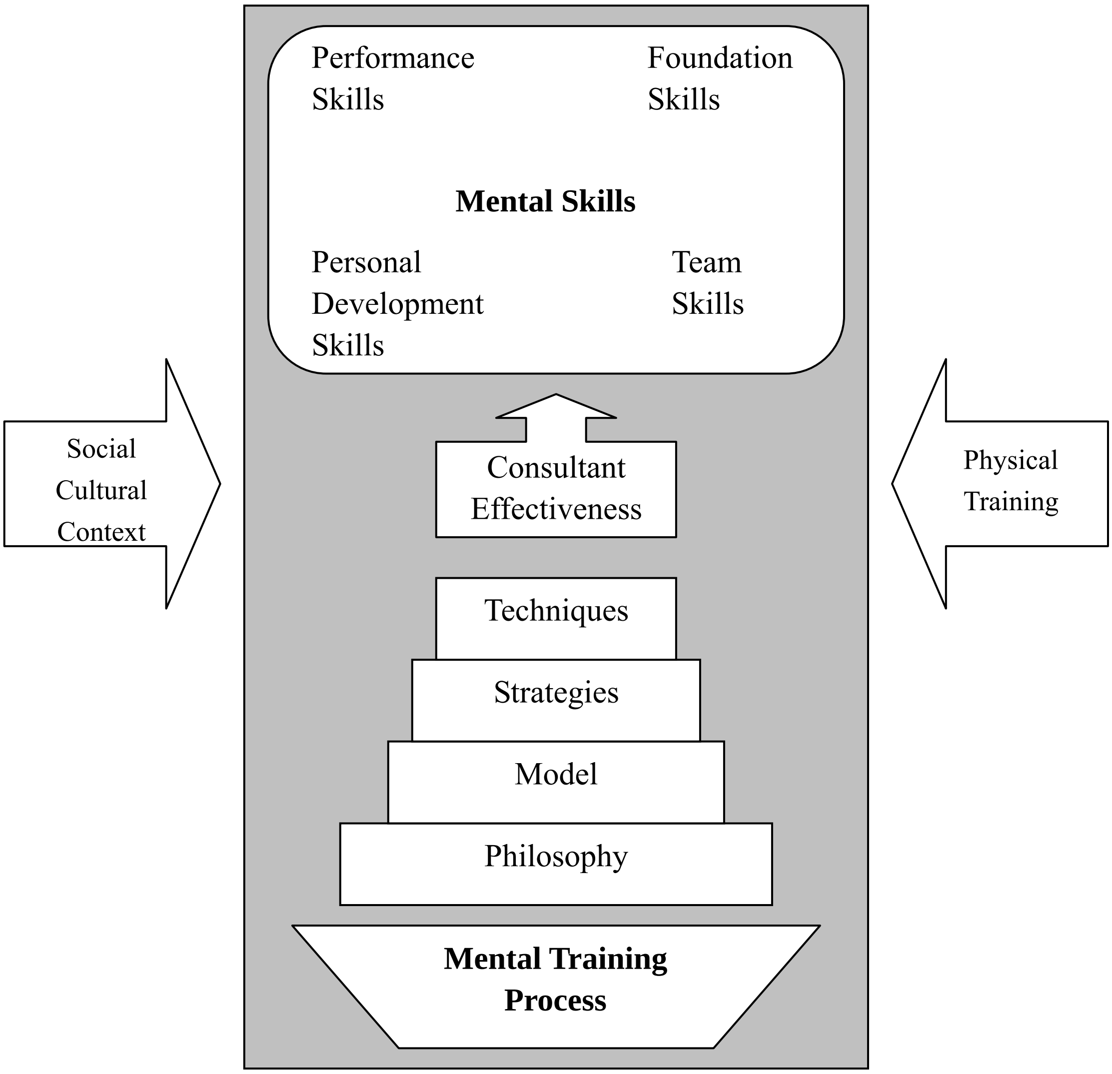


Figure 2. A framework for understanding mental skills training in sport (Vealey, 2007, p. 29).

As shown in Figure 2, Vealey (2007) argued that mental training process is "a complex, multilayer, integrative approach to developing mental skills in athletes" (p. 292). Specifically, the process of mental training is consisted of four layers: philosophy, model, strategies, and techniques. In addition, the process of mental training is greatly influenced by social cultural context and physical training, and it is also closely related with consultant effectiveness. Following is the detail description of this framework.

The targets of mental skills training in sport. Vealey (1988), on the basis of a content analysis of psychological skills training approach in sport that had been published in books in North America from 1980 to 1988, concluded that mental skills that had been involved in various mental skills training approach could be categorized into three types: foundation skills, performance skills, and facilitative skills. This classification of mental skills have been modified and extended by Vealey (2007) in her newest contribution on mental skills in sport. In terms of the new classification, there are four types of mental skills: (a) foundation skills, (b) performance skills, (c) personal development skills, and (d) team skills. Vealey (2007) stated that these types of mental skills are the mainly targets of mental skills training in sport. Table 4 presents different types of psychological skills as well as the typical examples of each type.

Table 4. Psychological skills involved in mental skills training in sport (adapted from Vealey, 1988, 2007).

Psychological Skills (1988)	Psychological Skills (2007)
Foundation skills	*Foundation skills*
● Volition	● Achievement drive
● Self-awareness	● Self-awareness
● Self-esteem	● Productive thinking
● Self-confidence	● Self-confidence
Performance skills	*Performance skills*
● Optimal physical arousal	● Perceptual-Cognitive skill
● Optimal mental arousal	● Attentional focus
● Optimal attention	● Energy management
Facilitative skills	*Personal development skills*
● Interpersonal skills	● Identity achievement
● Lifestyle management	● Interpersonal competence
	Team skills
	● Leadership
	● Communication
	● Cohesion
	● Team confidence

According to Vealey (2007), foundation skills are “intrapersonal resources that are necessary to achieve success in sport” (p. 288), and achievement drive, self-awareness, productive thinking, and self-confidence are typical examples of foundation skills; performance skills are “mental ability critical to the execution of skills during sport performance” (p. 290), and perceptual-cognitive skill, attentional focus, and energy management are typical examples of performance skills; personal development skills are "mental skills that represent significant maturational markers of personal development and that allow for high-level psychological functioning through clarity of self-concept, feelings of well-being, and a sense of relatedness to others" (p. 290), and identity achievement and interpersonal competence are two typical examples of personal development skills; team skills are "collective qualities of the team that are instrumental to an effective team environment and overall team success" (p. 291), and team confidence, cohesion, communication, and leadership are typical examples of team skills.

The process of mental training. As shown in Figure 2, the process of mental training is made up of hierarchical layers. The first layer in the mental training process is *philosophy*. Professional philosophy is the foundation of sport psychology practice, and "significantly shapes the consultant's approach to the essential elements of the consulting process such as gaining entry, assessment, conceptualization of the issue and the intervention, implementation, evaluation, and bringing closure to the consulting relationship" (Poczwardowski, Sherman, & Ravizza, 2004, p. 446). A definition of professional philosophy offered by Poczwardowski et al is as follows:

> Professional philosophy refers to the consultant's beliefs and values concerning the nature of reality (sport reality in particular), the place of sport in human life, the basic nature of a human being, the nature of human behavior change, and also the consultant's beliefs and values concerning his or her potential role in, and the theoretical and practical means of, influencing their clients toward mutually set interventions goals (p. 449).

As for the philosophy of mental skills training in particular, Vealey (2007) defined it as a consultant's "set of ideas and beliefs about the nature of mental skills and mental training, usually including program objectives and respective roles of the consultant, athlete, and coach in the process" (p. 292). According to Vealey, there were three main philosophical differences in mental skills training in sport, namely, educational versus clinical approaches, program-centered versus athlete-centered approaches, and performance enhancement versus personal-development approaches.

The second layer in the mental training process is the *model* of mental training intervention emanating from the consultant's philosophy of mental training. The models of mental training intervention in sport identified by Vealey (2007) include: family systems models (Hellstedt, 1995; Zimmerman, Protinsky, & Zimmerman, 1994), self-regulatory or cognitive-behavioral models (Boutcher & Rotella, 1987; Hanin, 2000; Kirschenbaum & Wittrock, 1984; Moore & Stevenson, 1994), behavioral management models (Martin & Toogood, 1997; Martin, Thompson, & McKnight, 1998; Tkachuk, Leslie-Toogood, & Martin, 2003), educational mental skills models (Orlick, 2000; Vealey, 1988, 2005), development models (Danish & Hale, 1981; Danish & Nellen, 1997; Danish, Petitpas, & Hale, 1992; Greenspan & Andersen, 1995; Weiss, 1995), sport-specific mental skills models (Ravizza & Hanson, 1994; Smith & Johnson, 1990; Thomas & Over, 1994), clinical intervention models (Gardner & Moore, 2004), and perceptual training models (A. M. Williams & Ward, 2003).

The third layer of the mental training process is the *strategies* emanating from the consultant's philosophy and intervention model. According to Vealey (2007), the strategies of mental training intervention are "the organizational plans of action that operationalize how the intervention specifically works, typically using sequential steps, multiple phases, or the practical packaging of mental training techniques into a coherent, integrative program" (p. 294). The following are some examples of strategies used in the mental training intervention in sport listed by Vealey: the Five-Step Strategy (Singer, 1988), the P3 Thinking and goal mapping (Vealey, 2005), centering (Nideffer & Sagal, 2006), the five-step approach to mental training using biofeedback (Blumenstein, Bar-Eli, & Tenenbaum, 2002).

The final layer of the mental training process is the techniques, they are "specific procedures or methods used in a mental training strategy" (Vealey, 2007, p.294). The most widely used mental training techniques in sport include imagery, goal setting, thought management, and physical relaxation/arousal regulation, self-talk, biofeedback training, performance profiling, etc.

The consultant effectiveness. The consultant effectiveness is particularly concerned with the interpersonal and technical skills of the consultants. The consultant's interpersonal skills were particularly related with their listening skills, and the consultants' technical skills were related with their ability to create useful, specific strategies and techniques. As what Vealey (2007) stated, "the effective mental training requires interpersonally and technically skilled consultant who are able to personally and professionally fit mental training programs to meet the special needs of athletes, coaches, teams, and organizations" (p. 295). The characteristics of effective and ineffective sport psychology consultants have been researched by some researchers through interviewing athletes (Gould, Murphy, Tammen, & May, 1991; Orlick & Partington, 1987). Table 5 presents a summary of the characteristics of effective and ineffective sport psychology consultants (Weinberg & Gould, 2007, p. 262):

Table 5. The characteristics of effective and ineffective sport psychology consultants (Weinberg & Gould, 2007, p. 262).

Effective consultants

- were accessible and could establish rapport with athletes,
- were flexible and knowledgeable enough to meet the needs of individual athletes,
- were likeable and had something very concrete or practical to offer,
- conducted several follow-up sessions with athletes throughout the season, and
- were trustworthy and fit in with the team.

Ineffective consultants

- had poor interpersonal skills,
- lacked sensitivity to the needs of individual athletes,
- lacked specific psychology knowledge to apply to the sport setting,
- demonstrated inappropriate application of consulting skills at competitions, and
- relied on a “canned” approach when implementing psychological skills.

The influencing factors on mental training process. As shown in Figure 2, the physical training and social-cultural context are two influencing factors on the mental training process. According to Vealey (2007), athletes develop and enhance their mental skills through physical training designed by coaches. Therefore consultants on the one hand have to be well-informed about the specific physical training requirements for the athletes and be able to integrate mental training into the physical training process, on the other hand have to guide and train coaches how to integrate mental skills training into their physical training sessions.

The process of mental skills training in sport is influenced by social-cultural context because the process occurs within a specific social-cultural context including “the unique subcultures of various types of sport, as well as the broader cultural factors that influence athletes’ mental skills and their participation in mental skills training” (Vealey, 2007, p. 292). Many issues comes from the social-cultural context for sure will influence the effectiveness of the mental skills training, if they are not deal with properly.

2.2.3 The Popular Fallacies for Mental Training in Sport

The acceptance and effectiveness of mental skills training in sport are often impeded by some misconceptions. The following are some popular fallacies of mental skills training in sport (Weinberg & Gould, 2007; Rushall, 2006).

Fallacy 1: Mental skills training is not useful. Mental skills training is stigmatized and distrusted by some coaches and athletes. However, a great number of anecdotal reports and empirical studies have substantiated that mental skills training do enhance athletes' performance (e.g., Gould & Carson, 2007; Vealey, 2007; Weinberg & Gould, 2007).

Fallacy 2: Mental skills training is for elite athletes only. Mental skills training is not useful for elite athletes only. It is also widely carried out for young, developing athletes (Tremayne & Newbery, 2005; Weiss, 1991).

Fallacy 3: Mental skills training is for the "problem" athletes only. Mental skills training in sport does not mainly focus on the mental disorder and sport-related problem such as eating disorder, substance abuse, violence. Rather, it mainly focuses on enhancing athletic performance and facilitating personal development. Generally speaking, elite athletes exhibit a small range and frequency of mental disorder because of natural selection process (Van Raalte & Andersen, 2002), and "Only 10% of athletes exhibit behaviors and mental disorders that require the expertise of a clinical sport psychologist" (Weinberg & Gould, 2007).

Fallacy 4: Mental training producing effects quickly and easily. It is naïve to believe that mental training will produce effects by simply teaching mental skills and techniques. The principal idea of mental training is similar to that of physical training: a determined number of hours and deliberate exercises are needed. For the athlete aims at acquiring mental skills and techniques, a weekly practice session may be suitable; for the athlete aims at becoming mental control specialist, daily based psychological training is necessary (Dosil, 2006).

2.2.4 The Phases of Mental Skills Training Programs in Sport

In general, any psychological skills training program is consisted of three phases: (a) education phase, (b) acquisition phase, and (c) practice phase (Weinberg &. Gould, 2007). The objectives and focus in every phase are different.

The main objectives in the education phase include: (a) to introduce the concept of every psychological skill involved in the program, (b) to make athletes recognize why these mental skills are important and how these skills affect performance, and (c) to explain how these skills can be learned.

The acquisition phase is mainly concerned with learning skills through strategies, techniques, and exercise. For example, to develop relaxation skill through exercise of progressive muscle relaxation, to develop refocusing skill through self-talk.

The practice phase focuses on three main objectives: (a) to improve skills through repeated exercise used in the acquisition phase, (b) to practice skills through using it in sports training, and (c) to apply skills in actual sports competitions.

2.2.5 Key Steps for Conducting Mental Training Programs in Sport

Gould (2000) argued that there are two typical approaches for conducting mental training programs in sport: (a) program-centered approach, and (b) problem-centered approach. Mental training based on program-centered approach is conducted following a preplanned program designed based on the consultant's ideas. It is carried out in an effort to make athletes and/or teams psychologically stronger. On the contrary, mental training based on problem-centered approach is designed based on the problems experienced by coaches and athletes. It is carried out in an effort to overcome particular psychological problems

Gould and Carson (2007) stated that, no matter which approach for conducting mental training (i.e. program-centered versus problem-centered) is adopted, the key steps are similar for a consultant. The key steps include: (a) explain the purpose of the program and the role and responsibilities of the consultant; (b) determine specific topics and needs to address and identify barriers to mental skills development; (c) hold meetings to increase awareness and convey critical information; (d) identify on and off-the field strategies to develop skills; (e) implement intervention strategies; (f) get feedback and adjust strategies; and (g) evaluate progress and consultant effectiveness, and modify the program.

Gould and Carson (2007) noted:

> These steps are presented as a general guide for organizing a mental skills training program to enhance psychological preparation for sport. However, they should not be viewed as invariant and are not time-dependent. For instance, it is not uncommon to do steps 1-4 in an initial meeting with an athlete. Similarly, as one consults, he or she is constantly employing many of the steps in an iterative fashion. (p. 123)

2.3 SUMMARY

In this section, a recapitulatory overview of mental assessment and mental training in the field of applied sport psychology is offered respectively.

With regard to mental assessment, it is defined and differentiated from psychological testing and psychological test in this section. Psychological test is only one type of tools used for mental assessment, and psychological testing is one part of mental assessment in case psychological tests are adopted as tools in a mental assessment. In general, mental assessment is characterized by a multi-method, multi-faceted approach, that is, multiple types of methods are adopted for data collection (e.g., psychological test, interview, behavior observation, etc), and the client is assessed from multiple facets (e.g., performance, feelings and perceptions, etc). Of course, mental assessment can be conducted based on the information from only one type of source (e.g. mental tests or interview). In fact, a great majority of assessment in sport psychology are conducted only based on the information derived from various psychological tests, except for some assessments on the effectiveness of mental skills training, in which both performance and psychological structures are measured to provide information. In the field of applied sport psychology, such multi-method, multi-faceted assessment is especially important for practitioners to diagnose an athlete and to tailor individualized intervention program based on the diagnosis. Considering the above distinctions between mental assessment and mental testing, the MTTS tool is discussed in the present paper as a tool for psychological assessment rather than psychological testing. Specifically, the MTTS tool is both a device to provide tasks as well as a tool for mental assessment, in the execution of tasks provided by the MTTS tool, the respondent can be assessed from multiple facets (e.g., performance, mental skills, perceived effort, etc) through multiple types of methods (e.g, tests, interview, behavioral observation, etc).

In addition, a framework for understanding mental assessment in sport (Vealey, 1998) has been introduced in detail. Within this framework, various issues surrounding mental assessment in sport are classified into four domains: athlete characteristics, contextual characteristics, organizational culture of sport, and consultant characteristics. Vealey stated that "the purpose of the framework is to attempt to provide a common articulation of assessment considerations in applied sport psychology" (p. 444), and she advocated taking into account these domains in any mental assessment in sport to avoid arising of practical and ethical issues. Out of question, this framework is of great significance to get a comprehensive understanding of mental assessment in sport. However, a systematic approach based insight into mental assessment in sport is not reflected through this framework.

With regard to mental training, four aspects related to mental training in sport psychology have been discussed in the present paper. The first aspect is concerned with definitions of mental training and mental skills training. Basically, the term mental training used in sport psychology by various authors can be interpreted as (a) training of mental process, (b) mental practice, and (c) mental preparation (Hackfort & Munzert, 2005). Mental skills training was defined by Gould and Damarjian (1998) as the systematic employment of mental skills in the execution of sport-related goals. This understanding of mental skills training coincides with the idea of mental skills training presented in the present paper: mental skills training refers to teach mental skills as well as systematic use of mental skills in the execution of specific tasks, the process of use mental skills actually is a process of practice mental skills. It is worthy to be noted that mental skills have begun to be taught as life skills through sport participation by many practitioners so that they can be used in other situations beyond sport (see Danish & Nellen, 1997; Hellison, 1995). Andersen (2000) pointed out that psychological skills can be used for a variety of purposes that do not concern performance, e.g., coping with injuries, transitions out of sport, and personal issues. In addition, mental skills training are transferring by more and more sport psychology consultants from sport to business and other fields, for example, working with astronauts, physicians, police officers, firefighters, financial consultants, and dancers.

In a special issue of the *Journal of applied sport psychology* (2002, issue 4), there were articles concerned with applying sport psychology principles to work with professionals in other arenas.

The second aspect is concerned with a framework for understanding mental skills training in sport (Vealey, 2007). According to this framework, the process of mental skills training is a complicated process involving philosophy, model, strategies, and techniques, and this process is influenced by social cultural context and physical training. The targets of mental skills training include foundation skills, personal skills, personal development skills, and team skills. This framework is of great significance for getting a comprehensive understanding of mental skills training in sport.

The third aspect is concerned with discussion on some misunderstanding about mental training in sport existing among coaches and athletes. They either think psychological training is not useful, or think psychological training producing effects quickly and easily, or misdeem that psychological training is for elite athletes or "problem" athletes only. These misconceptions about mental training are barriers that might interfere with their acceptance of mental training, their motivation to engage in mental training, their commitment in mental training exercises, and eventually interfere with the effectiveness of mental training. For example, an athlete will not ask for help from sport psychologists on his or her own initiative if the athlete believes that psychological training is useless, even if he or she is asked by coaches to engage in mental training, the athlete will not do his or her best. Therefore, it is absolutely necessary to make coaches and athletes have correct understanding about mental training before starting a mental training intervention. Hopefully, the discussion in this section will help to correct the misconceptions about mental training existing among them.

The last aspect is concerned with the steps for conducting a mental training program in sport. Basically, in sport psychology, mental training program can be conducted based on two approaches: program-centered approach and problem-centered approach (Gould & Carson, 2007). No matter which way is adopted to conduct a mental training program, the key steps that a consultant follows are similar. It should be noted that following similar steps does not mean these step are invariant. For example, depending on time available, sport psychology consultants can either combine some steps into one, or employ some steps in an iterative fashion. Moreover, depending on the ability and skills of the consultants, the effectiveness of the mental training interventions following similar steps might be different. For instance, some consultants establish rapport from athletes and coaches quickly and easily after the step 1 (explain the program purposes and consultant's role and responsibilities) while others can not; some consultants identify the needs of athletes correctly after the step 2 (conducting assessment to determine specific needs) while others can not.

3 ELABORATION OF THE MTTS TOOL IN THE FRAME OF AN ACTION-THEORY BASED MENTAL ASSESSMENT AND TRAINING APPROACH

Applied work in sport psychology must be founded on appropriate theories. In the field of applied sport psychology, professionals provide practical services to athletes and teams on the basis of diverse theories that already existed or cultivated by themselves. As Schack and Hackfort (2007) stated:

> The pure-research-oriented psychological disciplines (such as general psychology and developmental psychology) rely on different theoretical perspectives. One outcome of this has been a lack of any binding or fundamental theoretical approach in the applied disciplines (industrial psychology, clinical psychology, sport psychology, etc.). As a consequence, most sport psychologists cultivate their own theoretical basis for their practice work. Frequently, they are not aware of this theoretical basis, refraining from communication and thus avoiding any possibility of change. (p. 332)

Out of question, mental assessment and mental training as important practice work in applied sport psychology also must be carried out on appropriate theories. Vealey (1998) stated that “theory provides a conceptual model for the assessment process and for the subsequent intervention with athletes” (p. 435). So far, although a variety of models or approaches with regard to mental assessment and mental training in applied sport psychology have been developed on the basis on diverse theories, there still exists a need for a comprehensive theory. The main reasons are given as follow:

1. "Human beings are considered biopsychosocial units or systems" (Hackfort, 2006, p. 11). The term "biopsychosocial" not only indicates a multidimensional perspective (i.e., biological, psychological, and social perspective) of athletes, but also reflects the mediating role of psychological process between biological and social perspective. Therefore, psychological assessment and training in applied sport psychology should target at athletes' psychological perspective, as well as athletes biological and social perspective. However, many models or approaches concerned with mental assessment and mental training in sport are unidimentional . For instance, the widely employed mental skills model (Ravizza & Hanson, 1994; Thomas & Over, 1994; Orlick, 2000; Vealey, 2005) and performance profile model (Butler & Hardy, 1992) mainly concerns athletes' mental skills assessment and training; the psychophysiological assessment model (Lander, 1985; Blumenstein & Bar-Eli, 2005) concerns only the physiological changes of athletes; the family system model (Hellstedt, 1995; Zimmerman, Protinsky, & Zimmerman, 1994) mainly concerns the influence of family on athletes.

2. Although multidimensional models or approaches are also developed and used by some professionals, these models or approaches, in general, focus on the elements of the three dimensions without considering the links and interrelations between elements of different dimensions. For instance, the multimodal approach (Davies & West, 1991) concerns the assessment of behavior, affect, sensations, imagery, cognitions, interpersonal relations, and biological functioning, however, the dynamic correlations among these variables are not examined; the multidomain framework of mental assessment (Vealey, 1998) concerns the issues within four broad domains, yet the links between the issues in different domains are ignored.

3. The models or approaches based on the theories cultivated by the authors of the models are often exclusionary, which impedes communication and being perfect. As Vealey (1998) stated that “sport psychology is diverse does not mean that we cannot (or should not) find any common ground with regard to assessment and intervention techniques”, “by focusing more on inclusionary frameworks for assessment and practice, the diversity in applied sport psychology will become enriching as opposed to diversity” (p. 444).

For the above reasons, a mental assessment and training approach based on a comprehensive theory – action theory, is elaborated in this section. It is an elementarily and holistic oriented approach, that is, it concerns not only separate elements, but also systems formed by the interaction of various elements. As Hackfort (2006) stated:

> One cannot understand a system without first understanding the elements and the underlying processes of that system. In turn, it is possible to understand the functional meaning of single elements and processes without considering the links, interrelations, and the complex interplay within that system. (p. 12)

To be specific, this section is composed of four parts. Firstly, the action-theory perspective is introduced; then, the frame of an action-theory based mental assessment and training approach is offered; after that, the MTTS tool is elaborated; and finally, a summary of the above topics is provided.

3.1 The Action-Theory Perspective

3.1.1 The Concept of Action

In the action theory, *actions* are understood as a special class of behavior, they are intentionally organized and goal directed (Nitsch & Hackfort, 1981, 1984). As Nitsch (1982) stated, "we only speak of 'actions' as a special type of behavior, if a conscious goal underlies the behavior and if the psychophysical activity is organized intentionally for the purpose of goal attainment" (p. 58). It is to be noted that "intentionally organized and goal directed" does not mean that actions are completely conscious, on the contrary, there are a series of automatically performance sequences in any action, and any action will inevitably lead to some consequences that are not intentioned.

According to Nitsch (1982), actions differ from other types of behavior of organism such as reflexes, instincts or conditioned reactions in terms of two aspects: (a) stimuli in reflexes, instincts or conditioned reactions have a fixed meaning that is connected with a certain inevitable behavior, on the contrary, stimuli in actions do not have a fixed meaning and do not become meaningful unless they are subjective appraised based on certain purposes; (b) reactions in reflexes, instincts or conditioned responses are pre-established and occur automatically, on the contrary, reactions in actions are formed with certain purposes and do not occur automatically, that is, they are intentionally organized behavior.

Nitsch (1982) summarized three functions of actions: (a) Effect function: actions have influences on the person (actor) and/or the actor's environment, the most general purpose is to optimize the person-environment relation; (b) Presentation function: action is a personal presentation of the actor and a reflection of the actor's "internalized social values, standards, and rules" (p. 58); (c) Experiential function: the action forms is the premise of construction, examination, and modification of internal models about the actor him or herself and the environment, thus it is the basis for get personal and social experiences.

3.1.2 Essential Postulates Underlying Action-Theory Perspective

The action-theory approach can be summarized by four essential postulates, namely, *situation postulate*, *intentionality postulate*, *system postulate*, and *structure postulate*. These postulates are elucidated in tail in a series of related literature (e.g., Hackfort, 2006; Hackfort, Kilgallen, & Liu, 2009; Hackfort & Munzert, 2005; Nitsch, 1985; Schack & Hackfort, 2007).

3.1.2.1 Situation postulate

Situation postulate assumes that any action of human beings, without exception, occurs in a certain action situation structured by a specific person-environment-task (P-E-T) constellation (Figure 3) (Hackfort, 1986; Hackfort, Kilgallen, & Liu, 2009; Nitsch, 1985). The *person* within the constellation refers to the performer of an action, factors of person that are likely to influence an action situation include the person's physical and mental characteristics, states, and process, e.g., mood states, cognitive and motivational processes. The *environment* within the constellation refers to the conditions under which the task to be fulfilled, it comprises both material (or physical) environment (e.g. light and acoustic stimuli) and social environment (e.g. social support). The *task* in the constellation refers to the things need to be done, it contains motor tasks such as tracking or aiming stimuli, as well as mental tasks such as detecting or anticipation signals. Motor tasks and mental tasks can be presented individually, or in combination.

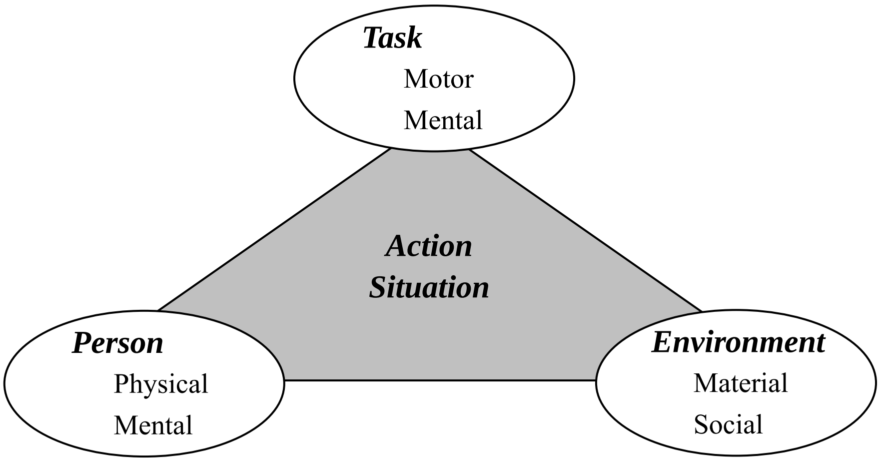


Figure 3. The model of action situation (Hackfort, 1986).

The objective factors of person, environment, and task formed an objective action situation structure. The subjective situation definitions are formed based on various interpretation or definitions to an objective situation structure. Nitsch (1985) points out that "it is prime important that the objective situation factors, subjective situation definitions and the relation between objective situation structure and subjective situation definitions are jointly taken into account as an indicator for an action's relation to reality" (p. 268).

3.1.2.2 Intentionality postulate

Intentionality postulate is advanced based on situation postulate. According to intentionality postulate, the actions of human beings, as distinguished from reflexes, instincts or conditioned responses that are pre-established, are intentionally organized behavior based on the subjective interpretation or definition of given person-environment-task situations. Through action, the dynamic interplay between person and environment is shaped and regulated, with general intention to "optimize the person-environment relationship, or one's situation, in order to maintain a favorable condition" (Hackfort, 2006, p. 13). It should be pointed out that intentionality doesn't mean that actions are completely conscious.

Understanding the intentionality process requires to clarify how intentions arise and how intentions transfer in the subject. The arising of intentions is thought to be linked with "some kind of internal representation of the person-environment-task constellation", and the intentions transfer is concerned with "how intentions (ideas) find their path from the center to periphery" (Hackfort & Munzert, 2005, p. 6; Schack & Hackfort, 2007, p. 333).

With regard to the condition of intentions creation, Hackfort (2006) states:

> Such intentions arise in the subject as soon as: (a) the existing interaction is no longer perceived as sufficient to meet the needs or goals of the subjects, (b) a more rewarding relationship is subjectively perceived or anticipated elsewhere, (c) a pleasant state is perceived to cease. (p. 12)

3.1.2.3 System postulate

Human being can be viewed as bio-psycho-social units or systems (Hackfort, 2006). In accordance with this view, system postulate assumes that the action of a person is closely linked with his or her biophysical, psychic, and socioecological systems (Hackfort, 2006; Hackfort & Munzert, 2005; Schack & Hackfort, 2007). In Figure 4, the interrelations of these systems in the organization of actions are illustrated.

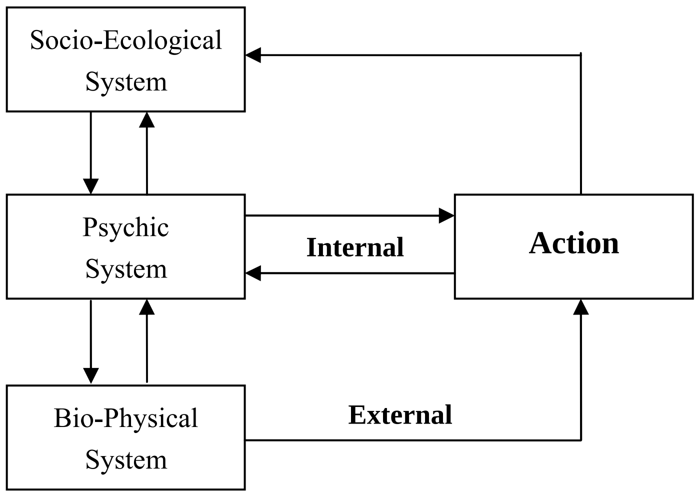


Figure 4. Interrelations of systems in the organization of actions (Hackfort, 2006, p. 13).

As shown in Figure 4, the psychic system interplay, on the one hand interacts with biophysical system and socioecological system respectively, on the other hand lies between the two systems mediating the relationship between them. Based on the interaction with biophysical and socioecological systems, psychic system endows an action with certain internal characteristic (i.e. intention underlying the action). The internal characteristic, combining together with the external characteristic of the action (i.e. external movements) that presented by biophysical system, constitute an integrated action. Of course, through executing the action, the previous socioecological and psychic systems are regulated.

From the system assumption, an action regulation system that includes a behavioral-control and an action-control system is presented in Figure 5 (Hackfort, 2006; Hackfort & Munzert, 2005). As shown in Figure 5, through forward-backward relation between physical and social processes, a behavioral-control system that regulates specifically the external parts of an action is established; through forward-backward relation between cognitive and affective processes, an action-control system that regulates specifically the internal parts of an action is established. In addition, the interaction between physical and social processes is mediated by the action-control system.

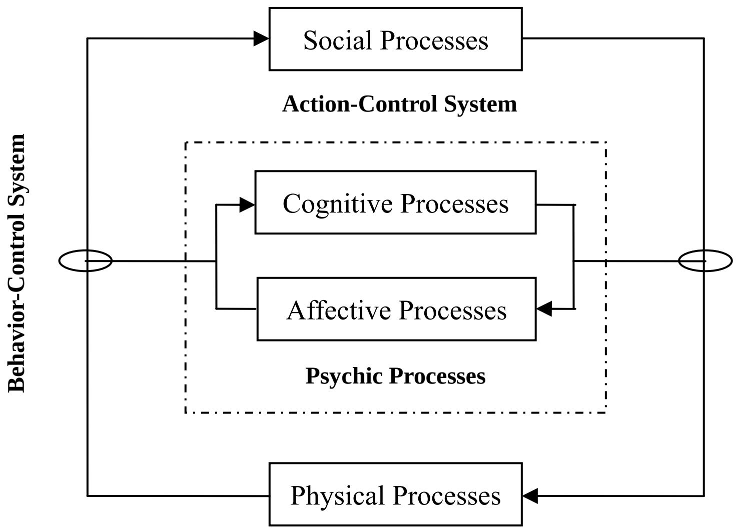


Figure 5. Action regulation system from system assumption (Hackfort, 2006, p. 14).

3.1.2.4 Structure postulate

Structure postulate is concerned with the structure of actions. The structure of a single action process consists of three different phases within the action continuum, namely, the anticipation phase, the realization phase, and the interpretation phase (Nitsch, 1982; Hackfort, 1991; Schack & Hackfort, 2007). In Figure 6 the triadic-phases structure of a single action is illustrated.

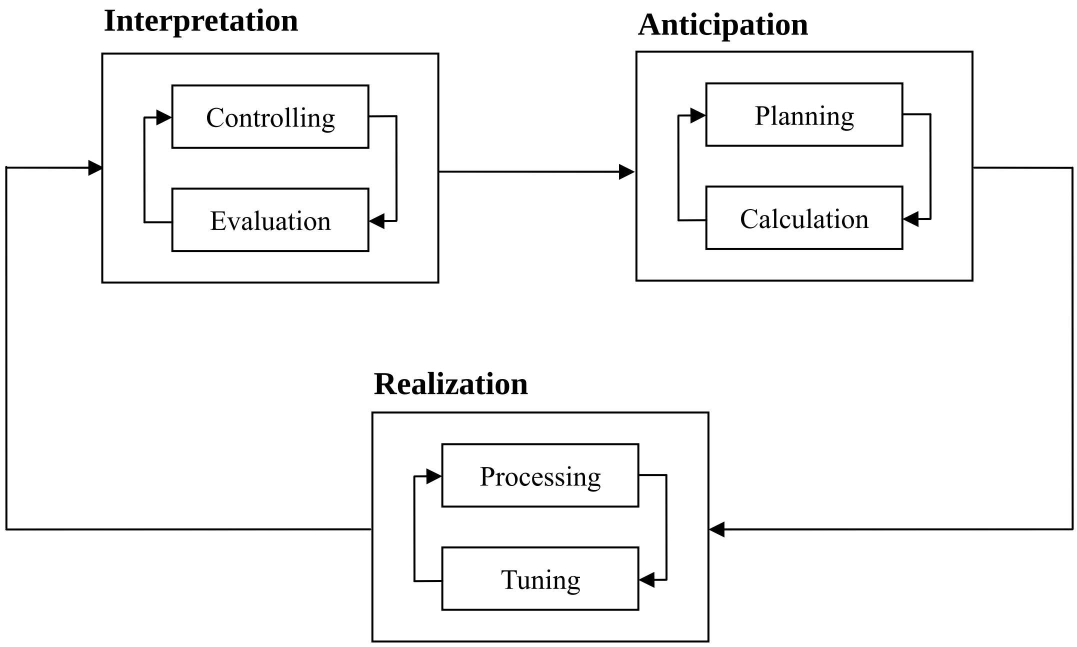


Figure 6. Triadic-phase structure of a single action (Hackfort, 1991, p. 67).

As shown in Figure 6, anticipation is the beginning phase in an action process. In this phase certain expectations about the action are formed through two interacted processes—calculation and planning. In the course of calculation process the effects of performing an action and the efforts have to put in the action are expected by assessing and appraising personal and situation conditions of the action. Specifically the personal conditions include individual abilities and motives and the situational conditions include difficulties and incentives of performing the action. The outcomes of anticipation determine whether an action is performed and with what expectations the action is performed. In the course of planning process a plan with regard to a certain goal defined in anticipation is designed by operationalizing effect and effort expectations. Specifically the operationalization of effect expectations need to consider aspiration level for the future personal achievement and the operationalization of effort expectations need to maximally incent effort in order to achieve a defined goal.

The realization is the second phase in an action process. In this phase the initial expectations resulted from anticipation phase are translated in external behaviors through processing and tuning processes. Processing process is with regard to the plan execution and tuning process is with regard to the regulation and modification of actual behavior in terms of the reality conditions. According to Nitsch (1982), such a translation relies on three influencing factors, i.e. plan execution, confrontation with reality, and feedback effects. Specifically, the actual behavior in the translation phase is directed by the plans developed in anticipation phase, regulated by the agreement of expectations with the reality in the execution of plans, and influenced by the continuously modified feedback about personal and situational action.

The interpretation is the final phase in an action process. In this phase the actual performance and results of an action as well as the corresponding causal attribution are interpreted through controlling and evaluation processes. Specially, in the course of controlling processes, the accordance and divergence are identified by comparing the real and desired outcomes, and then in the course of evaluation processes the conclusions about adequacy and deficiency of the calculation and planning processes in anticipation phase are drawn, and at the same time the causes of the real action results are traced.

The Triadic-phase structure of action is concerned with only a single action. But in real life, the performance of human being always involves a set of actions, and often a subsequent action may have already started when the previous action is still being performed. For example, the anticipation process (or realization process) of a subsequent action can start when the realization process (or interpretation process) of the previous action still in progress. On the basis of such interactions between actions, an overlapping action chaining is formed (Figure 7). It is “a necessary prerequisite for the performance of close action sequences” (Nitsch, 1982, p. 64).

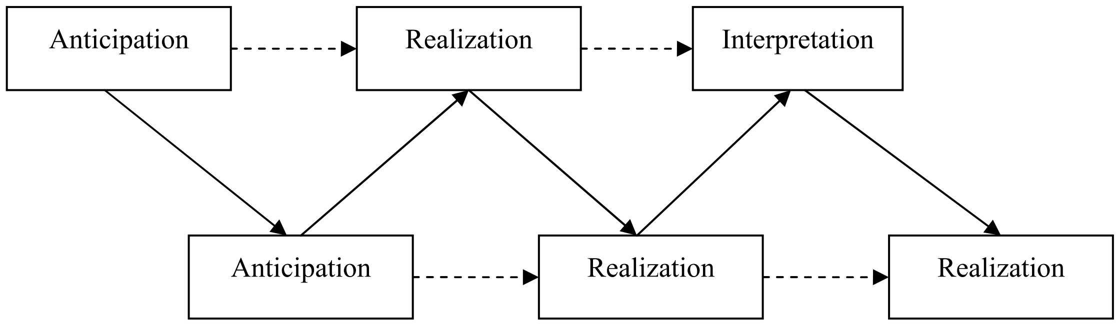


Figure 7. Overlapping action chaining (Nitsch, 1982, p. 65).

3.2 THE FRAMEWORK OF AN ACTION-THEORY BASED MENTAL ASSESSMENT AND MENTAL TRAINING APPROACH

"Psychological phenomena in a more general view can only be derived from their connection to action" (Nitsch, 1982, p. 58). From this point of view, the targets of mental assessment and mental training are essentially action-related psychological phenomena and abilities, that is, mental assessment and mental training are action-theory based. Here the framework of an action-theory based mental assessment and mental training approach is elaborated (see Figure 8). The four postulates underlying the action-theory perspective is fundamental for the development of this framework.

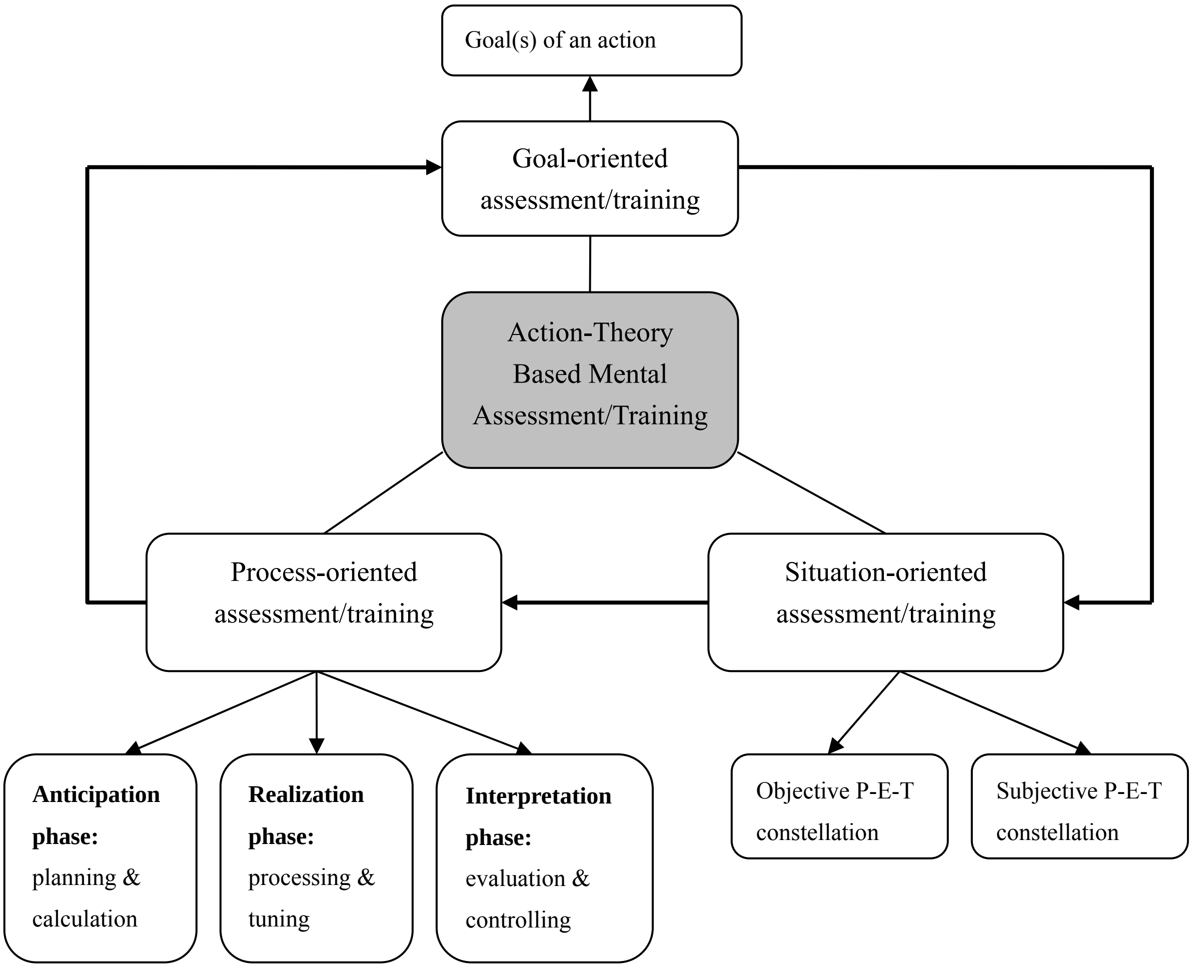


Figure 8. The frame of an action-theory based mental assessment and mental training.

3.2.1 Mental Assessment Based on the Framework

Essentially, the action-theory based mental assessment is concerned with assessing of action-related intentions (goal-oriented assessment), situations (situation-oriented assessment), and processes (process-oriented assessment).

As shown in Figure 8, an integral action-theory based mental assessment always begins with assessing the goals of performing the action because actions are goal-directed behavior. One typical example of goal-oriented assessment is goal achievement assessment. Following the goal-oriented assessment, situation-oriented assessment should be made to assessing the objective action situation formed by person-environment-task constellation, as well as the individual interpretation of this constellation (i.e. subjective action situation). Examples of situation-oriented assessment include assessing current mental skill ability, individual's personality, social support, task difficulty, and so on. Hackfort (2001) stated that "a person becomes aware about the person-environment-task constellation as soon as he or she defines a goal" (p. 90). He also offered a good applying example about the process of analyzing a ski racer's P-E-T constellation, in which task-oriented analysis, environment-oriented analysis, and person-oriented analysis were included. Process-oriented assessment concerns assessing mental processes and functions involved in the process of performing the action. Specifically, it includes all the assessments of psychological variables that might influence the planning and calculation processes in the anticipation phase (e.g., expectation, motivation, and task difficulty), the process and tuning processes in the realization phase (e.g., concentration, coping strategies, and arousal level), as well as the controlling and evaluation processes in the interpretation phase (e.g., attribution).

3.2.2 Mental Training Based on the Framework

In the applied sport psychology, mental assessment is often followed by corresponding interventions. As shown in Figure 8, goal-oriented assessment is often followed by intervention of goal setting to help athletes set rational goals, and mental representation of action situation is often followed with situation-oriented assessment.

Process-oriented mental training is the focus within the frame. It is conducted with purpose "to improve one's level of adaptation or create a better person-environment fit" (Hackfort, 2006, p. 13). Specifically, psychological functions related to mental control and mental regulation process are trained. According to Hackfort (2001), these psychological functions include (a) cognitive processes such as attention, imagery, and decision making; (b) emotional aspects such as anger- or anxiety-control, frustration tolerance; and (c) motivational tendencies such as control of the aspirational level, persistence.

3.3 Elaboration of the MTTS

Based on the action-theory perspective, Hackfort conceptualized a mental test and training system (MTTS) and organized the development of MTTS tools which refers to both computerized and field-oriented mental test as well as training regime (see Hackfort et al, 2009). In the current paper, the MTTS refers to the computerized part of the mental test and training system. The main structure of the system is given in Figure 9.

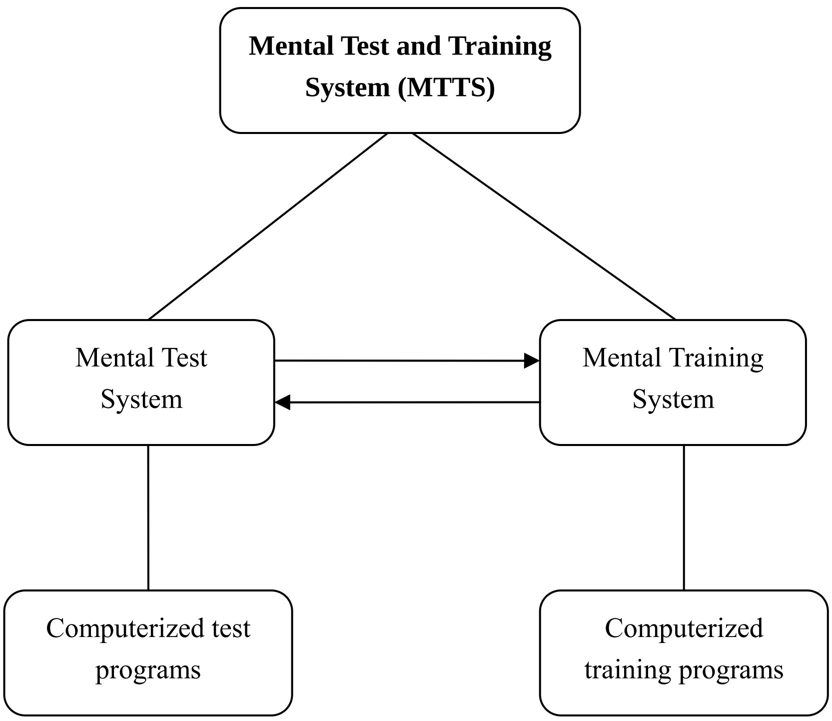


Figure 9. The main structure of the MTTS (Adapted from Hackfort et al., 2009, p. 17).

3.3.1 The Platform for Developing MTTS

The MTTS was developed by taking the Vienna Test System (VTS) and the Biofeedback $2000^{x\text{-pert}}$ (both of them managed by Dr. Schuhfried Company located close to Vienna, Austria) as its platform. The details of the VTS and the Biofeedback $2000^{x\text{-pert}}$ are described in the following paragraphs.

3.3.1.1 The Vienna Test System

The VTS was originally developed with a focus on the tests for clinical and traffic psychology. The tests in VTS include psycho-motor tests (e.g. reaction time test, two-hand coordination test, determination test, peripheral perception test, motor performance series test) and other types of tests such as personality test (Eysenck-Personality-Profiler-V6), interest test (General Interest Structure Test), IQ test (Raven’s Standard Progressive Matrices), etc.

The main hardware of the VTS is illustrated in Figure 10. It is composed of the control unit (for the test administrator) and the response 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 testing process, e.g., to enter the client’s personal information into database, to start, restart, and cancel a test or a test battery, etc. The response unit includes (a) output devices such as client monitor, peripheral display, flicker and fusion device, and work panel for motor performance test, by which the instructions and tasks of various tests are presented to the client, and (b) input devices such as universal panel, light pen, foot pedals, and so on, by which the client responds to the tasks in various tests.

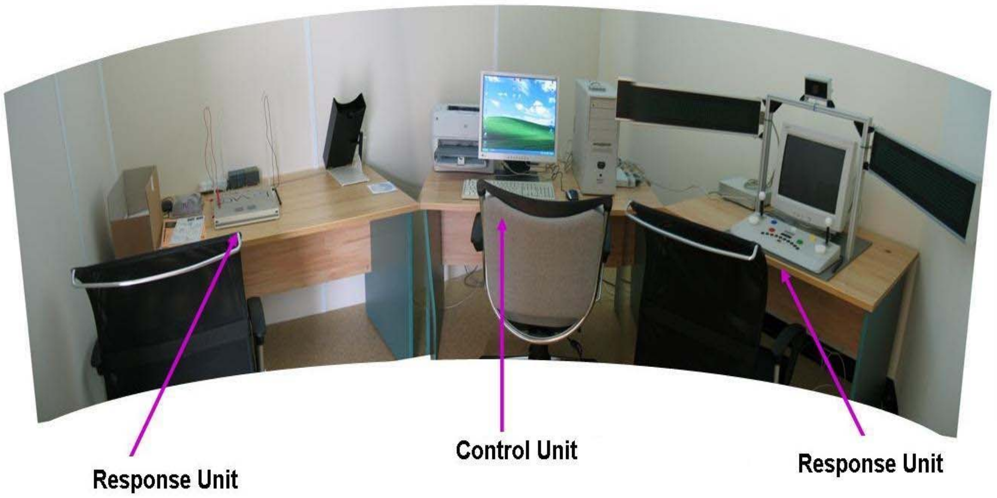


Figure 10. The main devices of the VTS (Hackfort et al., 2009, p. 17).

3.3.1.2 The Biofeedback 2000$^{x\text{-}pert}$

The device of the Biofeedback 2000$^{x\text{-}pert}$ includes: (1) a desktop or laptop with biofeedback programs, (2) one client monitor connected to the desktop or laptop, and (3) four 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 with 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 (EMG), and the fourth module are used to analyze the client's EEG. 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/her physiological reactions.

The Biofeedback 2000$^{x\text{-}pert}$ itself can be used independently as a tool of conducting mental training. Also, it can be lined to the VTS-based training setup by a marker cable (see Figure 11) to record physiological data during the mental training process. By analyzing the physiological data, the mental states during the mental training process can be monitored since the mind and body are interacted. For example, in a motor performance test, the data of EMG can be recorded to monitor client's emotion state (e.g. stress level). Through analyzing the relationship between performance and corresponding physiological data, the individual optimal zone for peak performance can be determined, and this zone, in return, serves as the target of mental preparation and mental tuning.

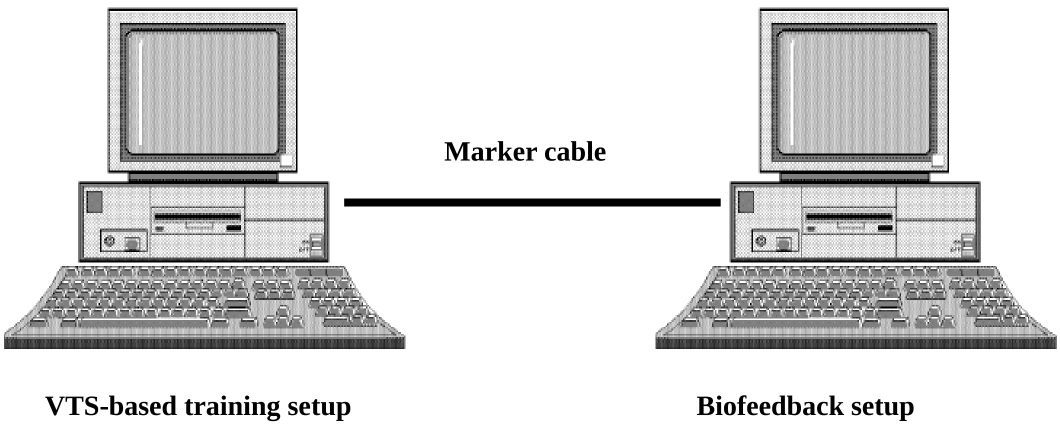


Figure 11. Linking illustration of the VTS-based training setup and the biofeedback setup (Hackfort et al., 2009, p. 20).

3.3.2 Examples of Ideas Associated with Developing MTTS

Taking VTS and Biofeedback 2000$^{x\text{-}pert}$ as platform, Hackfort et al. (2009) developed tools for the MTTS on the basis of two ideas: (a) developing sports- and sport-specific tests, and (b) creating special P-E-T constellations by integrating the mental test tool with other setups for the training and practice of mental functions. In the following paragraphs, examples about developing MTTS tools based on the two ideas were offered.

3.3.2.1 Developing a sports-specific test—Movement Detection Test (MDT)

The MDT (see Hackfort, Herle, & Debelak, 2010) is a sports-specific test developed for the purpose of measuring movement detection ability—an important ability for most of sports (Hackfort et al., 2009). It was originally conceptualized and developed by Hackfort and was modified and further developed by his sport psychology team including the author of the present paper.

In the MDT, three different test forms namely MDT-S1, MDT-S2, and MDT-S3 are included. The test always begins with presenting a square as well as a dot that is located in the middle of the square (see Figure 12).

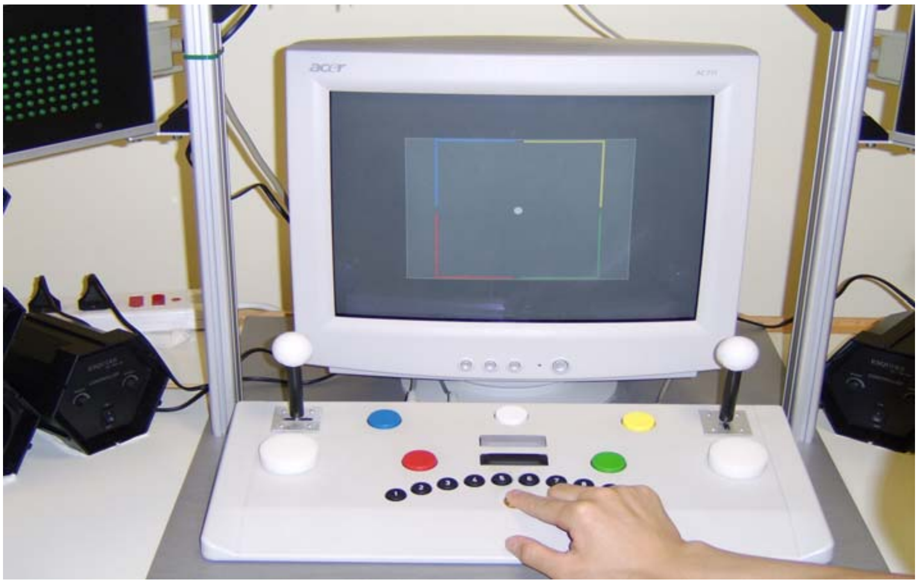


Figure 12. Illustration of the Movement Detection Test (Hackfort et al., 2009, p. 18).

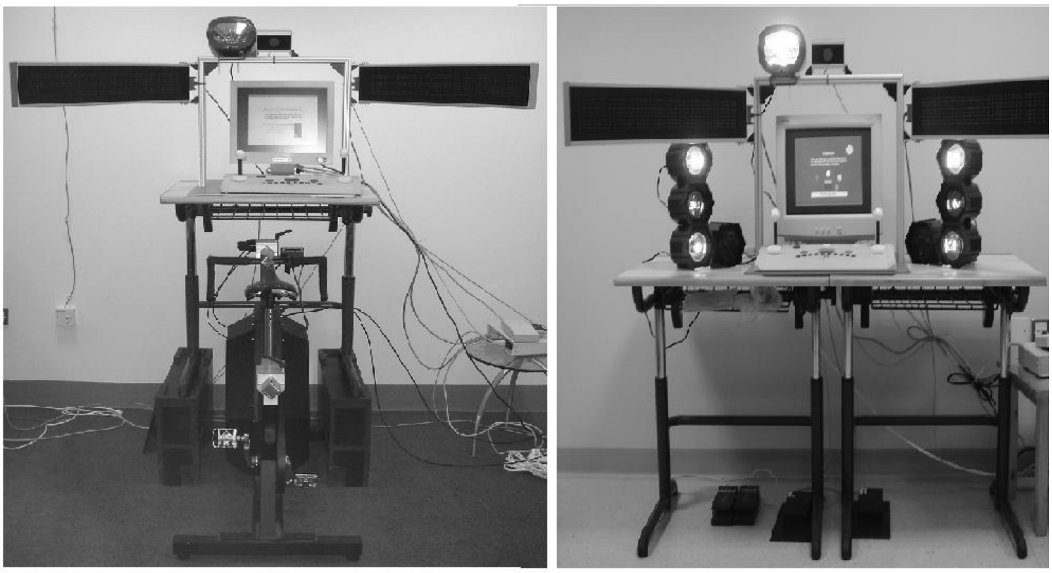
MDT-S1. In the MDT-S1, the square is presented with gray corners. The dot firstly rests in the center of the square, then start to move towards a random corner after random interval of time. The testee is required to press the black button on the panel as soon as possible anytime when he or she observes the dot begins to move. Totally 32 stimuli are presented in the test.

MDT-S2. In the MDT-S2, the square is presented with fixed red, blue, yellow, and green corners. The dot firstly rests in the center of the square, then start to move towards a random corner after random interval of time. The testee is required to press a button on the panel with color corresponding to that of the corner towards which the dot is moving, as soon as possible anytime when he or she observes the dot begins to move. Totally 32 stimuli are presented in the test. The moving direction of the stimulus and the times of stimuli moving toward every corner (n = 8) were fixed.

MDT-S3. The MDT-S3 is similar to the MDT-S2 except that in each trial the color of each corner of the square is given random from red, blue, yellow, and green, and the moving speed of the dot can be selected from three options: slow, medium, and fast. Totally 32 stimuli are presented in the test. The moving direction of the stimulus and the times of stimuli moving toward every corner are different from test to test since the color of each corner of the square is given random from red, blue, yellow, and green in each trial of a test.

3.3.2.2 Creating mental training situations

Based on the second idea about developing MTTS, Hackfort et al. (2009) created some training situations through integrating the mental test tool with special setups. Figure 13 presents two examples of training situations.



a b

Figure 13. Examples of creating specific action situations (Hackfort et al., 2009, p. 19).

As illustrated in Figure 13-a, a bicycle is used to create a motion situation. When it is integrated with a psycho-motor test, e.g. Peripheral Perception Test (PPT), the complexity of the task is increased since the client has to synchronously respond to the PPT and ride the bicycle under varying levels of physical load. At the same time, riding the bicycle altered client’s physical state, that is, the person is altered. In Figure 13-b, disturbing lights and CDs with various noises (e.g., white noise, noise of spectators in various sport competition) are also used to create specific action situations through modifying physical environment. These three setups (bicycle, CDs with noises, disturbing lights) can be used individually, or be used in combination.

3.3.3 Fundamental Ideas about Applying a MTTS in the Frame of Action-Theory Based Mental Assessment and Training Approach

In the light of the frame of action-theory based mental assessment and training approach, three fundamental ideas about applying a MTTS tool for mental assessment and training can be presented:

1. Mental assessment is regarded to be much broader and much more complex than mental testing. It involves collecting data through different methods (e.g. observation, interview, and testing) and evaluating various dimensions (e.g. emotion, cognition, and behavior) with regard to accomplishing a task. A MTTS tool can be used to provide an action-related task and to test the client's performance in accomplishing the task. At the same time, the client's behaviors as well as the mental functions and mental skills involved in the process can be evaluated through verbal reports and observations. The outcome from mental assessment serves as the basis for designing subsequent training programs and providing recommendation for practice and competition.

2. "Mental and motor activities are closely interrelated" (Hackfort et al., 2009, p. 16). Motor activities are always accompanied by a series of mental processes (e.g. thinking, anticipation, attention, and visualization) and mental skills (e.g. arousal control, self-talk, and imagery). Therefore, the process of performing motor activities, to a certain degree, is also a mental training and practice process. A MTTS tool can be used to create various specific action situations. Through performing motor activities in specific situations, the client's mental processes and mental skills are trained and practiced.

3. In the field of applied sport psychology, although many practitioners designed mental training programS on the basis of a prior mental assessment, most of tests and tools adopted in the assessment do not have a conceptual-based relationship to the training program because of lacking a comprehensive framework. Using a the MTTS tool, both mental assessment and the

subsequent mental training can be implemented in the frame of action-theory based mental assessment and training approach, and consequently, it can be typically used for carrying out mental assessment and the resulting mental training intervention.

3.4 SUMMARY

In this section, the action-theory perspective was introduced firstly. According to the action theory, action refers to an intentionally organized and goal directed behavior. The action-theory approach can be summarized through four essential postulates: situation postulate, intentionality postulate, system postulate, and structure postulate. These postulates serve as the theoretical foundations behind the various action-theory based practical work in sport.

Following the introduction of action-theory perspective, the frame of an action-theory based mental assessment and mental training approach was offered. Since action is always initiated by certain intentions, an action-theory based mental assessment begins with goal-oriented assessment, e.g., ego and task oriented goals, sports achievement motivation, etc. Then the situation constructed by a person-environment-task constellation, the factors of person (e.g., physical load, mood), environment (e.g., social support, physical conditions such as light, noise), and task (e.g., motor task such as two hands cooperation), as well as the interpretations of the situation and factors are assessed. After that, various mental control and mental regulation processes in the execution of an action are assessed (e.g., attention, relaxation, arousal control). Mental training based on the frame is corresponded with mental assessment and includes goal setting training, mental representation of action situation training, as well as mental control and mental regulation process training (e.g., attention, imagery, anxiety control, frustration tolerance, etc).

Finally, the MTTS tool was elaborated in the frame of action-theory based mental assessment and training approach. The MTTS tool serves not only a type of mental assessment tool, but also a device to provide tasks and to create situations for mental assessment and training purpose. The MTTS tool is a very flexible tool for mental assessment and training, practitioners can selected different devices or add new devices into the MTTS tool, depending on their design of interventions.

4 EXAMINATION OF THE MOVEMENT DETECTION TEST (MDT) IN A CHINESE ELITE ATHLETES SAMPLE

The previous section provided some basic information about the MDT. In this section, more information including results on studies in China to investigate the reliability and validity of the MDT in elite sports will be presented.

4.1 DESCRIPTION OF MDT

4.1.1 Theoretical Background

Movement detection, according to the senses used, can be divided into kinesthetic and visual movement detection. Kinesthetic movement detection concerns about detection of relative positions and movements of various parts of body, while visual movement detection concerns about detection of the occurrence of movements, as well as identification of the direction of movements of persons or things in external environment. In this paper, the term "movement detection" specially refers to visual movement detection unless noted otherwise.

In elite sports, good ability to detect movement is crucial for athletes to performing well in training and competition, especially for those who participate in open-skill sports such as tennis, basketball, and football. In these sports, athletes often need to detect the movements of ball as well as the movement of his or her opponent. Although the ability to detect and differentiate movement is quite important to a broad variety of sports, there is no tool specific for testing of it has been developed. The development of MDT makes it possible to test this ability.

Conceptually, detection of movement and identification of movement direction are two distinct perceptual tasks, detection of movement require to report of only the occurrence of movement without regard to direction of the movement. In the study of kinesthetic movement detection, researchers investigated not only the occurrence of movements, but also the direction of movements (e.g., Hesse, Wing, & Georgeson, n.d.; McCloskey, 1978). McCloskey (1978) argued report of movement direction as the criterion for movement detection best captures kinesthetic acuity. In the sport practice, simply to improve athletes’ movement detection ability is not sufficient to enhance their performance. To facilitate sport performance, athletes also have to improve their ability to make effective and reasonable reactions on the basis of correct and quick detection of movement, as well as identification of movement direction. Therefore, movement detection research in sport should include both detection movement occurrence and identification movement direction. The development of MDT was conceptually based on such an idea. Movement detection in the MDT is regarded as the integration of cognitive and motor component. Depending on the test form, the cognitive component is concerned with detecting occurrence of movement and a decision of the button to be pressed (in MDT-S1), or is concerned with detecting occurrence of movement, identifying direction of movement and deciding on the button to be pressed (in MDT-S2), or is concerned with detecting occurrence of movement, identifying the color towards which the stimulus moves, and deciding on the button to be pressed (in MDT-S3). For the motor component, no matter in which test form it is just concerned with processing the reaction (i.e. pressing corresponding button on the keyboard) as quickly as possible after the decision is made. The cognitive and motor components in the three test forms can be illustrated by a phase mode of movement detection (Figure 14).

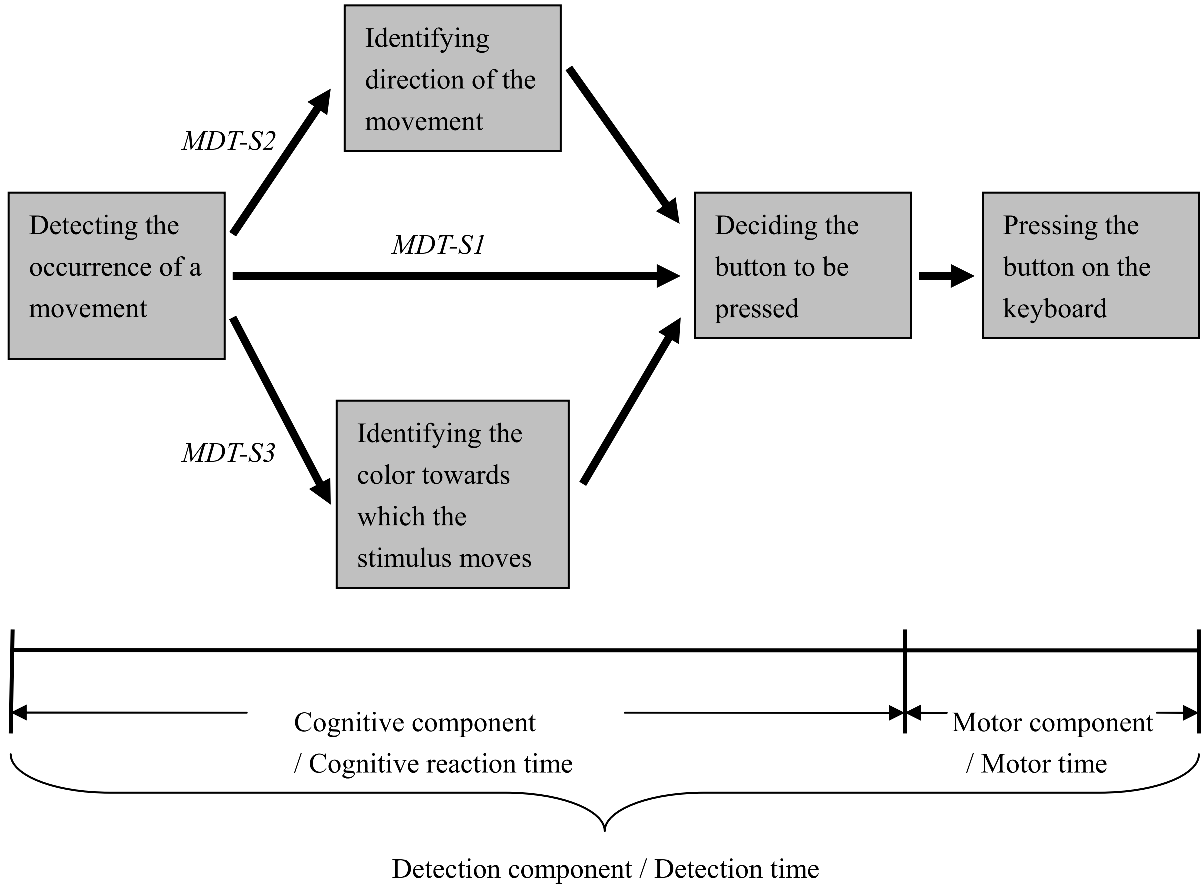


Figure 14. Phase model of movement detection.

4.1.2 Test Structure

4.1.2.1 Test forms

In the previous section, some descriptions about the test forms of MDT have been provided [see: *3.3.2.1 Development of a sports-specific test—Movement Detection Test (MDT)*]. Here a brief introduction about the three test forms of MDT is given:

- Test form S1 (i.e. MDT-S1): *Simple reaction – movement*. With this test form, a simple reaction to a black button is required as soon as the occurrence of a movement is detected by the respondent.

- Test form S2 (i.e. MDT-S3): *Choice reaction – direction of movement*. With this test form, a choice reaction for the appropriate color button is required as soon as the occurrence of a movement is detected and the direction of the movement is identified by the respondent.

- Test form S3 (i.e. MDT-S3): *Choice reaction – direction of movement with changing color coding*. With this test form, a choice reaction for the appropriate color button is required as soon as the occurrence of a movement is detected, the target color of the movement direction is identified, and the color button to be pressed is decided by the respondent.

4.1.2.2 Test Variables

The main variables, subsidiary variables, as well as additional variables of MDT are introduced as below:

Main variables. There are three main test variables in every test form of MDT:

- *Median Cognitive Reaction Time (MDRT) and Quartiles of the Cognitive Reaction Time (QART)* (msec). Cognitive Reaction Time is the time from start of the ball on the screen until the finger is left from the golden button. This variable is closely correlated with the speed of the cognitive component of the decision process while working the tasks of MDT.

- *Median Motor Time (MDMT) and Quartiles of the Motor Time (QAMT)* (msec). Motor time is the time from lifting the finger from the golden button until the finger pushes the black button (MDT-S1) or relevant colored button (MDT-S2 and MDT-S3). This variable is closely correlated with the motor speed of the implementation of the decision while working the tasks of MDT.

- *Median Detection Time (MDDT) and Quartiles of the Detection Time (QADT)* (msec). Detection time is the time between the moment the movement on the screen is initiated and the reaction button is pressed, that is, it refers to the entire time which is composed by the cognitive reaction time and motor reaction time.

The median and quartiles of the cognitive reaction time, motor time and detection time are calculated only from those reactions that are both correct and complete.

Subsidiary variables. The following are subsidiary variables of all test forms:

- *Number of trials*. The total number of stimuli presented.

- *Shortest and longest cognitive reaction time* (msec). The shortest and longest cognitive reaction time in each testing.

- *Shortest and longest motor time* (msec). The shortest and longest cognitive reaction time in each testing.

- *Shortest and longest detection time* (msec). The shortest and longest cognitive reaction time in each testing.

Additional variables. The following are additional variables of different test forms:

(1) The additional variables in MDT-S1:

  - *On time reactions*

  - *Too late reactions*

  - *No reactions*

- *False reactions*
- *Incompleted reactions*

(2) The additional variables in MDT-S2 and MDT-S3 include all the additional variables in MDT-S1, as well as:

- *False reaction-blue*
- *False-reaction-yellow*
- *False-reaction-green*
- *False reaction-red.*

4.1.3 Test Administration

The test administration of MDT is composed of instruction phase, practice phase, as well as test phase.

4.1.3.1 Instruction phase

Step-by-step instructions are presented on the screen to give the respondent the necessary information about the test. The instructions start by explaining what is to be measured in the test and instructing the respondent to keep his or her one finger on the gold button to switch to the second instruction.

In the second instruction, the stimulus (a white ball) and its location on the screen is described at first. Then the respondent is instructed to respond to the movement of stimulus by pressing a corresponding button on the keyboard depending on the different test forms. In MDT-S1, the respondent is required to press the black button on the keyboard as quickly as possible whenever he or she detects the ball starting to move; in MDT-S2 and MDT-S3, the respondent is required to press a corresponding color button on the keyboard as quickly as possible whenever he or she detects the ball starting to move and identifies the color of the movement direction. The respondent is required to replace his or her finger on the gold button after a reaction. Finally, the respondent is instructed to press the yellow button to start practice phase.

4.1.3.2 Practice phase

In the practice phase, the respondent has to complete four successive correct and timely responses to the stimuli presented. If an error is made, feedback is given to reminder the respondent which button should be press; if a response is not timely, feedback is given to remind the respondent to make a response before the ball disappears out of the frame. The practice is interrupted if four successive errors are made, and to contact test administrator is required. The administrator can if necessary to restart the instruction phase to ensure the instructions are fully understood by the respondent.

4.1.3.3 Test phase

The test phase is immediately followed by the test phase. Before starting test, an instruction including the time needed for the test phase, as well as a reminder “to react as quickly and accurately as possible” is presented to the respondent. The respondent is instructed to start test by pressing the black button on the keyboard. The feedbacks in the practice phase do not appear even errors or too late responses are made. At the end of test, the words “Thank you for your participation” is presented.

4.2 METHOD

4.2.1 Participants

One hundred and twenty-seven elite athletes (88 males and 39 females) were administered with MDT-S2. The participants ranged in age from 10 to 25 years, with an average age of 16 years (*M* = 16.31, *SD* = 3.02). They are engaged in 11 different sports including badminton (*n* = 31), Chinese chess (*n* = 1), diving (*n* =5), san shou (*n* = 21), swimming (*n* = 14), tennis (*n* = 12), track and field (*n* = 5), trampoline (*n* = 1), water polo (*n* = 9), weight lifting (*n* = 5), and wu shu routine (*n* = 23). The participants have taken part in their sports for 2 to 11 years, with an average of 5 years.

One hundred and two elite athletes (67 males and 35 females) were administered with MDT-S3. Among these participants, eighty-seven came from the sample of MDT-S2 testing and only fifteen were new participants. The participants ranged in age from 10 to 24 years, with an average age of 16 years (*M* = 15.88, *SD* = 2.81). They were engaged in 12 different sports including badminton (*n* = 27), Chinese chess (*n* = 1), diving (*n* =4), gymnastics (*n* = 1), san shou (*n* = 13), swimming (*n* = 15), tennis (*n* = 5), track and field (*n* = 2), trampoline (*n* = 1), water polo (*n* = 7), weight lifting (*n* = 4), and wu shu routine (*n* = 22). The participants have taken part in their sports for 2 to 10 years, with an average of 4.5 years.

One hundred and twenty-eight elite athletes (87 male and 41 female) were administered with RT-S1. Among these participants, eighty seven were also administered with both MDT-S2 and MDT-3, thirteen and twenty eight were also administered with MDT-S3 and MDT-S2 respectively. The participants ranged in age from 10 to 25 years, with an average age of 16 years (*M* = 16.16, *SD* = 2.99). They were engaged in sports tennis, badminton, diving, swimming, water polo, weight lifting, wu shu routine, san shou, gymnastics, track and field, and trampoline.

All the participants involving in this study are active elite athletes in Guangdong province, China. They participated in the study voluntary.

4.2.2 Instruments

4.2.1.1 The MDT-S2 and MDT-S3

The details of MDT-S2 and MDT-S3 have been given in the previous part of this section (see 4.1 DESCRIPTION OF MDT).

4.2.1.2 The Reaction Test (RT)

The RT (version, 29.01) is a test in the VTS that was designed for testing both a simple choice reaction time and a multiple choice reaction time in response to visual and acoustic signals (Prieler, 2007). The RT includes 10 different test forms (S1 to S10). In this study, the test form S1 (i.e. RT-S1) is used.

The stimulus used in the RT-S1 is yellow light. The respondent has to release his finger from the rest button and to press the reaction button as soon as possible when the stimulus is presented, then return his or her finger on the rest button again for the next trial. The test consists of practice and test phase. Five stimuli are presented in the practice phase and 28 stimuli are presented in the test phase. The time required for administration including instruction is about seven minutes. The main variables in the RT-S1 include mean reaction time and mean motor time.

4.2.3 Procedures

Three test batteries including (a) MDT-S2, RT-S1, and MDT-S3, (b) MDT-S2 and RT-S1, (c) MDT-S3 and RT-S1, were created and administered to eighty seven, twenty eight, and thirteen participants respectively. The test batteries were conducted on an individual athlete basis. The time required to administrate the test battery to a single participant is around 15 to 25 minutes, depending on the different test batteries as well as the participant's understanding of the test instructions. Before starting the tests, the participant's personal information including name, gender, age, education level, and sports discipline were typed into computer system.

4.3 Data Analysis

Data was analyzed using the statistical program SPSS 16.0 to assess reliability and validity of the MDT-S2 and MDT-S3. Specifically, the reliability was tested by calculating internal consistency values and split-half values， and the construct validity was examined by two means: (a) calculating the correlations among the variables of MDT-S2, MDT-S3, and RT-S1; (b) making one-way ANOVAs.

4.4 Results

4.4.1 Reliability

4.4.1.1 The internal consistency reliability

The internal consistency values (i.e. Cronbach's Alpha) of MDT-S2 and MDT-S3 were calculated separately with *N* of items = 32. For the MDT-S2, the internal consistency values of every "color-oriented" subtest (i.e., blue, yellow, green, and red) were calculated as well with *N* of items = 8, because the moving direction of every stimulus and the number of stimuli moving toward every color were fixed (*N* = 8). The values are presented in Table 6. The internal consistency values of the subtests in MDT-S2 varied from .68 to .92, with a mean value of .78; the internal consistency values of MDT-S2 varied from .88 to .95, with a mean value of .92; the internal consistency values of MDT-S3 varied from .84 to .96, with a mean value of .90.

Table 6. The internal consistency values of MDT-S2 and MDT-S3.

Test		**Reliability (Cronbach's alpha)**		
		Cognitive reaction time	**Motor reaction time**	**Detection time**
MDT-S2 (*n* = 127)	Blue	.83	.73	.79
	Yellow	.83	.68	.75
	Green	.82	.70	.73
	Red	.83	.82	.83
	Total	.95	.88	.92
MDT-S3 (*n* = 102)		.96	.91	.84

4.4.1.1 The Split-half reliability

The split-half reliability (odd-even split) of MDT-S2 and MDT-S3 were calculated respectively. As shown in Table 7, the split-half values of the MDT-S2 varied from .88 to .95, with a mean value of .92; the split-half values of the MDT-S3 varied from .87 to .96, with a mean value of .92.

Table 7. The split-half values of MDT-S2 and MDT-S3.

Test	**Reliability (split-half)**		
	Cognitive reaction time	**Motor reaction time**	**Detection time**
MDT-S2 (*n* = 127)	.95	.88	.92
MDT-S3 (*n* =102)	.96	.92	.87

Note. "odd-even split" were employed.

4.4.2 Validity

4.4.2.1 Correlations among the variables of MDT-S2, MDT-S3, and RT-S1

The RT-S1 has proved a comparative high reliability and validity (Prieler, 2007). Therefore, the main variables in RT-S1 can be used to assess the validity of MDT by calculating the correlations among the variables of MDT and RT.

The correlations among the variables of MDT-S2 and RT-S1. The correlations among the variables of MDT-S2 as well as the correlations between the variables of MDT-S2 and RT-S1 were analyzed and the results are presented in Table 8.

As shown in Table 8, the correlation analyses among the variables of MDT-S2 indicated that: (1) there was a low correlation (r = .04) between MDRT and MDMT; (2) there were high correlations between MDDT and MDRT (r = .75, p < .01), MDMT (r = .66, p < .01). The correlation analyses between the variables of MDT-S2 and variables of RT-S1 revealed that: (1) MRT was highly correlated with MDRT (r = .57, p < .01) and MDDT (r = .55, p < .01), but the correlation between MRT and MDMT was low (r = .22); (2) MMT was highly correlated MDMT (r = .64, p < .01) and MDDT (r = .48, p < .01), but the correlation between MMT and MDRT was low (r = .11).

Table 8. Correlation coefficients among the variables of MDT-S2 and RT-S1.

		MDT-S2[a]			RT-S1[b]	
		MDRT	MDMT	MDDT	MRT	MMT
	MDRT	1			.57**	.11
MDT-S2	MDMT	.04	1		.22*	.64**
	MDDT	.75**	.66**	1	.55**	.48**

Note. MRT = mean reaction time, MMT = mean motor time, MDRT = median cognitive reaction time, MDMT = median motor time, MDDT = median detection time. Pearson correlation coefficients are given.

$^{**}p < .01$, $^{*}p < .05$.

[a] $n = 127$. [b] $n = 115$.

The correlations among the variables of MDT-S3 and RT-S1. The correlations among the variables of MDT-S3 as well as the correlations between the variables of MDT-S3 and variables of RT-S1 were calculated. The results were presented in Table 9.

As shown in Table 9, for the variables of MDT-S3, correlation analyses revealed that: (1) there was a high negative correlation ($r = -.67$, $p < .01$) between MDRT and MDMT; (2) there were moderate to high correlations between MDDT and MDRT ($r = .43$, $p < .01$), MDMT ($r = .33$, $p < .01$). For the variables of MDT-S3 and RT-S1, correlation analyses revealed that the moderate and high correlations only existed between MMT and MDMT ($r = .42$, $p < .01$), MDDT ($r = .31$, $p < .01$).

Table 9. Correlation coefficients among the variables of MDT-S3 and RT-S1.

		MDT-S3 [a]			RT-S1 [b]	
		MDRT	MDMT	MDDT	MRT	MMT
MDT-S3	MDRT	1			.16	-.16
	MDMT	-.67**	1		-.05	.42**
	MDDT	.43**	.33**	1	.18	.31**

Note. MRT = mean reaction time, MMT = mean motor time, MDRT = median cognitive reaction time, MDMT = median motor time, MDDT = median detection time. Pearson correlation coefficients are given.

***p* < .01, **p* < .05.

[a] *n* = 102. [b] *n* = 100.

The correlations among the variables of MDT-S3 and MDT-S2. The correlations between the variables of MDT-S3 and variables of MDT-S2 were calculated. The results are presented in Table 10.

As shown in Table 10, the correlation analyses suggested that: (1) there were high correlations in MDRT (r = .58, p < .01), MDMT (r = .53, p < .01) between MDT-S3 and MDT-S2; (2) there were moderate to high correlations between MDDT of the MDT-S3 and MDRT (r = .48, p < .01), MDMT (r = .32, p < .01) of the MDT-S2, however, the correlations between MDDT of the MDT-S2 and MDRT, MDMT of the MDT-S3 were low; (3) there was a high correlations (r = .57, p < .01) in MDDT between MDT-S2 and MDT-S3.

Table 10. Correlation coefficients among the variables of MDT-S3 and MDT-S2.

		MDT-S2 [a]		
		MDRT	MDMT	MDDT
MDT-S3 [a]	MDRT	.58**	-.22*	.26*
	MDMT	-.29*	.53**	.15
	MDDT	.42**	.33**	.54**

Note. MRT = mean reaction time, MMT = mean motor time, MDRT = median cognitive reaction time, MDMT = median motor time, MDDT = median detection time. Pearson correlation coefficients are given.

** $p < .01$, * $p < .05$.

[a] $n = 88$.

4.4.2.2 One-Way ANOVA

One-Way ANOVAs were conducted to determine whether the MDT-S2 and MDT-S3 could differentiate between the scores of athletes participated in open- and closed-skill sports. According to Fischman and Oxendine (1998), open-skill sports refers to sports played in a constantly changing environment, in which several athletes compete with and against one another, while closed-skill sports refers to sports played in a relatively unchanging and constant environment, in which athletes compete against one or more individuals. The open-skill sports in the current study include sanshou, badminton, water polo, and tennis, the closed-skill sports include weight lifting, diving, swimming, gym, trampoline, wushu routine, track and field, and Chinese cheers.

One-way ANOVA on the data from MDT-S2. The data collected from MDT-S2 were analyzed by One-Way ANOVA and the results are presented in Table 11.

As shown in Table 11, the open-skill sports group was faster than closed-skill sports group in median cognitive reaction time, median motor time, and median detection time. The differences in median cognitive reaction time and median detection time between the two groups were significant, while the difference in median motor time between the two groups was not significant.

Table 11. Descriptive statistics of open- and closed-skill sports groups, along with *F* values and significance levels calculated on the data from MDT-S2.

		Mean[a]	*SD*	*F*	*Sig.*
MDRT	Open-skill sports[b]	311.99	39.29	4.31	.04
	Closed-skill sports[c]	325.35	30.58		
MDMT	Open-skill sports[b]	161.96	32.04	1.77	.19
	Closed-skill sports[c]	169.57	31.60		
MDDT	Open-skill sports[b]	479.68	49.94	5.08	.03
	Closed-skill sports[c]	499.15	45.46		

Note. MDRT = median reaction time, MDMT = median motor time, MDDT = median detection time.

[a]All the times in msec.

[b]*n* = 73. [c]*n* = 54.

One-way ANOVA on the data from MDT-S3. The results of One-Way ANOVA for data from the MDT-S3 are presented in Table 12.

As shown in Table 12, although the open-skill sports group was faster than the closed-skill sports group in median cognitive reaction, median motor time, and median detection time, only the difference in median detection time between the two groups was significant. No significant differences were identified in median cognitive reaction time and median motor time between the two groups.

Table 12. Descriptive statistics of open- and closed-skill sports groups, along with *F* values and significance levels calculated on the data from MDT-S3.

		Mean[a]	*SD*	*F*	*Sig.*
MDRT	Open-skill sports[b]	471.06	84.61	.44	.51
	Closed-skill sports[c]	481.59	74.59		
MDMT	Open-skill sports[b]	235.17	72.39	.64	.43
	Closed-skill sports[c]	246.69	72.59		
MDDT	Open-skill sports[b]	722.13	56.68	6.37	.01
	Closed-skill sports[c]	751.51	64.02		

Note. MDRT = median reaction time, MDMT = median motor time, MDDT = median detection time.

[a]All the times in msec.

[b]$n = 52$. [c]$n = 49$.

4.5 Discussion and Conclusion

In this chapter, the reliability and validity of the MDT-S2 and MDT-S3 have been examined in a Chinese elite athlete sample. The results are summarized and discussed separately as follows.

4.5.1 The MDT-S2

In terms of internal consistency reliability, Vincent (1999) argued that the Cronobach's Alpha values above .80 are generally deemed adequate, and the values between .70 and .80 are admissible in behavior sciences. The minimum level of α = .70 was also recommended by Nunnally and Bernstein (1994). In this study, reliability analysis of MDT-S2 indicated that the Cronobach's Alpha values of cognitive reaction time, motor time, and detection time were above .88 with an average value of .92, the values of the "color-oriented" subtests were above .70 aside from the motor reaction time of parts of the yellow subtest (α = .68). In addition, the split-half values of the cognitive reaction time, motor time, and detection time were above .88. It thus can be concluded that the MDT-S2 is a test with high reliability.

The correlation analyses among the test variables of MDT-S2 indicated that median detection time was highly correlated with median reaction time and median motor time, while the correlation coefficient between the median reaction time and median motor time was small. It demonstrates that cognitive reaction time and motor time are two different dimensions within the MDT-S2, and both of them are necessary component parts of detection time. In addition, the correlation analyses between the variables of MDT-S2 and the variables of RT-S1 revealed high correlations between median cognitive reaction time (variable of the MDT-S2) and mean reaction time (variable of the RT-S1), median motor time (variable of the MDT-S2) and mean motor time (variable of the RT-S1), as well as the low correlations between the median cognitive reaction time and mean motor time, median motor time and mean reaction time. In "Construct validity" (n.d.), it states that "evaluation of construct validity requires that the correlations of the measure be examined in regards to variables that are known to be related to the construct (purportedly measured by the instrument being evaluated or for which there are theoretical grounds for expecting it to be related)". A measure is regarded to have good construct validity if the correlations are high. In this study, the reaction time measured by RT-S1 and the cognitive reaction time measured by MDT-S2, as well as the motor time measured by RT-S1 and the cognitive reaction time measured by MDT-S2 are theoretically correlated. Therefore, the correlations between them can be analyzed to evaluate the constructed validity of MDT-S2. To sum up the results of the above correlation analyses, it can be concluded that the MDT-S2 is a test with good construct validity.

As previously stated, athletes who are engaged in open-skill sports are likely to play in a constant changing environment, while athletes who are engaged in closed-skills sports are likely to play in a relatively unchanging and stable environment. Therefore, it is assumed, in theory, that athletes involved in open-skill sports have better movement detection ability than their counterparts involved in closed-skill sports. The MDT-S2 is deemed to have good construct validity if it could differentiate between athletes in open- and closed-skill sports. In this study, the results of one-way ANOVA revealed that cognitive reaction time and detection time could significantly discriminate between athletes in open- and closed-skill sport. It is yet another demonstration of the good construct validity of MDT-S2. The motor time could not discriminate between athletes in open- and closed-skill sports probably because the cognitive processes (i.e. detect the occurrence of movement and identify the direction of movement) have little influence on the following motor time. Conceptually, the cognitive reaction time is closed correlated with the speed of the cognitive components of the decision process while working the task of MDT, but the motor time has nothing to do with the cognitive components of the decision process, it is closely correlated with the motor speed of the implementation of the decision while working the task of MDT (Hackfort, Herle, & Debelak, 2010).

4.5.2 The MDT-S3

In terms of reliability of the MDT-S3, analyses of internal consistency indicated that Cronbach's Alpha values of cognitive reaction time, motor time, and detection time were .96, .91, and .84 respectively, and the split-half value of them were above .87

with mean value of .92. The results demonstrate the MDT-S3 has good reliability. The reliability of the "color-oriented" subtests were not assessed because the moving direction of stimulus and the times of the stimulus moving towards the various corners were different from test to test.

The correlation analyses among variables of the MDT-S3 revealed a moderate and a high correlation between the median detection time and median motor time, median cognitive reaction time respectively. It suggests that cognitive reaction time and motor time are necessary component parts of detection time. In addition of that, a high negative correlation between the cognitive reaction time and motor time was identified. It suggests that cognitive reaction time and motor time are two different dimensions within the MDT-S3, but motor time will increase along with the decrease of cognitive reaction time, or the other way around. The correlation analyses between the variables of MDT-S3 and the variables of RT-S1 revealed a moderate and a high correlation between the mean motor time and median detection time, median motor time. The correlations between mean reaction time and median cognitive reaction time, median detection time, which in theory may be closely, are slow. Other correlation analyses between the variables of MDT-S3 and the variables of MDT-S2 revealed high correlations in median cognitive reaction time, median motor time, and median detection time between the two test forms, as well as the moderate to high correlations between the median detection time of MDT-S3 and the median motor time, median cognitive reaction time of MDT-S2, however, the correlations between the median detection time of MDT-S2 and the median cognitive reaction time, median motor time of MDT-S3, which in theory may be closely, are low. To sum up the results of all correlation analyses, it may be taken for granted that the construct validity of MDT-S3 could not be proven sufficiently in this study and should be investigated in further studies.

One-way ANOVA also revealed that only median detection time can differentiate between athletes who were involved in open- and closed-skill sports. No significant differences in median cognitive reaction time and median motor time between athletes in open- and closed-skill sports have been identified. The construct validity of MDT-S3 could not be proven as well in this analysis.

There were two possible reasons for the poor construct validity of MDT-S3 in this study. They are discussed as below:

Firstly, the original idea behind the development of MDT-S3 was to develop a tool for training movement detection ability. Based on this idea, the MDT-S3 was designed with three options (slow, median, and fast) in the moving speed of the stimulus, and the moving direction of the stimulus and the times of the stimulus moving towards every corner were randomly changed. That is, the MDT-S3 was design to make it different from test to test so that the athlete can not remember the moving direction of every stimulus when he or she is trained repeatedly, and has to react by using detection ability rather than memory. Obviously, such a design will increase training effectiveness if MDT-S3 is used as a tool for training purpose, but will sacrifice validity when it is used as a test for its non-standardized design.

Secondly, in terms of the original idea, cognitive reaction time and motor time represent two different variables. Cognitive reaction time is closely correlated with speed of a series of cognitive processes including detection of the occurrence of movements, identification of the color of the corner towards which the stimulus moves, as well as the final decision making of which button to be pressed, while motor reaction time is just closely correlated with the motor speed after decision making. Therefore, in concept, cognitive reaction time is the time from start of the ball on the screen until the finger is left from the golden button, and all cognitive components are assumed to occur in this time period; while motor time is the time from lifting the finger from the golden button until the finger pushes a corresponding response button, and it is assumed that except for motor activity, no cognitive component occurs in this time period. It is observed that, during the testing, some athletes released their fingers from the rest button soon after the decision making, while others released their fingers soon after they detected the occurrence of movement, or soon after they detected the movement and identified the color towards which the stimulus moves. That is, the time for completing part of cognitive components was calculated as motor time.

The relations among the cognitive reaction time, motor time, and detection time can be simply formulated as: *cognitive reaction time + motor time = detection time*. Obviously, implementing cognitive components in motor time period will increase motor time but decrease cognitive reaction time. This may be the possible reason of why the cognitive reaction time was negative correlated with the motor reaction time, as well as why both cognitive reaction time and motor time can not differentiated between athletes in open- and closed-skill sports group.

In conclusion, the MDT-S2 is proved to be a test with high reliability and validity, while the construct validity of the MDT-S3 is proved to be not acceptable in this study. An improvement in the test instruction could be an appropriate solution to improve the validity of MDT-S3.

The following is the current instruction suggested to be modified in the MDT-S3 (Figure 15). Depending on understanding of this instruction, the respondent may release the finger from gold button immediate after he or she detects the starting to move, and then to identify the color towards which the ball moves and to decide which button to press. With such a response, the cognitive reaction time is decreased while the motor time is increased.

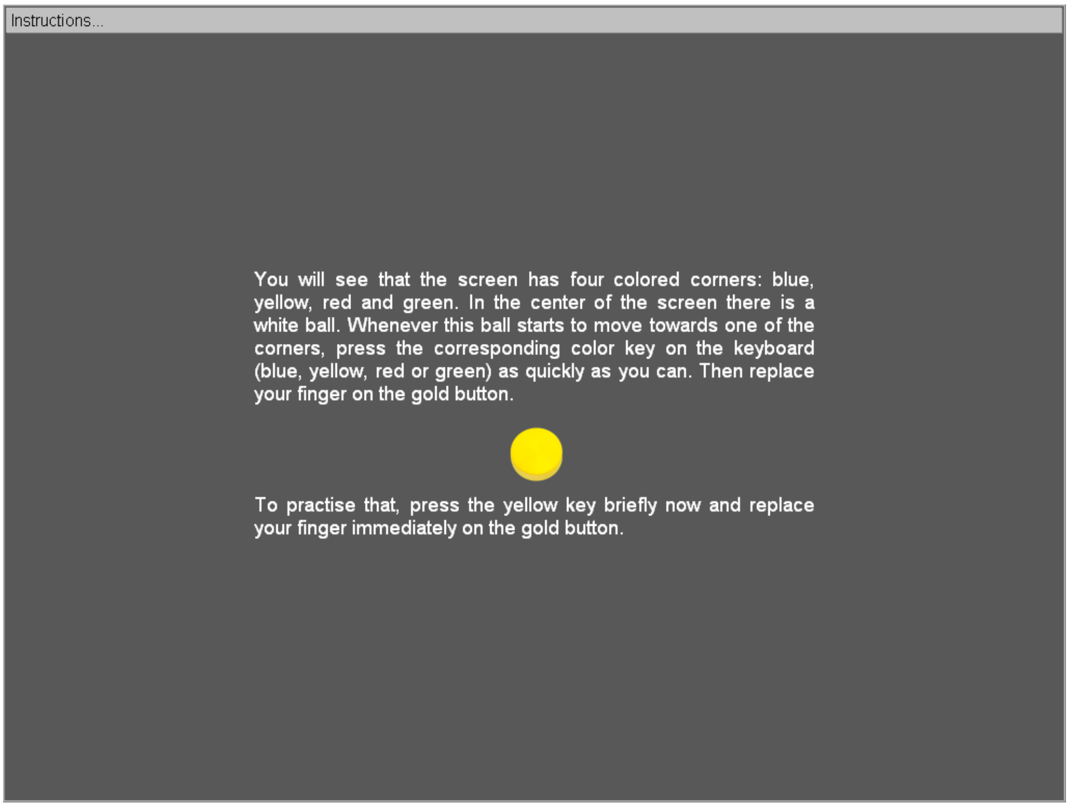


Figure 15. The instruction suggested to be modified in MDT-S3.

The suggested instruction is:

> .... Anytime when you observe the occurrence of movement, first identify the color of the corner towards which the dot moves, and decide which color button to pressed, than release your finger from the rest button and press the color button as fast as possible.

5 THE PRACTICAL APPLICATION OF THE MTTS TOOL IN THE FRAME OF ACTION-THEORY-BASED MENTAL ASSESSMENT AND TRAINING APPROACH

5.1 INTRODUCTION

In the field of applied sport psychology, the efficacy of mental training has been widely explored by many investigators. Most of the investigations provide evidences and indicated that psychological skills (e.g., goal setting, relaxation, imagery, self-talk, and thought stopping) were indeed effective for enhancing performance (Haddad & Tremayne, 2009; Hall & Rodgers, 1989; Hamilton, Scott, & MacDougall, 2007; McCaffrey & Orlick, 1989; Patrick & Hrycaiko, 1998; Rogerson & Hrycaiko, 2002; Thelwell & Greenlees, 2003; Theodorakis, Weinberg, Natsis, Douma, & Kazakas, 2000) and for achieving desired performance-related outcomes such as decreased anxiety (Conroy & Metzler, 2004; Elko & Ostrow, 1991; Savoy & Beitel, 1997), enhanced self-confidence (Bakker & Kayser, 1994; Burton, 1988; Mamassis & Doganis, 2004; Tremayne & Tremayne, 2004) and self-efficacy (Hatzigeorgiadis, Zourbanos, Goltsios, & Theodorakis, 2008; Tremayne & Tremayne, 2004)), as well as mental toughness, hardiness, dispositional optimism, and positive affectivity (Sheard & Golby, 2006), when they were applied individually or as a psychological skills training package.

Gould and Carson (2007) pointed out that although the efficacy of mental skills training had been supported by numerous studies, there were four inherent challenges required careful consideration. These challenges include: (a) mental skills training are often carried out in a dynamic sport environment in which strict control of variables are not allowed, which makes it difficult to determine the relationships and causal relationships between variables; (b) research on the effectiveness of mental skills training is not conducive to large scale projects, which reduced the generalizability of the research findings; (c) the common conception of mental skills training is lacked, in some research single-skills interventions are studied, while in others mental skills packages are studied; and (d) various methods are employed to train same mental skills in studies, which makes comparisons of methods problematic.

In addition to the four challenges provided by Gould and Carson (2007), another shortcoming existed in the design of this kind of research requires careful consideration as well. That is, in most research about the efficacy of mental training, a sequence that had been commonly employed for experimental design was: assessing the baseline of performance and desired mental attributes → implementing psychological skills training → reassessing the level of performance and desired mental attributes → identifying the improvement of performance and mental attributes. Obviously, taking such experimental design, the conclusion that psychological skills training facilitating performance and desired psychological attributes was drawn based on two underlying hypotheses: (a) Participants had mastered mental skills, and (b) participants applied what they had mastered in their sport activities. Whether the participants had mastered mental skills or not can be estimated by comparing the levels of mental skills abilities before and after psychological skills training. Unfortunately, although investigators took mental skills assessment questionnaires (Patrick & Hrycaiko, 1998; Thelwell & Greenlees, 2003), manipulation check protocol (Hatzigeorgiadis, et al., 2008), and self-assessment form (Rogerson & Hrycaiko, 2002) to remind and monitor participants to use mental skills, and to check participants' usage of mental skills, few investigators assessed the baseline and improvement of mental skills abilities (Fournier, Calmels, Durand-Bush, & Salmela, 2005; Patrick & Hrycaiko, 1998), as well as how effective the mental skills were for the participants (Haddad & Tremayne, 2009).

In this section, it is reported on a mental assessment and training intervention which was offered on the basis of the ideas about applying the MTTS tool in the frame of action-theory based mental assessment and training approach. Within the process of intervention, mental assessment and training were dynamically interrelated, that is, on the one hand, the effectiveness of mental training sessions was assessed continuously and, on the other, the assessment result was fed back to the participant soon after every training session. The main purpose of the intervention was to train participants' ability to optimize action situations. In terms of action-theory approach, the ultimate goal of mental training in elite sports is to train athletes' ability to optimize various action situations because any behavior or performance of an athlete, without exception, is executed under a certain action situation. In addition, two second purposes related to optimizing action situations were included: (a) to create action situations by manipulating MTTS tool and to organize mental training in the situations, and (b) to teach, practice and enhance mental skills concerned with optimization of action situations.

With regard to the purposes of optimizing an action situation, Hackfort (2006) stated as follows:

> This [optimizing an action situation] is done to improve one's level of adaptation or create a better person-environment fit. The criteria for "better" can be emotional factor (e.g., more pleasant, comfortable), instrumental (less costly, or more beneficial), or an intellectual factor (e.g., a better understanding). (p. 13)

Following Hackfort's (2006) understanding, participants in the current study were trained to optimize action situations in order to perform better, or to perform with less effort, or to obtain optimal experience in their performance. Accordingly, a participant's ability to optimize action situation was assessed by measuring his or her (a) performance, (b) perceived effort on the tasks, and (c) experience of flow state. Flow is a subjective optimal experience that has been originally proposed by Csikszentmihalyi (1975) in the field of intrinsic motivation. Flow state emerges when people are completely and totally absorbed in an activity, and at the moment people perceive a balance between perceived challenges and skills in the activity, and feel pleasure, happiness, satisfaction, enjoyment, controllability of actions and environment, and superior functioning, etc (Csikszentmihalyi, 1975, 1982, 1990; Csikszentmihalyi & Csikszentmihalyi, 1988). In the past decade, flow in sport and exercise have been widely researched by some authors (e.g., Jackson, 1992, 1995, 1996; Jackson & Csikszentmihalyi, 1999; Jackson & Eklund, 2002; Jackson, Kimiecik, ford, & Marsh, 1998; Jackson & Marsh, 1996; Jackson, Martine, & Eklund, 2008; Kimiecik & Stein, 1992) since Csikszentmihalyi (1992) encouraged application of the theory of flow to physical activity settings. In this intervention program, the flow state was employed based on such a hypothesis: when in an optimized action situation, the participant's performance would be characterized by experience of controllable, automatic, with less effort, etc. These experiences are similar to the experiences of flow state.

To achieve the second purposes, three action situations for mental training were created in the current study. The details of the situations were described in the following part (see: 5.2.4 Experimental Design). Taking into account these action situations and the high demands of the tasks in the motor-performance tests for mental training, five mental skills (i.e., relaxation, imagery, self-talk, thought stopping, and refocusing) concerned with optimizing action situations were taught and executed in the process of intervention. Specifically, relaxation, imagery, and self-talk were selected because these skills have been proved to facilitate sports performance by numerous investigations (e.g., Fournier, Calmels, Durand-Bush, & Salmela, 2005; Patrick & Hrycaiko, 1998; Sheard & Golby, 2006); thought stopping, refocusing were selected because, in the light of previous experience of using MTTS for mental test and mental training, participants inevitably made a series of wrong reactions during testing, which always brought their thought linger at the past mistakes and distracted their focus, and eventually impaired their performance in the testing. Certainly, this can often happens in sports competition. There are many cases of athletes whose performance deteriorated suddenly and lost game rapidly, after they made a mistake in the match and could not forget it and refocus on the next actions. Therefore, to let athletes know the importance of thought stopping and refocusing and to train their ability of thought stopping and refocusing are very necessary and significant.

In order to remind and monitor their practice these mental skills in the training sessions, a Mental Skills Usage Questionnaire were administrated to participants soon after every training session. In addition, the baseline and the post-intervention level of task-specific mental skills were measured to evaluate the effectiveness of mental skills learning and practice.

5.2 METHOD

5.2.1 Participants

At the beginning of the study, totally 30 male athletes participated in the study voluntary. They were divided randomly into an experimental group (n = 20) and a control group (n = 10) after balancing sport disciplines. However, three participants in the experimental group and one participant in the control group dropped out from the study after the second session for the reason of clash between the mental training and study in school. Therefore, totally 26 participants involved in the entire study. All participants are full-time athletes and they train in a province-level team (i.e., Guangdong province team, China). The current athletic levels of the participants range from national level III to national level I. The demographic descriptions of participants were given in detail in Table 13.

Table 13. Demographic descriptions of the participants.

Group	Age *(years)*				Sport discipline	Sports experience *(years)*			
	Min	*Max*	*M*	*SD*		*Min*	*Max*	*M*	*SD*
Control group (*n* = 9)	17	25	21	2.87	Chinese martial arts (*n* = 6); trampoline (*n* = 3)	3	10	6.78	2.22
Experimental group (*n* = 17)	15	29	19.53	3.71	Chinese martial arts (*n* = 12); trampoline (*n* = 5)	3	12	7.35	2.26
Total (*n* = 26)	15	29	20.04	3.46	Chinese martial arts (*n* = 18); trampoline (*n* = 8)	3	12	7.15	2.22

5.2.2 Apparatus and Tasks

In the current study, the MTTS tool was taken as platform for the organization of mental assessment and training. Specifically, the apparatus included the hardware of VTS, a MP4 player and two speakers, three flickering LED lights.

The tasks were provided by two motor-performance tests within the MTTS, they are test form S1 of the Determination Test (DT-S1), as well as test form S2 and S3 of the Movement Detection Test (MDT-S2, and MDT-S3). The details of the MDT have been provided in the previous section, and the details of the DT will be given below.

5.2.3 Measures

5.2.3.1 Demographic Survey

A demographic survey was administered to the participants sample to obtain their specific information, including name, gender, date of birth, sport discipline, experience in the sport, and the current athletic level, etc (see Appendix 1).

5.2.3.2 DT-S1

DT is a complex multi-stimuli reaction test developed with main purpose of measuring stress tolerance, which was defined by Kisser (1986) as "the individual's ability to resist the effect of the stimuli - that is, his ability to utilise modes of behaviour that enable him to cope as effectively as possible with the situation" (cited from Neuwirth & Benesch, 2007, p. 6).

In the DT, visual (five circles colored blue, white, yellow, green, and red, as well as two white rectangles) and acoustic stimuli (high and low tone) are designed. These stimuli can be presented in three different ways, namely, reaction mode, action mode, and adaptive mode (Neuwirth & Benesch, 2007). With reaction mode, the presentation time per stimulus is fixed. At the end of the fix time, the next stimulus is presented regardless of whether a reaction has been made or not. With action mode, the test duration is fixed, and the presentation time per stimulus is determined by the respondent, the next stimulus will not be presented till a correct response has made to the current one. With the adaptive mode, the presentation time per stimulus is automatically varied, depends on the respondent's pace of work. It is calculated as the mean of the previous eight reaction times (if an incorrect response happed, its reaction time is doubled for calculating). During the testing, the respondent is required to respond to stimuli as quickly as possible no matter which mode is adopted, such a design makes it possible to "measure behavior under different levels of psychological and physiological stress, since an appropriately high signal frequency can put any individual in a situation in which he is overstretched and can no longer handle the necessary responses” (Kisser, 1986, cited from Neuwirth & Benesch, 2007, p. 6).

The DT-S1 is a test form in which stimuli are presented in the adaptive mode. This form of presentation, according to Neuwirth and Benesch (2007), “ensures that the subject is always working at the limit of his ability and that ‘reactive stress tolerance’ is therefore being fairly measured” (p. 7)

Three independent variables are measured in this test: (a) number of correct reactions, which includes both on time and delayed correct reactions, is the main variable using to evaluate the stress tolerance of a respondent; (b) number of incorrect reactions, which includes all inappropriate reactions, is closely linked to attention function with a high number indicates an impaired attention function; (c) number of omitted reactions, which scores the number of stimuli to which no correct or incorrect responses are given, provides information of a respondent’s resignation tendencies.

5.2.3.3 MDT-S2 and MDT-S3

The details of the MDT-S2 and MDT-S3 have been described in the previous sections (see: 4 EXAMINATION OF THE MOVEMENT DETECTION TEST (MDT) IN A CHINESE ELITE ATHLETES SAMPLE) .

5.2.3.4 Perceived Effort Questionnaire

A singe-item questionnaire was designed to measure participants’ perceived effort that he expended on the task during the testing. Participants were required to rating the effort on a scale of 1 to 7, where 1 = *no effort at all* and 7 = *went all out* (see Appendix 2).

5.2.3.5 Short (9-Item) Flow State Scale 2

Jackson and Eklund (2002) developed the Flow State Scale (FSS) to assess the state or situation-specific experience of flow. The scale consists of nine 4-items dimensions, namely, challenge skill balance, action awareness, clear goals, unambiguous feedback, concentration on task, sense of control, loss self-consciousness, transformation of time, ad autotelic experience. To improve the psychometric properties, item modification was made by Jackson and Eklund. The FSS-2 is a new version based on such a modification.

The short (9-Item) FSS-2 is an abbreviated version of the FSS-2 (Jackson, Martin, Eklund, 2008). It was designed by selecting one item from each of the nine 4-item dimensions of FSS-2. It is always administrated following a specific activity, and respondents are required to answer each item on a 5-point Likert-type scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*) (see Appendix 3).

5.2.3.6 Mental Skills Competence Checklist

A Mental Skills Competence Checklist was designed to evaluate the baseline and post-intervention level of the mental skills. Specifically, relaxation, imagery, thought-stopping, and refocusing were evaluated by a set of non-standardized questionnaires, self-talk was evaluated by participants report, and relaxation ability was also evaluated by a biofeedback relaxation system GSR2™ (see Appendix 4).

5.2.3.7 Mental Skills Usage Questionnaire

Patrick and Hrycaiko (1998) developed the Mental Skills Assessment Questionnaire (MSAQ) to monitor the usage of mental skills and to remind the participants using mental skills in psychological skills training intervention. It is an eight-item checklist (*yes/no* answer format) with two items pertaining to each of the four mental skills (i.e., relaxation, imagery, self-talk, and goal setting). Although the MSAQ is not a standardized and validated instrument, it has been used by authors in several studies (Blakeslee & Goff, 2007; Thelwell & Greenlees, 2001; Thelwell & Maynard, 2003).

A Mental Skills Usage Questionnaire was developed based on MSAQ to monitor the mental skills usage in the current intervention. It includes six items modified from the items related to relaxation, imagery, and self-talk in MSAQ, as well as four new items related to thought stopping and refocusing (see Appendix 5).

5.2.3.8 Social Validation Questionnaire

Wolf (1978) originally introduced and named the concept of social validity in applied behavior analysis. According to Wolf, the assessment of social validity of an intervention is concerned with three distinct but related elements: (a) the goals of treatment, (b) the treatment procedure, and (c) the outcomes produced by treatment procedures. In psychology most researchers now follow wolf's idea to assess the social validity of interventions.

In sport psychology, social validity has also been assessed by many authors to evaluate the effect of interventions, e.g., mental skills training. The assessment of social validity usually involves asking questions related to (a) the importance of improvement, (b) the significant of improvement, and (c) the satisfaction with intervention procedure (Blakeslee & Goff, 2007; Patrick & Hrycaiko, 1998; Pates, Maynard, & Westbury, 2001; Thelwell & Greenlees, 2001, 2003). In the present study, a social validation questionnaire was administered to the participants in experimental group at the end of this study. There are four questions included in the questionnaire: (a) "How important is the mental training to improve your performance?" with responses ranging from 1 (*not at all important*) to 5 (*extremely important*); (b) "Do you experience any significant improvement after the mental training sessions?" with responses ranging from 1 (*not at all significant*) to 5 (*extremely significant*); (c) "How satisfied are you with the mental training program?" with responses from 1 (*not at all* *satisfied*) to 5 (*extremely satisfied*); and (d) "Are you going to use what you learned from the mental training sessions in your training and competition?" with responses ranging from 1 (*absolutely not will*) to 5 (*absolutely will*) (see Appendix 6).

5.2.4 Experimental Design

An intervention program in which mental assessment and training were integrated closely had been designed for the experimental group. The structure of the program was composed of four parts namely initial assessment, mental skills teaching, mental training organization, and final assessment. The program was completed within seven sessions (session 1: initial assessment; session 2: mental skills teaching; session 3-6: mental training organization; session 7: final assessment) for every participant, which were carried out over three weeks. With the exception of session 2 in which the mental skills were taught to the participants in groups (the participants were divided into three groups in terms of their sports training and study time), in the other sessions every participants took part in individually. Totally 105 sessions were conducted to the participants in the experimental group, and all the sessions were administered by the author of the present paper.

By modifying the factors of P-E-T constellation, three action situations were created under which mental training were organized. More specifically, the situation 1 was created by modifying the factors of "environment" through presenting disturbing noise and light in the testing process; the situation 2 was created by modifying the factors of "task" through speeding up the move of dot in MDT-S3 and exchanging the position of left and right foot pedals in DT-S1 to increase the difficulty of "tasks"; the situation 3 was created by modifying the factors of "person" through conducting mental training intervention after their sports training. These action situations were applied singlely or mixedly in the organization of mental training in session 3-6.

Participants in the control group were required to complete the motor-performance tests just as those completed by their counterparts in the experimental group, under a neutral situation to examine the practice effectiveness. Every participant took part in six sessions individually, and totally 54 sessions were administered by the author of the present paper.

5.2.5 Procedures

5.2.5.1 Procedures for the experimental group

The procedure of the intervention for the participants in the experimental group is illustrated in Figure 16.

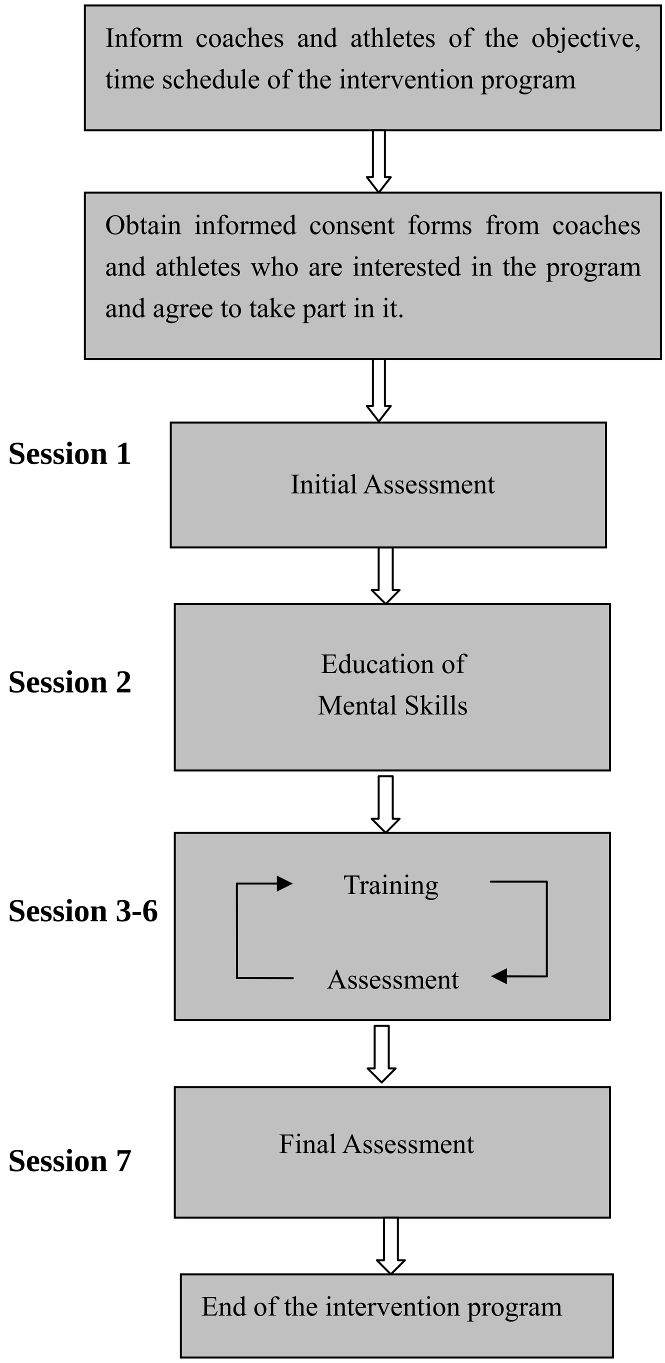


Figure 16. Procedure of intervention for the participants in the experimental group.

Previous to starting the intervention program, athletes and coaches were informed of the objectives of the program. They were also told that the program was composed of seven sessions, which would take place over two to three weeks. Except for the session 2, the other sessions were scheduled individually so as to not interfere with their school and practice, they took part in the sessions at the time that they felt best to them. Permission to conduct the intervention program was obtained from both coaches and athletes, and those who were interested in the program and agreed to participate in the program completed an informed consent form (see Appendix 7 and 8).

Session 1—Initial assessment. The initial assessment was conducted following such procedures: firstly, the participant was asked to complete a demographic survey. Secondly, a battery of motor-performance tests including MDT-S2, DT-S1, and MDT-S3 were administered to the participant. For every test, the testing process consists of an instruction phase, a practice phase, and the test phase. In the instruction phase, step by step the instructions were presented on the screen to give the participant the necessary information about the test, and these instructions were also explained by the administrator to make sure they were fully understood by the participant. The instruction phase is followed by the practice phase. In the practice phase, the participant practiced running the test examples. The administrator restarted the practice phase till the participant showed a relatively consistent performance. After that the participant started the test phase to complete the test. Immediately after the completion of the motor-performance tests, the Perceived Effort Questionnaire, the Short Flow State Scale, and the Mental Skills Competence Checklist were administered to the participant in turn. The session 1 was lasted appropriately 60-70 minutes depends on different participant.

Session 2—Education of Mental skills. The participants were divided into three groups (group 1: n = 5; group 2: n = 6; group 3: n = 6) and they took part in this session in group.

In this session, five types of mental skills, namely relaxation, imagery, self-talk, thought stopping, and refocusing, were introduced and taught to participants firstly.

The mental skills were taught to the three groups following a same "Mental Skills Teaching Outline" (see Appendix 9) designed for the purpose of this study to make sure the identity of teaching to every participant.

Then the discussions and suggestions about how these skills could be used to enhance their performance in the motor-performance tests followed. For example, the participants were suggested to think the instruction and practice phases of every motor-performance test as a warm-up phase, in which they can assess their physical and psychological preparation and make corresponding regulations, e.g., relaxing body and mind, imaging the buttons on the response panel, and the tasks required to be completed, executing self-talk to encourage themselves, etc. Other examples include: (1) the participants were suggested to relax the muscles if they feel tensions during the testing; (2) the participants were suggested to forget the mistakes and to refocus as soon as possible through self talking so that they could respond to the next stimuli quickly and accurately. The session needed 90-100 minutes, with a 5-minute break after teaching of relaxation and imagery.

Session 3 to 6—Mental training organization. In each of the four sessions, mental training was organized in a single case situation created by modifying the factors of P-E-T constellation (see 5.2.4 Experimental Design), or under the combination of the three constellations. Specifically, in the session 3 and 4, the mental training was organized under the configuration of situation 1 and 2 respectively; in the session 5, the mental training was organized under the combination of the configuration of situation 1 and 2; and in the session 6 the mental training was organized under the combination of the configuration of situation 1, 2, and 3.

In every mental training session the participants were required to apply the mental skills that were taught and discussed in the session 2 to optimize the action situation to enhance their performance on the motor-performance. Immediately after the completion of motor-performance tests, the use of mental skills during the testing was assessed and a feedback was given to the participants. This assessment could on the one hand monitor the use condition of these skills, on the other hand remind and encourage the participants to use these skills in the next mental training session. The details of how to practice the mental skills taught in session 2 in the process of motor-performance testing, as well as how to provide feedback after testing are illustrated in Figure 17.

Session 7—Final assessment. The final assessment was almost a repetition of the initial assessment, except that the participants needed to assess the use of mental skills during the testing and to complete a Social Validation Questionnaire.

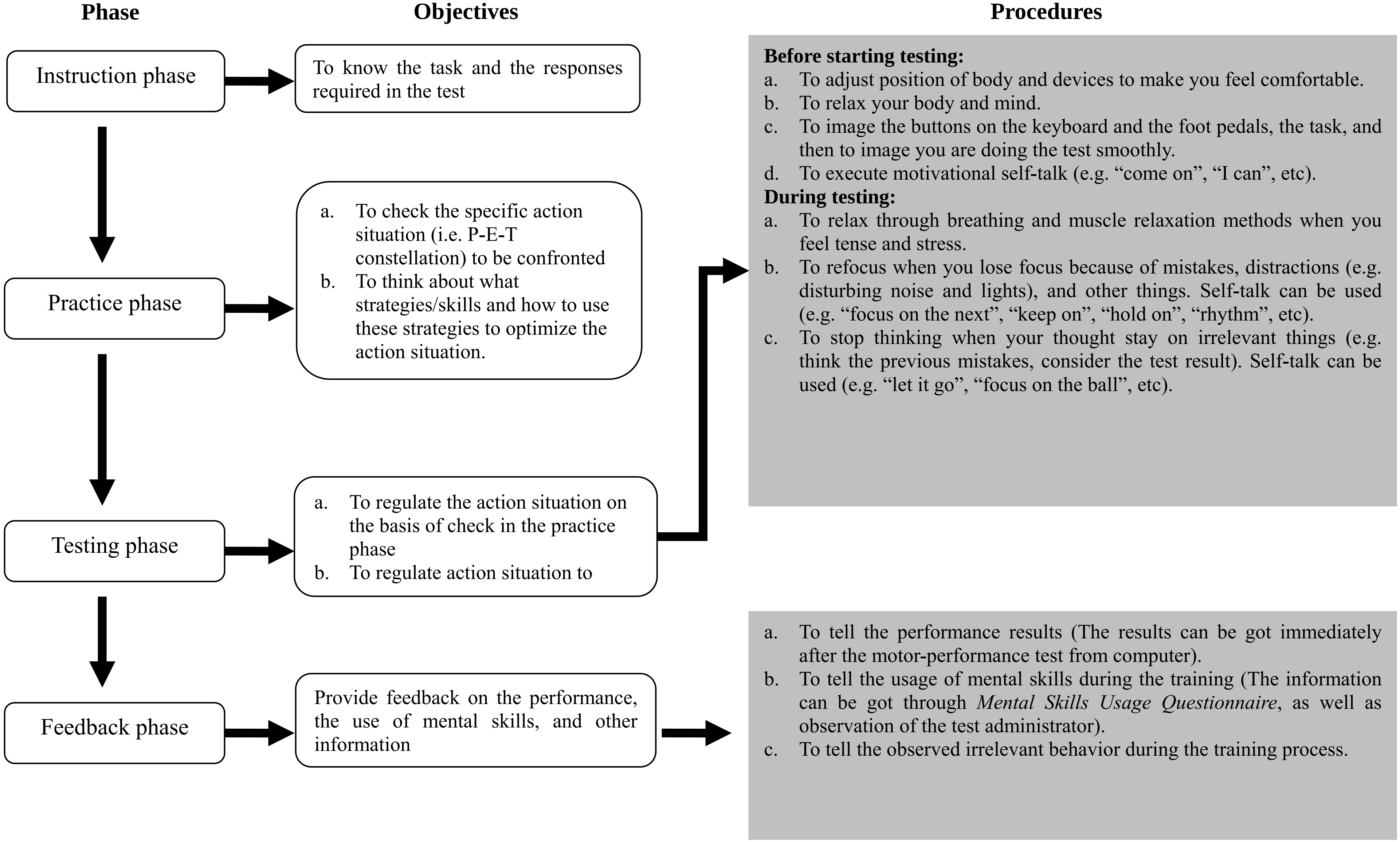


Figure 17. Details of the organization of a mental training session.

5.2.5.2 Procedures for the control group

Prior to starting the first session, permissions to conduct the testing were obtained from both coaches and participants (see Appendix 7 and 8). They were told that these sessions were designed to train and improve athletes' movement detection ability and stress tolerance. They were also informed about the total sessions and the time for a single session. Every participant took part in the study voluntarily.

The participants in the control group took part in six sessions of motor-performance testing (MDT-S2, DT-S1, and MDT-S3) in the same neutral situation, and the time for one session was about 30 minutes. In the first session, the motor performance tests were conducted following the parallel process in the experimental group. That is, in the instruction phase, step by step the instructions were presented on the screen to give the participant the necessary information about the test, and these instructions were also explained by the administrator to make sure they were fully understood by the participant. The instruction phase is followed by the practice phase, in which the participant practiced running the test examples. The administrator restarted the practice phase till the participant showed a relatively consistent performance. After that the participant started the test phase to complete the test.

In addition to the motor-performance tests, the perceived effort and experience of flow state were assessed as well immediately after the motor-performance testing in both first and last sessions. But no mental skills and techniques were taught and discussed in any session. After the completion of one session, statement such as "well done", "keep at it next time" were offered to encourage them to continue participation in the following sessions.

5.2.6 Data Analysis

Two types of analyses, i.e., individual-based and group-based analyses, were conducted. In the individual-based analyses, the percentage of athletes or the number of athletes whose scores in the MDT, DT, perceived effort, experience of flow state, and mental skills have been increased, decreased, or maintained unchanged were calculated respectively.

In the group-based analyses, statistic analyses were performed by the SPSS 16.0 software, following three steps:

Step 1: one-way analysis of variance (one-way ANOVAs) were used to identify the difference between control and experimental group in MDT, DT, perceived effort, experience of flow state, and mental skills at pre-intervention. In the original design, participants were randomized into control and experimental group after balancing the sports, age, and experience. However, one participant withdrew from control group and three participants withdrew from experimental group during the intervention phases. Therefore, it was necessarily to examine if there were differences existing between control and experimental group in pre-intervention test variables. The pre-intervention test variables included: (a) median cognitive reaction time, median motor time, and median detection time in the MDT, which were used to evaluate participants' performance in the MDT; (b) total correct responses, total incorrect responses, and total omitted responses in the DT, which were used to evaluate participants' performance in the DT; (c) perceived effort, which were used to evaluate participants' perceived effort they expended in the performance testing; and (d) experience of flow state, which were used to evaluated participants flow experience in the performance testing.

Step 2: following the one-way ANOVAs, paired sample *t* tests were used to identify the changes of all above test variables from pre- to post-intervention for both control and experimental group. The squared point-biserial correlation coefficient (r_{bp}^2)

was calculated to estimate the effect size in case a significant difference was identified (Sheard & Golby, 2006).

Step 3: a series of analysis of covariance (ANCOVA), with pre-intervention scores as covariates, were conducted to examine differences between control and experimental group in improvements (post-intervention scores minus pre-intervention scores) in MDT, DT, perceived effort, and experience of flow state. Effect size (η^2) was provided in case a significant difference was identified.

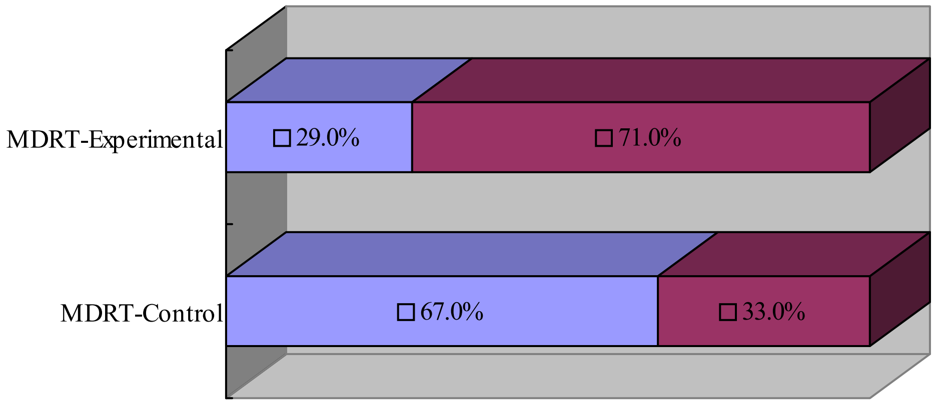
The mental skills were analyzed in terms of step 2 because they were assessed only to participants in the experimental group. The self-talk used in the pre- and post-intervention performance testing was analyzed through interview. In addition, the percentage of mental skills used before, during, and after intervention were figured out using formula "(Yes) total/10 x 100 = ______%".

5.3 RESULTS

5.3.1 Analysis of Performance in the MDT

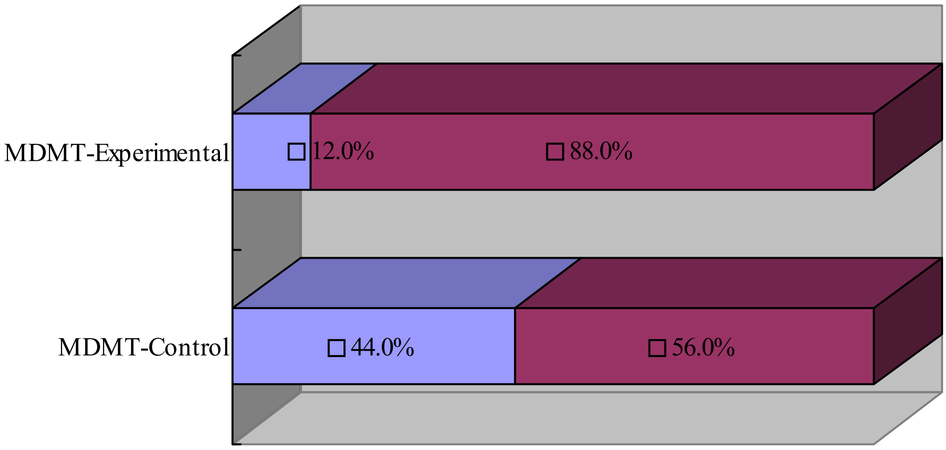
5.3.1.1 Individual-based analysis

The individual variations of performance in the MDT between pre- and post-intervention were calculated firstly. The results indicated that: (1) 71% athletes in the experimental group exhibited faster median cognitive reaction time at post-intervention, yet only 33% athletes in the control group exhibited faster median cognitive reaction time at post-intervention (Figure 18); (2) 88% athletes in the experimental group exhibited faster median motor time at post-intervention, but 56% athletes in the control group exhibited faster median motor time at post-intervention as well (Figure 19); and (3) 88% athletes in the experimental group exhibited faster median detection time, but 67% athletes in the control group exhibited faster median detection time at post-intervention as well (Figure 20). Although the percentage of athletes who exhibited improvement of performance was much higher in the experimental group than in the control group, further statistic analyses based on groups were necessary to identify the intervention effects.



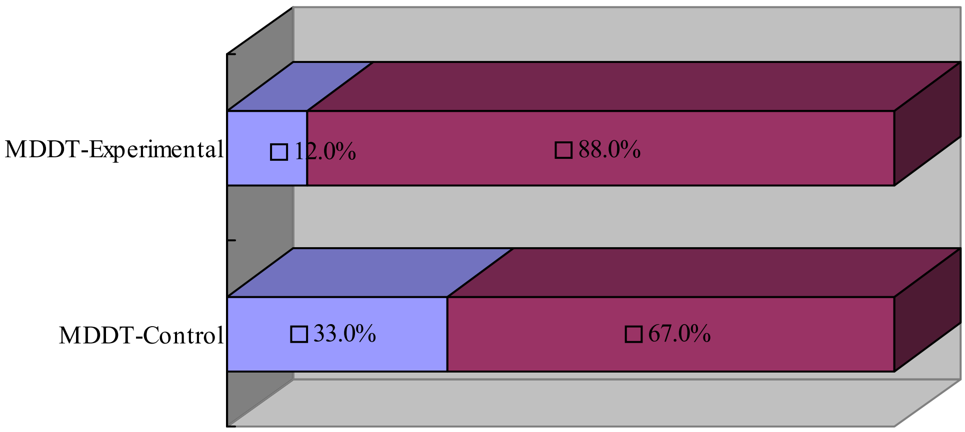
	MDRT-Control	MDRT-Experimental
Decrease	33.0%	71.0%
Increase	67.0%	29.0%

Figure 18. Percentage of number of athletes who increased or decreased the median cognitive reaction time (MDRT) in the Movement Detection Test.



	MDMT-Control	MDMT-Experimental
Decrease	56.0%	88.0%
Increase	44.0%	12.0%

Figure 19. Percentage of number of athletes who increased or decreased the median motor time (MDMT) in the Movement Detection Test.



	MDDT-Control	MDDT-Experimental
Decrease	67.0%	88.0%
Increase	33.0%	12.0%

Figure 20. Percentage of number of athletes who increased or decreased the median detection time (MDDT) in the Movement Detection Test.

5.3.1.2 Group-based analysis

Means and standard deviations of pre- and post-intervention test scores in the MDT from control and experimental group were presented in Table 14.

Table 14. Means and standard deviations of pre- and post- intervention test scores in the MDT from both control and experimental group.

	MDRT (mse)		MDMT (mse)		MDDT (mse)	
	M	*SD*	*M*	*SD*	*M*	*SD*
Control group[a]						
Pre-	343.22	38.77	170.22	37.15	518.33	56.77
Post-	347.00	38.51	154.89	31.71	506.44	59.04
Experimental group[b]						
Pre-	347.29	39.07	161.06	21.59	518.41	42.59
Post-	320.12	41.19	133.53	26.71	456.47	57.65

Note. MDRT = median cognitive reaction time; MDMT = median motor time; MDDT = median detection time.

[a]n = 9. [b]n = 17.

The one-way ANOVA showed no significant differences between control and experimental group in median cognitive reaction time, F (1, 25) = .06, p = .80, median motor time, F (1, 25) = .64, p = .43, and median detection time F (1, 25) = .00, p = .99, at pre-intervention.

With regard to the changes between pre- and post-intervention, analyses of the scores from control group showed no significant changes in median cognitive reaction time, t (8) = -.25, p = .81, median motor time, t (8) = 1.21, p = .26, and median detection time, t (8) = .53, p = .62. However, analyses of the scores from experimental group revealed a significant decrease in median cognitive reaction time, t (16) = 2.49, $p < .05$, $r_{bp}^2 = .11$, a very significant decrease in median motor time, t (16) = 4.43, $p < .01$, $r_{bp}^2 = .25$, and a very significant decrease in median detection time, t (16) = 4.87, $p < .001$, $r_{bp}^2 = .28$. In Figure 21, 22, and 23, the variations of the median cognitive reaction time, median motor time, and median detection time in both control and experimental group pre- and post-intervention were displayed respectively.

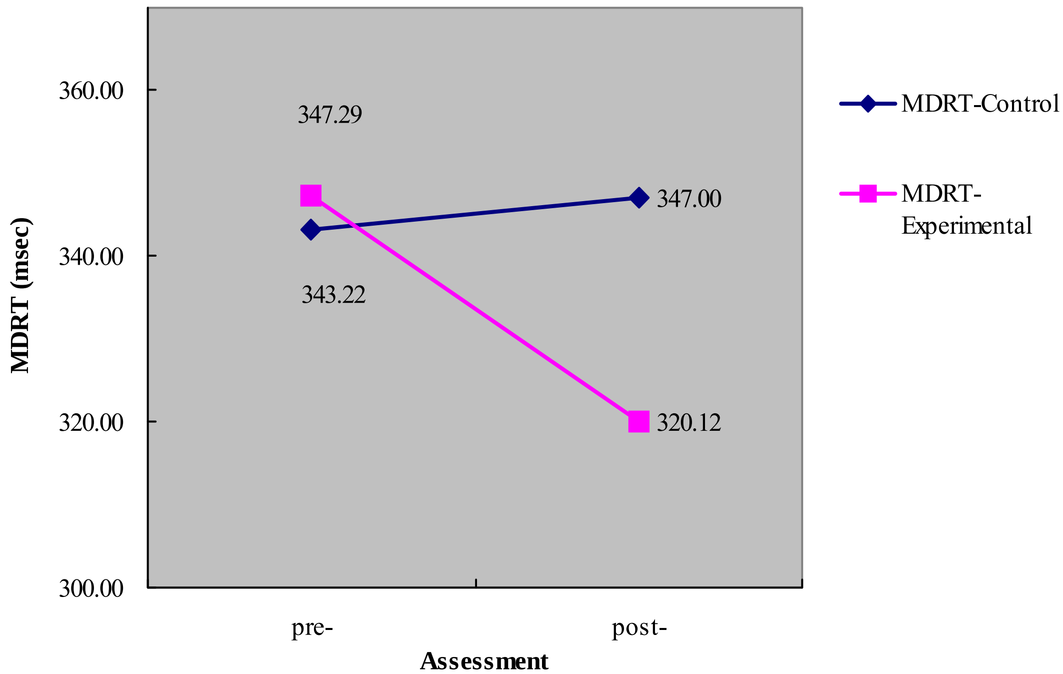


Figure 21. The variation of median cognitive reaction time (MDRT) in both control and experimental group before and after intervention.

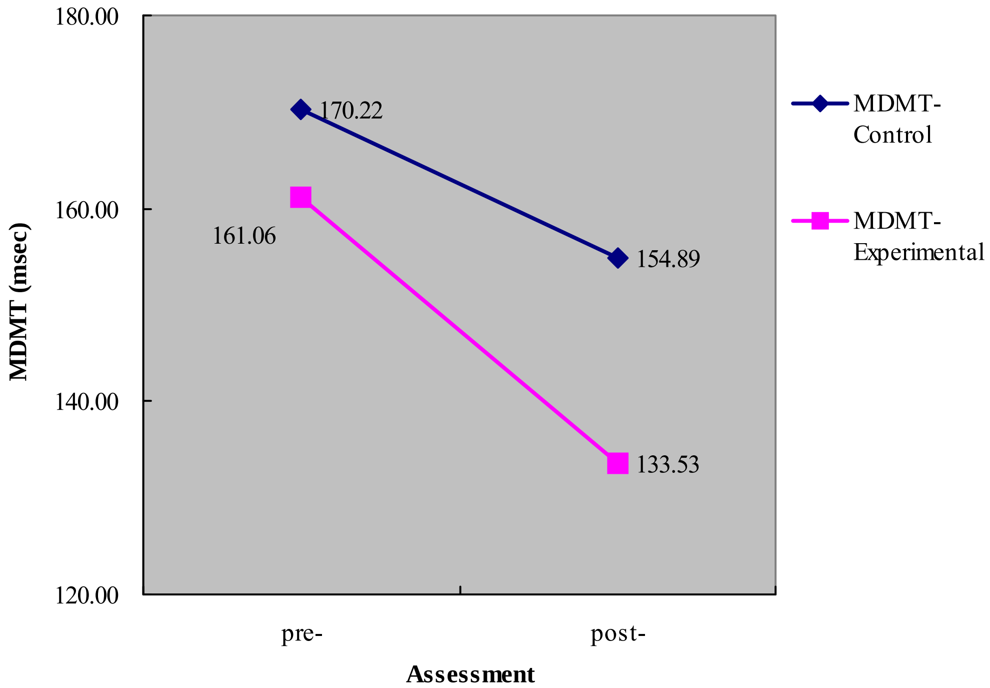


Figure 22. The variation of median motor time (MDMT) in both control and experimental group before and after intervention.

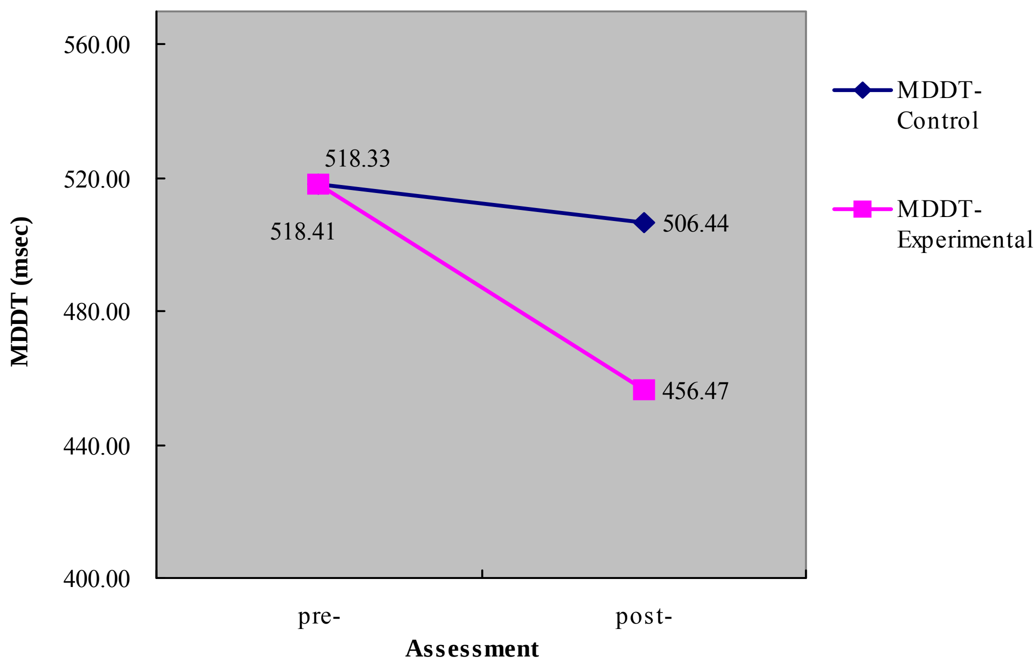


Figure 23. The variation of median detection time (MDRT) in both control and experimental group before and after intervention.

With regard to the differences between the control and experimental group in performance improvement, the ANCOVA with pre-intervention scores as covariates revealed a significant effect of group in the improvement in median detection time, but no significant effect of group was identified in the improvement in median cognitive reaction time and in median motor time (Table 10). In addition, the analyses showed significant effects of pre-intervention scores in the improvement in median cognitive reaction time, median motor time, and median detection time (Table 15).

Table 15. Means and standard deviations of improvements in the MDT from both control and experimental group, along with corresponding *F* values, significance levels, and effect sizes.

	Experimental group[a]		Control group[b]		Group effect			Pre-intervention scores effect		
	M	*SD*	*M*	*SD*	*F*	*p*	η^2	*F*	*p*	η^2
ΔMDRT (mse)	-27.18	44.95	3.78	45.32	3.19	.09	.12	9.87	.01	.30
ΔMDMT (mse)	-27.53	25.63	-15.33	37.99	2.49	.13	.10	8.62	.01	.27
ΔMDDT (mse)	-61.94	52.47	-11.89	67.94	5.03	.04	.18	4.67	.04	.17

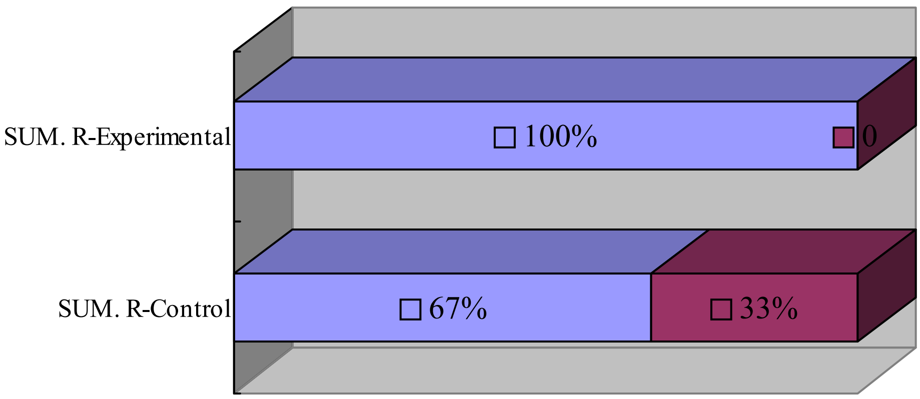
Note. ΔMDRT = increment of median cognitive reaction time from pre- to post-intervention; ΔMDMT = increment of median motor time from pre- to post-intervention; ΔMDDT = increment of median detection time from pre- to post-intervention.

[a]*n* = 9. [b]*n* = 17.

5.3.2 Analysis of Performance in the DT

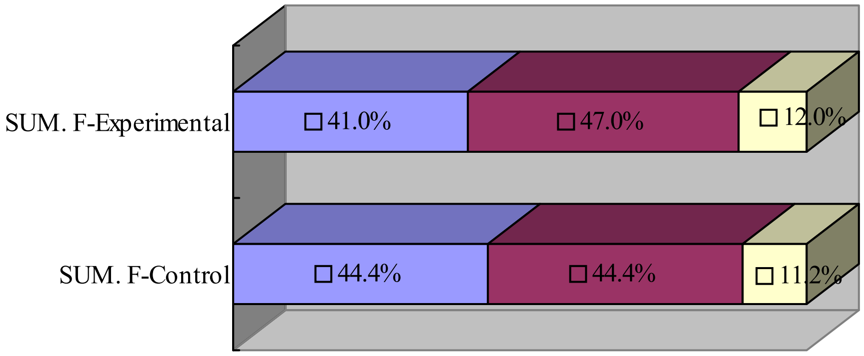
5.3.2.1 Individual-based analysis

The individual-based analysis found that: (1) all (100%) the athletes in the experimental group and 67% athletes in the control group improved their total correct responses (Figure 24); (2) 47% athletes in the experimental group and 44.4% athletes in the control group reduced their total incorrect responses (Figure 25); and (3) 82% athletes in the experimental group and 44% athletes in the control group reduced their total omitted responses (Figure 26). Although the athletes who decreased the total incorrect responses in the control and experimental group was in roughly equal proportions, the percentage of athletes who increased the total correct responses and who decreased the total omitted responses in the experimental group were obviously higher than those in the control group. The further analyses to indicate whether the performance improvements were significant or not in control and experiment group were conducted in the following.



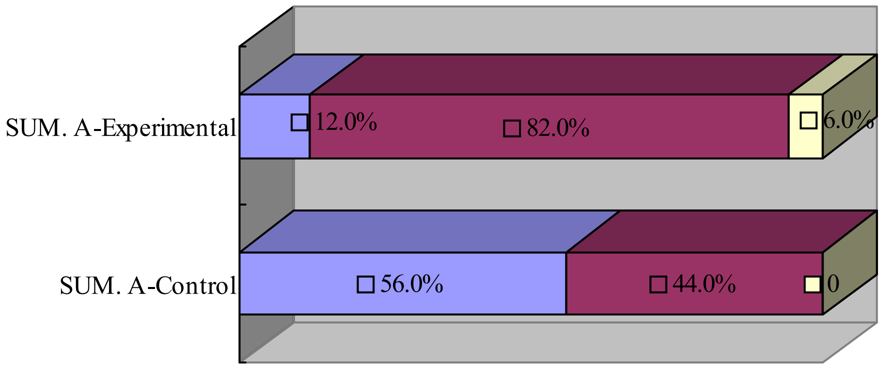
	SUM. R-Control	SUM. R-Experimental
Decrease	33%	0
Increase	67%	100%

Figure 24. Percentage of number of athletes who increased or decreased the total correct responses (SUM. R) in the Determination Test.



	SUM. F-Control	SUM. F-Experimental
No change	11.2%	12.0%
Decrease	44.4%	47.0%
Increase	44.4%	41.0%

Figure 25. Percentage of number of athletes who increased or decreased the total incorrect responses in the Determination Test.



	SUM. A-Control	SUM. A-Experimental
No change	0	6.0%
Decrease	44.0%	82.0%
Increase	56.0%	12.0%

Figure 26. Percentage of number of athletes who increased or decreased the total omitted responses (SUM. A) in the Determination Test.

5.3.2.2 Group-based analysis

Means and standard deviations of pre- and post-intervention test scores in the DT from control and experimental group were presented in Table 16.

Table 16. Means and standard deviations of pre- and post- intervention test scores in the DT from both control and experimental group.

	SUM. R		SUM. F		SUM. A	
	M	*SD*	*M*	*SD*	*M*	*SD*
Control group[a]						
Pre-	290.33	35.36	25.11	12.03	16.44	6.00
Post-	303.11	45.87	23.33	18.25	17.11	9.20
Experimental group[b]						
Pre-	262.53	54.04	29.59	21.78	19.71	8.86
Post-	356.12	42.78	25.94	13.47	11.65	4.29

Note. SUM. R = total correct responses; SUM. F = total incorrect responses; SUM. A = total omitted responses.

[a]$n = 9$. [b]$n = 17$.

The one-way ANOVA showed no significant group differences at pre-intervention in total correct responses, F (1, 25) = 1.92, p = .18, total incorrect responses, F (1, 25) = .32, p = .58, and total omitted responses F (1, 25) = .79, p = .38.

With regard to the changes between pre- and post-intervention, analyses of the scores from control group showed no significant changes in total correct responses, t (8) = -1.12, p = .30, in total incorrect responses, t (8) = .40, p = .70, and in total omitted responses, t (8) = -.20, p = .85. The similar analyses of the scores from experimental group revealed a very significant increase in total correct responses, t (16) = 12.93, $p < .01$, $r_{bp}^2 = .49$, and a very significant decrease in total omitted responses, t (16) = 3.73, $p < .01$, $r_{bp}^2 = .22$. But no significant change in total incorrect responses was identified, t (16) = .83, p = .42. The changes of these variables over time were displayed in Figure 27, Figure 28, and Figure 29.

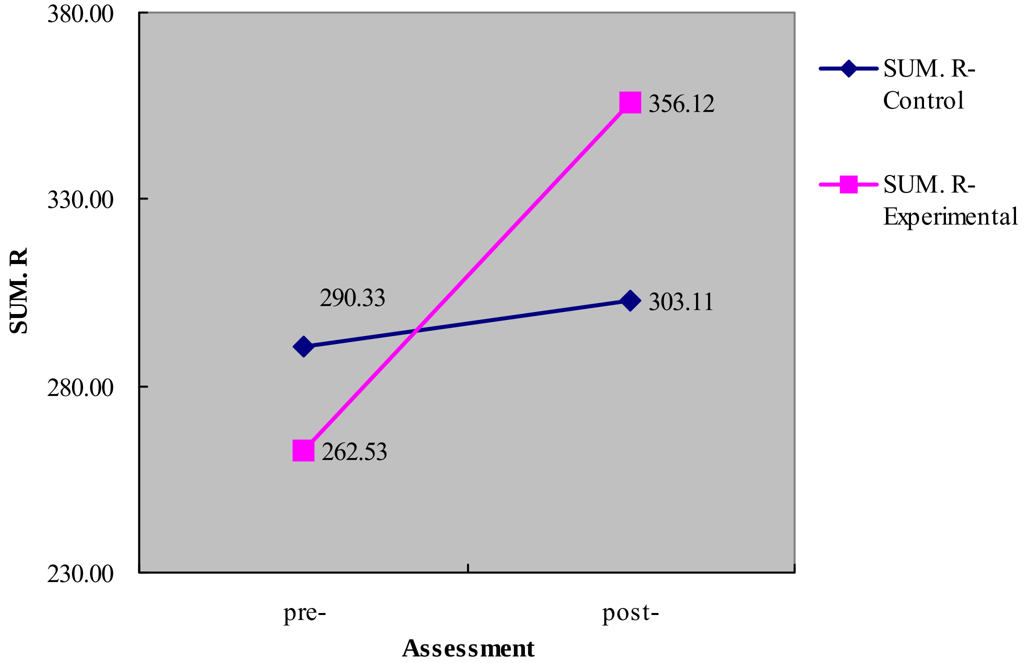


Figure 27. Total correct responses (SUM. R) at pre- and post-intervention for both control and experimental group.

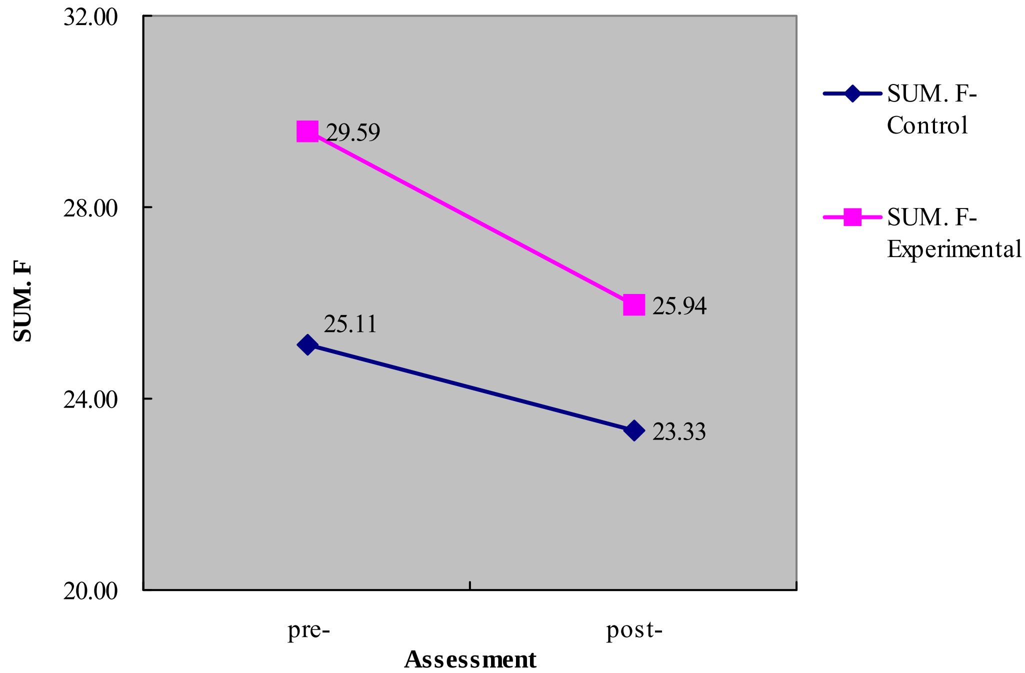


Figure 28. Total incorrect responses (SUM. F) at pre- and post-intervention for both control and experimental group.

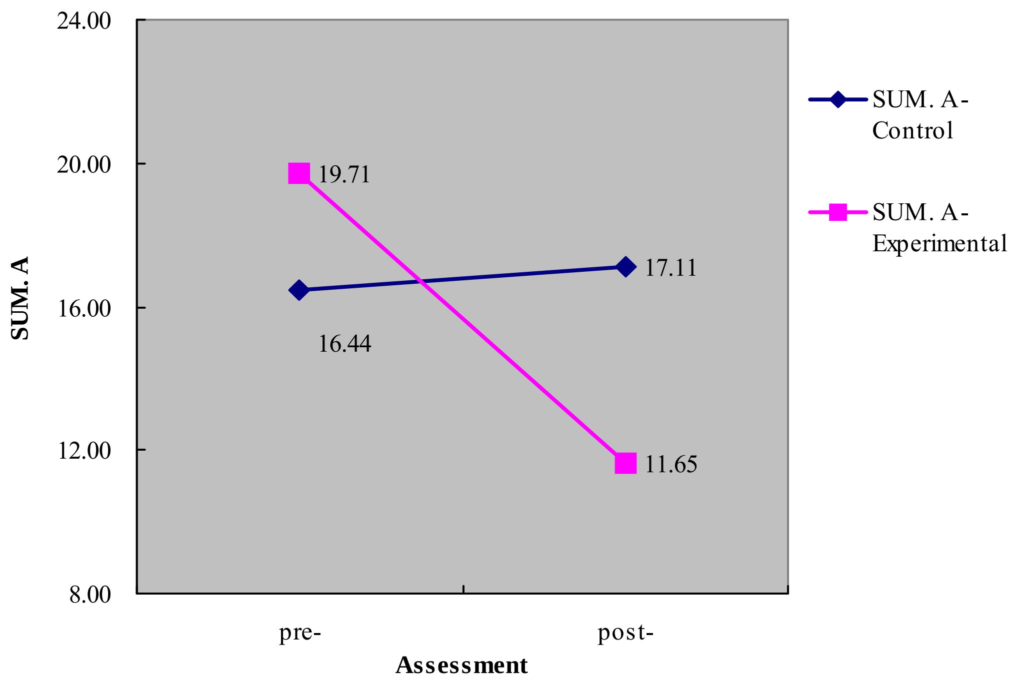


Figure 29. Total omitted responses (SUM. A) at pre- and post-intervention for both control and experimental group.

The ANCOVA with pre-intervention scores as covariates revealed significant group effects in the improvement in total correct responses and in total omitted responses, but no significant group effect was identified in the improvement in total incorrect responses (Table 17). In addition, the analyses revealed significant effects of pre-intervention scores in the improvements in total correct responses, total incorrect responses, and total omitted responses (Table 17).

Table 17. Means and standard deviations of improvements in the DT from both control and experimental group, along with corresponding *F* values, significance levels, and effect sizes.

	Experimental group[a]		Control group[b]		Group effect			Pre-intervention scores effect		
	M	*SD*	*M*	*SD*	*F*	*p*	η^2	*F*	*p*	η^2
ΔSUM. R	93.59	29.84	12.78	34.39	35.47	.00	.61	6.45	.02	.22
ΔSUM. F	-3.65	18.07	-1.78	13.23	.01	.91	.00	16.30	.00	.42
ΔSUM. A	-8.06	8.90	.17	10.10	5.55	.03	.19	30.86	.00	.57

Note. ΔSUM. R = increment of total correct responses from pre- to post-intervention; ΔSUM. F = increment of total incorrect responses from pre- to post-intervention; ΔSUM. A = increment of total omitted responses from pre- to post-intervention.

[a]*n* = 9. [b]*n* = 17.

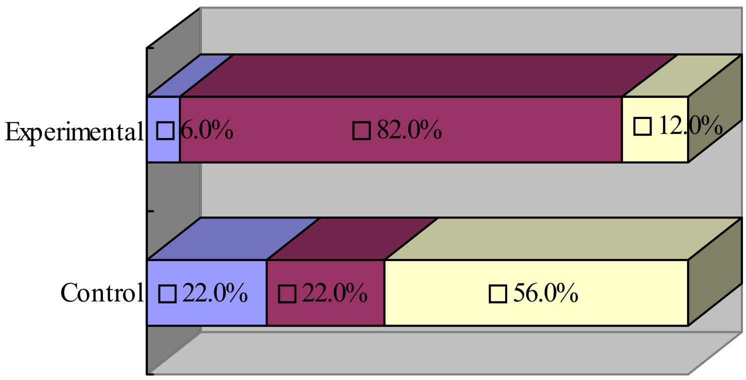
5.3.3 Analyses of Perceived Effort and Experience of Flow State

5.3.3.1 Individual-based analysis

The results of analysis of individual variations in perceived effort and experience of flow state were as follows:

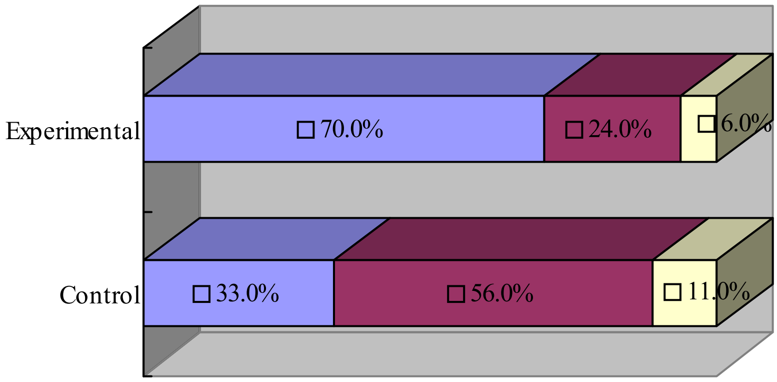
With regard to perceived effort, in the experimental group, 82% athletes reported that they expended less effort on the post-intervention than on the pre-intervention testing, 6% athletes reported they expended more effort, and the rest athletes (12%) reported equal perceived efforts, while in the control group, only 22% athletes reported that they expended less effort on the post-intervention than on the pre-intervention testing, the rest athletes reported either more effort (22%) or equal effort (56%) (Figure 30).

With regard to experience of flow state, in the experimental group, 70% athletes reported increased level of experience of flow state in the post-intervention testing compared with that in the pre-intervention testing, 24% reported decreased level of experience of flow state, and 6% reported invariable level of experience of flow state, whereas in the control group, only 33% athletes reported increased level of experience of flow state in the post-intervention testing compared with that in the pre-intervention testing, the rest athletes reported either decreased (56%) or invariable (11%) level of experience of flow state (Figure 31).



	Control	Experimental
No change	56.0%	12.0%
Decrease	22.0%	82.0%
Increase	22.0%	6.0%

Figure 30. Percentage of number of athletes who reported increased or decreased perceived effort.



	Control	Experimental
No change	11.0%	6.0%
Decrease	56.0%	24.0%
Increase	33.0%	70.0%

Figure 31. Percentage of number of athletes who reported increased or decreased level of experience of flow state.

5.3.3.2 Group-based analysis

In the Table 18, the means and standard deviations of perceived effort and experience of flow state at pre- and post-intervention for both control and experimental groups were presented.

The one-way ANOVA indicated no significant difference between control and experiment group in perceived effort at pre-intervention, F (1, 24) = .37, p = .55, as well as in experience of flow state, F (1, 24) = .32, p = .58.

Table 18. Means and standard deviations of perceived effort and experience of flow state at pre- and post- intervention for both control and experimental groups.

	Perceived effort		Experience of flow state	
	M	*SD*	*M*	*SD*
Control group[a]				
Pre-	5.22	1.20	28.22	3.90
Post-	5.11	.78	27.89	4.26
Experimental group[b]				
Pre-	5.53	1.23	29.06	3.40
Post-	3.71	1.11	32.29	3.70

Note. [a]$n = 9$. [b]$n = 17$.

For the experimental group, paired sample *t* tests revealed a significant decrease in perceived effort, t (16) = 5.12, $p < .01$, $r_{bp}^2 = .21$, as well as a significant increase in experience of flow state from pre- to post-intervention, t (16) = -3.09, $p < .01$, $r_{bp}^2 = .06$; For the control group, paired sample t tests revealed no significant changes between pre- and post-intervention in perceived effort, t (8) = .36, $p = .73$, and in experience of flow state t (8) = .60, $p = .56$. In Figure 32 and Figure 33, the changes of perceived effort and experience of flow state in both control and experimental group before and after intervention were given respectively.

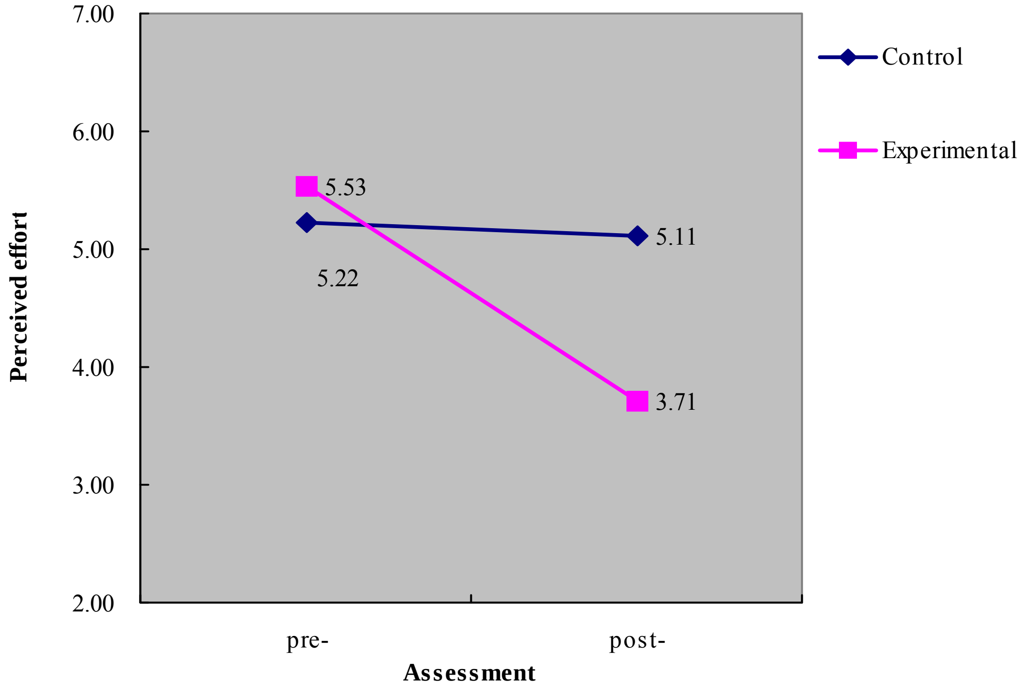


Figure 32. The change of perceived effort in both control and experimental group before and after intervention.

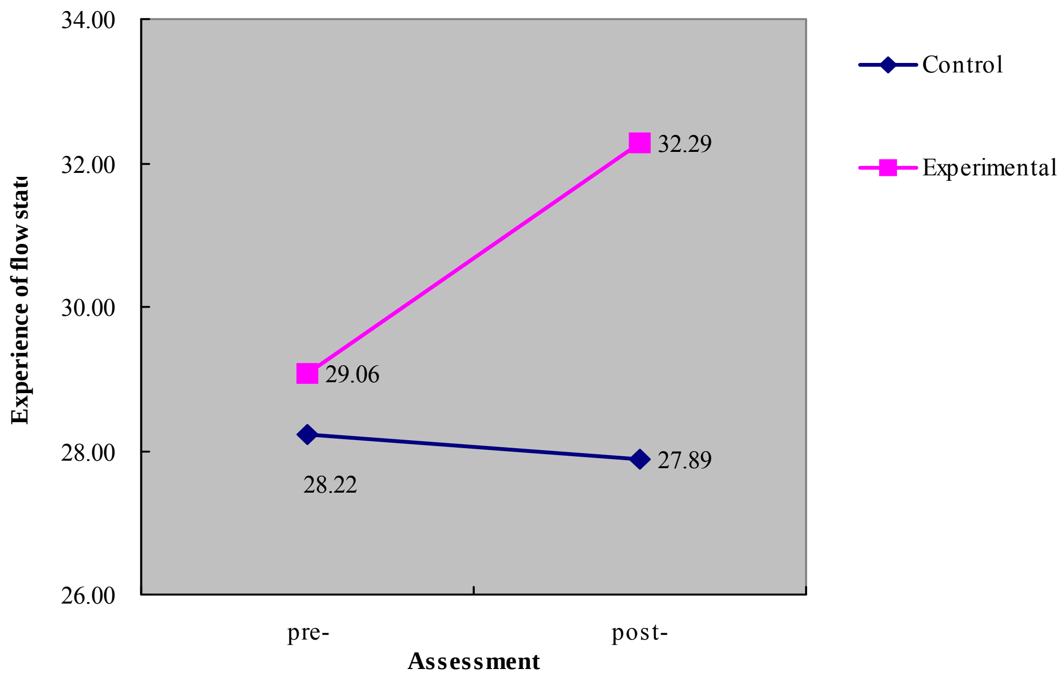


Figure 33. The change of experience of flow state in both control and experimental group before and after intervention.

The ANCOVA, with scores at pre-intervention as covariance, showed a very significant group effect in perceived effort and in experience of flow state, as well as significant effect of pre-intervention scores (Table 19).

Table 19. Means and standard deviations of the decrease in perceived effort and of the increase in experience of flow state from both control and experimental group, along with corresponding *F* values, significance levels, and effect sizes.

	Experimental group[a]		Control group[b]		Group effect			Pre-intervention scores effect		
	M	*SD*	*M*	*SD*	*F*	*p*	η^2	*F*	*p*	η^2
ΔPerceived effort	-1.82	1.47	-.11	.93	13.42	.00	.37	20.37	.00	.47
ΔExperience of flow state	3.24	4.32	-.33	1.66	7.79	.01	.25	4.91	.037	.18

Note. ΔPerceived effort = increment of perceived effort from pre- to post-intervention; ΔExperience of flow state = increment of experience of flow state from pre- to post-intervention.

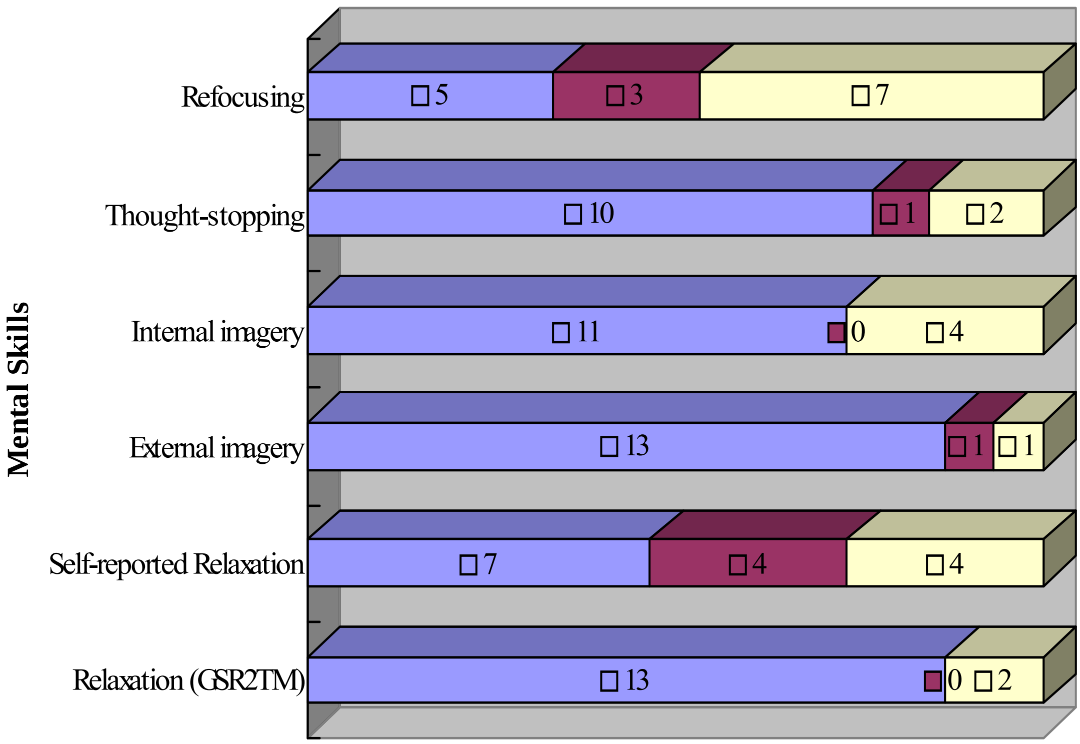
[a]*n* = 9. [b]*n* = 17.

5.3.4 Analyses of Mental Skills Competence of the Participants in the Experimental Group

Because two participants were absent from the assessment of mental skills competence at post-intervention, therefore totally 15 participants in the experimental group were assessed and analyzed.

5.3.4.1 Individual-based analysis

The individual-based analysis was conducted by calculating the numbers of athletes who increased or decreased their mental skills after intervention. As illustrated in Figure 34, more than two-thirds of athletes improved in relaxation ability (measured by GSR2^{TM}) (*n* = 13/15), external imagery (*n* = 13/15), internal imagery (*n* = 11/15), and thought-stopping (*n* = 10/15); however, there were also more than half of athletes did not improved (i.e. scores decreased or maintained unchanged) in self-reported relaxation (*n* = 8/15) and refocusing (*n* = 10/15).



	Relaxation (GSR2TM)	Self-reported Relaxation	External imagery	Internal imagery	Thought-stopping	Refocusing
□ No change	2	4	1	4	2	7
■ Decrease	0	4	1	0	1	3
□ Increase	13	7	13	11	10	5

Figure 34. Number of athletes in the experimental group (*n* = 15) who increased or decreased their mental skills.

5.3.4.2 Group-based analysis

Means and standard deviations of mental skills at pre- and post-intervention of the 15 participants in experimental group were presented in Table 20.

The ability to relax measured through GSR2™ Biofeedback Relaxation System indicated that six participants were not able to relax within 5 minutes at pre-intervention. Measures at post-intervention indicated that four of the six improved their relaxation ability and were able to relax within 75, 180, 200, and 203 seconds (M = 164 seconds). The other two remained unable to relax within 5 minutes. For the participants (n = 9) who were able to relax within 5 minutes at pre- and post-intervention, a paired sample t test showed a very significant decrease in the time to be relaxed, $t\ (8) = 4.34$, $p < .01$, $r_{bp}^2 = .56$.

Table 20. Means and standard deviations of the mental skills at pre- and post-intervention of the experimental group.

Mental skills	Pre-intervention [a]		Post-intervention [a]	
	M	*SD*	*M*	*SD*
Relaxation (GSR2™) [b, c]	190.56	55.05	94.00	33.83
Self-reported relaxation level	4.27	1.53	4.87	1.41
External imagery	3.40	2.06	6.33	.82
Internal imagery	4.20	1.82	5.93	.59
Thought-stopping	3.93	1.34	5.40	1.40
Refocusing	4.93	1.49	5.33	1.18

Note. [a]*n* = 15.

[b]Relaxation (GSR2™) indicated the time (in second) to be relaxed that was measured through GSR2™ Biofeedback Relaxation System.

[c]Means and standard deviations were calculated from data of nine participants who could be relaxed within 5 minutes at pre- and post-intervention.

Paired sample *t* tests for the self-reported relaxation, imagery, thought-stopping, and refocusing indicated that there were significant improvements on external imagery, $t\,(14) = -5.36$, $p < .01$, $r_{bp}^2 = .46$, on internal imagery, $t\,(14) = -4.03$, $p < .01$, $r_{bp}^2 = .32$, and on thought-stopping, $t\,(14) = -2.90$, $p < .05$, $r_{bp}^2 = .24$. No significant improvements on relaxation and refocusing were observed, the *t* values and significant levels were $t\,(14) = -1.19$, $p = .26$, and $t\,(14) = -1.15$, $p = .27$ respectively.

5.3.4.3 Qualitative analysis of self-talk

The usage of self-talk when executing motor-performance tests in the training sessions was investigated through an open-ended question: “please recall what self-talk you used in the training session just finished. Then write down all of them”. The qualitative data of self-talk from initial and final assessment were analyzed separately to identify the improvement in using of self-talk. The results indicated that 13 (76%) and 15 (88%) participants reported using of self-talk in the initial and final assessment, respectively.

Hackfort and Schwenkmezger (1993) defined self-talk as a “dialogue in which the individual interprets feelings and perceptions, regulates and changes evaluation and convictions, and gives him/herself instructions and reinforcement” (p. 355). In the present study, self-talk refers to the use of cue words or phrase either external (loud) or internal before or during the execution of motor-performance tests to trigger appropriate action, with the purpose of enhancing performance. Based on this definition, the self-talk used in this study was divided into positive/relevant and negative/irrelevant self-talk when conducting qualitative analysis, and the positive/relevant self-talk was considered characterize by: (a) cue words or phrases, (b) affirmatives, (c) rationalization, (d) present tense, and (e) first person. In Figure 32 and Figure 33, the raw data themes of self-talk in the initial and final assessment were categorized into positive/relevant and negative/irrelevant self-talk. The values enclosed in parentheses represent the number of participants who used the self-talk.

As illustrated in Figure 35 and Figure 36, in the initial assessment, three pieces of positive/relevant and fourteen pieces of negative/irrelevant self-talk raw data themes were identified; in the final assessment, it is just the opposite, seventeen pieces of positive/relevant and four pieces of negative/irrelevant self-talk raw data themes were identified.

- Self-talk in initial assessment
  - Positive/ relevant self-talk
    - Be focused (1)
    - Relax (1)
    - Relax and stay focused (1)
  - Negative/ irrelevant self-talk
    - Do not give up (2)
    - Shit, mistake again. Give more attention (4)
    - I made so many mistakes, forget this test and work hard on the next one (2)
    - It is so difficult (3)
    - Oh, it is so difficult, I make a mistake again. Why I make the same mistake all the time (1)
    - Shit! It is too fast to keep on. I am confused (2)
    - My response is a bit slow. I have to react quickly (1)
    - My response is disordered. I have to adjust soon (2)
    - Do not daydreaming (1)
    - Calm down. Do not be nervous. Do not too care about the mistake, complete the test first. It is just a test and I don't need to be nervous (1)
    - Make a mistake, too slow, … (1)
    - Probably red this time, yellow this time, … (1)
    - Do not think / forget the mistakes (2)
    - I must be No 1 (1)

Figure 35. The usage of self-talk in the initial assessment.

Self-talk in final assessment

- Positive/ relevant self-talk
  - I can (2)
  - I feel fine (1)
  - Come on (2)
  - Focus on tests (1)
  - Be focused (5)
  - Focus on the ball (1)
  - Relax, breathe deeply (1)
  - Relax and stay focused (2)
  - Calm down and take it easy (1)
  - Refocus (1)
  - Keep on going (1)
  - Rhythm (3)
  - Act according to circumstances (1)
  - Back to be ordered (1)
  - Red, … blue, … green, … (1)
  - Faster (1)
  - Keep it up (2)
- Negative/ irrelevant self-talk
  - Do not be nervous (2)
  - Do not think it (mistake) anymore (1)
  - Do not be affected by others (1)
  - Shit, a mistake (1)

Figure 36. The usage of self-talk in the final assessment.

5.3.5 Analysis of the Usage of Mental Skills

Analysis of the scores from Usage of Mental Skills Questionnaire indicated that the mental skills taught in the session 2 were frequently used and practiced by most of athletes during every mental training session (i.e. from session 3-6). As shown in the Table 21, the percentage of total mental skills used by athletes in every training session ranged from 50% to 100%, and a great majority of athletes used more than 70% mental skills in every training session. The average percentage of mental skills used in every training session was 81.3%, 83.3%, 81.3%, and 86.4% respectively.

Table 21. Distribution of number of athletes under different percentage of total mental skills used by athletes in every training session.

Percentage of total mental skills used	Number of athletes			
	TS1	TS2	TS3	TS4
50%	2	-	-	-
60%	-	-	2	-
70%	4	5	3	3
80%	1	4	5	3
90%	4	2	1	4
100%	4	4	4	4
Total number of athletes[a]	15	15	15	14

Note. TS = training session

[a] The number of athletes in TS1, TS2, and TS2 was 15 because two participants were absent from assessment; the number of athletes in TS4 was 14 because besides the two absentees, another participant's score was invalid.

5.3.6 Analysis of Social Validity

All the participants in the experimental group (n = 17) completed the social validity questionnaire at the end of the intervention program. The number and percentage of participants who gave different response to each question within the social validity questionnaire were presented in the Table 22. A great majority of participants responded to each question by circling the number □ (important/significant/satisfied/will), or □ (extremely important/extremely significant/extremely satisfied/absolutely will).

Table 22. Number and percentage of participants who responded to each question of the social validity questionnaire.

How important is the mental training to improve your performance	① *(Not at all important)*	②	③ *(Somewhat important)*	④	⑤ *(Extremely important)*
n **(%)**	-	-	-	9 (53%)	8 (47%)
Do you experience any significant improvement after the mental training sessions	① *(Not at all significant)*	②	③ *(Somewhat significant)*	④	⑤ *(Extremely significant)*
n **(%)**	-	-	1 (6%)	10 (59%)	6 (35%)
How satisfied are you with the mental training program	① *(Not at all satisfied)*	②	③ *(Somewhat satisfied)*	④	⑤ *(Extremely satisfied)*
n **(%)**	-	-	1 (6%)	10 (59%)	6 (35%)
Are you going to use what you learned in your training and competition	① *(Absolutely not will)*	②	③ *(Occasionally will)*	④	⑤ *(Absolutely will)*
n **(%)**	-	-	-	2 (12%)	15 (88%)

5.4 Discussion of the Intervention Study

In the present section, a study on the application of MTTS tool for mental assessment and mental training of elite athletes was conducted. Overall, the findings from the study indicate that participants improved their ability to optimize action situations, as well as some mental skills competence.

5.4.1 Improvement in the Ability to Optimizing Action Situations

5.4.1.1 Improvements in performance

Performance variation in the MDT. Analysis of individual performance variation in the MDT between pre- and post-intervention revealed that percentages of athletes who showed progress in performance (i.e., faster median cognitive reaction time, median motor time, and median detection time at post-intervention) are higher in the experimental group than in the control group. This trend is corroborated by a series of Paired-Samples *t* tests, which revealed significant improvements of performance in the experimental group after five sessions mental training intervention, while no significant performance improvement in the control group.

Although there is difference in performance progress between the experimental and control group, the significant intervention effect on performance progress in the experimental group can not be taken for granted. Because in longitudinal studies participants' post-intervention scores is usually influenced by their pre-intervention scores. Therefore, in the present study, despite statistical analyses suggest that the difference in pre-intervention performance between experimental and control group is not significant, it is still assume that the slight difference in pre-intervention performance may cause the significant difference in performance improvements between the two groups. In fact, a series of analysis of covariance not only reveal a significant intervention effect on median detection time, as well as a trend toward significant effect on the improvement of median cognitive reaction time (p = .09) and on median motor time (p = .13) respectively, but also reveal a significant effect of pre-intervention performance on the improvement of median cognitive reaction time, median motor time, and median detection time respectively. Conceptually, the detection time refers to the time of a process including cognitive reaction and motor reaction to a movement. Therefore, the intervention effect on performance in the MDT is accounted significant despite the intervention effect is not significant on median cognitive reaction time and on median motor time separately.

Performance variation in the DT. Results of individual analyses reveal that percentages of athletes who exhibited improvements in total correct responses and in total omitted responses are obvious higher in the experimental group than in the control group, however, the percentages of athletes who exhibited improvement in total incorrect responses are almost equal in the two groups.

Results of paired-sample *t* tests for the groups coincide with those of individual analyses. Participants in the experimental group exhibit significant improvements in total correct responses and in total omitted responses after mental training intervention, but no significant improvement in total incorrect responses is identified. In the control group, no any significant improvement is identified.

As discussed in the previous paragraphs about performance variation in the MDT, despite both individual analyses and *t* tests for groups suggest improvements of performance in the experimental group, whether the intervention effect on the performance improvement is significant or not still can not be concluded unless the difference in performance improvements between the experimental and control group are identified after controlling the effects of pre-intervention performance. In this study, analyses of covariance showed a significant intervention effect on the improvement of total correct responses and of total omitted responses respectively, but no significant intervention effect is identified on the improvement of total incorrect responses.

5.4.1.2 Improvements in perceived effort and experience of flow state

Individual-based analyses suggest that the percentages of athletes who exhibited improvements in both perceived effort (i.e., athletes reported less effort at post-intervention than at pre-intervention) and experience of flow state (i.e., athletes reported higher flow experience at post-intervention than at pre-intervention) are obviously higher in the experimental group than in the control group. Paired-sample *t* tests for groups also reveal significant improvements of perceived effort and experience of flow state in the experimental group, yet no any significant improvements is identified in the control group.

The analyses of covariate revealed a significant intervention effect on the improvement of perceived effort and on the improvement of flow experience respectively. In addition, a significant effect of covariance (i.e. the scores of perceived effort and flow experience at pre-intervention) were also identified.

5.4.2 Improvement in Mental Skills Competence

Individual-based analyses suggest that more than second-thirds participants exhibited improvements in relaxation competence (measured by GSR2^{TM}), internal and external imagery, and thought-stopping at post-intervention when comparing with the scores at pre-intervention. Statistic analyses for the group also suggest significant improvements in the three mental skills.

It is interesting to note that the results from measures of the GSR2^{TM} indicated most participants' improved their relaxation ability, and the improvements for the group between the post- and pre-intervention was significant, however, less than half participants' self-reported relaxation level at final assessment session was higher than that at initial assessment session, and the difference in self-reported relaxation levels for the group between the final and initial assessment was not significantly. That is to say, although the participants exhibited significant improvement in relaxation ability at final assessment session, the level of relaxation was not increased significantly with the improvement of relaxation ability. The inconsistency between the relaxation ability and relaxation level can be interpreted in the inverted-U hypothesis. According to the inverted-U hypothesis, there is a progressive improvement in performance as arousal levels increase from drowsiness to alertness, but with the arousal levels continues to increase beyond alertness to a high excited state, performance begins to decreases progressively (Landers & Arent, 2006). In the present study, the mean relaxation levels rated through a 7-point Likert-type scale (1 = *extremely tense* and 7 = *extremely relaxed*) at initial and final assessment session were 4.27 and 4.87 respectively, both were at moderate level. It suggests that the participants probably keep the relaxation state at moderate level intentionally in order to obtain optimum performance.

Qualitative analysis of self-talk showed a great improvement in the use of self-talk. In the initial assessment, although self-talk was widely employed by most participants (17 pieces of raw data themes were identified from 13 participants), a great majority of them were negative/irrelevant self-talk. These negative/irrelevant self-talk characterized by: (a) using long sentence rather than cue word or phrase, for example, "Calm down. Do not be nervous. Do not too care about the mistake, complete the test first. It is just a test and I don't need to be nervous"; (b) using past/future rather present tense, for example, "I made so many mistakes, forget this test and work hard on the next one", "Probably red this time, yellow this time, …". This kind of self-talk will make athletes focus on or stay in past or future, and ignore what is happening at present; (c) using irrational rather rational sentence, for example, "I must be No 1"; and (d) using negative rather than affirmative cues or phrases, "Do not …" is one of the typical examples of this kind of self-talk. As Henschen (2007) stated:

> One interesting fact is that the body will follow the subject of the thought, not exactly what is said or thought. When a basketball player is at the free throw line and thinks "Don't miss," actually he or she just instructed the body to miss the shot. When a golfer says to

> himself or herself, "Don't hit it into the water," the body actually hears "water" and attempts to hit in that direction. (p. 134)

Positive self-talk can serve to enhance performance, increase motivation, build confidence, etc (Van Raalte, Brewer, Rivera, & Petitpas, 1994; Weinberg, Grove, & Jackson, 1992). However, negative self-talk "frequently leads to the frustration, anxiety, and depression commonly felt about training and competition" (Henschen, 2007, p. 133). Therefore, to use self-talk in a positive direction is crucial for athletes.

In the education session of mental skills, positive self-talk as well as its relationship to performance were introduced first, and then how to use self-talk in a positive direction as well as how to replace the negative self-talk with positive one were illustrated by taking the negative self-talk in the initial assessment as examples. It is indicated that, after four mental training sessions, positive/relevant self-talk was widely used by most participants in the final assessment. Totally seventeen pieces of positive self-talk raw data themes were identified. Only four pieces of negative self-talk raw data themes were identified from 3 participants. It shows a great improvement in self-talk, positive self-talk skill not only was mastered by participants, but also was frequently used by them.

5.4.3 Variation in the usage of mental skills

Analyses indicated that more than 87% participants used over 70% mental skills in each mental training session. The results suggest that a great majority of participants used mental skills frequently in the training sessions when running motor-performance tests.

Mental skills training is not only concerned with education of mental skills, but also much concerned with the exercises and applications of them, especially exercises involving motor task. In this kind of exercises, athletes are required to integrate utilizing mental skills into executing motor task. Henschen (2007) stated that "the athletes must be cognizant of how to employ these skills in addition to recognizing their important" (p. 128). The integration of utilizing mental skills and executing motor task on the one hand can make athletes have chance to practice mental skills and to learn how to use them effectively, on the other hand can make athletes recognize the important of mental skills on performance enhancement. Athletes believe their own experience much more than oral instructions and lectures from others!

In this study, the frequent use of mental skills in the training sessions is one reason of improvement in mental skills. At the same time, from the usage of mental skills, athletes recognized the important of mental skills in performance enhancement, and decided to use the skills in their future sports training and competition. The evidence from analyses of performance and social validity provided support to these conclusions.

5.4.4 The Social Validity

The social validity of the study was confirmed by participants in the experimental group. Nearly all the participants considered mental training intervention of great importance for enhancing their performance. They also stated that they had gained a lot from the training sessions and they for sure are going to applying what they learned in the sports training and competition. They expressed high satisfaction with the contents and procedures of the mental assessment and training intervention offered to them.

In summary, the study in this section is the first application of MTTS tool to conduct mental assessment and training on the basis of action-theory approach, in elite sports. The experiment results approve that the mental training intervention carried out in the study has significant effects on the improvement of ability to optimize action situation. More specifically, the participants' performance is enhanced after mental training intervention, and they experience less effort and stronger flow feelings when running the tests. It is to be noted that scores at pre-intervention were identified to have significant effects on the improvements of performance, perceived effort, and flow experience, reminding to consider the effects of measures at baseline on the improvement differences between intervention and control group is absolutely necessary, even the difference in baselines between the groups are not significant. In addition to the improvements in the ability of optimizing action situation, the participants also perfected mental skills in the intervention sessions, and learned how to apply these mental skills effectively.

The above positive results also demonstrate that the MTTS tool is of great value for mental assessment, diagnosis and training in sport, when it is used in the frame of action-theory-based mental assessment and training approach. With the MTTS tool, specially-tailored training programs in the frame of action theory approach can be developed for athletes in different sports, through creating sport-specific, individualized action situation, as well as through integrating mental skills training into execution of motor task.

5.4.5 Limitation and Future Direction

5.4.5.1 Limitation

Although the study provides valuable results, there are three major limitations in the study:

1. The number of sample in both control and experimental group is small, which probably decreased the accuracy of statistical results. Cohen (1988) thought that the small sample may increase the likelihood of Type II error. Tabachnick and Fidell (2001) also stated that too small groups may make it difficult to reveal minimal meaningful differences. However, in applied (especially with elite athletes) sport psychology research it is difficult to include more

participants in the control group, especially in the interventional study aims at positive outcomes. Athletes and coaches don't want to get nothing from the intervention.

2. Lacking of a group of participants who are just required to execute motor-performance tests in action situations without being taught mental skills. In the present study, although the intervention effects have been identified, the effects may be caused by using mental skills, or by the training situations created through modifying the person-environment-task constellation, or by both. Because of lacking an experimental group with only one intervention (i.e., under different training situation without using mental skills, or using mental skills under a same neutral situation), it is not possible to conclude the exact cause of these effects.

3. The participants' feelings, their use of mental skills, and their behavior throughout the entire intervention period were not assessed and monitored because of the heavy workload, and consequently, the small changes in some aspects might be ignored. As Wollman (1986) stated that "small consistent changes may be seen in a single-subject design but not emerge significantly in a group design" (p. 136). Patrick and Hrycaiko (1998) argued that "smaller changes (on a consistent basis) for elite athletes are often considered significant by coaches and athletes" (p. 285).

5.4.5.2 Future direction

Considering the limitations in this study, future research based on MTTS tool should be conducted with appropriate sample in both control and experimental group, and with additional experimental group which doesn't involving mental skills teaching and learning, to ensure more comprehensive and accurate understanding of the intervention effects, however, such a design would make it very difficult to find enough athletes divided into three groups and to ensure that the number of participants ensure the possibility of statistical analyses. In addition, in the applied sport psychology work, it is recommended to use MTTS tool for individual-based assessment, diagnosis, and training, so that practitioners have adequate time and energy to assess and diagnose the client from more aspects, for example, observation, interview, etc. These methods are not used in the present study because it requires a great deal of time and energy.

6 OVERALL DISCUSSION

To develop more sports- and sport-specific test on the platform of VTS is one direction of developing MTTS. In this paper, an important sports-specific test, MDT, was introduced and examined. It is the first standardized tool for measuring movement detection ability in sport. The results from both experimental and intervention study indicate that MDT-S2 has good reliability and validity, and can be used to measure athletes' movement detection ability, while MDT-S3 is a good tool that can be used to train athletes' movement detection ability effectively.

The results from the intervention study also provide evidence that the MTTS concept and tools are useful for conducting mental assessment and training. When being used for mental assessment, it can provide more accurate performance-related information than traditional paper-and-pencil tests (e.g. the usage of some mental skills during the testing can be observed directly by the test administrator); when being used for mental training, it helps to improve the participant's some mental skills competence through using the skills repeatedly, and ultimately, helps to improvement the participant's ability to optimize various action situation. The results of the intervention study also indicate that performance, perceived effort, and flow state experience are three effective parameters in evaluating one's ability to optimize action situation.

7 SUMMARY AND PERSPECTIVES

Mental assessment and mental training are two dominant domains in the field of applied sport psychology. Strictly speaking, mental assessment should be the starting and ending points of any intervention in applied sport psychology, including mental training.

In this paper, a recapitulatory overview of mental assessment and training in sport was offered firstly. In some psychological disciplines (e.g. clinical psychology and assessment psychology), the definition of psychological assessment as well as the differences between psychological assessment and psychological testing, psychological test have been clarified. Generally speaking, psychological tests are only tools in the mental assessment and mental testing; mental assessment is a complex process involving gathering data (usually from multiple sources including psychological tests), scoring, interpreting scores, and making inferences based on the information derived from scores; mental testing is a relatively simple process involving collection of data (only from psychological tests), scoring, and interpretation of scores, but making inferences is not involved in this process. “The use of tests for making decisions about a person, a group, or a program should always take place within the context of psychological assessment” (Urbina, 2004, p. 23). Unfortunately, in sport psychology, the discussion on the distinctions between mental assessment and mental testing is inadequate. As a consequence, a holistic or systematic approach on mental assessment is still lacking in the field of applied sport psychology, and many professionals conduct assessment mainly through a single psychological test or battery of psychological tests in their applied work with athletes. Although Vealey (1998) categorized various issues with regard to mental assessment in applied sport psychology into four domains in her multidomain framework, a holistic or systematic approach is still lacked since the interplay between the issues in different domains are not considered.

A holistic or comprehensive systematic perspective is also lacking in professionals' applied work of conducting mental training to athletes. In applied sport psychology, mental training is often conducted to develop athletes' mental skills in order to enhance their sport performance. Mental skills can enhance sport performance only if an athlete must have ability to use mental skills successfully in his or her performing situation. This situation is influenced by the factors related to the person (i.e. the athlete), the environment, and the specific task, as well as the interactions of person, environment, and task. However, the mental training programs in applied sport psychology involve only teaching mental skills, or teaching mental skills and doing skills-related exercises, but practices of using mental skills learned in various person-environment-task situations are not included in the programs.

Following the overview of mental assessment and training in sport, a holistic frame about mental assessment and mental training was presented based on the action-theory approach. According to this frame, mental assessment and mental training are concerned with intention (goal), situation, and process of actions. The intention, situation, and process of an action are interrelated: the action is initiated by intentions, based on the intentions the person-situation-environment situation is evaluated and interpreted, and the interpretation of the situation then influences mental control and mental regulation in the process of action, finally, the initial intention is modified based on evaluation of performance and thus the result of the action. On the basis of this holistic frame, the MTTS was elaborated. It takes the VTS and Biofeedback $2000^{x\text{-}pert}$ as basic platforms, and the development of the system is always in progress. Basically, there are two main ideas on the development of the MTTS: (a) developing sport- or sports-specific tests by taking VTS as platform, and (b) appending setups that can be integrated with the MTTS to create situations for mental assessment and training purpose.

Finally, two empirical studies were carried out. The first study is concerned with the examination of a sports-specific test (i.e. MDT) in a Chinese elite athlete sample. It is recognized by coaches and athletes that movement detection is very critical for a broad variety of sports, especially for the team sports such as basketball and football. However, there is no specific tool had been developed to measure athletes' ability of movement detection prior to the development of MDT.

The MDT was developed to measure athletes' movement detection ability from dimension of reaction time. There are three test forms of MDT have been developed, in each test form movement detection has a different operational definition. The use of a rest button makes it possible to distinguish between cognitive reaction time and motor time. The detection time is the sum of cognitive reaction time and motor time. The results of examination in the present study suggested that MDT-S2 has sound reliability and validity. The MDT-S3, although has proved high reliability, the validity has not been proved. There are two possible reasons for the poor validity of MDT-S3: (a) the original idea behind development of MDT-S3 is to develop a tool for training movement detection ability, therefore the moving direction of the stimulus and the times of the stimulus moving towards every corner were designed different from test to test, the consequence of such a design is that the difficult of the test may different from person to person; (b) some participants released their fingers from the rest button before all the cognitive components were completed, as the consequence of this "early reaction", the participants cognitive reaction time reduced and motor time increased. One possible solution to improve the validity of MDT-S3 is to improve the test instruction.

The second empirical study is concerned with practical application of the MTTS concept and tools on the basis of an action-theory intervention consisting a mental assessment and training approach. In this study, a mental training program with MTTS as tool was implemented to 17 elite Chinese athletes to improve their ability to optimize action situations and to improve their mental skills competence. The results suggested that: (a) the participants improved their performance, felt a decrease in effort/energy and experienced high flow state when coping with the same task after the mental training intervention; (b) the participants improved their relaxation, imagery, and thought-stopping skill after the mental skills training intervention. In addition, the significant increase of using positive self-talk in the post-intervention assessment indicated that the participants improved their self-talk skill.

In summary, the MTTS concept and tools have been proven to be useful for conducting mental assessment and training to athletes, when it is used in the frame of an action-theory based approach. The results of the two reported studies provide evidences that using MTTS is connected with the following advantages:

1. The validity of mental assessment is high because the tools of and the theories behind mental assessment and mental training are correlated, which ensures that what is assessed is what is trained.

2. The mental assessment is implemented based on a multi-method and multi-faceted approach. The athlete is assessed from his or her performance, perceptions, feelings, and behaviors through tests, questionnaire, interview, observation, etc.

3. In the process of mental training, whether mental skills are employed or not can be observed directly. In the existing research of mental training for athletes, the use of mental skills is often evaluated based on the athletes' self-report.

4. The process and results of mental training can be monitored and assessed easily because the athlete's behavior can be observed and his or her scores of

action performance can be got immediately after the training, which makes it possible to provide immediate feedback.

Conceptually, a complete application of MTTS tool for mental assessment and training should be consisted of three phases: (a) training in lab, (b) transformation to training field, and (c) realization in competition (Figure 38). Assessing and training athletes' ability to optimize action situation in lab is only the first phase. The second phase is concerned with transforming what learned in lab to the daily sport training, and the third phase is concerned with applying what learned in competitive situations. In this paper, only the intervention effectiveness in the first phase has been reported, therefore the ecological validity of this intervention could not be confirmed. This will be an important future research direction.

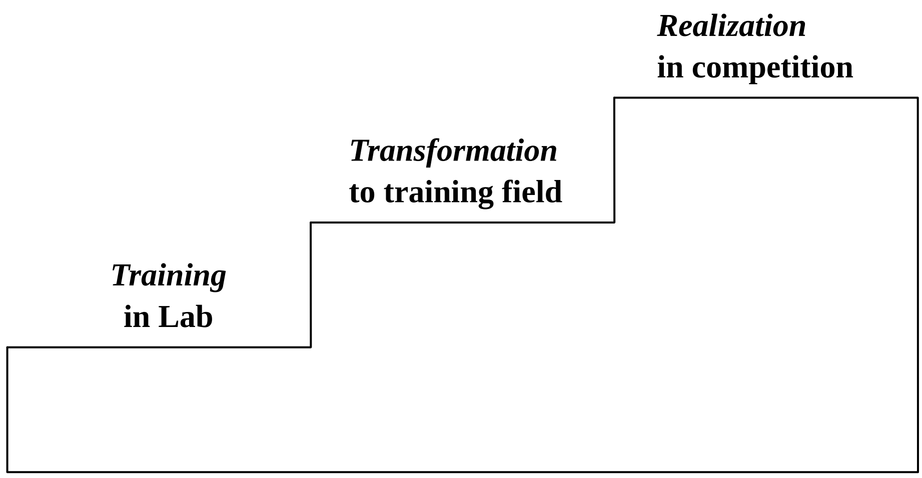


Figure 37. The three phases of applying MTTS concept and tools for mental assessment and training.

REFERENCES

Anastasi, A. (1988). *Psychological testing.* New York: Macmillan.

Andersen, M. B. (Ed.). (2000). *Doing sport psychology.* Champaign, IL: Human Kinetics.

Bakker, F. C., & Kayser, C. S. (1994). Effect of a self-help mental training programme. *International Journal of Sport Psychology, 25*, 158-175.

Blakeslee, M. L., & Goff, D. M. (2007). The effects of a mental skills training package on equestrians. *The Sport Psychologist, 21*, 288-301.

Blumenstein, B., & Bar-Eli, M. (2005). Biofeedback applications in sport. In D. Hackfort, J. L Duda, & R. Lidor (Eds.), *Handbook of research in applied sport and exercise psychology: International perspectives* (pp. 185-197). Morgantown, WV: Fitness Information Technology.

Blumenstein, B., Bar-Eli, M., & Tenenbaum, G. (2002). *Brain and body in sport and exercise: Biofeedback applications in performance enhancement*. Eastbourne, East Sussex, England: Wiley.

Boutcher, S. H., & Rotella, R. J. (1987). A psychological skills educational program for closed-skill performance enhancement. *The Sport psychologist, 1*, 127-137.

Burton, D. (1988). Do anxious swimmers swim slower? Reexamining the elusive anxiety-performance. *Journal of Sport and Exercise Psychology, 10*, 45-61.

Butler, R. J., & Hardy, L. (1992). The performance profile: Theory and application. *The Sport Psychologist, 6*, 253-264.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences.* San Diego, CA: Academic Press.

Cohen, R. J., & Swerdlik, M. E. (2002). *Psychological testing and assessment: An introduction to tests and measurement* (5th edition). Boston: McGraw-Hill.

Conroy, D. E., & Metzler, J. N. (2004). Patterns of self-talk associated with different forms of competitive anxiety. *Journal of Sport & Exercise Psychology, 26*, 69-89.

Construct validity. (n.d.). Retrieved August 1, 2011, from Wikipedia: http://en.wikipedia.org/wiki/Construct validity

Csikszentmihalyi, M. (1975). *Beyond boredom and anxiety.* San Francisco: Jossey-Bass.

Csikszentmihalyi, M. (1982). Towards a psychology of optimal experience. In L. Wheeler (Ed.), *Annual review of personality and social psychology* (Vol. 3, pp. 13-36). Beverly Hills, CA: Sage.

Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience.* New York: Harper & Row.

Csikszentmihalyi, M. (1992). A response to the Kimiecik & Stein and Jackson papers. *Journal of Applied Sport Psychology, 4*, 181－183.

Csikszentmihalyi, M., & Csikszentmihalyi, I. (1988). *Optimal experience: Psychological studies of flow in consciousness.* Cambridge: Cambridge University Press.

Danish, S. J., & Hale, B. D. (1981). Toward an understanding of the practice of sport psychology. *Journal of sport psychology, 3*, 90-99.

Danish, S. J., & Nellen, V. C. (1997). New roles for sport psychologists: Teaching life skills through sport to at risk-youth. *Quest, 49*, 100-113.

Danish, S. J., Petitpas, A. J., & Hale, B. D. (1992). A developmental-educational intervention model of sport psychology. *The Sport Psychologist, 6*, 403-415.

Davies, S., & West, J. D. (1991). A theoretical paradigm for performance enhancement: The multimodal approach. *The Sport Psychologist, 5*, 167-174.

Domino, G., & Domino, M. L. (2006). *Psychological testing: An Introduction* (2^{nd} ed.). New York: Cambridge University Press.

Dosil, J. (2006). Applied sport psychology: A new perspective. In J. Dosil (Ed.), *The sport psychologist's handbook: A guide for sport-specific performance enhancement* (pp. 3-17). England, West Sussex: John Wiley & Sons Ltd.

Duda, J. L., & Whitehead, J. (ed.). (1998). *Advances in sport and exercise psychology measurement*. Morgantown, WV: Fitness Information Technology.

Durand-Bush, Salmela, & Green-Demers. (2001). The Ottawa Mental Skills Assessment Tool (OMSAT-3). *The Sport Psychologist, 15*, 1-19.

Elko, P., & Ostrow, A. (1991). Effects of a rational emotive program on heightened anxiety levels of female college gymnasts. *The Sport Psychologist, 5*, 235-255.

Fischman, M. G., & Oxendine, J. B., (1998). Motor skill learning for effective coaching and performance. In J. M. Williams (Ed.), *Applied Sport Psychology: Personal growth to peak performance* (3rd ed.) (pp.13-27). Mountain View, CA: Mayfield.

Fournier, J. F., Calmels, C., Durand-Bush, N., & Salmela, J. H. (2005). Effects of a season-long PST program on gymnastic performance and on psychological development. *International Journal of Sport and Exercise Psychology, 3*, 59-77.

Gabler, H., Janssen, J. –P., & Nitsch, J. R. (1990). *Gutachten "Psychologisches Training" in der Praxis des Leistungssports. Probleme und Perspektiven*. Köln: Sport und Buch Strauss.

Gardner, F. (1995). The coach and team psychologist: An integrated organizational model. In S. M. Murphy (Ed.), *Sport psychology interventions* (pp. 147-175). Champaign IL: Human Kinetics.

Gardner, F., & Moore, Z. E. (2004). The multi-level classification system for sport psychology (MCS-SP). *The Sport Psychologist, 18*, 89-109.

Gould , D. (2000). Performance enhancement consulting: Lessons, guidelines, and common problems. In B. A. Carlsson, U. Johnson, & F. Wetterstrand (Eds.), *Proceedings of sport psychology conferences in the new millennium: A dynamic research-practice perspective* (pp. 43-54). Halmstad, Sweden: Centre for Sport Science/School of Social and Health Sciences.

Gould, D., & Carson, S. (2007). Psychological preparation in sport. In B. Blumenstein, R. Lidor, & G. Tenenbaum (Ed.), *Psychology of sport training: Perspectives on sport and exercise psychology Vol. 2* (pp. 115-136). Oxford: Meyer & Meyer Sport.

Gould, D., & Damarjian, N. (1998). Mental skills training in sport. In B. C. Elliot (Ed.), *Applied sport science: Training in sport. International Handbook of Sport Science*: Vol. 3. (pp. 69-116). Sussex, England: Wiley.

Gould, D., Murphy, S., Tammen, V., & May, J. (1991). An evaluation of U.S. Olympic sport psychology consultant effectiveness. *The Sport Psychologist, 5*, 111-127.

Gould, D., Tammen, V., Murphy, S., & May, J. (1989). An examination of U.S Olympic sport psychology consultants and the services they provided. *The Sport Psychologist, 3*, 300-312.

Greenspan, M. J., & Andersen, M. B. (1995). Providing psychological services to student athletes: A developmental psychology model. In S. M. Murphy (Ed.), Sport psychology interventions (pp. 177-191). Champaign IL: Human Kinetics.

Hackfort, D. (1986). *Theorie und Analyse sportbezogener Ängstlichkeit (Theory and analysis of sport-related trait anxiety)*. Schorndorf: Hofmann.

Hackfort, D. (1991). Emotion in sport: An action theoretical analysis. In C. D. Spielberg, I. G. Sarason, Z. Kulcsar, & G. L. Van Heck (Eds.), *Stress and emotion: Anxiety, anger, and curiosity, Vol. 14* (pp. 65-73). New York: Hemisphere Publishing Corporation.

Hackfort, D. (2001). Experiences with application of action-theory-based approach in working with elite athletes. In G. Tenenbaum (Ed.), *The practice of sport psychology* (pp. 89-99). Morgantown, WV: Fitness Information Technology.

Hackfort, D. (2006). A conceptual framework and fundamental issues for investigating the development of peak performance in sports. In D. Hackfort & G. Tenenbaum (Eds.), *Essential processes for attaining peak performance: Perspectives on sport and exercise psychology Vol. 1* (pp. 10-25). Oxford: Meyer & Meyer Sport.

Hackfort, D., Herle, M., Debelak, R. (2010). *Manual of Movement Detection Test (Version, 21.00)*. Vienna: Schuhfried GmbH.

Hackfort, D., Kilgallen, C., & Liu, H. (2009). The action theory-based Mental Test and Training System (MTTS). In T. –M. Hung, R. Lidor, & D. Hackfort (Eds.), *Psychology of sport excellence: International perspectives on sport and exercise psychology* (pp. 15-24). Morgantown, WV: Fitness Information Technology.

Hackfort, D., & Munzert, J. (2005). Mental simulation. In D. Hackfort, J. Duda, & R. Lidor (Eds.), *Handbook of research in applied sport and exercise psychology -International perspectives* (pp. 3-16). Morgantown, WV: Fitness Information Technology.

Hackfort, D., & Schwenkmezger, P. (1993). Anxiety. In R. N. Singer, M. Murphey, & L. K. Tennant (Eds.), *Handbook of Research on Sport Psychology* (pp. 328–364). New York: MacMillan.

Haddad, K., & Tremayne, P. (2009). The effects of centering on the free-throw shooting performance of young athletes. *The Sport Psychologist, 23*, 118-136.

Hall, C., & Rodgers, W. (1989). Enhancing coach effectiveness in figure skating through a mental skills training program. *The Sport Psychologist, 3*, 142-154.

Hamilton, R. A., Scott, D., & MacDougall, M. P. (2007). Assessing the effectiveness of self-talk interventions on endurance performance. *Journal of Applied Sport Psychology, 19*, 226-239.

Hanin, Y. L. (2000). Successful and poor performance and emotions. In Y. L. Hanin (Ed.), Emotions in sport (pp. 157-187). Champaign, IL: Human Kinetics.

Hatzigeorgiadis, A., Zourbanos, N., Goltsios, C., & Theodorakis, Y. (2008). Investigating the functions of self-talk: The effects of motivational self-talk on self-efficacy and performance in young tennis players. *The Sport Psychologist, 22*, 458-471.

Hellison, D. (1995). *Teaching responsibility through physical activity.* Champaign, IL: Human Kinetics.

Hellstedt, J. C. (1995). Invisible players: A family systems model. In S. M. Murphy (Ed.), *Sport psychology interventions* (pp. 117-146). Champaign, IL: Human Kinetics.

Henschen, K. (2007). Mastering the psychological skills. In D. Hackfort (Ed.), *Striving for excellence: First ASPIRE Sport Science Conference* (pp. 127-136). Morgantown, WV: Fitness Information Technology.

Hesse, C. W., Wing, A. M., & Georgeson, M. A. (n.d.). A temporal derivative model of kinesthesia for movement detection and direction discrimination. Retrieved August 7, 2011, from http://psg275.bham.ac.uk/bbs/paper/CHesse_PandP_sub.pdf

Jackson, S.A. (1992). Athletes in flow: A qualitative investigation of flow states in elite figure skaters. *Journal of Applied Sport Psychology, 4*, 161 – 180.

Jackson, S. A. (1995). Factors influencing the occurrence of flow in elite athletes. *Journal of Applied Sport Psychology, 7,* 138–166.

Jackson, S.A. (1996). Toward a conceptual understanding of the flow experience in elite athletes. *Research Quarterly for Exercise and Sport, 67*, 76 – 90.

Jackson, S.A., & Csikszentmihalyi, M. (1999). *Flow in sports: The keys to optimal experiences and performances.* Champaign, IL: Human Kinetics.

Jackson, S. A., & Eklund, R. C. (2002). Assessing flow in physical activity: The Flow State Scale-2 (FSS-2) and Dispositional Flow Scale-2 (DFS-2). *Journal of Sport & Exercise Psychology, 24*, 133 – 150.

Jackson, S.A., Kimiecik, J., Ford, S., & Marsh, H.W. (1998). Psychological corrrelates of flow in sport. *Journal of Sport & Exercise Psychology, 20,* 358 – 378.

Jackson, S.A., & Marsh, H.W. (1996). Development and validation of a scale to measure optimal experience: The flow state scale. *Journal of Sport & Exercise Psychology, 18,* 17 – 35.

Jackson, S. A., Martin, A. J., & Eklund, R. C. (2008). Long and short measures of flow: The construct validity of the FSS-2, DFS-2, and new brief counterparts. *Journal of Sport and Exercise Psychology, 30*, 561-587.

Jones, G., Hanton, S., & Connaughton, D. (2002). What is this thing called mental toughness? An investigation of elite sport performers. *Journal of Applied Sport Psychology, 14*, 205-218.

Kimiecik, J. C., & Stein, G. L. (1992). Examining flow experiences in sport contexts: Conceptual issues and methodological concerns. *Journal of Applied Sport Psychology, 4,* 144–160.

Kirschenbaum, D. S., & Wittrock, D. A. (1984). Cognitive-behavioral interventions in sport: A self-regulatory perspective. In J. M. Silva & R. S. Weinberg (Eds.), *Psychological foundations of sport* (pp. 81-91). Champaign, IL: Human Kinetics.

Kisser, R., Krafack, A., & Vaughahn, Chr. (1986). Determinationsgeräte. In R. Brickenkamp (Ed.), *Handbuch apparativer Verfahren in der Psychologie* (pp. 225-249). Göttingen: Hogrefe.

Lander, D. M. (1985). Pwychophysiological assessment and biofeedback. In J. Sandweiss & S. Wolf (Eds.), *Biofeedback and sport science* (pp. 63-105). New York: Plenum.

Landers, D. M., & Arent, S. M. (2006). Arousal-performance relationships. In J. M. Williams (Ed.), *Applied sport psychology: Personal growth to peak performance* (5th edtion, pp. 260-284). New York: McGraw-Hill.

Maloney, M. P., & Ward, M. P. (1976). *Psychological assessment: A conceptual approach*. New York: Oxford University.

Mamassis, G., & Doganis, G. (2004). The effects of a mental training program on juniors pre-competitive anxiety, self-confidence, and tennis performance. *Journal of Applied Sport Psychology, 16*, 118-137.

Martin, G. L., & Toogood, A. (1997). Cognitive and behavioral components of a seasonal psychological skills training program for competitive figure skaters. *Cognitive and Behavioral Practice, 4*, 383-404.

Martin, S. B., Thompson, C. L., & McKnight, J. (1998). An integrative psychoeducational approach to sport psychology consulting: A case study. *International Journal of Sport Psychology, 29*, 170-186.

McCaffrey, N., & Orlick, T. (1989). Mental factors related to excellence among top professional golfers. *International Journal of Sport Psychology, 20*, 256-278.

McCann, S. C., Jowdy, D. P., & Van Raalte, J. L. (2002). Assessment in sport and exercise psychology. In J. L. Van Raalte & B. W. Brewer (Eds.), *Exploring sport and exercise psychology* (2nd edition., pp. 291-305). Washington, DC: American Psychological Association.

McCloskey, D. I. (1978). Kinesthetic Sensibility. *Physiological Reviews, 58*, 763-820.

Moore, W. E., & Stevenson, J. R. (1994). Training for trust in sport skills. *The Sport Psychologist, 8*, 1-12.

Moran, A. P. (2004). *Sport and exercise psychology: A critical introduction*. New York: Routledge.

Neuwirth, W., & Benesch, M. (2007). *Manual of Determination Test (Version, 32.00)*. Vienna: Schuhfried GmbH.

Nideffer, R. M., & Sagal, M. (2001). *Assessment in sport psychology*. Morgantown, WV: Fitness Information Technology.

Nideffer, R. M., & Sagal, M. (2006). *Applied sport psychology: Personal growth to peak performance* (pp. 382-403). Boston: McGraw-Hill.

Nitsch, J. R. (1982). Analysis of action and functionalistic approaches in sport psychology. In E. Geron (Ed.), *Handbook of sport psychology: Vol. 1. Introduction to sport psychology* (pp. 58-75). Netanya, Israel: Wingate Institute.

Nitsch, J. R. (1985). The action-theoretical perspective. *International Review for Sociology of Sport, 20*(4), 263-282.

Nitsch, J. R., & Hackfort, D. (1981). *Stress in schule und hochschule: Eine handlungspsychologische funktionsanalyse* [*Stress in school and university: An action psychology functional analysis*]. In J. R. Nitsch (Ed.), *Stress* (pp. 263-311). Bern, Switzerland: Huber.

Nitsch, J. R., & Hackfort, D. (1984). Basisregulation interpersonalen Handelns im Sport [Tuning of interpersonal acting in sports]. In E. Hahn & H. Rieder (Hrsg.), *Sensumotorisches Lernen und Sportspielforschung* [*Sensori-motor learning and research in sports games*] (pp. 148-166). Köln: bps.

Nunnally, J. C., & Bernstein, I .H. (1994). *Psychometric theory* (3rd edition). New York: McGraw-Hill.

Orlick, T. (1986). *Coaches training manual to psyching for sport.* Champaign, IL: Human Kinetics.

Orlick, T. (2000). In pursuit of excellence (3rd ed.). Champaign IL: Human Kinetics.

Orlick, T., & Partington, J. (1987). The sport psychology consultant: Olympic coaches' view. *The Sport Psychologist, 1*, 95-102.

Ostrow, A. C. (ed.). (1996). *Directory of psychological tests in sport and exercise sciences* (2nd ed.). Morgantown, WV: Fitness Information Technology.

Pates, J., Maynard, I. W., & Westbury, T. (2001). An investigation into the effects of hypnosis on basketball performance. *Journal of Applied Sport Psychology, 13*, 84-102.

Patrick, T. D., & Hrycaiko, D. W. (1998). Effects of a mental training package in an endurance performance. *The Sport Psychologist, 12*, 283-299.

Poczwardowski, A., Sherman, C. P., Ravizza, K. (2004). Professional philosophy in the sport psychology service delivery: Building on theory and practice. *The Sport Psychologist, 18*, 445-463.

Prieler, J. (2007). *Manual of Reaction Test*. Vienna: Schuhfried GmbH.

Ravizza, K., & Hanson, T. (1994). *Heads-up baseball: Playing the game on pitch at a time.* Chicago: Contemporary.

Reber, A. S., & Reber, E. (2001). *The penguin dictionary of psychology* (3rd ed., pp. 431 & pp. 743). London: Penguin Books Ltd.

Rogerson, L. R., & Hrycaiko, D. W. (2002). Enhancing competitive performance in ice hockey goaltenders using centering and self-talk. *The Journal of Applied Sport Psychology, 14*, 14-26.

Rushall, B. S. (2006). Psychological factors and mental skills in wrestling. In J. Dosil (Ed.), *The sport psychologist's handbook: A guide for sport-specific performance enhancement* (pp. 375-399). England, West Sussex: John Wiley & Sons Ltd.

Ryba, T. V., Stambulova, N. B., & Wrisberg, C. A. (2005). The Russian origins of sport psychology: A translation of an early work of A. C. Puni. *Journal of Applied Sport Psychology, 17*, 157-169.

Sagal, M. –S., Sagal, P. T., & Miller, G. E. (2004). Assessment in sport psychology. In C. Spielberger (Ed.), *Encyclopedia of applied psychology, vol, 1*. (pp. 177-190).

Savoy, C., & Beitel, P. (1997). The relative effect of a group and group/individualized program on state anxiety and state self-confidence. *Journal of Sport Behavior, 20*, 364-376.

Schack, T., & Hackfort, D. (2007). Action-theory approach to applied sport psychology. In G. Tenenbaum & R. C. Eklund (Eds.), *Handbook of sport psychology* (3rd ed., pp. 332-351). New Jersey: John Wiley & Sons, Inc.

Schuijers, R. (2009). Application of mental training with elite athletes. In T. M. Huang, R. Lidor, & D. Hackfort (Eds.). *Psychology of Sport Excellence: International perspectives on sport and exercise psychology* (pp. 105-119). Morgantown, WV: Fitness Information Technology.

Sheard, M., & Golby, J. (2006). Effect of a psychological skills training program on swimming performance and positive psychological development. *International Journal of Sport and Exercise Psychology, 4*, 149-169.

Singer, R. N. (1988). Psychological testing: What value to coaches and athletes? *International Journal of Sport Psychology, 19*, 87-106.

Smith, R. E., & Johnson, J. (1990). An organizational empowerment approach to consultation in professional baseball. *The Sport Psychologist, 4*, 347-357.

Sundberg, N. (1977). *Assessment of persons*. New York: Prentice-Hall.

Tabachnick, B. G., & Fidell, L. S. (2001). *Using multivariate statistics* (4th ed.). New York: Harper & Row.

Thelwell, R. C., & Greenless, I. A. (2001). The effects of a mental skills training package on gymnasium triathlon performance. *The Sport Psychologist, 15*, 127-141.

Thelwell, R. C., Greenlees, I. A. (2003). Developing competitive endurance performance using mental skills training. *The Sport Psychologist, 17*, 318-337.

Thelwell, R. C., & Maynard, I. W. (2003). The effect of a mental skills package on „repeatable good performance" in cricketers. *Psychology of Sport and Exercise, 4*, 377-396.

Theodorakis, Y., Weinberg, R., Natsis, P., Douma, E., & Kazakas, P. (2000). The effects of motivational versus instructional ST on improving motor performance. *The Sport Psychology, 14, 253-272*.

Thomas, P. R., & Over, R. (1994). Psychological and psychomotor skills associated with performance in golf. *The Sport Psychologist, 8*, 73-86.

Tkachuk, G., Leslie-Toogood, A., & Martin, G. L. (2003). Behavioral assessment in sport psychology. *The Sport Psychologist, 17*, 104-117.

Tremayne, P., & Newbery, G. (2005). Mental skill training program for children. In D. Hackfort, J. Duda, & R. Lidor (Eds.), *Handbook of research in applied sport and exercise psychology -International perspectives* (pp. 93-106). Morgantown, WV: Fitness Information Technology.

Tremayne, P., & Tremayne, B. (2004). Children and sport psychology. In T. Morris & J. Summers (Eds.), *Sport psychology: Theory, applications and issues* (2nd ed., pp. 529-546). Milton, Queensland, Australia, Wiley.

Urbina, S. (2004). *Essentials of psychological testing.* NJ: Wiley.

Van Raalte, J. L., & Andersen, M. B. (2002). Referral processes in sport psychology. In J. L. Van Raalte & B. W. Brewer (Eds.), *Exploring sport and exercise psychology* (2nd ed., pp. 325-337). Washington, DC: American Psychological Association.

Van Raalte, J. L., Brewer, B. W., Rivera, P. M., & Petitpas, A. J. (1994). The relationship between observable self-talk and competitive junior players' match performances. *Journal of Sport and Exercise Psychology, 16*, 400-415.

Vealey, R. S. (1988). Future directions in psychological skills training. *The Sport Psychologist, 2*, 318-336.

Vealey, R. S. (2005). *Coaching for the inner edge.* Morgantown, WV: Fitness Information Technology.

Vealey, R. S. (2007). Mental skills training in sport. In G. Tenenbaum & R. C. Eklund (Eds.), *Handbook of sport psychology* (3rd ed., pp. 287-309). New Jersey: John Wiley & Sons, Inc.

Vealey, R. S., & Garner-Holman, M. (1998). Applied sport psychology: Measurement issues. In J. L. Duda (Ed.), *Advances in sport and exercise psychology measurement* (pp. 433-446). Champaign, IL: Human Kinetics.

Vincent, W. J. (1999). *Statistics in kinesiology* (2nd ed.). Champaign, IL: Human Kinetics.

Weinberg, R., & Gould, D. (2007). *Foundations of sport and exercise psychology* (4th ed.). Champaign, IL: Human Kinetics.

Weinberg, R. S., Grove, R., & Jackson, A. (1992). Strategies for building self-efficacy in tennis players: A comparative analysis of Australian and American coaches. *The Sport Psychologist, 6*, 3-13.

Weiss, M. R. (1991). Psychological skill development in children and adolescents. *The Sport Psychologists, 5*, 335-354.

Weiss, M. R. (1995). Children in sport: An education model. In S. M. Murphy (Ed.), Sport psychology interventions (pp. 39-69). Champaign, IL: Human Kinetic.

Williams, J. M., & Straub, W. F. (2006). Sport psychology: Past, present, future. In J. M. Williams (Ed.), *Applied sport psychology: Personal growth to peak performance* (5th ed., pp. 1-14). Boston: McGraw-Hill.

Williams, A. M., & Ward, P. (2003). Perceptual expertise: Development in sport. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sport: Advances in research on sport expertise* (pp. 219-249). Champaign, IL: Human Kinetic.

Wolf, M. M. (1978). Social validity: The case for participative measurement or how applied behavior analysis is finding its heart. *Journal of Applied Behavior Analysis, 11,* 203-214.

Wollman, N. (1986). Research on imagery and motor performance: Three methodological suggestions. *Journal of Sport Psychology, 8*, 135-138.

Zimmerman, T. S., Protinsky, H. O., & Zimmerman, C. S. (1994). Family systems consultation with an athletic team: A case study of themes. *Journal of Applied Sport Psychology, 6*, 101-115.

TABLE OF APPENDICES

APPENDIX 1

Demographic Survey

Name: ______________________________

Gender: ☐ Male ☐ Female

Date of birth: _________ (year) ________ (month) ________ (date)

What sport do you participate at present? _______________________________________

How many years do you participate in your current sport? ________ years

What is your current athletic level? ____

Do you have any experience of learning mental training?

☐ Yes ☐ No

APPENDIX 2

Name: ______________________________ Date: ____________

Perceived Effort Questionnaire

How much effort did you expend on the test today?

(Please circle the appropriate number)

1	**2**	**3**	**4**	**5**	**6**	**7**
No effort at all						Went all out

APPENDIX 3

Name: ______________________________ Date: ____________

Short Flow State Scale 2

Directions: Below are some statements that describe your feelings during the testing. Please read each carefully and rate the extent to which you agree.

	Strongly disagree				Strongly agree
1. I fell I am competent enough to meet the high demands of the situation	①	②	③	④	⑤
2. I do things spontaneously and automatically without having to think	①	②	③	④	⑤
3. I have a strong sense of what I want to do	①	②	③	④	⑤
4. I have a good idea while I am performing about how well I am doing	①	②	③	④	⑤
5. I am completely focused on the task at hand	①	②	③	④	⑤
6. I have a feeling of total control over what I am doing	①	②	③	④	⑤
7. The way time passes seems to be different from normal	①	②	③	④	⑤
8. I am not concern with others	①	②	③	④	⑤
9. The experience is extremely rewarding	①	②	③	④	⑤

APPENDIX 4

Name: ____________________________ Date: ____________

Mental Skills Competence Checklist

Relaxation

1. Biofeedback relaxation system GSR:
   (1) the number on the dial: _________
   (2) time to be relaxed (tone disappear): ________ (min)
2. The relaxation level during the testing

1	2	3	4	5	6	7
extremely tense						extremely relaxed

Imagery

1. Image (see) color buttons: red, blue, white, yellow, and green (visual imagery)

1	2	3	4	5	6	7
Very hard to see	Hard to see	Somewhat hard to see	Neutral (not easy nor hard)	Somewhat easy to see	Easy to see	Very easy to see

2. Image (feel) doing tests (kinesthetic imagery)

1	2	3	4	5	6	7
Very easy to feel	Easy to feel	Somewhat easy to feel	Neutral (not easy nor hard)	Somewhat hard to feel	Hard to feel	Very hard to feel

Self-Talk

List all the self-talk and self-statement during the testing:

Thought Stopping and Refocusing

1. Easy or hard to stop thinking mistakes

1	2	3	4	5	6	7
Very hard to stop	Hard to stop	Somewhat hard to stop	Neutral (not easy nor hard)	Somewhat easy to stop	Easy to stop	Very easy to stop

2. Easy or hard to refocus on the tasks

1	2	3	4	5	6	7
Very hard to refocus	Hard to refocus	Somewhat hard to refocus	Neutral (not easy nor hard)	Somewhat easy to refocus	Easy to refocus	Very easy to refocus

APPENDIX 5

Name: ____________________________ Date: ____________

Mental Skills Usage Questionnaire

Instruction: Below are some questions about the mental skills you probably used in during the testing of today. Please read carefully and indicate if these skills are used (*yes*) or not (*no*) by you.

	Yes	No
1. Did you perform a relaxation technique before your testing (e.g., centering when stretching to be mentally calm and/or physically relaxed)?	________	________
2. Did you use a relaxation strategy during your testing (e.g., used self-statements and/or centering to maintain a relaxed and loose mental and/or physical state)?	________	________
3. Did you mentally rehearse before you went for your testing?	________	________
4. Did you use imagery in any way during your testing?	________	________
5. Did you perform any self-statements during the preparation for your testing?	________	________
6. Did you use positive self-talk or coping self-statements during the testing?	________	________
7. Did you try to stop thinking it immediately after a mistake had happened during the test?	________	________

8. Did you give up the idea immediately when you were not satisfied with your performance in the testing and you didn't want to do your best? ________ ________
9. Did you try to refocus on the task at hand when you were distracted by mistakes and negative thoughts during the testing? ________ ________
10. Did you try to refocus on the task at hand when you were distracted by the noise and other things during the testing? ________ ________

Percent of total skills used: (Yes) total/10 x 100 = ______%

APPENDIX 6

Name: ____________________________ Date: ____________

Social Validation Questionnaire

Directions: Below are some statements that describe your perceptions about the mental training sessions. Please read each carefully and indicate your perceptions. Your answers will be treated as absolutely confidential.

	Not at all important		Somewhat important		Extremely important
1. How important is the mental training to improve your performance	①	②	③	④	⑤
	Not at all significant		Somewhat significant		Extremely significant
2. Do you experience any significant improvement after the mental training sessions	①	②	③	④	⑤
	Not at all satisfied		Somewhat satisfied		Extremely satisfied
3. How satisfied are you with the mental training program	①	②	③	④	⑤
	Absolutely not will		Occasionally will		Absolutely will
4. Are you going to use what you learned from the mental training sessions in your training and competition	①	②	③	④	⑤

APPENDIX 7

Consent for Sport Psychology Assessment and Training

(For coaches)

I hereby give my permission for a sport psychology assessment and training research to my athletes. The objective of this research is to evaluate the effectiveness of a mental assessment and training program. I understand that the information provided is strictly confidential. None of athletes' individual data will be released to anyone other than the athletes themselves, without the permission of them. But I understand that athletes' individual data may be used as part of a database on the premise that personal information will not be released.

I understand that if the athletes feel uncomfortable, they have right to ask the assessment and training be stopped at any time while assessing and training, as well as to withdraw from the research.

Name: ____

Signature: ____

Date: ____

APPENDIX 8

Consent for Sport Psychology Assessment and Training

(For athletes)

I hereby give my permission for a sport psychology assessment and training research. I have been given ample time to ask questions and have received satisfactory responses. I voluntarily agree to participate in the research. I understand that I can choose not to participate in the research, and I understand that I can drop out from the research at any time I may choose without any consequences.

I understand that all information obtain from the research is strictly confidential and will not release to anyone than me, without my permission. But I also understand that my individual data may be used as part of a database on the premise that personal information will not be released.

Yes, I give my informed consent.

Name: ______________________________

Signature: ___________________________

Date: _______________________________

APPENDIX 9

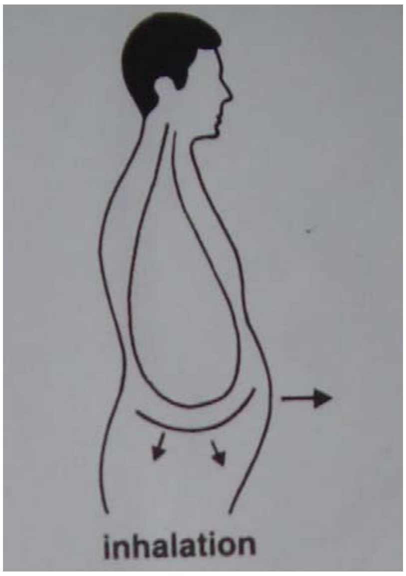
The Outline of Teaching Mental Skills

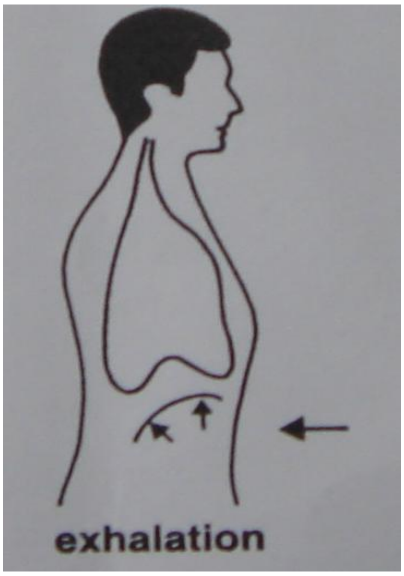
Relaxation (30 minutes)

- Discussion the importance of relaxation training
- Introduce and perform abdominal breathing exercise *(perform nine times per day as a homework)*

Steps:

- Sit down in a comfortable position.
- Put one palm on the belly and the other one on the sternum.
- Inhale through nose (smoothly and deeply) and expand abdomen; exhale through mouse (slowly and smoothly) and pull the abdomen in.
- Let the chest stay relatively still.
- Repeat several times.





- Introduce and perform progressive muscle relaxation exercise *(perform twice per day as a homework)*

  Steps:

  - Sit down in a comfortable position, close your eyes.
  - Breathe restful. Do not attempt to control the speed of breath, just let it happen.
  - Tense the muscles in the face, holding four seconds and then release them, then feel the difference between being tight and being relaxed. Repeat the process (i.e., tighten–hold-release-feel difference). Then move to the muscle in the shoulder and neck, the arms, the hands, the upper back, the chest, the abdomen, the low back, the buttocks, the crus and ham, and the feet. Execute the process twice in every muscle group.
  - Scan all the muscle groups from head to feet, repeat the tightening-relaxing process.

- Discussion how to integrate the skill into motor performance testing to practice the skill and to improve performance

  Practice in the testing:

  - ✧ Breathing three times before starting practice phase
  - ✧ Scan the muscle groups in the body and relax the tense muscle(s) before starting testing phase
  - ✧ Relax the tense muscle(s) during the testing

Imagery (20 minutes)

- Introduce imagery: definition, importance to performance
- Perform an imagery exercise *(perform once per day as a homework)*

  Exercise 1:

Place yourself in a familiar place where you usually perform your sport (e.g., gym). It is empty except for you. Stand in the middle of this place and look all around. Notice the quiet emptiness. Pick out as many details as you can. What does it smell like? What are colors, shapes, and forms that you see? Now image yourself in the same setting. (Vealey, 2005, p. 196)

Exercise 2:

Image your self in the same sitting as in the exercise 1, but this time there are many spectators there. Imagine yourself getting ready to perform. Try to experience this image from inside your body. See the spectators, your teammates, your coach, and the opponents. Try to hear the sounds of the noisy crowd, your teammates' chatter, your coach yelling encouragement, and the particular sounds of your sport. Recreate the feelings of nervous anticipation and excitement that you have prior to competing. How do you feel? How will you respond when the competition begins? (Vealey, 2005, p. 196)

- Discussion how to integrate the skill into motor performance testing to practice the skill and to improve the performance

Practice in the testing:

Perform the following imagery exercises before starting the test phase:

✧ Image the stimuli to be presented in the tests (colors and tones)

✧ Visualize the reaction buttons and foot pedals linking to corresponding stimuli

✧ Image you are doing test easily and smoothly, image the feeling of you body.

Self-talk (15 minutes)

- Introduce self-talk: definition, importance to performance

> How we think and talk to ourselves in our minds dictates the directions our body will follow. … One interesting fact is that

> the body will follow the subject of the thought, not exactly what is said or thought. … The body is a servomechanism of the mind, and self-talk is the messenger. (Henschen, 2007, p. 134)

- Teach how to execute self-talk

  Characteristics of positive cue or trigger words:

  - briefness
  - affirmative
  - present tense
  - first person

- Discussion how to integrate the skill into motor performance testing to practice the skill and to improve the performance

  - Self talking immediately before the testing phase: “come on!”
  - Self talking during the testing: “relax!” “go on!” “focus”

Thought-stopping (15 minutes)

- Introduce thought-stopping
- Teach how to execute thought-stopping

  - Use self-talk skill: “stop!” “let go”
  - Switch thought to right thing at a moment

- Discussion how to integrate the skill into motor performance testing to practice the skill and to improve the performance

- ✧ After a mistake happen during the testing
- ✧ After a negative thought during the testing: e.g., “I don’t want complete the test because I made so many mistakes”

Refocusing (15 minutes)

- Introduce refocusing

Sport Situations that May Require Refocusing (Vealey, 2005, p. 262, adapted from Orlick, 1986)

- ✧ Pre-event hassle
- ✧ Non-ideal conditions
- ✧ Delay in competition
- ✧ Overwhelmed with distractions the day of competition (family, friends, exams, deadlines)
- ✧ Poor performance at beginning of competition
- ✧ Big mistake (error)
- ✧ Criticism from coach or teammate
- ✧ Mind wandering and distracted
- ✧ Fear opponent and doubt own ability
- ✧ Feeling focused and ready, but not performing as well as usual

- Teaching how to refocusing

Refocusing strategies (Vealey, 2005, p. 262-263):

- ✧ Remain present-oriented and refuse to focus on the past

- ✧ Use the Refocusing Worksheet for Athletes (Orlick, 1986)

Situation or Distraction	Preferred Response	Focus or Cue Word (to bring on preferred response)

- ✧ Work through a list of potential distractions/obstacles specific to your sports by noting how you can best respond and refocus in these situations.

- Discussion how to integrate the skill into motor performance testing to practice the skill and to improve the performance

  - ✧ List all the potential distractions in the testing, think how to respond and refocus in these situations, e.g., self-talk, present and/or next stimulus oriented focus.

Eidesstattliche Erklärung

Hiermit gebe ich die eidesstattliche Erklärung ab, dass ich diese Arbeit selbständig verfasst, sie keiner anderen Fakultät vorgelegt und alle benutzten Materialien und Quellen angegeben habe.

.... Munich, 22nd February 2012
Hao LIU

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