

Computerized cognitive and psychomotor battery



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The primary goal of this study was to develop and validate the computerized cognitive and psychomotor battery for the sharp shooters. In order to construct the test, task analysis were carried out. For the experts in the field of psychology, experienced shooters and coaches were interviewed in the army marksmanship training center. Based on that skills and abilities required for the shooters were identified. In order to quantify those skills eight tests were identified i. e. Reasoning, visualization, shifting of attention, simple reaction time, complex reaction time, sustained attention, Eye- Hand Co-ordination and mental stamina (to with stand the match pressure). Initially the test protocols and requirement were developed and those were discussed with the software experts. The software professionals prepared the test software by using OPENGL and MYSQL software packages. After computerized the battery, validation process were started. In order to establish the psychometric properties, the study has carried out in two phase. In the first part of the research was focused on the validation of cognitive and psychomotor battery and in the second part validation of self reported mental toughness scale.

In order to establish the psychometric properties of perceptual and motor battery around 650 samples were collected from shooters in IMA and Army Marksmanship unit. To establish the reliability, test retest method employed to investigate the temporal stability, for this 45 shooters were collected from Army marksmanship Unit (8 months' time interval) (Mean age 24. 2 & SD 3. 8 Average year of experience in shooting 3. 5). Overall the correlation was moderate, the lowest value was obtained in simple reaction time (See table No). For rests of the scales temporal consistency was moderate level. Apart

from that pair sample t tests used to check the consistency of the score in the two levels. There was no significant difference between the mean test and retest scores mean scores. This findings supports the test battery is maintaining adequate temporal consistency.

To study the factorial validity, exploratory factor analysis was carried out. Findings shows that three factor were emerged and it explains 60. 2 %. In factor I reasoning and perceptual style test is loaded (), Factor II Vigilance, Eye hand Coordination and shifting of attention is loaded and in Factor 3 simple and choice reaction time is loaded (). The tests loaded on factor I, it measures logical reasoning and decision making of an individual, and both the tests are non verbal matrix test, which may be the cause of loading both the test in Factor I. In the second factor, Sustained attention Shifting of attention and Eye hand Coordination are loaded, theoretically it was not expected the psychomotor test shared common variance with the test that measures attention and concentration. In the Eye hand coordination test subject has to focus and move the ball with the help of the Joystick, and to perform the task the subject is not only required psychomotor skills but the subject has to concentrate and focused the task, which may be the cause of loading this test in Factor II. In the Factor III, the tests measures the psychomotor skills (simple and Choice reaction time) are loaded. To cross validate the latent structure emerged in the exploratory analysis, a separate confirmatory factor analysis were carried. Two competing models were developed but the results shows that the three dimensional oblique model is adequately fitting the data.

After factorial validity, to establish the predictive validity of cognitive and psychomotor battery, separate set of data were collected from the participants of talent shooting competition and shooters performance appraisal data from the training institute. And to establish the validity, t-test and discriminant analysis were carried out to predict how far the battery is predicting the performance of the shooters. In the talent shooting competition around 415 IMA cadets were participated in the shooting competition, in this only 397 cadets were under gone cognitive and psychomotor battery. After competition only 17 cadets were recommended for shooter sport. Results of the analysis reveals shows that there is a significant difference between the recommended and non recommended shooters in cognitive and psychomotor skills. Particularly reasoning ability, spatial visualization, handy steadiness, reaction time and sustained attention of recommended shooters (N= 17) significantly different from than the below non recommended shooters and this indicated that they are better in cognitive and psychomotor abilities (except divided attention) than non-recommended shooters.

To further validate the battery, performance appraisal reports were received. Trainer and coaches assessed the shooters, based on the performance in the national and international competitions, based on those shooters were rated as below average and above average shooters. Data were collected from 50 experienced shooters; finally 36 pistol shooters (mean age 23. 1 and SD 3. 25) reports were received for validation, in these 11 shooters were rated as below average and 25 shooters as above average shooters. Results shows that above average shooters are better in sustained attention and

handsteadyness. In the discriminant analysis, both the variables explain 25.4% of the variation in the dependent variable and it correctly classify 75 % of respondents into ' Above average' or ' below average shooters. Overall predictive accuracy of the discriminant function is called the ' hit ratio'. Non Recommended shooters were classified with slightly better accuracy (76%) than recommended shooters (72.7 %).

Overall the cognitive and Psychomotor test are significantly predicting the performance of the shooters. Particularly in the novice shooters, parameters related to perceptual style, choice reaction time and handsteadyness play a major factor for predicting the performance. These parameters (except handsteadyness) are measuring the constructs related to logical reasoning and decision making. It may be due the participants are not skilled shooters they are novice, while shooting they required more cognitive resources, because they are in the learning phase. But in the skilled shooters (experienced shooters) sustained attention and Eye hand coordination is significantly predicting performance. Basically these constructs are measuring the alertness and psychomotor coordination, this may be due to the shooters are experienced and they are in the automatic phase, so they are not required much cognitive resources to perform the task. Findings of this study partially support the Ackerman's theory of skill development. According to Ackerman's (1988) theory of skill development predicts differential relations of cognitive and psychomotor to different phases of skill development. When participants are learning the task, cognitive variables should have a higher impact on performance than psychomotor variables, with the opposite relation when participants are in the practice phase.

Further to explore is there any difference between the different categories of shooters in cognitive and psychomotor abilities. For this, test were administered to slow and rapid shooters, in this category particularly trap and skeet shooters has to hit the fast moving target in the different direction, for this task, the shooter has to be extra cautious, proper Psychomotor coordination and quick reaction time is required, but the findings of the study shows that the rapid shooters mean score of shifting of attention, handsteadyness and reaction time is slightly better than the slow shooters, but it's not statistically significant.

As a part of this research , to explore how training and experience in shooting competition improves on perceptual and motor skills, in order to answer this question , newly inducted (less than five years) and experienced shooters (more than five years) were identified and administered the psychomotor battery. Results show that there is no statistically significant difference between the groups in the cognitive and psychomotor abilities. It revealed that training, exposure and experience in shooting are not improved much in cognitive and psychomotor skills. From this we can infer that, if the skills are not improved much in training and experience, better it can be identified in the induction level to make successful shooters, but further in-depth longitudinal study has to be carried out to support this finding. Overall the validation study reveals that cognitive and psychomotor skills are significantly contributing for shooting performance.

Apart from the cognitive & Psycho-motor abilities, emotional component plays a vital role in shooting sports performance. He/she may be technically competent and innate aptitude for shooting but if he is not able to control

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the emotion and with stand the match pressure, he/she will lose the game.

The next part of the research is focused on the construct of mental toughness. Although mental toughness is a broad term that has been associated with a variety of mental skills, little has been done to quantify mental toughness for research and assessment purposes. The current study is conceptually based on the available literature and previous concepts believed to be related to mental toughness. The next part describes the method used to establish a mental toughness questionnaire

The second part of the research focused on development and validation of Mental Toughness Questionnaire (MTQ), for that available literature and concepts to be related to mental toughness were explored, based on that initially 120 items were generated, subsequently which were reduced to 100 items based on expert opinion. Consequently, the same was subjected to items analysis (item total correlation and factor loading) and it finally reduced to 40 items.

Further to explore whether the mental toughness scale is uni-dimensional or multidimensional in nature, and to study the latent structure of the questionnaire, principal component factor analysis was employed. In the factor analysis, three factors were emerged and it's explained 45.4 % of variance and it termed as self confident, self control and resilience and to cross validate the latent structural model, confirmatory factor analysis was carried out , which rejected the alternative models (uni-dimensional three dimensional orthogonal and second order factor model) and supported the three dimensional oblique model.

In order to establish the reliability of the tool, Test retest reliability ($r = 0.635$) and internal consistency reliability ($r = 0.912$) was established. Apart from the face and content validity and to establish criterion validity, concurrent, construct and predictive validity were identified. In the concurrent validity the mental toughness tool is significantly correlated (0.683^{**}) with the existing mental toughness scale and to establish the construct validity both convergent and divergent validity were established. In the convergent validity it is related with the theoretically relevant constructs (i. e. Resilience, Hardiness, neuroticism and positive - Negative affectivity) and for divergent validity it's not correlated with the theoretically irrelevant constructs.

Further to identify how far the mental toughness scale is predicting the efficiency of the shooters performance. For this predictive validity is established with the following criteria's i. e. Expert & Novice shooters, shooting score in the competition and successful & unsuccessful shooters in the competition.

In order to establish the predictive validity, the tests were administered to the expert and novice shooters. Finding shows that mean mental toughness score for expert shooters ($M = 174$ $SD = ?$) was significantly different from Novice shooters ($M = 162$, $SD = .54$) and indicated that Expert shooters being more mentally tough than Novice ($t = -5.666$, $df = 279$, $4p < .001$). It supports the findings of Shin and Lee (1994) studied and compared mental toughness between elite and non elite Korean female athletes. They found that elite athletes enjoyed higher levels of mental toughness comparing with their non-elite counterparts.

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Apart from that, further analysis carried out to identify how far the mental toughness scale is predicting the shooting performance, for that the MTs score has correlated with the shooting score. Findings show that both the variables are significantly positively correlated and in the stepwise regression, mental toughness factor I (Self confident) explains 4.6% variance in shooting score. Martin and Gill (1991) found self-confidence to be significantly and positively related to distance running performance, but found no significant relationship between cognitive anxiety and running performance. Similarly Hardy (1996b) and Parfitt and Pates (1999) found that self-confidence accounted for a significant proportion of performance variance over and above that accounted for by cognitive anxiety

Analyses of variance revealed that mean mental toughness score of Successful shooters (Medal recipient) is significantly higher than the average and below average performers.

In order to see whether is there any influence of age, gender and experience of shooter is related with mental toughness. Adams Nicholls et. al. (2009) reported that there is a significant relationship between mental toughness and gender, age and sporting experience.

According to age, evidence from developmental sports psychology research found young and old adults differ in their self perception social influence motivation and self regulation with regard to sports participation (Weiss 2004). Therefore the role of development factors such as age could influence the mental toughness. Findings of the results showed that there is a significant relationship with age and mental toughness (0.243*). In

particular, it appears that when people get older they improve in overall mental toughness, and more specifically in their levels of commitment, emotional control and life control. These findings have significant implications for the development of mental toughness. Clough et al. (2002) have suggested that mental toughness is a trait-like personality characteristic, and Golby and Sheard (2004) have suggested genetic links. But, our findings suggest that life experience may well be an important factor in determining mental toughness levels.

In respect of competitive experience, Connaughton Waedey, Hanton and Jones (2008) reported that competitive experience was a crucial factor in the development of mental toughness among athletes. The result of the study shows that there is no significant relation between the shooting experience and mental toughness. It reveals that the training imparted for the shooters and the experience they gained from the shooting exposure is not significantly improved the mental toughness. Age and years of experience are of course closely related variables ($r = .79$ in this study). Therefore learning experiences and/or biological changes might be responsible for the small changes in the attributes underlying mental toughness. In order to further study whether the shooting experience is improving the mental toughness or not, a small longitudinal study was conducted to check whether there are any changes in mental toughness after induction into training and the participation in national and international events. Around 20 participants samples were selected and administered the test during the Young blood competition, in these only 11 participants were selected and inducted for training in Army marksmanship unit. After that participants undergone

training and participated competitions, one year after again the MTS data collected from the same candidates to check there is any improvement in MT's, findings revealed the mean mental toughness score is improved slightly after undergone training and participation in competitions but it's not statistically significant.

Further exploratory analyses examined the relationship between gender and mental toughness. But the result of the study shows that, no gender differences were found on the scale, but previous studies (Nicholls et al., 2009; Findlay & Bowker, 2009) suggest that males would have higher mental toughness than females.

Social desirability is the tendency for individuals to portray themselves in generally favorable light. Edwards (1957) defined the construct as a tendency to provide socially desirable responses to statements in self-description. Marlowe & Crowne (1960) defined it as a tendency to give culturally sanctioned and approved responses. Jackson (1984) saw it as a tendency to describe oneself in terms judged as desirable and to present oneself favorably. These definitions indicate a style of responding that is separate from the specific personality content dimension to be measured by a psychological test. A potential problem for a self-report personality scale is whether an elevated score represents a high score on the test's content dimension or a tendency to present oneself favorably. Various methods exist for coping with social desirability in self-report inventories. First, a forced-choice format could be used for the test. Response options for any test item would then be matched for social desirability. Second, test items could be selected for a scale based on those items being more strongly representative

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of the psychological construct of interest than social desirability. Third, test instructions could be tailored to reduce the likelihood that test takers will respond in terms of social desirability. Fourth, social desirability could be statistically removed from the score generated on the test. Fifth, the questionnaires under investigation are correlated with a Social Desirability Scale and consequently demonstrating that the questionnaires under investigation do not correlate with the social desirability scale or if they do, that the correlations of these questionnaires with other variables of interest are not significantly attenuated when scores from Social Desirability Scale are partialled out (Mummendey, 1981). To identify the social desirability of this tool the 40 items of the newly constructed Mental toughness scale was administered with the Social Desirability Scale - 17 (Ströber, 1991) on a sample of 281. The Social Desirability Scale - 17 was developed because some items the Marlowe-Crowne Scale was found to be inapplicable to the present day. The scale has high reliability ($\alpha = .80$). It shows a convergent correlation of $r = .68$ with the Marlowe-Crowne Scale. The correlation between the two test was found to be statistically significant ($r = -.001$). Finally, the MTS score was positively correlated ($r = 0.29$, $p > .001$) with the SDS-17 Score. However its magnitude was relatively small with social desirability accounted for only 7.5% of scale variance.

This finding suggests that mental toughness assessment and training may prove valuable in enhancing performance and retention of the shooters