INTELLIGENCE, MOTIVATION AND PERSONALITY AS PREDICTORS OF TRAINING PERFORMANCE IN THE SOUTH AFRICAN ARMY ARMOUR CORPS

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DECLARATION

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ABSTRACT

Intelligence, Motivation and Personality as Predictors of Training Performance in the South African Army Armour Corps

It is well documented that intelligence (*g*, or general cognitive ability) is one of the best predictors of job and training performance (Ree, Earles & Teachout, 1994; Schmidt & Hunter, 1998). However, research evidence suggests that its predictive validity can be incremented by measures of personality and motivation. In this study, measures of general cognitive ability, training motivation and personality were administered to South African Army trainee soldiers (N = 108) to investigate the ability of the measures to predict training performance criteria. Hierarchical multiple regression was used to investigate the relationship between the predictor composites and two composites of training performance. Multiple correlations of .529 ($p < .01$) and .378 ($p < .05$) were obtained for general soldiering training proficiency and core technical training proficiency respectively. Findings reveal different prediction patterns for the two criteria, as general cognitive ability contributed to significantly predicting the criterion of general soldiering training performance, but not core technical training proficiency. Similarly, training motivation and openness to experience were not found to predict general soldiering training proficiency, but predicted core technical training proficiency. Therefore, the results indicate that the addition of motivation to a model already containing measures of general cognitive ability does add incremental validity; R^2 increased from .051 to .109 ($p < .05$). Adding personality to a model already containing general cognitive ability and motivation also explains additional variance; R^2 increased from .109 to .143, although this change was marginal ($p = .055$). Furthermore, evidence of interaction between intelligence and training motivation was found when predicting training performance, as motivation influenced performance only for individuals with lower intelligence scores. The implications of the results are discussed and areas for further research are highlighted.

OPSOMMING

Intelligensie, Motivering en Persoonlikheid as Voorspellers van Opleidingsprestasie in die Suid-Afrikaanse Leër Pantserkorps

Verskeie studies toon aan dat intelligensie (*g*, of algemene kognitiewe vermoë) een van die beste voorspellers is van prestasie ten opsigte van werk en opleiding (Ree, Earles & Teachout, 1994; Schmidt & Hunter, 1998). Navorsingsbewyse dui egter ook aan dat hierdie voorspellingsgeldigheid verhoog kan word deur die toevoeging van metings van persoonlikheid en motivering. In die huidige studie, is metings van algemene kognitiewe vermoë, opleidingsmotivering en persoonlikheid afgeneem op soldate onder opleiding in the Suid Afrikaanse Leër ($N = 108$). Die doel hiermee was om te bepaal tot watter mate hierdie metings saam opleidingsprestasie voorspel. Hiërargiese meervoudige regressie-ontleding was gebruik om die verband tussen die voorspellersamestellings en twee opleidingprestasiekriteria te bepaal. Meervoudige korrelasies van .529 ($p <. 01$) en .378 ($p < .05$) was onderskeidelik verkry vir Algemene Krygsopleidingsprestasie (GSTP) en Tegniese Korpsopleidingsprestasie (CTTP), onderskeidelik. Die resultate toon verder verskillende voorspellingspatrone vir hierdie twee kriteriummetings. Eerstens, het algemene kognitiewe vermoë beduidend bygedra tot die voorspelling van GSTP, maar nié tot CTTP nie. Verder het opleidingsmotivering en persoonlikheid (oopheid tot ervaring) nie GSTP voorspel nie, maar wél CTTP. Met ander woorde, die resultate dui aan dat die toevoeging van motivering tot ‘n model wat reeds metings van algemene kognitiewe vermoë bevat, wel inkrementele geldigheid tot gevolg het; R^2 het toegeneem vanaf .051 tot .109 ($p < .05$). Die toevoeging van persoonlikheid tot ‘n model wat reeds algemene kognitiewe vermoë en motivering bevat, verklaar ook addisionele variansie; R^2 het toegeneem vanaf .109 tot .143, alhoewel hierdie inkrementering slegs marginaal ($p = .055$) was. Laastens, is bewyse van ‘n interaksie-effek tussen intelligensie en opleidingsmotivering gevind in die voorspelling van opleidingsprestasie. Daar is bevind dat motivering prestasie slegs beïnvloed het vir individue met laer intelligensietellings. Die implikasies van die resultate word bespreek en areas vir verdere navorsing word aangedui.

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To those taking this same road "There is no shortcut to any place worth going, victory lies in overcoming obstacles everyday" Author unknown.

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CHAPTER ONE: BACKGROUND AND OBJECTIVES OF THE STUDY

1.1. Introduction

The military is widely renowned for its training programs, possibly since training is a way of life in the armed forces. In peace-time, military personnel are known to "spend about 100% of their time in training, getting ready" (Salas, Milham & Bowers, 2003, p. 14). From an organisational perspective, training is considered an investment and therefore predicting which employees are likely to succeed in training is important (Brown, Le & Schmidt, 2006). However, most recent reviews of models of individual predictors of training performance (e.g., Alliger, Tannenbaum, Bennett, & Shotland, 1997; Tziner, Fisher, Senior & Weisberg, 2007) do not adequately explain variance in training performance and, as such, more integrated views of psychological predictors of training performance are necessary.

1.2. Justification for and Value of This Research

It is well established in literature that job performance is predominantly a function of general cognitive ability, or *g,* and that *g* is one of the primary determinants of training performance (Hartmann, E. Kristensen, T.S. Kristensen & Martinussen, 2003; Hunter, 1986; McHenry, Hough, Toquam, Hanson & Ashworth, 1990; Ree, Caretta & Steindl, 2001; Ree, Earles & Teachout, 1994; Schmidt & Hunter, 1998). Hunter (1986) summarises the findings of three significant studies on the validity of general cognitive ability: Ghiselli's life work spanning the years 1949-1973, 515 validation studies carried out by the U.S. employment service and 30 years of work carried out by the U.S. military. Ghiselli (in Hunter, 1996) reported that the predictive validity of *g* for predicting job performance ranged between .27 and .61 with validity increasing as complexity increases. In addition Ghiselli (in Hunter, 1996) found that *g* predicted training success with validity coefficients ranging from .37 to .87. Of the 515 validation studies carried out by the U.S. employment service on the General Aptitude Test Battery, 425 of the studies looked at job proficiency with a sample size of 32,124 participants and 90 of the studies looked at training success with a sample size of 6,496 participants. The results indicated that *g* predicted high complexity jobs with a validity of .58 for job performance and .50 for training success. For medium complexity jobs validity coefficients of .51 for job performance and .57 for training success were obtained. Lastly the U.S. military studies focusing on training success revealed validity coefficients ranging from .58 to .67 and were based on a sample of nearly half a million military personnel.

Hunter (1986) explains that cognitive ability predicts job performance because it predicts learning and job mastery; he adds that cognitive ability is highly correlated with job knowledge which is highly correlated with job performance/technical proficiency. Since mastering the job is fundamental to job performance and general cognitive ability predicts learning, it is to be expected that general cognitive ability will be the key predictor of job performance and in this instance training performance. Training provides the link, as it is through training that one has the opportunity to learn the job, a precondition to performance.

Schmidt and Hunter (1998), in their meta-analysis of 85 years of research on the validity of selection methods, report that for predicting training performance *g* boasts a validity coefficient of .56, whereas for other predictors this figure is smaller; employment interviews (.35), job experience (.01) and years of education (.20). While it is evident that *g* claims the highest predictive validity, the reality is that a significant amount of variance in training performance (44%) cannot be accounted for by using measures of *g* for prediction.

Measures of specific abilities (s_n) have not been found to always add statistically significant incremental validity over *g* in explaining training performance (Brown et al., 2006; McHenry et al., 1990; Ree et al., 1994). Ree et al. (1994) go as far as claiming that when it comes to factors influencing training performance, "there is not much more than *g*". They base their conclusion on the results of their research study (78,041 US Air Force personnel across 82 jobs) showing that the incremental validity added by s_n was only .021, thereby concluding that there is not much more than *g*. However, there are exceptions to this general finding. For example, De Kock and Schlechter (2009) found that spatial ability can add incremental predictive validity over *g* for predicting pilot training performance.

There is stronger support for the ability of personality measures to add statistically significant incremental variance over *g* (McHenry et al., 1990; Ree et al., 2001; Tziner et al., 2007). Anderson, Ones, Sinangil and Viswesvaran (2001, p. 190) state that "knowing ability predicts job performance with a validity of .52 and conscientiousness (personality variable) predicts performance with a validity of .23 is like knowing that water on average freezes at 0 degrees celsius". In other words, it is common knowledge that ability is the best predictor of performance and that that validity can be incremented by measures of conscientiousness. Schmidt and Hunter (1998) found that, with regard to conscientiousness, the predictive gain in adding this factor to *g*-measures was 16%. The results of the Army Project A studies provide further support in this regard; *g* was found to be the best predictor of core technical task proficiency, general soldiering proficiency and effort and leadership, however the best predictors of maintaining personal discipline, physical fitness and military bearing were the temperament/personality factors (McHenry et al., 1990). Schmidt and Hunter (1998) explain that an increase in validity depends not only on the validity of the measure added to *g* but also on the correlation between the two measures; the smaller the correlation, the larger the increase in overall validity. Personality measures are for the most part uncorrelated with ability tests which offers an explanation as to their increase in overall validity over *g* (Ree et al., 2001), thereby explaining more of the criterion space than *g* alone.

Furthermore, Colquitt, LePine and Noe (2000) have shown that a validity coefficient of .63 for predicting training performance can be obtained if a measure of motivation is added to a measure of *g*, which means that by adding a measure of motivation, an additional 19% of the variance in performance can be explained. Naylor, Pritchard and Ilgen's (in Colquitt et al., 2000, p. 682) theory of motivation, views motivation "as the proportion of personal resources devoted to a task" and that individual differences (personality, ability, or demographics) create differences in total resource availability. Tziner et al. (2007) explain that trainees with high levels of motivation to learn and therefore a greater reservoir of personal resources, invest greater efforts in training and are consequently more successful in acquiring new skills than trainees with lower motivation. Motivation to learn may prepare trainees to receive the maximum benefits from training by heightening their attention and increasing their receptivity to new ideas, in this way, motivated trainees are more ready to learn.

Training motivation/resource capacity is influenced by individual and situational variables which operate before, during and after training (Colquitt et al., 2000). Specifically, these variables are pre-training self-efficacy, valence and job involvement, with motivation to learn mediated by locus of control, conscientiousness, anxiety, age, climate and cognitive ability. Motivation to learn in turn predicts learning outcomes (declarative knowledge, skill acquisition, post-training self efficacy, reactions, and transfer) and job performance (Colquitt et al., 2000). It is therefore clear that *g* is only one of the variables creating differences in one's personal resource capacity, and that personality too, plays a significant role in influencing motivation which drives both behaviour and performance. McHenry et al. (1990) add that performance is more than being able to perform critical tasks under standardised conditions. It is often required of individuals to engage in activities not directly related to one's core functions but which are important for success as these activities support the informal (social, organisational and psychological) requirements of a particular organisation. Participation in these other activities in order to support situational circumstances affects levels of motivation and is a function of general cognitive ability and personality.

This is especially true in the military as engagement in activities not directly related to one's core task form part of the 'ritualistic rites of passage' which are necessary for acceptance/success even though these activities may be considered by outsiders to be irrelevant (Jones, in Gal & Mangelsdorff, 1991; Dover in Gal & Mangelsdorff, 1991). The job performance model established for Army Project A (referred to previously) includes factors such as maintaining personal discipline and physical fitness which, in addition to core technical task proficiency, influence performance and are critical components of success thus supporting the notion of more holistic models of training performance.

In conclusion, training performance is a complex, multi-dimensional criterion, requiring improved understanding of how knowledge, skills and abilities (KSAs) combine and interact resulting in performance. Predictors which add incremental variance to the established measures of general cognitive ability are critical as the increases translate into increases in practical value such as improved decision making expressed as an increase in utility, or output in monetary terms (Schmidt & Hunter, 1998). This study will investigate whether the inclusion of personality and motivation as predictors of training performance in addition to *g*, can explain additional variance in training performance. In this sense, this research addresses a gap in current knowledge because much of the literature on the predictiveness of *g* has focused on job performance as the criterion rather than training performance. The practical benefits from conducting this research would be to contribute to the literature on personnel psychology, and hopefully, inform a future selection battery with improved explanatory power. Lastly, the findings could inform the design and delivery of training programmes which would maximise training performance.

1.3. Composition of Thesis

The composition of this thesis is as follows: chapter one provides an introduction to the research problem, focusing on the antecedents of human performance in a training context. Furthermore this chapter provides an overview of the aim and value of the research.

Chapter two provides an extensive review of the literature on personnel psychology relating to measurement, selection and human performance. Specifically, the variables being investigated in this research are defined, namely: general cognitive ability, training motivation, personality and training performance. Additionally terminology relevant to these variables are defined followed by a proposed empirical model, informed by the literature, which outlines the possible relationships between the variables.

Chapter three focuses on the research strategy followed in this study and outlines the hypotheses formulated, the sample demographics, measuring instruments and statistical analyses. Chapter four reports on the statistical techniques used, analysis of the research data and the findings thereof. Lastly the final conclusions of the study and recommendations are presented in chapter five.

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

Psychological testing has a significant impact on human lives and therefore, 'getting it right' is imperative. Gregory (2004, p. 2) states that "Psychological tests are used as aids in making a variety of decisions about people, the results of which alter individual destiny in profound ways; one's entry into a tertiary institution, job or even clinical diagnoses rest in part on the meaning of test results as interpreted by psychologists". In order to fully understand and appreciate the science of 'getting it right', i.e. of understanding human performance and its drivers as a way of making informed decisions about people, an understanding of certain fundamental principles of measurement is required. Against this backdrop, the nature and value of scientific selection is discussed.

2.2. Definition of Selection

Selection can be defined as "choosing from a number of available participants, a smaller number to be hired for a given job" (Guion, 1965, p. 8). Gatewood and Feild (1994, p. 3) add that selection is "…the process of collecting and evaluating information about an individual in order to extend an offer of employment". The basis of selection is that choices or decisions about individuals need to be made, whether for the purpose of selecting an individual for a job, training program, promotion or for other purposes. The term selection, as used in this context, refers to this broader definition of selection.

In order to make these choices about people, certain information must be measured such as the knowledge, skills and abilities required to perform well on important aspects of the job. The belief informing personnel psychology and providing the foundation of selection is that individual differences exist and that variation along a particular trait dimension or measurable characteristic of the individual is related to variation along a job performance dimension (Guion, 1965).

Given that individual differences exist, "the rationale for using psychometric tests in the selection process lies in the purported ability of the testing instruments to accurately and objectively assess an applicant's ability to perform the work required by the job" (Ritson in Muller & Schepers, 2003, p. 87). Furthermore it is stipulated in the guidelines of the Society for Industrial and Organisational Psychology of South Africa that "the underlying assumption of any personnel selection procedure is that the procedures used can predict one or another important and relevant behavioural requirement or job performance aspect of the position" (Society for Industrial & Organisational Psychology [SIOPSA], 2005, p. 1). In other words, when using psychometric tests the focus should ultimately be on the decision-making that it allows.

2.3. The Nature of Measurement

Measurement is fundamental to research. Quantification of events, places, objects and things involve measurement and all statistical procedures depend on measurement (Kerlinger & Lee, 2000).

Gatewood and Feild (1994, p. 114) explain that "measurement involves the application of rules for assigning numbers to objects to represent quantities of attributes". Numbers summarise and indicate the amount or degree of an assessed attribute. Therefore differences in test scores must reflect differences in attributes or performance and not the way in which the test has been scored. Although in psychological assessment the attributes measured are not directly observable, they can be inferred from indicants of that which we are trying to measure. An indicant simply represents something that points to something else (Gatewood & Feild, 1994).

The question regarding which attributes should be measured is answered through job analysis which is a process whereby information on the behaviours required to perform a task is obtained as well as on the context in which those behaviours must be performed (Schmitt & Chan, 1998). This process informs the employee attributes critical for success, against which individuals can then be assessed. Predicting which individuals should be hired involves the identification and measurement of two types of variables, the criterion and the predictor. The criterion serves as a measure of what is meant by employee success on the job, it is the dependant variable to be predicted or explained in terms of something else that can be assessed earlier (Guion, 1965). The second variable, the predictor, represents the indicants of those attributes identified through job analysis as being important for job success (Guion, 1965). The selection of predictors and criteria must be based on their importance and relevance to the job and they must be representative of aspects or tasks critical to job success (Gatewood & Feild, 1994).

2.4. Scientific Selection

Guion (1965) suggests that a common fallacy is the belief that the administration of aptitude, proficiency, or personality tests alone constitutes ‘scientific selection’. He explains that the purpose of science is to seek invariance or define the limit within which a generalisation, inference or prediction is true. Kerlinger and Lee (2000) support this view by stating that the basic aim of science is to explain natural phenomena. However, the explanation of these ‘phenomena’ must be informed by an understanding of the psychological processes underlying and determining training performance (Schmidt & Hunter, 1998) which requires an understanding of both the predictor and criterion domain, as well as the relationship between the two. A typical problem in the way that the criterion measure is viewed is that it is not considered behaviour to be explained in as much as it is considered behaviour that reflects the excellence of the test (Guion, 1965).

Therefore scientific selection results from sound scientific procedures, ones which are systematic, controlled, empirical and guided by theory. These procedures involve careful development of criteria, tests and appropriate models of prediction (Guion, 1965). Three criteria which determine whether a procedure is scientific are: 1) formulation of hypotheses, 2) controlled observation and 3) replication. In personnel testing, the test specialist hypothesises that certain traits measured by tests create variations in job performance, as measured by the criterion (Guion, 1965). The concept of control refers to the elimination of contaminating influences on research results for example through standardising administration procedures (Guion, 1965). Lastly, this author states that scientific research requires results that can be replicated, in other words subjected to further analysis by having someone else repeat the study with the same hypothesis. It is only when a hypothesis can be verified by independent research studies that a generalisation can be considered valid.

In conclusion, the essence of science would be the ability to forecast or predict future behaviour and the continuous search for ways that such predictions can become increasingly accurate and free from error. This would result in a greater understanding of that which predicts and affects performance.

2.5. Selection in the Military Context

Psychological tests have been used in military personnel selection since the beginning of the nineteenth century (Gregory, 2004; Hartmann et al., 2003; Muchinsky, Kriek & Schreuder, 2005; Steege & Fritscher, 1991). The goal of a military organisation is to achieve maximum overall defence effectiveness and psychological testing plays a critical role in achieving this goal (Gal & Mangelsdorff, 1991).

Although methodological specificity and procedures in military selection are not specific or necessarily unique to the military, what is specific and unique is the complex nature of the military environment. Military organisations represent a category of 'meta-organisations' which are big and complex organisations characterised by complex organisational structures, many sub-units, diverse functions and activities, many jobs and career routes and many employees (Dover in Gal & Mangelsdorff, 1991). In addition, the setting, mission and nature of skills and criteria required are of an exclusive nature, for example the criterion of combat performance (Gal & Mangelsdorff, 1991).

These challenges and unique requirements ultimately imply that errors in selection and placement are of great consequence in the military setting (Guion, 1965). The overall control the military has over soldiers, the potential threat to life involved in combat operations and the cost implications of placing individuals in the wrong positions considerably influence selection research and application (Dover in Gal & Mangelsdorff, 1991; Muller & Schepers, 2003). Therefore, the search for better predictors of success in military training is ongoing and is a function of the high costs related to personnel training, both human and financial (Hartmann et al., 2003) as well as the need for recruiting competent and well suited soldiers in order to ensure defence effectiveness.

2.6. Concepts Relevant to Selection

Reliability and validity are concepts for evaluating measurements, specifically in the case of mental measurement in psychology (Guion, 1965; Muchinsky et al., 2005). Since the adequacy of measurement influences the trustworthiness of results of research, these two concepts are briefly discussed.

2.6.1. Reliability

Gatewood and Feild (1994, p. 154) define reliability as "a characteristic of scores on selection measures and is referred to as the degree of dependability, consistency or stability of those scores". Guion (1965, p. 30) expands on this definition by adding that reliability is "the extent to which a set of measurements is free from random-error variance".

It is well documented in the literature on psychological assessment that any instrument contains an element of error and an element of truth because selection measures/instruments do not have perfect reliability (Gatewood & Feild, 1994; Guion, 1965; Nunnally, 1978). Therefore, in classical test theory, total variance is variance due to systematic causes (true measures plus any repeatable contamination) and variance due to variable or random errors. Guion explains that systematic variance is a source of variance which is constant for an individual in the two sets of measures correlated, for example, actual ability or individual differences. Error variance is a source of variance which causes performance of individuals to be different in one set of measures from the performance in the other set. These factors are present at the time of measurement and distort respondents' scores as they are not related to the characteristic, trait or attribute being measured. Such factors could be fatigue, noise, lighting, anxiety, the individual administering a selection measure, the individual scoring etc. which have different effects on individuals' responses to selection instruments (Gatewood & Feild, 1994; Guion, 1965).

Reliability is determined by the degree of consistency (correlation) between two sets of scores on a measure from the same individuals and the result of this correlation is the correlation coefficient. If measures are consistent they tend to be free from variance due to random errors (Guion, 1965). This author further explains that systematic variance *causes* correlation and hence increases the size of the correlation coefficient as this variance comes from repeated or constant characteristics of the individuals measured whereas error variance comes from characteristics of the people being measured which *inhibit* correlation thereby lowering the size of the correlation coefficient (Guion, 1965; Nunnally, 1978).

Finally, the amount of error that exists in psychological tests is an important attribute of the measure. If scores on a selection measure contain too much error (low reliability) one cannot have confidence in such a selection device or the decisions made based on the results (Gatewood & Feild, 1994).

2.6.2. Validity

The crux of science is the certainty with which inferences can be made, which is the crux of validity; this is what we aim 'to get right' with the use of tests in selection. If a predictor is correlated with job relevant criteria, then inferences can be made from scores on that measure about individuals' future performance, in training or on the job, in terms of these criteria. Therefore validity refers to the degree to which accumulated evidence and theory support specific interpretations of test scores entailed by proposed uses of a test (American Educational Research Association [AERA], American Psychological Association [APA] & National Council for Measurement in Education [NCME], 1999).

Gatewood and Feild (1994) state that validity represents the most important characteristic of a measure, however validity is not an inherent property of a selection measure, rather it is a *relationship* between the selection measure and some aspect of the job. In other words, it is not the measure or content of the measure that is valid but rather it is the inferences that can be made from scores on the measure. As a result a measure can have more than one validity depending on the number of inferences to be made for the criteria available.

2.6.2.1. Types of Validation Strategies

The validity of an inference can be determined by gathering evidence using different strategies. There are three sources of evidence which will be discussed in this section; evidence of validity based on content, evidence based on the internal structure of a selection measure and evidence based on relationships with measures of other variables (SIOPSA, 2005). Validity however is a unitary concept and therefore each source of evidence is not necessarily an alternative approach but rather each source is necessary to provide a holistic picture of validity.

2.6.2.1.1. Content validity.

A measure is said to have content validity when it can be shown that its content (items/questions) representatively samples the content (job behaviours and KSAs) of the job for which the measure will be used (Nunnally, 1978). This method principally relies on expert judgement in determining the validity of a measure as opposed to the application of quantitative techniques; therefore the emphasis is on description rather than statistical prediction (Gatewood & Feild, 1994). These authors emphasise that job analysis is the essential ingredient in the successful conduct of a content validation study enhanced by 'psychological fidelity' meaning that when the same knowledge, skills and abilities required to perform the job successfully are also required on the predictor, the measure is psychologically similar to the job (Gatewood & Feild, 1994; Guion, 1965; Nunnally, 1978).

2.6.2.1.2. Construct validity.

A construct refers to the attribute, characteristic, quality, or concept assessed by a measure. Due to the abstract nature of some constructs, indicants (operational measures) of the construct are assessed using predictors. The question is therefore 'does this indicant really assess the construct under investigation?' To answer this question, construct validation is required which involves the collection of evidence used to test hypotheses about relationships between measures and their constructs (.i.e. the relationships among items, components of the selection procedures or scales measuring constructs) (Schmitt & Chan, 1998).

2.6.2.1.3. Criterion-related validity.

Lastly, this type of strategy involves the comparison of test scores with one or more external variable or criterion believed to measure the attribute under study (Kerlinger & Lee, 2000). Criterion-related validity consists of both concurrent and predictive validation strategies. In concurrent validation information is obtained at one point in time, on both a predictor and a criterion for a *current* group of employees (Schmitt & Chan, 1998). This type of strategy may result in lowered test motivation because the group of individuals on which data is being gathered are already employed in an organisation. The test results may significantly be affected in this regard as the respondents may not take the testing as seriously (Schmitt & Chan, 1998). In contrast, predictive validation involves the collection of data over time as opposed to the collection of data at one point in time. The focus is on determining the degree to which a current measure (the predictor) can predict the variable of real interest (the criterion), which is not observed until sometime in the future (Gatewood & Feild, 1994). Since job applicants rather than employees serve as the data source, test motivation may be of a higher, more realistic level and influence the way in which the tests are completed (Schmitt & Chan, 1998). The weakness in this method is the time interval required to determine the validity of the measure being examined (Nunnally, 1978). The way in which content validity differs from criterion-related validity is that the prime emphasis in content validity is on the construction of a new measure rather than the validation of an existing one.

Typically, criterion-related validity strategies result in a validity coefficient which is used to judge validity. The validity coefficient is simply an index that summarises the degree of relationship between the predictor and criterion (Gatewood & Feild, 1994). There are two important elements of a validity coefficient, its sign and its magnitude. The sign indicates the direction of the relationship, either positive or negative and the magnitude indicates the strength of the association between a predictor and criterion. The range of the coefficient is from - 1.00 to + 1.00. The closer the coefficient is to +/- 1 the stronger the relationship. When the validity coefficient is close or is equal to .00 then no relationship exists between the predictor and the criterion. If the validity coefficient is not statistically significant, then the selection measure is not a valid predictor of a criterion (Gatewood & Feild, 1994; Kerlinger & Lee, 2000). By squaring the validity coefficient (r^2_{xy}) an index of a tests' ability to account for the performance differences between individuals on a test or predictor can be obtained. This index (also known as the 'coefficient of determination') represents the percentage of variance in the criterion that can be explained by variance associated with the predictor (Gatewood & Feild; 1994, Guion, 1965; Kerlinger & Lee, 2000).

The three validation strategies are not separate and distinct but rather interrelated. Together, these strategies form the evidence for determining what is really being measured and how well, as opposed to what we think is being measured. This holistic view indicates that the notion of validity has changed over time: from the view that validity is a property of a test score to the realisation that interpretation (inferences) and use of the test score is the proper subject of validation (Steege & Fritscher, in Gal & Mangelsdorff, 1991). Hence there is a more unified view of validity where appropriateness, meaningfulness, and usefulness of score based inferences are inseparable (Steege & Fritscher in Gal & Mangelsdorff, 1991). In other words, to validate an action inference requires "validation not only of the score meaning but also of value implications and action outcomes, especially appraisals of the relevance and utility of the test scores for particular applied purposes and of the social consequences of using the scores for applied decision making" (Messick, in Gal & Mangelsdorff, p. 25).

2.6.2.2. Factors Influencing the Size of the Validity Coefficient

It is important to understand the factors that affect the size of the validity coefficient, so that those that increase the size can be maximised and those that decrease the size can be minimised or controlled for. A brief discussion of three of these factors follows.

2.6.2.2.1. Reliability of the criterion and predictor.

Reliability (explained in section 2.6.1) in personnel research is crucial as it serves as a ceiling for validity (Guion, 1965). Lowered reliability has a negative effect on validity. If both the criterion and predictor variables have measurement error, error is compounded and the validity coefficient will be lowered even further.

2.6.2.2.2. Restriction of range.

Restriction of range is the term used to explain the situations in which variance in scores on selection measures (criterion/predictor) has been reduced. An important assumption in personnel psychology is that individuals differ along traits (Guion & Highhouse, 2006). This assumption extends to calculating a validity coefficient as it is assumed that there is variance in individuals' scores on the criterion and predictor. If there is little variance in scores for one or both variables then observed validities will tend to underestimate the true validities (Murphy & Davidshofer, 2005; Schmitt & Chan, 1998). Therefore restriction of range occurs because individuals scoring low in the test are not hired and as a result their test scores cannot be used in computing the validity coefficient. Since the full range of ability is not present in the sample it is more difficult for the predictor to identify differences among people as measured by the criterion (Burke, Hobson & Linsky, 1997).

Research by Thorndike (in Hunter & Burke, 1994) highlights the significant impact of range restriction. He provides comparisons of validities prior to and after the impact of range restriction in a study for the U.S. Army Air force during World War II. The validity coefficients of seven tests ranged from .18 (finger dexterity) to .46 (general information) with a composite validity of .64. Analyses were subsequently performed and only those composite scores exceeding the cut-off set for use of the test battery were included. Only 13% of the original sample met the cut-off. The composite validity then fell to .18. In the original unselected sample the validity was .40, in the selected sample it fell to -.03, indicating the effect of range restriction on the validity of a predictor.

2.6.2.2.3. Criterion contamination.

Criterion scores become contaminated when they are influenced by variables other than the predictor. The effect of contamination is to alter the magnitude of the validity coefficient, for example performance evaluation ratings which are often subject to being contaminated through rater bias (Gatewood & Feild, 1994).

The factors discussed above create limitations in study design by inhibiting the size of the validity coefficient and are referred to as artefacts. Knowledge of these factors (i.e., the reliability of predictor and criterion measures, and the degree of range restriction in the study) allows psychometric analysis of the extent to which variation across studies is due merely to the limitations of study design (i.e. due to artefacts) or true variation (Hunter & Burke, 1994). In this regard, Hunter and Schmidt (in Hunter & Burke, 1994) state that sampling error is the most significant of the eleven artefacts they listed. Furthermore research on validity generalisation has shown that sampling error tends to account for 75% of the variance in validities when in fact the true variance is zero (Hunter & Burke, 1994). Therefore, if the ratio of error to observed variance is 75% or greater then observed variance is said to be entirely attributable to artefacts.

In conclusion, Schmidt and Hunter (1998, p. 262) state that "from the point of view of practical value; the most important property of a personnel assessment method is predictive validity: the ability to predict future training performance; job-related learning and other criteria". The use of hiring methods with increased predictive validity leads to substantial increases in employee performance as measured in percentage increases in output; increased monetary value of output; and increased learning of job related skills.

2.7. Criterion of Training Performance

In the preceding section it was emphasised that the adequacy of inferences or predictions made depend on the adequacy of both the predictor and criterion measures, as well as an in-depth understanding of the two domains (Gatewood & Feild, 1994; Guion & Highhouse, 2006; Murphy & Davidshofer, 2005 & Nunnally, 1978). Criteria represent a complex interrelation of the behaviours of members of organisations, as well as of the results of their work and, lastly, of organisational effectiveness (Steege & Fritscher, in Gal & Mangelsdorff, 1991). This complexity makes defining and understanding the criterion a challenging task. The process of defining the criterion measure is informed by job analysis and involves determining what is done in a job or on training by an individual, under what conditions, for what purposes and the indicants or measures of performance most critical to job/training success. Furthermore the criterion measure should define what is meant by job/training performance and by implication high scores on this measure should define what is meant by successful job/training performance (Schmitt & Chan, 1998).

Defining the criterion in the military context poses additional challenges due to the nature of the military environment in terms of rank structures, lines of authority and job levels. This creates the dilemma regarding the level at which prediction should be aimed. Should performance be predicted in command jobs, staff jobs, training jobs, operation-type jobs or with respect to daily home unit functioning or functioning in the combat environment? This issue of 'what' exactly should be predicted, training or operational success is an ongoing debate (Jones, in Gal & Mangelsdorff, 1991).

On the one hand, the supporters of *operational* success contend that optimising prediction against training criteria could result in the exclusion of soldiers who would be better in operational units or combat and the inclusion of soldiers who can cope with training demands but not with their operational duties (Jones, in Gal & Mangelsdorff, 1991). Jones adds that on the other hand, the advocates of *training* success argue that it is the trainers' job to develop and equip trainees to be effective in operational situations, as training course content and its measures of success should be related to operational requirements. It is therefore imperative that training be job-relevant and the evaluation of trainees be realistic and not based on criteria which are easy to administer and collect but which are irrelevant to operational performance (Jones, in Gal & Mangelsdorff, 1991).

Training proficiency is the criterion measure used in this study as indicative of training performance and is a measure of employees' performance immediately after completing a training program (Gatewood & Field, 1994). Training proficiency data is viewed as a favourable criterion measure over job performance, firstly, due to the increased control of the selection specialist in the measurement process and the resulting reduction in error of measurement (Gatewood & Feild, 1994; Guion, 1965). Selection specialists can design training programs consistent for all employees regardless of physical location, thereby increasing control through standardisation of the programs/assessments. In addition instructors can be trained around specific instructional methodologies, as another way of increasing control (Muchinsky et al., 2005).

Secondly, the validity coefficients between predictors and training measures are more direct indicators of the relationship between KSAs and work level than the validity coefficients using other criterion measures (Dover, in Gal & Mangelsdorff, 1991; Gatewood & Feild, 1994). These authors add that as a result the training proficiency measure is influenced more by the individual's KSAs and less by organisational/extraneous factors because of the shorter time period between measurements which is a more accurate reflection of actual performance achieved. This is of great significance in the military; because of the long career sequences and diverse jobs in each of the stages of one's typical career path, interim criteria (training scores), which are closer representations of the final criteria, need to be applied (Dover, in Gal & Mangelsdorff, 1991) and used as the basis for career-influencing decisions.

Training proficiency can be measured in several ways. Firstly, paper and pencil tests, where knowledge is formally assessed, are frequently used (Alliger et al., 1997). There should be a match between the extent of topic coverage in training and the number of questions asked about this topic in the test. Secondly, judgemental data or ratings are frequently used, where an individual familiar with the work of another is required to judge his or her work. Measurement is obtained by using a rating scale with numerical values (Gatewood & Feild, 1994).

There are criticisms regarding the use of ratings or judgemental data because judgements rely on opinion and are highly susceptible to assessment error due to the inadvertent or intentional bias by the rater which would contaminate and distort the scores (Gatewood & Feild, 1994; Guion, 1965). In addition, it has been found that superiors/instructors of different hierarchy levels differ in their judgement of the importance of single activities with respect to their relevance for performance assessment and viewpoints of what constitutes acceptable performance (Braun, Wiegand, & Aschenbrenner in Gal & Mangelsdorff, 1991). Studies focusing on intra-rater and inter-rater consistency reveal that consistency between repeated assessments is best if the same raters assess on the basis of the same methods (r = .84). Lower consistency is found where different methods are used by the same raters (r = .57) and consistency is lowest when different raters use different methods (r = .30) (Braun et al., in Gal & Mangelsdorff, 1991). Therefore, uniformity is necessary for improving intra and inter-rater reliability.

Despite these challenges the use of judgemental data is unavoidable, particularly in the military. Supervisors or instructor appraisals are often the only available criterion and “in view of the control commanders have over their subordinates and with respect to the potential involvement in combat, superiors’ appraisals are of marked importance in the military” (Dover, in Gal & Mangelsdorff, 1991, p. 134). The problem of bias can be addressed by training supervisors/instructors, which would minimise errors in ratings because raters would be able to identify the types of behaviour indicative of various levels of performance within each dimension, resulting in a uniform understanding of the relevant aspects of performance and the level at which performance on these aspects should be expected (Gatewood & Feild, 1994).

A final point in support of the use of training scores as a criterion measure is that training is necessary for initial commissioning in the military. Identifying individuals who have no chance of graduating the conditional stage of training is necessary and useful (Dover, in Gal & Mangelsdorff, 1991). Ritualistic rites of passage are often embedded in initial training; newcomers who fail to negotiate these 'rites' may be regarded by insiders as true failures in the selection process, even though these failures in performance may be in areas in which psychologists deem to be irrelevant, e.g. parade, drilling, cleaning uniforms, etc. However, many of the training criteria used in determining success or failure in initial training cannot be considered irrelevant in the military context, such as: map reading, tactical use of weapons, basic engineering, learning to work in a team, displaying identification with the service or unit, etc. (Jones in Gal & Mangelsdorff, 1991).

To conclude, training is a pre-condition for job assignment in the military (Jones in Gal & Mangelsdorff, 1991). Emphasis is placed on training because of the close relationship between course content and measures of success to operational requirements. In support of this link Alliger et al. (1997) found a moderate positive link in the correlations between knowledge and behaviour (.11 to .18) or skills demonstration, emphasising that training is imperative for preparing trainees for on-the-job requirements. The choice of training proficiency as the criterion measure is thus supported by the criticality of training in a military setting as well as the benefits of using this criterion as discussed in this section.

2.8. Psychological Predictors of Training Performance

There are a number of psychological predictors used in personnel selection in general (Anderson et al., 2001; Schmidt & Hunter, 1998) and training performance in particular (Alliger et al., 1997; McHenry et al., 1990). However, for the purposes of this study only those relevant to the study will be discussed.

2.8.1. General Cognitive Ability

Individuals differ in terms of basic information processing capabilities or levels of cognitive resources (Carroll, 1993; Hunter, 1986; Jensen, 1998). Information processing includes cognitive functions such as stimulus apprehension, attention, perception, sensory discrimination, learning, short and long term memory, thinking, reasoning, problem solving, planning and the use of language. These differences translate into individual differences in learning, speed of learning (Jensen, 1998) and ultimately training or job performance (Hunter, 1986). The way in which such differences in cognitive capacity can be determined is through the measurement of general cognitive ability, or, as is commonly referred to, intelligence or *g* (Colquitt et al., 2000; Jensen, 1998).

The core of the theoretical construct of *g* is the phenomenon of positive correlations among measures of individual differences in cognitive abilities (Jensen, 1998). In other words, although there are a wide variety of differences between individuals in terms of information processing functions, these differences, however diverse, are all positively correlated in the general population.

2.8.1.1. The Structure of g

Given this phenomenon, the structure of cognitive ability has nevertheless been conceptualised in many different ways (Ree et al., 2001). Some theories support the view of intelligence as a collection of separate cognitive abilities, whereas other theories support the view of a single general factor (*g*). For example, Thurstone's (1938) (in Ree et al., 2001) model of Primary Mental Abilities did not include a general factor but rather hypothesised that ability consisted of seven independent primary factors spanning a more limited range of performances. Guilford's model of the Structure-of-Intellect (SOI) proposes 180 separate abilities resulting from the combination of three cognitive facets: operations, contents and products (in Ree et al., 2001). Spearman's (1923) model emphasised a general factor (*g*) and Cattell and Horn's (1978) work stressed broader group factors (e.g. fluid and crystallised intelligence (in Ree et al., 2001).

Despite the popularity of multiple aptitude theories, there has been growing consensus that cognitive abilities have a pyramidal or hierarchical structure (Brown et al., 2006; Carroll, 1993;

Ree et al., 2001). Hierarchical models imply higher-order sources as well as several specific lower-order sources.

Tests constructed to psychometrically assess *g* are founded on one of these theories or models. Regardless of the theory followed the commonality is that general cognitive ability is the construct being assessed and reflects the source of variance common to all the different ability measures represented by the various subtests of a cognitive test battery (Ree et al., 2001). However, it must be understood that the psychometric estimate of *g*, as obtained by a cognitive ability measure, is just an approximation of a latent variable or hypothetical construct (Anderson et al., 2001; Jensen, 1998). The specific knowledge and cognitive skills sampled by a test battery do not represent *g* themselves, but are merely ‘vehicles’ for estimating the latent variable.

Ree et al. (2001) concur that every test measures a general factor (*g*) common to all tests thereby supporting the hierarchical structure, but add that in addition, every test measures one or more specific factors (s_n) which have become known as group factors (e.g. verbal, numerical, spatial, mechanical, memory, learning, visual perception and clerical speed/accuracy). With this being said, the *g* factor alone (highest order factor) accounts for more of the variance than any of the group/specific factors used alone or in combination independently of *g* (Schmidt & Hunter, 1998). Further, research has shown that overall, the incremental validity of specific abilities over *g* is very poor (Anderson et al., 2001; Brown et al., 2006; Hunter & Burke, 1994; Ree et al., 1994), with only a few exceptions (e.g., De Kock & Schlechter, 2009). Supporting this finding, Thorndike (in Hunter & Burke, 1994) reported the comparative validity of measures of *g* versus specific ability composites for predicting success of 1900 enlisted U.S. Army trainees. Specific abilities showed little incremental validity (.03) beyond *g*. Using a large military sample (N = 78,041), Ree and Earles (in Anderson et al., 2001) found that training performance was more a function of *g* than specific factors. In addition, these researchers investigated whether *g* predicted training performance in the same way regardless of the type of job or level of difficulty. It was argued that although *g* was useful for some jobs, specific abilities were more important and therefore more valid for other jobs. The findings indicated that there was statistical evidence that the relationship between *g* and the training criteria differed, however these differences were so small to be of any practical predictive consequence (Ree et al., 2001).

This research study is aligned to the view that *g* has a hierarchical structure and that psychometric tests measure this general factor (*g*) as well as one or more specific or group factors. Specific intelligence or group factors have been hypothesised to influence military training performance in the armour environment. These specific intelligence factors (s_n) are verbal intelligence, visual-spatial intelligence and hand-eye coordination, which were identified through the job analysis of an armour corps soldier. Accordingly the psychological tests selected to measure these factors are based on the job analysis as discussed in chapter three and are based on the theory that *g* is structured hierarchically.

2.8.1.2. The Measurement of g

With an understanding of the structure of intellect, the ways in which *g* is measured can be discussed. The most widespread psychological device which operationalises/measures general cognitive ability is the aptitude test, the term ‘aptitude’ comprising the terms ability, intelligence or achievement tests (Jones, in Gal & Mangelsdorff, 1991). Aptitude can be defined as the “potential that a person has which will enable him/her to achieve a certain level of ability with a given amount of training and or practice” (Coetzee & Vosloo, 2000, p. 2).

Ability tests are hence differentiated by the nature of the content they measure (Gatewood & Feild, 1994). Commonly assessed abilities include memory span, numerical fluency, verbal comprehension, conceptual classification, semantic relations, general reasoning, conceptual foresight, figural classification, spatial orientation, visualisation, conceptual correlates, ordering, figural identification and logical evaluation (Jensen, 1998). Some tests combine scores on all test items into one total score which is indicative of overall cognitive ability. Other tests provide separate scores on each of the tested abilities and then add these scores together to report a general ability total score. Alternatively tests may concentrate on one or more separate abilities and therefore do not combine scores into a general ability measure (Ree et al., 2001).

In the case of cognitive ability tests, research suggests there is a close association between the content thereof and academic material (Gatewood & Feild, 1994; Guion, 1965). The first cognitive ability test was developed using formal educational materials and ability tests have frequently been validated using educational achievement as the criterion measure (Gatewood & Feild, 1994). Logically a strong relationship would then exist between cognitive ability scores and academic performance (Jones, in Gal & Mangelsdorff, 1991). Similarly, Hunter (in Colquitt et al., 2000) is of the opinion that cognitive tests measure the ability to learn in formal education and training situations. Formal education emphasises cognitive exercises and memorisation of facts and these are the components that make up a large part of many mental ability tests. However the same or similar abilities required for scholastic success are required for job success and therefore the use of mental ability tests is not only useful for academic selection.

2.8.1.3. Empirical Research Findings on the Predictiveness of g

Empirical research of two studies referred to previously provides further evidence supporting the critical importance and predictiveness of *g*. In 1990, Project A, a seven year research project aimed at developing a selection system for entry level positions in the U.S. Army, was undertaken (McHenry et al., 1990). According to Schmidt, Ones and Hunter (in Anderson et al., 2001) Project A has been the largest and most expensive selection research project in history. The major task of the project was to develop 65 predictor tests that could be used as selection instruments. The sample size comprised 4039 army entry-level employees. The analyses resulted in six domains of predictor instruments: general cognitive ability, spatial ability, perceptual-psychomotor ability, temperament or personality, vocational interest and job-reward preference. The second task was the development of components of work performance across entry-level jobs. Five components were determined: core technical task proficiency, general task proficiency, peer support and leadership, effort and self development, maintaining personal discipline and physical fitness and military bearing. The validity analysis results indicate that the general cognitive predictor domain correlated $r = .63$ and $r = .65$ for core technical proficiency and general soldiering proficiency respectively. Ree and Earles (in Anderson et al., 2001) showed that a composite of *g* predicted training performance with a corrected validity of .76.

Further, Schmidt and Hunter (1998) have provided a solid foundation in psychometric research through their review of what is known from cumulative empirical research about the validity of various personnel selection measures for predicting future job performance and job-related learning. In this study the predictive validity of 19 selection methods was investigated for both job and training performance. Overall, it was found that selection instruments predict training performance better than job performance; the average predictive validity of *g* was $r = .51$ for job performance and $r = .56$ for training performance. The results of this meta-analysis showed that *g* has essentially equal predictive validity for performance (amount learned) in job training programs for all job levels studied (Schmidt & Hunter, 1998).

It is from cumulative empirical research that Schmidt and Hunter (1998, p. 264) conclude that *g* occupies a unique place in personnel measures. The reasons they provide are: 1) *g* has the highest validity, lowest application cost and can be used across all jobs regardless of complexity levels; 2) the research evidence for the validity of measures of *g* for predicting job performance is stronger than that for any other method; 3) *g* has been shown to be the best available predictor of job-related learning and acquisition of job knowledge both on the job and in training programs; 4) the theoretical foundation for *g* is stronger than for any other personnel measure providing clarity on this construct.

It can hence be shown that general cognitive ability is a robust predictor, more so of training performance than job performance. Much of the predictive power of cognitive ability is explained by the relationship between cognitive ability, job knowledge and job performance (Hunter, 1986). Job knowledge determines how much and how quickly a person learns and complex learning is predicted by general cognitive ability, therefore performance in all complex tasks will be closely predicted by general cognitive ability. Hunter (1986) found a high correlation between ability and knowledge (.80 in civilian and .63 in military data), a high correlation between knowledge and performance (.80 in civilian and .70 in military data) and a high correlation between ability and performance (.75 in civilian and .53 in military data) thereby providing empirical evidence for these relationships. The rate at which one acquires knowledge is dependent on the rate at which one learns and learning is dependent on cognitive ability/

information processing abilities and differences in performance result from differences in cognitive ability (Colquitt et al., 2000).

The link is therefore through learning as *g* is the best predictor of job-related learning and learning the job is key to job mastery and performance. It can then be deduced that cognitive ability has its most important effect on performance indirectly through knowledge but there is also a direct effect of cognitive ability on performance independent of knowledge but it is smaller (Schmidt & Hunter, 1998). Furthermore cognitive ability is indirectly related to learning through increased self-efficacy, defined as an individual's beliefs in ones capabilities to organise and execute the courses of action required to produce given attainments (Colquitt et al., 2000, p.680) and is directly related to learning and job performance.

Consequently, when an employer uses general cognitive ability to select employees who are expected to have a high level of performance on the job, that employer is selecting those who will learn the most from job training programs and will acquire job knowledge faster from experience on the job (Schmidt & Hunter, 1998). Based on empirical research findings *g* can be considered the primary personnel selection measure for hiring decisions and various other personnel measures should be used as supplements to *g* measures (Ree & Earles, in Colquitt et al., 2000; Schmidt & Hunter, 1998). However, by adding measures of personality or motivation validity could be incremented (Anderson et al., 2001; Colquitt et al., 2000; Ree et al., 1994). The focus hereon is on the constructs of personality and motivation and their relationship to *g* and performance.

2.8.2. Personality

Many authors (Anderson et al., 2001; Costa & McCrae, 1992; Schmidt & Hunter, 1998) acknowledge that the use of personality assessment for predicting performance has been around for decades, although lacking substantial empirical evidence to support its value. Subsequently improvements in empirical investigations and the use of meta-analytic techniques have resulted in considerable amounts of evidence supporting the use of personality instruments in predicting performance (Barrick & Mount, 1991; McHenry et al., 1990; Ones, Viswesvaran & Schmidt, 1995; Pike, Hills & MacLennan, 2002), although their use in selection is still questioned by some (e.g., Morgeson, Campion, Diphove, Hollenbeck, Murphy & Schmitt, 2007).

Colquitt et al. (2000, p. 679) define personality as the “relatively stable characteristics of individuals (other than ability) that influence their cognition and behaviour”. In order to understand and explain human behaviour, these characteristics must be made explicit. One of the most prominent and widely researched theories of personality, the Five-Factor Model developed by Costa and McCrae (1992), suggests that most individual differences in personality can be classified into five broad, empirically derived domains: extraversion, agreeableness, openness to experience, conscientiousness and emotional stability. Kanfer (in Colquitt et al., 2000) goes on to explain that personality as encompassing these five domains, creates differences in self-set goals and the cognitive construction of individuals’ environments which go on to create between-person differences in behaviour. Therefore personality is a source of variation between individuals that occurs along five main domains, providing insight into the ‘additional factors’ contributing to variance in performance.

Conscientiousness and openness to experience are two of the five factors included in this research study because they have been shown to predict training performance as demonstrated through empirical research (Anderson et al., 2001; Barrick, Mount & Judge, 2001; Schmidt & Hunter, 1998; Pike et al, 2002). Of the five factors, the personality trait that has been widely studied in causal models of job performance is conscientiousness (Barrick et al., 2001; Pike et al., 2002; Schmidt & Hunter, 1998).

Anderson et al. (2001) explain that conscientiousness has sometimes been referred to as conformity or dependability as well as will- to-achieve because of its relationship to a variety of educational achievement measures. Traits associated with this dimension reflect dependability, thoroughness, responsibility and efficiency. Anderson et al. further explain that openness to experience has typically been referred to as intellect or culture and traits commonly associated with this dimension include curiosity, imagination, broad-mindedness and intelligence.

Conscientious individuals are hypothesised to be more dependable, well-organised, persevering and motivated to excel on the job (Tziner et al., 2007). In addition, this author adds that conscientious individuals tend to set high standards of performance and be committed to them, have more confidence in their ability to learn the training materials, have higher self-efficacy and a stronger desire to learn the training content (Nunes, 2003; Tziner et al., 2007). As a result of these qualities, conscientiousness is hypothesised to affect performance via several mechanisms; firstly, conscientious individuals are expected to engage in more organisational citizenship behaviours thereby increasing performance ratings (Schmidt & Hunter, 1998). Secondly, individuals with higher levels of conscientiousness are expected to spend more time on the task which can translate into higher job performance ratings and increased time spent on the job facilitates an increase in job knowledge which can enhance productivity and obtained job performance ratings (Schmidt & Hunter, 1998). Vasilopoulos, Cucina and Hunter (2007) in their research study argue that conscientiousness has a negative curvilinear relationship with training performance, meaning that individuals low and high in conscientiousness have lower performance scores than trainees at the middle of the distribution. In other words, performance increases with increases in conscientiousness up until a point where a threshold is reached and performance begins to decrease (Vasilopoulos et al., 2007).

2.8.2.1. Empirical Research Findings on the Predictiveness of Conscientiousness and Openness to Experience

Barrick and Mount (1991) examined the validity of the Big-Five personality dimensions in employment settings across five occupational groups – professionals, police, managers, sales and skilled/semi-skilled workers. Conscientiousness emerged as the most consistent predictor of job success among the five factors. Obtained correlation coefficients were: extraversion (.09), emotional stability (.10), agreeableness (.10), conscientiousness (.22) and openness to experience (.00). Anderson et al. (2001) reported, with reference to the Barrick and Mount study, that conscientiousness was the only dimension of personality whose validity generalised across jobs and settings. Openness to experience was related to training proficiency across all occupations, while agreeableness and emotional stability were unrelated to job performance for any of the occupations.

Additionally, empirical research shows that in predicting training performance, integrity tests produce higher incremental validity (.11) than any other measure added to date. The finding significant to this research is that the increment in validity produced by measures of conscientiousness (.9) was only slightly smaller than that for integrity (Schmidt & Hunter, 1998). When combined with *g* the combinations of these two predictors show the highest multivariate validity for job training programs; *g* plus an integrity test (mean test validity of .67) and *g* plus a conscientiousness test (mean test validity of .65) (Schmidt & Hunter, 1998). Moreover, Judge and Ilies (2002) in their meta-analysis found that conscientiousness correlated with performance motivation (average validity of .24) and generalised across studies providing further support for the importance of this construct and demonstrating its link to motivation. It can hence be said that conscientiousness is a "fundamental personality variable in studies of workplace behaviour" (Pike et al., 2002, p. 9) and should therefore occupy a central role in theories seeking to explain job performance.

In conclusion, the relationship between personality and job/training performance is modest. There are discrepancies with regard to the personality traits that are most predictive of performance; example Barrick and Mount (1991) found that conscientiousness was the only trait to correlate with job performance across occupational groups and job performance criteria, whereas in a separate study, as reported by Pike et al. (2002), it was found that agreeableness was most strongly related to job performance. However despite contradictions over which measure or dimension of personality is most predictive, the consensus is that personality is predictive of job/training performance.

2.8.3. Training Motivation

Of the variety of individual characteristics that influence learning and instruction, two of the most important have been shown to be motivation and intelligence (Corno & Snow in Colquitt et al, 2000). In this section, motivation as a predictor of training success is discussed. Results of the research presented here show that training motivation explained incremental variance in training outcomes beyond the effects of cognitive ability.

Training motivation is defined as "the direction, intensity and persistence of learning-directed behaviour in training contexts" (Colquitt et al., p. 678). If the earlier definition of motivation ("… the proportion of personal resources devoted to a task", Naylor, Pritchard & Ilgen in Colquitt et al., 2000, p. 682) is incorporated here then the degree of intensity and persistence one displays would be derived from one's personal resources. It is the context which distinguishes training motivation from general motivation; the task content in training contexts is new and complex and as such differs from the contexts in which general job performance is assessed (Colquitt et al., 2000). Even though some correlates of training motivation may not be context sensitive (e.g., valence, self-efficacy) other correlates could either be more relevant or more critical in a training context (e.g., age, anxiety, and career exploration) (Colquitt et al., 2000).

There are a number of theories of motivation in the literature two of which will be briefly discussed. Need-motive-value theories suggest that individuals' personality needs and other needs drive behaviour whereas cognitive choice theories suggest that it is not just needs, motives and values which drive behaviour but that there are mediating processes such as one's cognition which play an important role (Colquitt et al., 2000). For example, Vroom's expectancy theory (1964) suggests that trainees have *preferences* regarding the different outcomes that can result from participation in training, known as valence. Valence is defined as the "anticipated attractiveness or desirability of an outcome" (Vroom, 1964 in Sanchez, Truxillo & Bauer., 2000, p. 740). Secondly, this theory suggests that individuals also have *expectations* regarding the likelihood that effort put into training will result in mastery of training content; in other words, trying to do well on a course will lead to high scores on that course. This is known as expectancy, which is defined as the "subjective probability of effort leading to a specific outcome" (Vroom, 1964 in Sanchez et al., 2000, p. 740). Lastly individuals have certain *beliefs*, known as instrumentality, which is the "belief that performance will lead to a desired outcome" (Vroom, 1964 in Sanchez et al., 2000, p. 740). An example of instrumentality is when learners believe that passing the training courses will result in employment.

Vroom's theory has frequently been used to understand training motivation because the conditions upon which the theory is based are met in a training context. Behaviour is under the individuals' control, the behaviour-outcome linkages are unambiguous and there is a limited time span between assessment of predictors and observation of criteria (Kanfer in Colquitt et al., 2000).

From empirical research it is accepted (e.g. Kanfer, in Colquitt et al., 2000) that training motivation is a function of both individual (i.e. personality variables, job and career variables, self-efficacy, valence, demographics, values, motives and general cognitive ability) and situational characteristics (i.e. psychological climate, climate for transfer and support, manager or peer). Specifically, motivation is mediated by individual and situational characteristics and affects learning and job performance. A significant positive relationship between ability to learn and motivation found support in the study conducted by Nunes (2003), suggesting that a trainee who believes that he/she has sufficient ability to learn the material presented in the training course should also have greater learning confidence which in turn should increase his or her motivation to learn. However, even if a trainee possesses the required skills needed to learn the training program content, performance in the program will be poor if motivation is low or absent (Maier in Nunes, 2003). Noe (in Nunes, 2003) supports this finding and adds that although trainees may have the ability to benefit from training, they may fail to do so because of a lack of motivation.

Steers and Porter (in Nunes, 2003) suggest that motivation is composed of an energising, directing and maintenance component. In a training situation, motivation can be seen as a force that influences enthusiasm about the program (energiser), a stimulus that directs participants to learn and attempt to master training content (director) and a force that influences the use of newly acquired skills (maintenance). In a training setting, training motivation thus expresses itself in a number of ways and can influence attendance, amount of effort exerted and whether skills learned are applied.

2.8.3.1. Empirical Research Findings on the Predictiveness of Motivation

Kilcullen, Mael, Goodwin and Zazanis (in Pike et al., 2002) examined the individual attributes associated with effective job performance for 314 Special Forces soldiers in the U.S. military. Multiple predictors included cognitive ability, motivation and interest measures, physical fitness indices and demographic factors. Findings indicated that cognitive flexibility (.15), work motivation (.22) and achievement orientation (.25) were significantly related to performance.

Furthermore two models of motivation were formulated and tested by Colquitt et al. (2000) in an attempt to improve explanatory power and understand the nature of motivation, its antecedents, and role played in influencing success in training. These two models are based on integrative theories of motivation (e.g. need-motive and cognitive choice theories) as well as Kirkpatrick's (1976) model of training effectiveness, however with a broader view of learning based on the approach by Kraiger, Ford and Salas (in Colquitt et al., 2000). Learning has traditionally been conceptualised as knowledge acquisition. However, according to Kraiger et al. learning can take the form of cognitive outcomes such as declarative knowledge, skills-based outcomes (e.g. skill acquisition) or affective outcomes (e.g. motivational aspects such as post-training self-efficacy and attitudinal outcomes) and is thus broader in nature. The learning outcomes included in the model by Colquitt et al. are therefore declarative knowledge, skill acquisition, post-training self efficacy, reactions, transfer and job performance as well as motivation, intelligence, situational and personality variables.

In the first model, complete mediation is hypothesised where motivation is completely mediated by self-efficacy, valence and job involvement. The competing view or model is that complete mediation would not occur, the rationale being that individual characteristics and attitudes, as well as influences of situational variables on performance, are both direct and indirect and have effects during the entire training process; during learning, transfer and post-training job performance (Colquitt et al., 2000).

Meta-analytic results revealed that there was a positive relationship between motivation to learn, defined as "the desire on the part of trainees to learn the training material" (Colquitt et al., 2000, p. 681) and various learning outcomes: declarative knowledge $r_c = .27$; skill acquisition $r_c = .16$; reactions $r_c = .45$; transfer $r_c = .58$ and post-training self efficacy $r_c = .18$. When exploring the antecedents of motivation to learn a significant and relevant finding for this study was the relationship between cognitive ability and learning outcomes, which is consistent with previous research findings. The cognitive ability-declarative knowledge ($r_c = .69$), cognitive ability-skill acquisition (r_c = .38) and cognitive ability-transfer (r_c = .43) relationships were strong. Cognitive ability was weakly-moderately related to post-training self efficacy (r_c = .22).

Furthermore, their analysis results showed that when *motivation to learn* was investigated as the dependent variable, the personality variables explained an additional 27% in relation to the completely mediated model, the partially mediated model thereby explaining a total of 73% of the variance in motivation to learn. Analyses using *learning outcomes* as the dependent variable showed that motivation to learn was a significant predictor of all four outcomes (declarative knowledge (.39), skill acquisition (.22), post-training self-efficacy (.22) and reactions (.45)).

General cognitive ability predicted declarative knowledge (.76), skill acquisition (.42), and post-training self-efficacy (.25). In combination, motivation to learn and cognitive ability explained 63% of the variance in declarative knowledge, 20% of the variance in skill acquisition, 9% of the variance in post-training self-efficacy and 20% of the variance in reactions with the personality variables explaining incremental variance in all four outcomes. The significant finding is that motivation to learn explained variance in learning over and above general cognitive ability. Finally, when *post-training job performance* was analysed as the dependent variable, transfer explained 35% of the variance in job performance; the personality variables explained an incremental 12%.

Various conclusions can be drawn from these results, firstly the partially mediated model fit better than the completely mediated model. The partially mediated model showed significant results explaining 87% of the variance in declarative knowledge, 29% of the variance in skill acquisition, 86% of the variance in post-training self-efficacy and 47% of the variance in reactions. This means that individual and situational characteristics were critical influencing factors before training (by relating to training motivation), during training (by relating to learning levels) and after training (by relating to transfer and job performance), thereby supporting the importance of personality variables in understanding motivation (Colquitt et al., 2000). Although not a direct focus of this study, but still highly relevant, is the finding that situational variables were shown to be important, both in terms of the climate in which the trainee functions and the support the trainee receives from his/her supervisor and peers. These variables were related to motivation to learn, declarative knowledge, skill acquisition, reactions, transfer and job performance.

Secondly, in this study, general cognitive ability was again shown to be a significant predictor of training outcomes (Ree & Earles in Colquitt et al., 2000), however cognitive ability had a stronger relationship with traditional learning outcomes such as declarative knowledge or skill acquisition than it did with reactions or post-training self-efficacy.

Lastly, results showed that motivation to learn explained incremental variance in learning outcomes over and above *g*. Therefore when it comes to predicting learning outcomes there is "much more than *g*" (Colquitt, et al., 2000, p. 700), supporting the hypothesis that predictiveness can be incremented by personality variables and motivation.

2.9. Conclusion: Chapter Two

It is evident that various individual differences jointly affect training performance, a conclusion supported by Coetzee and Vosloo (2000, p. 2) who state that "aptitude together with interest, attitude, motivation and other personality characteristics will to a large extent determine the ultimate success of the person". Human performance is a function of individual and situational variables (Barrick & Mount; 1991; Colquitt et al., 2000; Hartmann et al., 2003; Hunter, 1986; McHenry et al., 1990; Ree et al., 1994; Ree et al., 2001; Schmidt & Hunter, 1998; Tziner et al., 2007), three of which are investigated in this study, i.e. intelligence or general cognitive ability, training motivation and personality. Based on the review of literature, a model of the interrelationships of these variables can be hypothesised. It appears that intelligence creates variance in performance due to the fact that individuals' information processing abilities differ, leading to differences in learning capacity. Intelligence therefore impacts performance directly and through motivation. Furthermore, one's personality creates differences in behaviour, which too, impact motivation due to their influences on trainees' expectancies and valence. Thus motivation is a result of the complex interaction and interrelation of these variables which determine one's resource capacity and amount of effort invested in a task. The hypothesised relationships between the various predictors chosen for this study and between the predictors and criterion measures are depicted in Figure 2.1.

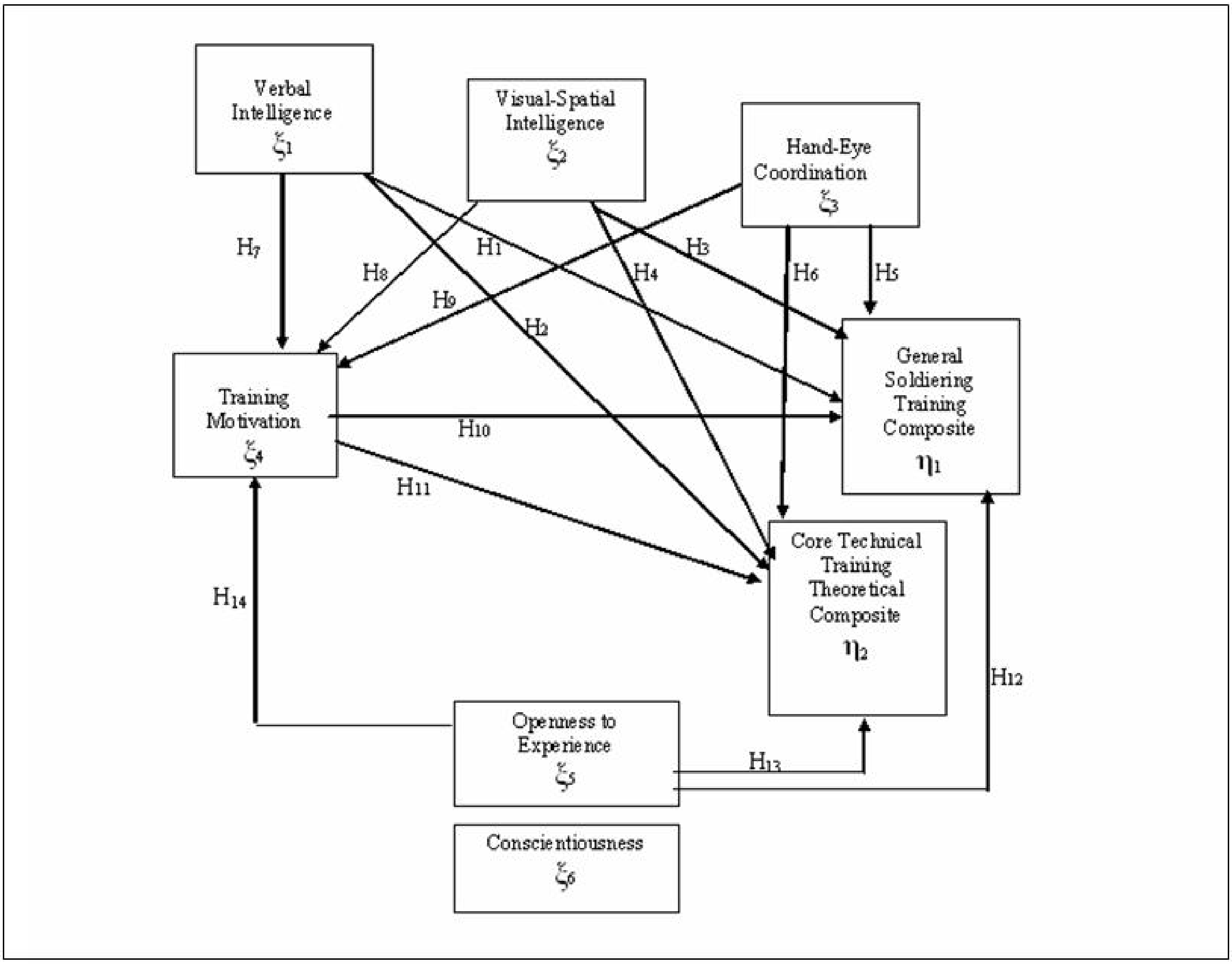

Figure 2.1. Hypothesised relationships between independent (general cognitive ability, training motivation & personality) and dependent variables (general soldiering training proficiency & core technical training proficiency).

CHAPTER THREE: RESEARCH METHODOLOGY

3.1. Introduction

Research methodology focuses on the individual steps in the research process and is concerned with the most objective tools and procedures to be used (Mouton, 2001). The theoretical framework presented in chapter two forms the basis of the research methodology outlined in this chapter. Consequently, the aim of the empirical research is formulated in specific research hypotheses.

3.2. Research Design

Research design is the plan and structure of investigation, conceived so as to obtain answers to research questions. The design "…tells us, in a sense, what observations to make, how to make them, and how to analyse the quantitative representations of the observations" (Kerlinger & Lee, 2000, p. 450). Research design furthermore demarcates the boundaries of research and formulates specific points of departure (Mouton, 2001).

This study follows an *ex-post facto* correlational design which forms part of a military project aimed at identifying possible measures to be used in future selection. This is a non-experimental design used to explore the correlation between the predictors and criteria. Non-experimental research is a descriptive type of research where the goal is to "provide an accurate picture of what a particular situation is; it attempts to identify variables that exist in a given situation and tries to describe the relationship that exists between those variables" (Muchinsky et al., 2005, p.125). Therefore, in an *ex-post facto* design experimental manipulation of the variables and random assignment are not possible, one is merely describing a situation. Stated differently, the purpose of an *ex-post facto* design is to test the hypothesis "if ξ then η" (Nunes, 2003, p. 62). The types of questions asked in non-experimental research are descriptive and predictive questions and the hypothesised relationships between the predictors and criteria are based on theoretical foundations (Kerlinger & Lee, 2000; Mouton, 2001).

Following the assumption that knowledge is objective and acquired rather than experienced (McIntyre, 2005), this research study follows the positivist paradigm. This assumes that knowledge is acquired, is based on facts and observers play a detached role in gathering knowledge. Linked to the positivist paradigm is the idea of determinism which is the theory that phenomena (events and behaviour) are not random, but can be explained as effects that have causes (McIntyre, 2005). In line with this paradigm, this study is an empirical study and follows mainly a quantitative approach, particularly in the analysis phase whereas the literature review is presented from a qualitative approach.

Furthermore this study forms part of a concurrent validation study as information is obtained on both the predictor and criterion for a *current* group of employees roughly at the same time (Guion, 1965; Schmitt & Chan, 1998). Tests are considered to be valid predictors of performance if statistically significant relationships with criteria exist. The strength of this approach is that the researcher has almost immediate information on the usefulness of a selection device. Three factors can affect the usefulness of a concurrent validation study: (a) differences in length of employment of the employees who participate in the study, (b) the representativeness of present employees to job applicants and (c) the motivation of employees to participate in the study (Gatewood & Feild, 1994). As discussed in chapter two of this study; the test-taking motivation of employees in comparison to job applicants is likely to be lower because their employment is secured and this may skew test results (Schmitt & Chan, 1998) thereby impacting the usefulness of the validation study. Furthermore, if the test battery (resulting from the validation study) is used for selection, the current employees (sample) would need to be representative of the job applicants (population) for the validated model to be applicable.

3.3. Hypotheses

A hypothesis is a conjectural statement of the relationship between two or more variables (Kerlinger & Lee, 2000). Hypotheses are important and indispensable tools of scientific research for the following reasons: hypotheses are the working instruments of theory and are deduced from theory, hypotheses can be tested and shown to be true or false, and hypotheses are powerful tools for the advancement of knowledge because they enable scientists to get outside themselves (Kerlinger & Lee, 2000).

Based on the literature review and the proposed relationships between the variables, the following hypotheses have been formulated:

Hypothesis 1:

A significant positive relationship exists between a trainee's verbal intelligence and general soldiering training proficiency.

H_{01}: $\rho[X_1, Y_1]=0$
H_{a1}: $\rho[X_1, Y_1]>0$

Hypothesis 2:

A significant positive relationship exists between a trainee's verbal intelligence and core technical training proficiency.

H_{02}: $\rho[X_1, Y_2]=0$
H_{a2}: $\rho[X_1, Y_2]>0$

Hypothesis 3:

A significant positive relationship exists between a trainee's visual-spatial intelligence and general soldiering training proficiency.

H_{03}: $\rho[X_2, Y_1]=0$
H_{a3}: $\rho[X_2, Y_1]>0$

Hypothesis 4:

A significant positive relationship exists between a trainee's visual-spatial intelligence and core technical training proficiency.

H_{04}: $\rho[X_2, Y_2]=0$
H_{a4}: $\rho[X_2, Y_2]>0$

Hypothesis 5:

A significant positive relationship exists between a trainee's hand-eye coordination and general soldiering training proficiency.

H_{05}: $\rho[X_3, Y_1]=0$
H_{a5}: $\rho[X_3, Y_1]>0$

Hypothesis 6:

A significant positive relationship exists between a trainee's hand-eye coordination and core technical training proficiency.

H_{06}: $\rho[X_3, Y_2]=0$
H_{a6}: $\rho[X_3, Y_2]>0$

Hypothesis 7:

A significant positive relationship exists between a trainee's verbal intelligence and level of training motivation.

H_{07}: $\rho[X_1, X_4]=0$
H_{a7}: $\rho[X_1, X_4]>0$

Hypothesis 8:

A significant positive relationship exists between a trainee's visual-spatial intelligence and level of training motivation.

H_{08}: $\rho[X_2, X_4]=0$
H_{a8}: $\rho[X_2, X_4]>0$

Hypothesis 9:

A significant positive relationship exists between a trainee's hand-eye coordination and level of training motivation.

H_{09}: $\rho[X_3, X_4]=0$
H_{a9}: $\rho[X_3, X_4]>0$

Hypothesis 10:

A significant positive relationship exists between a trainee's level of training motivation and general soldiering training proficiency.

H_{010}: $\rho[X_4, Y_1]=0$
H_{a10}: $\rho[X_4, Y_1]>0$

Hypothesis 11:

A significant positive relationship exists between a trainee's level of training motivation and core technical training proficiency.

H_{011}: $\rho[X_4, Y_2]=0$
H_{a11}: $\rho[X_4, Y_2]>0$

Hypothesis 12:

A significant positive relationship exists between openness to experience and a trainee's general soldiering training proficiency.

H_{012}: $\rho[X_5, Y_1]=0$
H_{a12}: $\rho[X_5, Y_1]>0$

Hypothesis 13:

A significant positive relationship exists between openness to experience and a trainee's core technical training proficiency.

H_{013}: $\rho[X_5, Y_2]=0$
H_{a13}: $\rho[X_5, Y_2]>0$

Hypothesis 14:

A significant positive relationship exists between a trainee's degree of openness to experience and level of training motivation.

H_{014}: $\rho[X_5, X_4]=0$
H_{a14}: $\rho[X_5, X_4]>0$

Hypothesis 15:

Verbal intelligence (ξ_1), visual-spatial intelligence (ξ_2), hand-eye coordination (ξ_3), training motivation (ξ_4) and openness to experience (ξ_5) each explain unique variance in general soldiering training proficiency (η_1).

H_{015}: $\beta[X_1] = 0|\beta[Y_1] \neq 0$
H_{016}: $\beta[X_2] = 0|\beta[Y_1] \neq 0$
H_{017}: $\beta[X_3] = 0|\beta[Y_1] \neq 0$
H_{018}: $\beta[X_4] = 0|\beta[Y_1] \neq 0$
H_{019}: $\beta[X_5] = 0|\beta[Y_1] \neq 0$
H_{a15}: $\beta[X_1] > 0|\beta[Y_1] \neq 0$
H_{a16}: $\beta[X_2] > 0|\beta[Y_1] \neq 0$
H_{a17}: $\beta[X_3] > 0|\beta[Y_1] \neq 0$
H_{a18}: $\beta[X_4] > 0|\beta[Y_1] \neq 0$
H_{a19}: $\beta[X_5] > 0|\beta[Y_1] \neq 0$

Hypothesis 16:

Verbal intelligence (ξ_1), visual-spatial intelligence (ξ_2), hand-eye coordination (ξ_3), training motivation (ξ_4) and openness to experience (ξ_5) each explain unique variance in core technical training proficiency (η_2).

H_{020}: $\beta[X_1] = 0|\beta[Y_2] \neq 0$
H_{021}: $\beta[X_2] = 0|\beta[Y_2] \neq 0$
H_{022}: $\beta[X_3] = 0|\beta[Y_2] \neq 0$
H_{023}: $\beta[X_4] = 0|\beta[Y_2] \neq 0$
H_{024}: $\beta[X_5] = 0|\beta[Y_2] \neq 0$
H_{a20}: $\beta[X_1] > 0|\beta[Y_2] \neq 0$
H_{a21}: $\beta[X_2] > 0|\beta[Y_2] \neq 0$
H_{a22}: $\beta[X_3] > 0|\beta[Y_2] \neq 0$
H_{a23}: $\beta[X_4] > 0|\beta[Y_2] \neq 0$
H_{a24}: $\beta[X_5] > 0|\beta[Y_2] \neq 0$

3.4. Sample of Research Participants

The sample in this research study comprises the 2007-2008 intake of Military Skills Development (MSD) troops (trainees) (N = 108) in the S.A. Army Armour Corps who have completed at least one of four functional courses specified by the client organisation. All participants are between the ages of 18 and 24 (SD = 1.380), with a minimum education level of Grade 12 (secondary schooling). 4.63% of the sample have tertiary level qualifications and most

(99%) of the participants in the sample are unmarried. In terms of race, 74% of the population are African, 7.4% are White, 9% are Asian and 17.6% are Coloured. The demographic profile of the sample is shown in table 3.1.

Table 3.1
Demographic Profile of the Sample

	GENDER	
RESPONSES	Frequency	Percentage
Male	83	76.9
Female	25	23.1
	RACE	
RESPONSES	Frequency	Percentage
African	80	74.1
White	8	7.4
Asian	1	.9
Coloured	19	17.6
	MARITAL STATUS	
RESPONSES	Frequency	Percentage
Single	107	99.1
Separated	1	.9
	EDUCATION	
RESPONSES	Frequency	Percentage
Matric	103	95.4
Post Matric Cert	3	2.8
Degree	1	.9
Diploma	1	.9
	AGE	
VARIABLE	Mean (years)	Standard Deviation
Age	21.76	1.380

Note. $N = 108$

3.5. Measuring Instruments

Measurement of the criteria and predictors are required in order to determine the relationships that exist between these variables. The way in which each variable in this study has been measured is discussed below.

3.5.1. Criterion Measure

The nature and requirements of a criterion measure have been discussed in chapter two, as well as the advantages of using training performance as the criterion (see section 2.7); this section focuses on the nature and content of the criterion in this study.

The training course results of the participants in this study comprised the criterion measure of training performance which consisted of paper and pencil tests as well as work samples. Success in the military environment requires competence not only in core areas/activities but also in general soldiering areas. Therefore in determining whether an individual is successful in training and on-the-job, means that both these avenues must be investigated which can be accomplished by forming a general soldiering and core technical training proficiency measure.

Participants completed two courses that formed part of the same training regiment (i.e., there was no time delay between the courses), each comprising several modules; Basic Military Training (BMT) and one of four functional training courses; Rooikat Driving and Maintenance, Rooikat Gunnery, Tank Driving and Maintenance or Tank Gunnery. Each type of evaluation was included in the research study for a specific purpose, since they involved sub-facets of training performance. From these course results, composite criterion scores were created to represent meaningful training proficiency criteria.

Firstly, Basic Military Training is generic soldiering skills training which every soldier is required to complete. The modules comprising the Basic Military Training cover general soldiering aspects such as safety, first aid, navigation, field and musketry training. The assessments of which are both theoretical and practical thereby giving a good general impression of training performance in different tasks. The Basic Military Training course results were used to form a composite that represented the overall relative training performance of each participant.

The composite was created by calculating the mean percentage score of the theoretical modules comprising the course.

Secondly, the functional training courses, of which there are two types with two courses each, were specifically selected as they are unique to the Armour corps as opposed to generic to the SANDF. The nature of the tasks comprising these courses requires more advanced subject knowledge relating to specialised corps training. The assessments are theoretical and give a good general impression of mastery of learning material in an applied job setting. From these course evaluations a core technical training proficiency composite was created by calculating the mean percentage score of the theoretical modules comprising the two functional training courses. It was decided that grouping the results could be justified since the nature of *learning* is the same for theory regardless of the course content. In support of this decision, subject matter experts (instructors) agreed that the relative difficulty of the two types of training courses was comparable. Participants are required to obtain 60% for the theoretical components and are allowed two attempts. However, for the purposes of this research, the first attempt scores were used.

Various measures were implemented to ensure that the reliability of training scores would not be compromised. The training courses were developed using the competency profile of an armour trainee, thus ensuring that the KSAs required on the job are the same KSAs required in training. The relevance of the criterion measure is further ensured by assessing individuals on the activities ("must be able to...") identified in the profiling stage (see section 3.6.1 for an explanation of the profiling methodology), as it is these activities that the individuals are required to perform both in the training phase in the SANDF and operational circumstances (this provided the foundation for content validity of the criterion measures). The rating sheets used for assessments were scrutinised by the researchers and it was concluded that they had adequate face validity. Training was conducted by instructors who have personally completed the training courses and who have extensive experience in the various functional areas (Danie Boshoff, personal communication, October 16, 2008). These requirements would render these instructors competent to conduct training and assess performance. Additionally, it is an organisational requirement that all instructors are trained as assessors. These measures all served to improve the probability of obtaining reliable scores. Even though the reliability of the criterion measures could not be calculated in this study due to a lack of item level data, Alliger et al. (1997) in their meta analysis, found that almost all internal consistency reliabilities for training proficiency scores as criterion measures were above .75.

In conclusion, it is necessary to re-emphasise that training is a way of life in the military (Salas et al., 2003) and that the military are renowned for their training programs. It is therefore fitting that training performance be used as the criterion measure. These training programs are representative of the tasks and attributes critical to job success; the same KSAs required to perform successfully on the job are required for success in training, i.e. there is high fidelity of the criterion measure. In a sense, the training proficiency measures used in this study approached the nature of work-sample tests, which have demonstrated high predictive validity (.54) for predicting job performance (Schmidt & Hunter, 1998). This ensures that training adequately prepares soldiers for on-the-job performance. Furthermore, research shows higher predictive validity indicators for training vs. job performance, for example Schmidt & Hunter (1998) found that the validity of general cognitive ability tests for predicting job performance was .51 in comparison to .56 for predicting training performance.

3.5.2. Predictor Measures

The identification of competencies (as derived from the job profile) provides an empirical basis to determine which personnel tests (predictors) should be used (Muchinsky et al., 2005) and hence inform the test battery. The psychological predictors used in this study are discussed below.

3.5.2.1. General Cognitive Ability

To measure general cognitive ability (*g*), a series of subtests from the Differential Aptitude Test (DAT), Senior Aptitude Test (SAT) and Situation Specific Evaluation Expert (Speex) were administered. It was decided to develop a composite measure of *g* since it has proven to be the best predictor of training performance (Hartmann et al., 2003; Hunter, 1986; McHenry et al., 1990; Ree et al., 2001; Ree et al., 1994; Schmidt & Hunter, 1998). Furthermore, the relatively small sample available for this study precludes the use of too many predictors since it could jeopardise statistical power (Tabachnick & Fidell, 1996). Guion and Highhouse (2006) state that scores on predictors can be combined in any of several models and, in this case, a linear, additive model was applied which requires that scores are summed to form a composite. Exploratory factor analysis (EFA) was used to aid the development of a composite measure of *g* as an indicator of general cognitive ability (Ree et al., 1994). Gatewood and Feild (1994) support the use of factor analysis for forming composites and describe a way, which involves correlating individual criterion measures with one another. The inter-correlation matrix is then factor analysed, which statistically combines the separate measures into clusters or factors which would serve as a composite performance measure. Unit weights were then assigned to predictors in forming the composites, since Dawes and Corrigan (in Guion & Highouse, 2006, p. 179) demonstrated that "more complex models offer no more than slight improvements over simple weights…in accounting for criterion variance" and "simpler nominal weights may do as well or better if variables are carefully selected, are positively correlated with each other and with the criterion, and do not differ greatly in validities or reliabilities" (p. 180).

As will be discussed in chapter four, three clear and interpretable factors emerged from the exploratory factor analysis (see table 4.13), thereby supporting the formation of three general cognitive ability composites, namely verbal intelligence, visual-spatial intelligence and hand-eye coordination. These composite scores were calculated by linearly combining unit weighted individual predictor scores that loaded on each of the factors. The individual measures that were later combined linearly will subsequently be discussed.

The first measure that was used in this study, the Differential Aptitude Test (Form K) (Coetzee & Vosloo, 2000), was originally designed for use in educational and career counselling contexts for learners in grade 7 to 12 and adults who passed these grades. The DAT subtests administered were: vocabulary, reading comprehension, spatial visualisation and mechanical insight. The reliability of the DAT subtests has been determined using the Kuder-Richardson reliability coefficient formula. The reliability coefficients are considered to be of an acceptable standard (Nunnally, 1978) and are consistent for the different grade groups. Reliability coefficients are reported in table 3.2.

Table 3.2

Reliability Coefficients of the DAT Subtests for Grade 12 Learners

Test	**Maximum Score**	**K-R 14**
Vocabulary	30	.75
Reading Comprehension	25	.80
Spatial Visualization		
Boys	25	.81
Girls	25	.74
Mechanical insight		
Boys	25	.76
Girls	25	.71

The test developers investigated the construct validity of the DAT subtests by conducting factor analysis on the data of the norm group. Two factors could meaningfully be established, factor one which refers to the language skills of the learner. It serves as a description of the individual's ability to reason verbally and includes the learner's knowledge and understanding of the language in which the test is constructed. Factor two includes all the tests with items containing no phrases, thereby consisting of symbols (numbers, letters, names and figures). This factor serves as a description of the tests requiring non-verbal reasoning. The correlation between the two factors is .74, indicating that this test battery measures an individual's ability to reason deductively and inductively. Predictive validity was determined using grade 11 learners' year end results. Pearson's product moment correlation coefficient was calculated between tests of the DAT and the learners' school subjects, indicated in table 3.3.

The second measure that was used in this study is the Senior Aptitude Test (SAT) (Fouché & Verwey, 1978), which was developed in order to measure a number of aptitudes of pupils and adults for vocational and selection purposes. The subtests of the SAT which were administered are: hand-eye coordination and writing speed. The reliability for these two subtests is reported as .93 for hand-eye coordination and .85 for writing speed (Fouché & Verwey, 1978). With regard to construct validity, six fields of aptitude are measured by the SAT, which, when combined, produce a measure of general intelligence as there is empirical evidence of an underlying factor. Predictive validity has been determined by the calculation of correlation coefficients between SAT scores and the scores pupils obtained in the different school subjects on lower and higher grade. The coefficients for higher grade subjects are given in table 3.4 (Fouch□ & Verwey, 1978).

Table 3.3

Correlations between Year-End Exam Results and DAT Total Scores for Grade 11 Learners

Test	**English**	**Afrikaans**	**Mathe-matics**	**Accounting**	**Economics**	**Business Economics**	**Natural Science**	**Biology**	**History**
Vocabulary	.69**	.57**	.45**	.28	.47**	.56**	.38*	.44*	.25
Reading Comprehension	.65**	.48**	.37**	.17	.23	.41**	.47**	.45**	.60**
Spatial Visualization	.53**	.45**	.40**	.17	.34*	.54**	.46**	.40*	.43*
Mechanical Insight	.54**	.40**	.33**	.23	.29	.50**	.40*	.33*	.13
N	96	96	96	42	42	42	35	35	21

Note. *$p \leq .05$. ** $p \leq .01$

N = Sample Size

Table 3.4

Correlations between Exam Marks in School Subjects and SAT scores for Grade 12 Learners

Test	English	Afrikaans	Mathematics	Natural Science	History	Geography	Accounting	Biology
Hand-Eye-Coordination	.157*	.103	.074	.220	.-015	.255*	.366	.265*
Writing Speed	.205**	.169*	.338*	.236*	.165	.032	.386	.383*
N	233	215	84	101	45	69	21	83

Note. *$p \leq .05$. ** $p \leq .01$

N = Sample Size

Lastly, three subtests of the Speex measure (Erasmus, Schaap & Kriel, 2004) were used in this study namely: observance, conceptualisation and listening potential. The aim of the Speex measure is to provide a comprehensive assessment package suitable for the assessment and development of human potential in the workplace. The Speex battery consists of two types of scales, namely cognitive and behavioural scales (Erasmus et al., 2004). Scales 100 (conceptualisation), and 1700 (listening potential) are cognitive scales which means that they assess intellectual potential. The authors report a Cronbach Alpha of r_{xx} = .90 for the conceptualisation scale, r_{xx} = .72 for the listening potential scale and r_{xx} = .76 for the observance scale (Schaap, 2001).

The subtests from the measures comprising each composite as revealed by the factor analysis are: vocabulary, reading comprehension and listening potential which make up the verbal intelligence factor; spatial visualisation, mechanical insight and conceptualisation which make up the visual-spatial intelligence factor and lastly hand-eye coordination and writing speed combine to form the hand-eye coordination factor (see table 4.13).

3.5.2.2. Training Motivation

Training motivation was assessed by means of a training motivation questionnaire based on a test-taking motivation scale, the Valence, Instrumentality, Expectancy and Motivation Scale Questionnaire (VIEMS), developed by Sanchez, Bauer and Truxillo (2000). The VIEMS is a multidimensional measure of motivation based on Vroom's expectancy theory (1964) and aims to assess motivation towards target behaviour, in this case, a specific training opportunity. According to the authors the choice of the expectancy theory as a guiding framework for the development of this measure is substantiated by the fact that this model has received extensive research attention and support in a variety of contexts and allows for a multidimensional and diagnostic approach to motivation (Sanchez et al., 2000). There are 13 items in the VIEMS; valence consists of three items, instrumentality consists of four items, expectancy consists of three items and the last three items assess attitude. Respondents are required to rate the extent to which they agree or disagree (five-point scale) with the statement based on their views of the training courses they have completed in the Armour Formation. For this purpose, the original context in the VIEMS was adapted to reflect the nature of the reference to the training opportunity in this study.

Sanchez et al. (2000) analysed the psychometric properties of the original VIEMS. Reliability coefficients for the three scales were reported as .94, .86 and .89 respectively. Confirmatory factor analysis performed on the ten items confirmed the three factor structure. Hierarchical regression was used to determine the unique variance added by each of the motivation scales. Results showed that the VIEMS subscales accounted for 7% of the variance in test scores. The findings of the research on this instrument as reported by the authors are as follows: the VIEMS had differential relationships with actual test performance, perceived test performance and test-taking experience. Pre-test instrumentality was lower than post-test instrumentality. No differences were found with valence or expectancy. Perceived performance was significantly related to post-test motivation; therefore applicants did adjust levels of motivation based on perceived performance. Perceptions of instrumentality were related to prior test taking experience with those who had not taken the exam previously reporting higher levels of instrumentality (pre and post levels of performance differ and this may be due to participants' perceptions of how well they did on the test).

For the purposes of this research, an unweighted linear composite of training motivation subscales was generated by calculating the sum of the valence, instrumentality and expectancy sub-scores for each participant.

3.5.2.3. Personality

Personality was assessed using the Ten Item Personality Inventory (TIPI) which was developed by Gosling, Rentfrow and Swann (2003) in response to the need for brief measures of personality for research purposes. Longer measures are frequently not feasible due to assessment time constraints and participant fatigue. The TIPI permits research that would otherwise not be possible using long instruments. The TIPI broadly measures the Big-Five personality dimensions. There are ten items (two items per scale), each item consisting of two descriptors, using the common stem "I see myself as". Respondents are required to rate the extent to which a pair of traits (descriptors) relates to themselves using a seven-point scale, ranging from disagree strongly to agree strongly. There is no time limit for the completion of this questionnaire, but it takes about one minute to complete.

Research on the instrument as reported by the authors shows acceptable psychometric properties on convergent and discriminant validity and test-retest reliability (based on a sub-sample of participants), when compared to other measures of the Big-Five personality factors. These results are presented in table 3.5.

When compared with other standard multi-item measures of the Big-Five dimensions, the TIPI displayed convergences that were comparable to these inventories (mean r = .77). Extraversion fared the best across the criteria and openness to experience and agreeableness fared least well. The convergent correlations (mean r = .77) far exceeded the discriminant correlations (absolute mean r = .20) and none of the discriminant correlations exceeded .36. Although shorter instruments are less reliable because they do not provide scores for the narrower facet-level constructs, the authors conclude that this instrument can stand as a reasonable proxy for longer Big-Five instruments, especially when research conditions dictate that a very short measure be used (Gosling et al., 2003).

Table 3.5

Test-Retest Reliability and Convergent Validities for the TIPI

Scale	Test-retest reliability	Convergent Validities
Extraversion	.77	.87**
Agreeableness	.71	.70**
Conscientiousness	.76	.75**
Emotional Stability	.70	.81**
Openness to experience	.62	.65**
N	180	1813
Mean	.72	.77

Note. *$p \leq .05$. ** $p \leq .01$
N = Sample Size

3.6. Procedure

In this section, each step of the research process is briefly discussed. The process began with job analysis resulting in a competency profile for an armour trainee; thereafter the criterion and predictor measures were defined. The last step in this process was the analysis of existing data that emanated from a concurrent validation study conducted by the client organisation.

3.6.1. Job Analysis

Job analysis is defined as "the collection of data describing (a) observable / verifiable job behaviours performed by workers, including both what is accomplished as well as what technologies are employed to accomplish the end results, and (b) verifiable characteristics of the job environment with which workers interact, including mechanical, social, and informational elements" (Muchinsky et al., 2005, p. 51). Gatewood and Feild (1994, p. 285) define job analysis as "a purposeful, systematic process for collecting information on the important, work-related aspects of a job". The most important use of job analysis information is thus the identification of competence (what needs to be achieved) and competencies (how it is achieved) for a specific position. A competency can also be viewed as "a construct that represents a constellation of the characteristics of the person that result in effective performance in his or her job" (Muchinsky et al., 2005, p. 65). These criteria become the basis for making selection decisions.

Job analysis is conducted using subject matter experts (SMEs), the job incumbent, supervisors and trained job analysts are considered subject matter experts. These SMEs form a committee who, in conjunction with the industrial psychologist, compile the profile of the specific job.

The profile of a general armour soldier in the SA Army Armour corps was compiled using a two method approach (the job profile cannot be supplied due to confidentiality agreement with client organisation), involving both a quantitative and a qualitative component. Firstly, the qualitative component involved a process where the SME committee was briefed on the profiling method and what was expected of them. The committee and facilitator then jointly derived the following:

Activities: (An action or series of actions and/or behaviours resulting in a measurable outcome). Subject matter experts were facilitated to define the required activities in the form "must be able to…" in measurable terms e.g. "Must be able to demonstrate the potential to grasp basic principles of physics and geography".

Outcomes: (The end Result). Subject matter experts were guided to define the required outcomes in the form "in order to…" for each activity, in such a manner that it clearly describes an end result e.g. “In order to conduct oneself in the technical environment”. The outcomes are linked to the corps functions as described in the approved doctrine.

The Physical Attributes: A standard list of physical attributes was provided and the subject matter experts were facilitated to link the appropriate physical attributes to the activities defined previously and similarly a standard list of environmental requirements was provided requiring subject matter experts to link the appropriate environmental requirements to the activities defined previously.

Corps Values: Subject matter experts were afforded the opportunity to identify the values endorsed by the corps. To ensure the incorporation of the organisational values in the selection profile, only those values that were documented as part of the extended corps doctrine were accepted.

Secondly, a quantitative approach was employed where the subject matter experts were guided, with the aid of a software program, to derive the competencies which encompass the required knowledge, skills and person attributes. The software program used was the Job Profiling Expert (JP Expert) developed by Erasmus (2002), where profiling forms part of the larger Situation Specific Job Profiling and Assessment System. The subject matter experts completed the JPI (job profiling inventory) questionnaires, during which the most important competencies were identified.

Once the competencies had been identified (explained above) and the JPI questionnaires completed, the two approaches (quantitative and qualitative) were then integrated by means of clustering the competencies. The competencies are clustered within the activities, outcomes and functions categories. During this step competencies which were allocated more than once during the three preceding steps, or similar competencies were removed/reworked/grouped.

Finally, the competencies were rated (the level of competency required) as either essential (rated 3), important (rated 2), or useful (rated 1). This rating assists assessors in allocating a weight to certain competencies during recruitment and selection. The profile compiled is used in designing training programs to simulate the tasks required on the job in order to develop the skills required to perform those tasks. For the purpose of this research study, the complete profile was collapsed into a simple structure in order to aid the subsequent statistical analysis of data.

3.6.2. Test Administration

The assessment measures were administered to the participants and predictor and criterion data collected by the client organisation and the researchers. Testing conditions were standardised in terms of test administrators, test sequence, testing times, break times and administration instructions. The only difference between the two testing occasions was the environment; one venue was a typical classroom set-up in a hall while the other venue was in a large canvas tent in the training area and therefore aspects such as noise may have had an influence on test performance. To control for possible effects, the researchers compared mean scores on all predictors and found no statistically significant differences for any of the predictors between the settings (see table 4.3).

The nature and purpose of the assessment was clearly explained to all participants in a covering letter (see Appendix B) and reiterated by the test administrators. Participants each signed a consent form (see Appendix B) stipulating that the data would be used for research purposes only, that their anonymity would be maintained, that they understand the nature of the assessments and that participation is voluntary. While the results are anonymous and reported at group rather than at individual level, members were asked to indicate their force numbers so that the corresponding course results (criterion data) could be obtained and matched to the predictor data. Participants first completed the Training Survey comprising the TIPI and the VIEMS followed by the general cognitive ability measures.

Following the collection of predictor and criterion data, the final stage in the process is the statistical analyses determining the predictor-criterion relationships. The extent to which the predictors predicted general soldiering proficiency was investigated as well as the extent to which the predictors predicted core technical training proficiency, the results of which are reported in chapter four.

3.7. Statistical Analysis

Prior to analyses, the questionnaires were checked for correctness of completion and no questionnaires were rejected. Data sets were cleaned and checked for accuracy (Field, 2005; Tabachnick & Fidell, 1996; SIOPSA, 2005) and a further spot check of accuracy of coding was conducted using a sample of the source documents.

A combination of univariate and multivariate statistical techniques were used to analyse the data and investigate the research hypotheses. Descriptive statistics entail summarising and describing the data/observations, specifically looking at means, standard deviations, skewness, kurtosis and normality statistics. Reliability analysis and exploratory factor analysis was used for exploratory data analyses (EDA), which were mainly used to investigate the psychometric measurement properties of the instruments. Inferential statistics (correlation and multiple regression analysis) were used to investigate the hypotheses (Field, 2005; Tabachnick & Fidell, 1996). The Statistical Package for the Social Sciences (SPSS) (Field, 2005) was used for the statistical analysis of data.

Prior to the main substantive analyses, the predictor composites had to be formed by means of exploratory factor analysis (EFA). The factor analysis results and inter-correlations between the various intelligence measures were investigated in order to develop a meaningful composite of general cognitive ability. There are three generally accepted ways of estimating *g* from a set of variables: principal components, principal axis factoring and hierarchical factor analysis (Gatewood & Feild, 1994; Ree et al., 1994), of which the technique of choice in this study is principal axis factoring. Based on factor-loadings, subtest scores which loaded strongly onto the general factor were added linearly into a composite measure of *g,* using unit weights for the individual variable scores (also see section 3.5.2.1 regarding the formation of the g composites). For training motivation an unweighted linear composite was generated by calculating the sum of the valence, instrumentality and expectancy sub-scores for each participant.

Once the predictor composites were created, Pearson product moment correlation analysis was used to determine relationships between the variables and explained and unexplained variance in the criteria. Simple (zero-order) Pearson correlation analyses were used to test H_{01} to H_{014}.

Lastly multivariate analysis techniques (standard and hierarchical regression) were used to investigate the predictive validity of the instruments. It can be argued that of all methods of analysis, multivariate methods are the most powerful and appropriate for scientific behavioural research as behavioural research problems are multivariate in nature and cannot be solved with a bivariate approach. According to Kerlinger and Lee (2000, p. 209) these methods “are like the behavioural reality they try to reflect: complex and difficult to understand”. Tabachnick and Fidell (1996) explain that the terms regression and correlation are used interchangeably to label the statistical procedures used to assess relations between the dependent and independent variables. However the term *regression* is used specifically when the intent of the analyses is *prediction* and the term *correlation* is used when the intent is simply to assess the *relationship* between the dependent and independent variables.

The types of regression strategies are differentiated by the order of entry of independent variables into the equation and the effect of correlated independent variables on overlapping variability. The hierarchical or sequential regression strategy enters the independent variables into the equation in an order specified by the researcher. Logical or theoretical considerations determine the order of entry of variables (Field, 2005; Tabachnick & Fidell, 1996) (i.e. variables with greater theoretical importance could be prioritised) and each independent variable is assessed in terms of what it adds to the equation at its own point of entry, in this way the unique variance that each predictor adds can be determined. The opposite could also apply whereby ‘nuisance’ variables are given higher priority for entry. However, Field (2005) is of the opinion that as a rule, known predictors from research or theory are entered into the model first in order of their importance for predicting the outcome, this was the method followed in this research study. The analysis proceeds in steps, with information about variables both in and out of the equation given in computer output at each step. Finally after all the variables have been entered, summary statistics are provided along with the information available at the last step.

Hierarchical regression was used to test H_{015} - H_{024}. The use of hierarchical regression as the analytic strategy is supported by the need for testing explicit hypotheses or enabling the researcher to control the advancement of the regression process (Tabachnick & Fidell, 1996). Explicit hypotheses are tested about the proportion of variance attributable to some independent variables after variance due to independent variables already in the equation is accounted for. Thus the research question in this type of strategy is: how much does this independent variable add to multiple R^2 after independent variables with higher priority have contributed their share to prediction of the dependent variable? (Tabachnick & Fidell, 1996). Using hierarchical regression, one can assess the improvement of the model at each stage of the analysis by looking at the change in R^2 and whether this change is significant.

The statistical technique of multiple regression is dependent on certain assumptions and therefore the data was screened for normality, multicollinearity, singularity and homoscedasticity (Field, 2005). The assumptions of multivariate normality were assessed using histograms and relevant statistics and the data was screened for the absence of outliers with the relevant transformations performed to normalise the data (see section 4.2.4).

3.8. Conclusion: Chapter Three

In this chapter the research plan was discussed, from the design of the research study, formulation of hypotheses and the sampling method to the identification of the criterion and predictor measures from the job analysis. Finally, the administration procedure and statistical analysis techniques were discussed. This study followed an *ex-post facto* correlational design aimed at investigating the relationship between the predictors and criteria. This type of research design is non-experimental and aims only to describe the situation between the variables. Several hypotheses were formulated based on the literature review in order to guide the research study.

The sample comprised Military Skills Development trainees (N = 108) in the SA Army Armour corps who had completed the necessary initial training courses required for basic proficiency in the armour corps. The predictor measures comprise three intelligence measures, a measure of training motivation and personality. The criterion measures comprise the trainees' course results which are theoretical assessments of both general military and technical military knowledge. A description of the statistical analyses performed and the results thereof follow.

CHAPTER FOUR: PRESENTATION OF RESEARCH RESULTS

4.1. Introduction

Various statistical techniques were utilised in this study to determine relationships amongst the constructs and the degree to which the independent variables predicted incremental variance in the dependent variables. These statistical techniques were discussed in chapter three whereas the results of the analyses will be discussed in this chapter; beginning with an overview of the descriptive statistics, dimensionality analysis and assumptions underlying multivariate analysis techniques, followed by a detailed discussion of the inferential statistical results.

4.2. Descriptive Statistics

The first step in the statistical analyses involved calculating the descriptive statistics of the predictor and criterion variables (see table 4.1). Descriptive statistics describe samples of subjects in terms of variables or combinations of variables and serve to summarise the data in research investigations (Tabachnick & Fidell, 1996). The analysis of the descriptive statistics is broken down into each assumption underlying the multivariate statistical analyses and follows in the next section.

4.2.1. *Assumptions Underlying Multivariate Statistical Analysis*

In order to draw conclusions about a population based on analyses performed on a sample, several assumptions must be confirmed in order to make those inferences or draw accurate conclusions about the reality that the sample represents (Field, 2005). The assumptions underlying regression are discussed in this section.

4.2.1.1. Accuracy of Data File and Missing Values

Post assessment, all questionnaires were checked for completeness, the original data was proofread against the computerised data and no problems were detected. Prior to analysis, the variables and composite variables were examined for accuracy of data entry, missing values and fit between their distributions and the assumptions of multivariate analysis, using various SPSS programs. The minimum and maximum values, means and standard deviations of each of the variables were inspected for plausibility (results are shown in table 4.1). Three individuals did not complete testing due to certain circumstances resulting in missing values on the *g* composites, however available data were retained to maximise the sample size (*N*). Subsequent analyses were conducted excluding cases PAIRWISE, to account for the three cases containing missing values.

Analysis of the descriptives (table 4.1) of all variables revealed low standard deviations in the general soldiering training proficiency criterion as well as the openness to experience and conscientiousness subscales. This, in conjunction with the small range (4 to 7) of the two personality subscales, was expected to inhibit resulting correlations because of range restriction.

4.2.1.2. Ratio of Cases to Independent Variables

According to Tabachnick and Fidell (1996) a sample size of $N \geq 50 + 8m$ is required for testing multiple correlation and $N \geq 104 + m$ is required for testing individual predictors, where m is the number of independent variables. There are five predictors in this sample, therefore adequate sample size of $N = 90$ in the case of the first equation and $N = 109$ in the case of the second equation was estimated. Against these criteria, the sample size in this study, N=108 was deemed sufficient for adequate statistical power for the main regression analyses that were used to test the hypotheses.

4.2.1.3. Outliers

An outlier is a case that differs substantially from the main trend of the data which bias the mean and inflate the standard deviation (Field, 2005). Tabachnick and Fidell (1996) further distinguish between univariate and multivariate outliers; a univariate outlier being an extreme value on one variable whereas a multivariate outlier is a strange combination of scores on two or more variables.

4.2.1.3.1. Univariate outliers.

The presence of univariate outliers was explored by means of boxplots. Three cases in the hand-eye coordination and two cases in the general soldiering proficiency variables were identified as outliers, even though they were not categorised as extreme (i.e., values larger than three standard deviations above the mean). The researchers refrained from deleting these cases from the initial analyses since they did not seriously affect the mean once they were deleted (as shown in table 4.2) and it was intended that a maximum number of cases be preserved for analysis due to a limited sample size.

4.2.1.3.2. Multivariate outliers.

The Mahalanobis distance is the distance of a case from the centroid of the remaining cases where the centroid is the point created at the intersection of the means of all the variables (Tabachnick & Fidell, 1996). This statistic is used to detect multivariate outliers by comparing the distance values against a chi-square value for five degrees of freedom (one degree of freedom for each independent variable) and $p < .001$. Therefore the chi-square value is calculated to be 20.515 and any distance values bigger than this value would be considered a multivariate outlier. No cases were identified through Mahalanobis distance as multivariate outliers with $p < 0.001$.

4.2.1.3.3. Residual outliers.

Examination of residuals' scatterplots provides a test of assumptions of normality, linearity, and homoscedasticity between predicted dependent variable scores and errors of prediction (Tabachnick & Fidell, 1996). Assumptions of regression analysis are that the residuals are normally distributed around the predicted dependent variable scores, that residuals have a straight-line relationship with predicted dependent variable scores and that the variance of the residuals about predicted dependent variable scores is the same for all predicted scores (Tabachnick & Fidell, 1996). Two residual outliers were identified (one per dependent variable) with an absolute standardised residual greater than three. In order to obtain a more reliable regression analysis, both of these outliers were eliminated from further analyses.

Table 4.1
Analysis of Univariate Descriptives of all Variables

Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance	Skewness		Kurtosis	
Variable	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Openness to Exp Sub-scale	108	3	4	7	6.44	.792	.628	-1.523	.233	1.585	.461
Conscientiousness Sub-scale	108	3	4	7	6.71	.619	.384	-2.614	.233	6.994	.461
Valence Sub-scale	108	12	3	15	12.92	2.989	8.937	-2.020	.233	3.980	.461
Instrumentality Sub-scale	108	16	4	20	14.72	4.370	19.100	-.788	.233	-.228	.461
Expectancy Sub-scale	108	12	3	15	13.44	1.795	3.221	-2.176	.233	9.396	.461
Motivation Composite	108	38.000	12.000	50.000	41.083	7.636	58.301	-1.303	.233	1.878	.461
Verbal Factor –Raw	105	37	27	64	44.96	7.935	62.960	.140	.236	-.453	.467
Visual Spatial –Raw	105	35	37	72	60.71	7.317	53.533	-.656	.236	.236	.467
Hand-Eye Coordination –Raw	105	108	61	169	108.88	19.436	377.744	.411	.236	.3897	.467
Total CTTP Score	108	28	65	92	79.22	5.605	31.415	.005	.233	-.327	.461
Total GSTP Score	108	25	68	93	80.85	4.457	19.866	-.073	.233	.214	.461
Valid N (listwise)	105										

Note. CTTP – Core Technical Training Proficiency
GSTP – General Soldiering Training Proficiency

Table 4.2
Comparison of Means Post Deletion of Univariate Outliers on the Hand-eye Coordination Variable

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Hand-eye coordination - raw	102	69	152	108.29	17.554
Hand-eye coordination - raw	104	61	156	108.30	18.600
Hand-eye coordination - raw	105	61	169	108.88	19.436

4.2.1.4. Normality, Linearity and Homoscedasticity

Underlying multivariate procedures is the assumption of multivariate normality, which is the assumption that each variable and all linear combinations of the variables are normally distributed (Tabachnick & Fidell, 1996). When the assumption is met, the residuals of analysis are also normally distributed and independent. Statistical inference becomes less and less robust as distributions depart from normality and even when the statistics are used purely descriptively, normality, linearity and homoscedasticity of variables enhance the analysis (Tabachnick & Fidell, 1996). The assumption of multivariate normality applies differently to different multivariate statistics; for analyses where subjects are not grouped the assumption applies to the distribution of the variables themselves or to the residuals of the analyses.

Normality: To assess normality of the distribution of the variables in the model the researchers conducted one-sample Kolmogorov-Smirnov tests, which test the null hypothesis that a sample comes from a particular distribution. Findings, as shown in table 4.4, indicate that all variables are normally distributed except the training motivation composite and openness to experience subscale, which are significantly negatively skewed. To improve pairwise linearity and to reduce skewness thereby improving normality, the motivation and openness to experience variables were logarithmically transformed. The one-sample Kolmogorov-Smirnov tests were repeated post transformations. While the Kolmogorov-Smirnov p values for openness to experience remained unchanged (.000), the *p* values for motivation increased from .037 to .065 as shown in table 4.4 (*p* values should be greater than .05). Although transformation of the variable changed the Kolmogorov-Smirnov value to greater than .05, the effect of transformation was minimal and therefore not retained due to the complication it would present to the interpretation of the results of subsequent analyses. A second reason exists for rejecting the transformations to reduce skewness. It is possible that the population of military trainees is not normally distributed in terms of motivation and openness to experience and it may be unrealistic to expect a normal distribution. Logically, individuals on training programs which are important to them would exhibit higher motivation in general, since high valence is the anticipated attractiveness or desirability of an outcome. Furthermore, since the nature of the military occupation is one in which openness to change and new experiences are desirable qualities, the high degree of self-selection and organisational selection can be expected to result in individuals with higher levels of openness to experience. Hence the assumption that these two variable scores come from a normal distribution can be questioned.

Linearity: The assumption of linearity is that there is a straight-line relationship between two variables (where one or both variables can be combinations of several variables) (Tabachnick & Fidell, 1996). Linearity between two variables was assessed by inspection of bivariate scatterplots and it was found that the variables were linearly related in all cases; there were no serious deviations from linearity as judged by the scatterplots.

Homoscedasticity: The assumption of homoscedasticity is that the variability in scores for one continuous variable is roughly the same at all values of another continuous variable (Tabachnick & Fidell, 1996). Homoscedasticity is related to the assumption of normality because when the assumption of multivariate normality is met, the relationships between the variables are homoscedastic (Tabachnick & Fidell, 1996). Homoscedasticity was assessed by inspection of bivariate scatterplots, which should be roughly the same width all over with some bulging toward the middle. Investigation of the scatterplots indicated that overall, the assumption of homoscedasticity held, although there was a slight indication of heteroscedasticity between motivation and hand-eye coordination. According to Tabachnick and Fidell (1996) the failure of homoscedasticity (i.e., heteroscedasticity) is caused either by non-normality of one of the variables or by the fact that one variable is related to some transformation of the other.

4.2.1.5. Multicollinearity and Singularity

Multicollinearity and singularity are problems with a correlation matrix that occur when variables are too highly correlated; with multicollinearity the variables are very highly correlated (.90) and with singularity the variables are redundant, in other words, one of the variables is a combination of two or more of the other variables (Tabachnick & Fidell, 1996). Either bivariate or multivariate correlations can create multicollinearity or singularity, if a bivariate correlation is too high it shows up in a correlation matrix as a correlation above .90.

The determinants revealed in the factor analyses of the subscales of each predictor (training motivation and personality) indicated that multicollinearity was not problematic. The Variance Inflation Factor (VIF) statistics for the two criteria, general soldiering proficiency and core technical training proficiency, were all less than the critical value of ten, and the tolerance statistics were above the critical value of .1. However the critical condition indices violate the critical cut-offs for both models (greater than 15 and 30). Singularity was not evident through the analyses. The collinearity diagnostic results are shown in table 4.5 and table 4.6.

4.2.1.6. Comparison of Means on all Variables between Functional Groups

It was suspected that there may be differences in test performance between trainees since the sample comprises members from two different units (1 Special service Battalion and 1 SA Tank Regiment) which is why there were two types of functional training (as discussed in chapter three). As a result the means on the predictors and criteria were compared to control for this possibility. As shown in table 4.3, there were no statistically significant differences in the means across all variables.

Table 4.3

Comparison of Means on all Variables between Functional Groups

Group Statistics

Variable	Unit	N	Mean	Std. Deviation	Std. Error Mean
Verbal Composite –Raw	1SSB	65	45.48	7.744	.961
	1SATR	40	44.12	8.265	1.307
Visual Spatial Composite-Raw	1SSB	65	60.57	7.558	.937
	1SATR	40	60.95	6.994	1.106
Hand-Eye Coordination -Raw	1SSB	65	112.00	21.287	2.640
	1SATR	40	103.80	14.866	2.350
Motivation Composite	1SSB	68	38.838	8.321	1.009
	1SATR	40	44.900	4.156	.657
Openness to Exp Sub-scale	1SSB	68	6.58	.689	.084
	1SATR	40	6.21	.905	.143
Core Technical Training Proficiency	1SSB	68	78.00	5.422	.658
	1SATR	40	81.28	5.363	.848
General Soldiering Training Proficiency	1SSB	68	81.52	4.207	.510
	1SATR	40	79.70	4.685	.741

4.3. Item Analysis

The items comprising a test or questionnaire are constructed to reflect variance in each of the subscales. Internal consistency is a measure of reliability which refers to the degree to which the items that make up a scale are all measuring the same underlying attribute. Cronbach's coefficient alpha, which provides an indication of the average correlation among all of the items that make up the scale, was used to determine the reliability of the subscales (Field, 2005; Nunnally, 1978; Tabachnick & Fidell, 1996). Reliability analysis is therefore necessary to determine the degree of dependability, consistency or stability of a measure and subsequently scores on that measure (Gatewood & Feild, 1994). According to Nunnally (1978) an acceptable reliability coefficient is a minimum of .7 in most applications of basic research, although higher values should be used when test scores are used for selection decision-making.

Table 4.4

Kolmogorov-Smirnov Test of Normality, Pre and Post Transformation

One-Sample Kolmogorov-Smirnov Test

		Openness to Exp subscale	Log Transformed Openness to Exp	Motivation Composite	Log Transformed Motivation	Valence subscale	Instrumentality Sub-scale	Expectancy Sub-scale	Verbal Composite Raw	Visual-Spatial Composite Raw	Hand-Eye-Co-ord Composite Raw	Total CTTP Score	Total GSTP Score
N		108	108	108	108	108	108	108	105	105	105	108	108
Normal Parameters[a]	Mean	6.44	.15	41.083	.85	12.92	14.72	13.44	44.96	60.71	108.88	79.22	80.85
	Std. Deviation	.792	.186	7.636	.397	2.989	4.370	1.796	7.935	7.317	19.436	5.605	4.457
Most Extreme Differences	Absolute	.295	.324	.136	.126	.243	.152	.196	.087	.092	.084	.049	.046
	Positive	.242	.324	.121	.076	.243	.114	.193	.087	.061	.084	.049	.037
	Negative	-.295	-.213	-.136	-.126	-.211	-.152	-.196	-.061	-.092	-.040	-.047	-.046
Kolmogorov-Smirnov Z		3.070	3.370	1.415	1.308	2.525	1.580	2.033	.886	.946	.858	.514	.481
Asymp. Sig. (2-tailed)		.000	.000	.037	.065	.000	.014	.001	.412	.332	.453	.955	.975

Note. Test distribution is Normal.

CTTP – Core Technical Training Proficiency

GSTP – General Soldiering Training Proficiency

Table 4.5

Collinearity Diagnostics for General Soldiering Training Proficiency

Coefficients[a]

	Model	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	T	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	63.201	5.126		12.329	.000		
	Verbal Composite –Raw	.233	.057	.433	4.116	.000	.691	1.447
	Visual Spatial Composite –Raw	.070	.057	.121	1.214	.228	.765	1.306
	Hand-Eye Co-ord Composite – Raw	.017	.022	.071	.765	.446	.880	1.137
	Motivation Composite	.003	.049	.006	.063	.950	.939	1.065
	Openness to Exp Sub-scale	.172	.478	.032	.360	.719	.957	1.045

Note. Dependent Variable: General Soldiering Training Proficiency
N=100

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions (Constant)	Verbal Composite – Raw	Visual Spatial Composite - Raw	Hand-Eye Co-ord Composite – Raw	Motivation Composite	Openness to Exp Sub-scale
1	1	5.907	1.000	.00	.00	.00	.00	.00	.00
	2	.042	11.921	.00	.09	.00	.07	.50	.00
	3	.022	16.347	.00	.22	.08	.61	.00	.00
	4	.015	19.943	.01	.25	.01	.08	.31	.53
	5	.011	23.652	.02	.41	.54	.01	.03	.26
	6	.004	38.808	.96	.03	.37	.23	.15	.21

Note. Dependent Variable: General Soldiering Training Proficiency
N=100

Table 4.6

Collinearity Diagnostics for Core Technical Training Proficiency

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	T	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	72.518	7.233		10.026	.000		
	Verbal Composite Raw	.086	.079	.121	1.087	.280	.669	1.496
	Visual-Spatial Composite Raw	.097	.081	.127	1.201	.233	.744	1.344
	Hand-Eye Co-ord Composite Raw	-.048	.032	-.147	-1.522	.131	.889	1.125
	Motivation Composite	.280	.072	.365	3.919	.000	.957	1.045
	Openness to exp subscale	-1.503	.647	-.214	-2.321	.022	.976	1.025

Note. Dependent Variable: Core Technical Training Proficiency

N = 101

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions (Constant)	Verbal Composite Raw	Visual-Spatial Composite Raw	Hand-eye Co-ord Composite Raw	Motivation Composite	Openness to exp subscale
1	1	5.909	1.000	.00	.00	.00	.00	.00	.00
	2	.038	12.409	.00	.14	.01	.05	.45	.01
	3	.022	16.468	.00	.17	.08	.66	.00	.00
	4	.016	19.100	.01	.13	.00	.05	.36	.59
	5	.010	23.819	.03	.52	.54	.01	.08	.17
	6	.004	39.066	.96	.03	.38	.23	.12	.23

Note. Dependent Variable: Core Technical Training Proficiency

N = 101

4.3.1. Training Motivation

The motivation subscales of the Training Survey Questionnaire were analysed through the SPSS RELIABILTY procedure to identify and perhaps eliminate items not contributing to an internally consistent description of the dimensions under investigation. The results of the item analyses of the motivation subscales are shown in tables 4.7 to 4.9. Inspection of the reliability coefficients of the subscales revealed reasonably high alpha values; valence (.957), instrumentality (.904) and expectancy (.764), all higher than the recommended value of .7 (Nunnally, 1978).

Through item analysis two items, one in the instrumentality subscale (item 6) and one in the expectancy subscale (item 10), were flagged as being somewhat problematic. However due to the fact that there are a limited number of items in each subscale, the decision was made to retain these two items.

4.3.2. Personality

Cronbach alpha values are dependent on the number of items in the scale; when there are a small number of items (less than 10) Cronbach alpha values could be quite small (Nunnally, 1978). Since there are only two items comprising each subscale of the Ten Item Personality Inventory (TIPI) it was not meaningful to determine the Cronbach alpha values and in this instance the mean inter-item correlations are reported (N = 108) (see table 4.10). Optimal mean inter-item correlation values range from .2 to .4 (Nunnally, 1978). The authors of the TIPI report test-retest reliability coefficients which are shown in table 3.5.

Table 4.7

Reliability Analysis of the Valence Subscale

Item-Total Statistics

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Valence Item 1	8.57	4.116	.907	.827	.937
Valence Item 2	8.65	4.062	.896	.804	.945
Valence Item 3	8.61	3.997	.921	.848	.927

Reliability Coefficients

N of Cases = 108.0 N of Items = 3

Alpha = .957

Table 4.8

Reliability Analysis of the Instrumentality Subscale

Item-Total Statistics

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Instrumentality Item 4	10.95	10.998	.775	.649	.880
Instrumentality Item 5	11.15	9.978	.871	.772	.843
Instrumentality Item 6	11.01	12.290	.671	.471	.914
Instrumentality Item 7	11.06	11.081	.832	.707	.860

Reliability Coefficients

N of Cases = 108.0 N of Items = 4

Alpha = .904

Table 4.9

Reliability Analysis of the Expectancy Subscale

Item-Total Statistics

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Expectancy Item 8	9.06	1.407	.592	.412	.703
Expectancy Item 9	8.94	1.631	.706	.501	.578
Expectancy Item 10	8.89	1.763	.518	.302	.766

Reliability Coefficients

N of Cases = 108.0 N of Items = 3

Alpha = .764

Table 4.10

Mean Inter-Item Correlations of the Conscientiousness and Openness to Experience Subscales

Correlations

Item		Conscientiousness Item 3	Conscientiousness Item 8	Openness to Exp Item 5	Openness to Exp Item 10
Conscientiousness Item 3	Pearson Correlation	1.000	.041	-.086	.099
	Sig. (1-tailed)		.338	.188	.155
Conscientiousness Item 8	Pearson Correlation	.041	1.000	.074	.216*
	Sig. (1-tailed)	.338		.222	.012
Openness to Exp Item 5	Pearson Correlation	-.086	.074	1.000	.174*
	Sig. (1-tailed)	.188	.222		.036
Openness to Exp Item 10	Pearson Correlation	.099	.216*	.174*	1.000
	Sig. (1-tailed)	.155	.012	.036	

Note. $N = 108$

* Correlation is significant at the 0.05 level (1-tailed)

Inter-item correlations for the two subscales are generally low (all are below $r = .3$), indicating that the items do not correlate well within the two scales. However, there is a statistically significant positive relationship between items 5 and 10, both intending to measure openness to experience. $R = .174$, p (one-tailed) $< .05$.

There is no statistical relationship between item 3 (dependable, self disciplined) and 8 (disorganised, careless) ($r = .041$, p (one-tailed) $> .05$) which is discouraging as these items are intended to reflect the same construct – conscientiousness. However a significant correlation was found between item 8 intending to measure conscientiousness and item 10 intending to measure openness to experience $r =.216$, p (one-tailed) $< .05$ indicating an overlap between the two scales.

Furthermore item 3 (dependable, self-disciplined) also correlates positively with item 10 (conventional, uncreative) ($r = .099$, p (one-tailed) $> .05$); however, this relationship is not statistically significant. Given these findings, it was decided to retain only the openness to experience subscale. The conscientiousness subscale was excluded from further analyses due to poor inter-item correlations (low internal consistency).

4.3.3. General Cognitive Ability

Each of the cognitive ability tests used in this study are established tests, widely used in South African samples (with acceptable psychometric properties) and therefore the reliability coefficients were not computed in this study. The reliability coefficients for the respective tests in previous studies are reported in tables 3.2 to 3.4.

4.4. Dimensionality Analysis

Principal axis factoring with varimax rotation was subsequently performed on each subscale comprising the general cognitive ability predictor and on the items comprising the training motivation and personality predictors to further evaluate the extent to which each item reflects a single, common underlying construct. According to Wilkinson, Blank and Gruber (1996) principal components analysis (PCA) and common factor analysis or principal axis factoring will lead to similar substantive conclusions. However PCA is generally preferred for purposes of data reduction whereas common factor analysis is preferred when the research purpose is detecting data structure or causal modelling. Tabachnick and Fidell (1996) add that the choice between PCA and factor analysis depends on one's assessment of the fit between models, the data set and the goals of the research. Since the goals of this research were to determine causality underpinned by theory, the principal axis factoring technique was used. The objective of these analyses was to confirm the uni-dimensionality of each subscale and to remove items with inadequate factor loadings (Theron, 2006). The Kaiser criterion (i.e., eigenvalue-greater-than-unity) and scree plots were used to determine the number of factors to extract (Theron, 2006).

4.4.1. Training Motivation

The results of the foregoing analyses indicated that the subscales (valence, instrumentality and expectancy) comprising the construct of training motivation are uni-dimensional and factor loadings are satisfactory ranging between .594 and .929 (see table 4.11). Correlations between the items within each subscale range between .411 and .896 which seems to suggest that the items generally do reflect their designated latent variable with reasonable success. Exploratory factor analysis conducted on the items of the three subscales simultaneously, confirmed the three-factor structure of this construct. The eigenvalues for the three factors are as follows: valence (5.384), instrumentality (1.521) and expectancy (1.203) thereby contributing 53.8%, 15.2% and 12% respectively of the variance in the scale. The cumulative variance contributed by the three factors is 81.084%. Furthermore, the determinant of each scale is greater than .00001 indicating that multicollinearity is not problematic (Field, 2005).

Table 4.11

Factor Loadings of all Items Comprising the Training Motivation Construct

Rotated Factor Matrix[a]

Item	Factor 1	Factor 2	Factor 3
Valence Item 1	.887	.251	.155
Valence Item 2	.846	.282	.173
Valence Item 3	.929	.224	.161
Instrumentality Item 4	.479	.668	.242
Instrumentality Item 5	.375	.819	.232
Instrumentality Item 6	.054	.720	.248
Instrumentality Item 7	.329	.808	.151
Expectancy Item 8	.269	.231	.634
Expectancy Item 9	.162	.138	.867
Expectancy Item 10	.034	.178	.594

Note. Extraction Method: Principal Axis Factoring

Rotation Method: Varimax with Kaiser Normalization

Rotation converged in 5 iterations

4.4.2. Personality

The inter-item correlation matrix of this measure was analysed for the hypothesised constructs according to the TIPI model due to the small number of items. From the five subscales of the TIPI, only the openness to experience subscale was observed through a statistically significant inter-item correlation ($r = .174$, p (one-tailed) $< .05$) (see table 4.10).

The items of the remaining four subscales showed no statistically significant relationships within subscales and, in some cases, correlations across subscales were found as well as a number of other inter-correlations not proposed by the model. Factor analysis of all items measuring the five subscales was subsequently performed and five factors emerged as shown in table 4.12, although these were not the five factors as hypothesised by the authors. The researchers found a strong factor for neuroticism (items 2 and 4) and another factor (items 7 and 8), but this factor was not interpretable.

A possible explanation for the factor-split of the subscales may be due to a language problem as participants may not have understood the meaning of the items. This question should be addressed in further research.

4.4.3. General Cognitive Ability (g)

Factor analysis was performed on the raw scores of the measures of intelligence in order to identify groupings of abilities, in other words to construct composite measures for the subsequent regression analyses. The results indicated the emergence of three clear factors using the criterion of factor loadings >.4 (rotated factor loadings are provided in table 4.13). These three factors are identified as: verbal intelligence (subtests: vocabulary, reading comprehension, listening Potential), visual-spatial reasoning (subtests: spatial visualisation, mechanical insight, conceptualisation) and hand-eye coordination (subtests: writing speed, hand-eye coordination). As a control, factor analysis was subsequently conducted on the norm scores of the measures and the same factors emerged with similar factor loadings.

Table 4.12

Factor Loadings of all Items Comprising the TIPI Subscales

Rotated Factor Matrix[a]

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Extraversion Item 1	.075	-.190	-.121	.061	.271
Extraversion Item 6	-.110	.027	.034	-.030	.460
Agreeableness Item 2	-.002	.008	.540	.107	-.080
Agreeableness Item 7	.896	.141	-.097	.004	-.162
Conscientiousness Item 3	.028	.047	.055	.778	.045
Conscientiousness Item 8	.439	.103	.177	.019	.163
Emotional Stability Item 4	.076	-.062	.690	-.059	.074
Emotional Stability Item 9	.180	.822	-.033	.168	-.075
Openness to Experience Item 5	.175	.350	-.082	-.121	.252
Openness to Experience Item 10	.247	.076	.031	.083	.345

Note. Extraction Method: Principal Axis Factoring
Rotation Method: Varimax with Kaiser Normalization
Rotation converged in 8 iterations

Table 4.13

Factor Loadings of all General Cognitive Ability Predictors

Rotated Factor Matrix[a]

Test	Factor 1	Factor 2	Factor 3
DAT 1 – Vocabulary			
Candidates Total Score	.858	.130	.163
DAT 5 – Reading			
Comprehension			
Candidates Total Score	.644	.246	.087
DAT 7 - Spatial Visualisation	.		
Candidates Total Score	352	.510	-.190
DAT 8 – Mechanical Insight			
Candidates Total Score	.441	.459	-.389
SPEEX 100 –			
Conceptualisation			
Candidates Total Score	.166	.627	.086
SPEEX 400 – Observance			
Candidates Total Score	.108	.443	.097
SPEEX 1700 – Listening	.		
Potential			
Candidates Total Score	556	.282	.028
SAT 11 – Hand-Eye			
Coordination			
Candidates Final Score	.222	.122	.421
SAT 12 – Writing Speed		-	
Candidates Total Score	-.009	.008	.530

Note. Extraction Method: Principal Axis Factoring

Rotation Method: Varimax with Kaiser Normalization

Rotation converged in 6 iterations

4.5. Reliability of Composite Measures

Following the item and dimensionality analysis, the reliability of the composite measures was explored. Composites were formed as the sample size in this study prohibited the use of too many predictors (see paragraph 3.5.2.1 and 3.5.2.2). Secondly, in combining the predictors, the reliability of measurement increases (Nunnally, 1978). The reliability of the composite measures was calculated using the following formula by Murphy and Davidshofer (2005):

$$r_{ss} = 1 - \frac{k - (k\overline{r_{ii}})}{k + (k^2 - k)\,\overline{r_{ij}}}$$

Where:

r_{ss} = reliability of the sum of scores
k = number of tests
r_{ii} = average test reliability
r_{ij} = average correlation between tests

The composite reliabilities for general cognitive ability were computed as follows: verbal intelligence = .88, visual-spatial intelligence = .9 and hand-eye coordination = .91 whereas the composite reliability for training motivation is .94.

4.6. Results

Once it had been determined that the data set met the assumptions or requirements for statistical analysis, the next step was to test the hypotheses (see chapter 3, section 3.3). Firstly the inter-correlation results are discussed followed by a presentation of the multiple regression results.

4.6.1. Inter-Correlations

The first objective was to determine if relationships between the constructs or variables in this study exist and, more specifically, how these relationships relate to the original hypotheses. Correlation is the measure of the size and direction of the linear relationship between two variables, whereas squared correlation is the measure of the strength of association between variables (Tabachnick & Fidell, 1996). Correlation however, does not indicate causality; rather regression is used to predict one variable from another. Pearson's product-moment correlation coefficient, r, has been used to establish the nature of the various relationships between the variables. According to

Tabachnick and Fidell (1996) this statistic is the most frequently used measure of association and the basis of many multivariate calculations.

Prior to the calculation of the Pearson product-moment correlation coefficients, preliminary analyses were performed to ensure there were no violations of the assumptions underlying multivariate statistical analysis, specifically, normality, linearity and homoscedasticity as discussed in section 4.2.1.

The inter-correlations between each predictor and each criterion (general soldiering training proficiency and core technical training proficiency) follow as relating to the hypotheses set in section 3.3, beginning with the measures of general cognitive ability (*g*) followed by training motivation and openness to experience. The intercorrelations are shown in table 4.14.

4.6.1.1. The Relationship between Verbal Intelligence and General Soldiering Training Proficiency

The relationship between a trainee's verbal intelligence (as measured by three general cognitive ability tests) and general soldiering training proficiency (as measured by obtaining an average score for theoretical assessments covering a number of modules) was investigated using Pearson's product-moment correlation coefficient. From the correlation matrix (table 4.14) it can be seen that a moderate, positive and significant relationship exists between these two variables $r = .510$, p (one-tailed) $< .01$, confirming hypothesis one.

The implication of this finding is that an increase in trainees' level of verbal intelligence would be related to an increase in their performance on theoretical assessments. This finding is consistent with the extensive literature on the relationship between general cognitive ability and training performance, specifically that the acquisition of knowledge and skills depends on learning and that since learning depends on individual differences in cognitive ability, general cognitive ability should predict success in training (Ree et al., 1994; Schmidt & Hunter, 1998).

4.6.1.2. The Relationship between Verbal Intelligence and Core Technical Training Proficiency

The analysis of the relationship between verbal intelligence and a trainee's core technical training proficiency (as measured by obtaining an average of the scores on theoretical assessments covering a number of modules) revealed a positive, yet insignificant relationship between these two variables $r = .059$, p (one-tailed) > .05 (table 4.14). Therefore hypothesis two, stating that a significant positive relationship exists between verbal intelligence and core technical training proficiency, could not be corroborated since there was insufficient evidence to reject H_{02}. This insignificant correlation contradicts previous research findings (Anderson et al., 2001; Colquitt et al., 2000; Hunter, 1986; Hunter & Burke, 1994; Ree et al., 2001) and evidence in this study, where it was found that verbal intelligence was related to general soldiering training proficiency (see paragraph 4.6.1.1). It would be expected that verbal intelligence would be related to performance on both training programs, specifically in theoretical assessments, regardless of course content.

4.6.1.3. The Relationship between Visual-Spatial Intelligence and General Soldiering Training Proficiency

The correlation matrix (table 4.14) indicates that there is a moderate, positive and significant correlation between visual-spatial reasoning (as measured by three general cognitive ability tests) and general soldiering training proficiency, $r = .325$, p (one tailed) < .01, with high levels of visual-spatial reasoning associated with high levels of performance in general soldiering training assessments. H_{03} is therefore rejected in favour of H_{a4}, thus confirming hypothesis three.

4.6.1.4. The Relationship between Visual-Spatial Intelligence and Core Technical Training Proficiency

Hypothesis four stating that a significantly positive relationship exists between a trainee's visual-spatial intelligence and core technical training proficiency was confirmed through the analyses as there is a weak yet significant correlation, $r = .162$, p (one-tailed) < .05 as indicated in table 4.14.

4.6.1.5. The Relationship between Hand-Eye Coordination and General Soldiering Training Proficiency

The relationship between these two variables was found to be insignificant, r = .093, p (one-tailed) > .05 as shown in table 4.14, H_{a5} is thus rejected.

4.6.1.6. The Relationship between Hand-eye Coordination and Core Technical Training Proficiency

There is insufficient evidence to support hypothesis six; a negative and insignificant relationship exists between hand-eye coordination and core technical training proficiency r = -.096, p (one-tailed) > .05 (table 4.14). The same results were found for general soldiering training proficiency and may in part be explained by the logic that hand-eye coordination may be unrelated to theoretical nature of the training criterion measures in this training program.

4.6.1.7. The Relationship between Verbal Intelligence, Visual-Spatial Intelligence, Hand-Eye Coordination and Training Motivation

There is insufficient evidence to reject H_{07}, H_{08} and H_{09}, since these hypotheses proposed a positive relationship between the measures of intelligence and training motivation (as measured by the VIEMS). Findings from the correlation analysis of both dependent variables indicated that there is a negative relationship between motivation and intelligence. From table 4.14 it is shown that verbal intelligence and motivation r = -.138, p (one-tailed) > .05, visual-spatial reasoning and motivation r = -.050, p (one-tailed) > .05 as well as hand-eye coordination and motivation r = -.156, p (one-tailed) > .05 are negatively related and therefore the three hypotheses are rejected.

4.6.1.8. The Relationship between Training Motivation and General Soldiering Training Proficiency

The correlation matrix as reported in table 4.14 indicates that the relationship between these two variables is negative (r = -.066, p (one-tailed) > .05) and not statistically significant, thus H_{010} could not be rejected.

4.6.1.9. The Relationship between Training Motivation and Core Technical Training Proficiency

From the results of the analyses as presented in table 4.14, it can be seen that there is a positive and significant moderate relationship between training motivation and core technical training proficiency (r = .246, p (one-tailed) < .01), with high levels of motivation associated with increased performance in core tasks. H_{011} is therefore rejected in favour of H_{a11}. This finding is consistent with that found by Colquitt et al. (2000) showing that there is a relationship between motivation and general cognitive ability.

4.6.1.10. The Relationship between Openness to Experience and General Soldiering Training Proficiency

The relationship between openness to experience (as measured by the TIPI) and general soldiering training proficiency was found to be positive yet insignificant, r =.107, p (one-tailed) > .05. H_{12} could therefore not be rejected; results are shown in table 4.14.

4.6.1.11. The Relationship between Openness to Experience and Core Technical Training Proficiency

Hypothesis 13 stating that there is a significantly positive relationship between openness to experience and core technical training proficiency could not be confirmed (r = -.137, p (one-tailed) > .05) (table 4.14), suggesting that higher levels of openness to experience are associated with decreased performance levels in core technical theoretical assessments. This finding may in part be explained by the fact that theoretical assessments may not be perceived as tasks requiring an open mind, rather with more practical tasks trainees are given an opportunity to explore. The findings regarding Hypothesis H_{012} and H_{013} seem to contradict previous research findings linking openness to experience to motivation (Pike et al., 2002).

4.6.1.12. The Relationship between Openness to Experience and Training Motivation

Findings indicate that while there is a positive relationship between openness to experience and training motivation, the relationship is not significant r = .089, p (one-tailed) > .05 (table 4.14).

4.6.1.13. Additional Correlations Indicated by the Data Analysis

During the data analysis, a number of correlations between the predictor measures were found and are shown in table 4.14. A significant positive and moderate correlation was found between verbal intelligence and visual-spatial reasoning $r = .493$, p (one-tailed) $< .01$ and between verbal intelligence and hand-eye coordination $r = .220$, p (one-tailed) $<.05$ for both criteria. These findings would be expected given the underlying common factor of all three measures which is *g* (Anderson et al., 2001; Ree et al., 1994; Schmidt & Hunter, 1998).

4.6.2. Corrections for Unreliability and Restriction of Range

In the section on scientific selection (section two) the concepts of reliability and validity were discussed and it was pointed out that a measure will always have a degree of error associated with it and hence a measure will never have perfect reliability (Gatewood & Field, 1994; Guion, 1965; Nunnally, 1978). In this regard, observed correlations between predictors and criteria may be underestimated due to this error. Therefore correcting the correlations for attenuation, either due to unreliability or restriction of range, gives an estimate of what the correlation between two variables would be if the measure of each variable were perfectly reliable (Nunnally, 1978). In other words, correction is used to determine what the increase in a correlation would be if the reliability of the measures used increased. However correcting the correlation for attenuating effects also affects the standard error of the correlation and hence Theron (in Nunes, 2003, p.104) states that “the effect of the corrections could thus be that of increasing, decreasing or leaving unaltered the posteriori probability of rejecting H_0”.

Unreliability of Criterion: Since reliability is a necessary condition for validity, it is usually deemed appropriate to correct observed correlations for imperfect measurement in the form of unreliability (American, Psychological Association, 2003). It is important for theoretical and practical purposes to ask what the correlation would be if two variables were measured with perfect reliability, but, in personnel research this question is rarely important.

Table 4.14

Correlations between Predictors and Criteria

Correlations

Variable		Verbal Composite Raw (ξ1)	Visual-Spatial Composite Raw (ξ2)	Hand-Eye Co-ord Composite Raw (ξ3)	Openness to Exp Sub-scale (ξ5)	Motivation Composite (ξ4)	Total CTTP Score (η2)	Total GSTP Score (η1)
Verbal Composite Raw (ξ1)	Pearson Correlation	1.000	.493**	.220*	.099	-.138	.059	.510**
	Sig. (1-tailed)		.000	.012	.157	.080	.274	.000
Visual-Spatial Composite Raw (ξ2)	Pearson Correlation	.493**	1.000	.021	.070	-.050	.162*	.325**
	Sig. (1-tailed)	.000		.415	.239	.304	.049	.000
Hand-Eye Co-ord Composite Raw (ξ3)	Pearson Correlation	.220*	.021	1.000	.030	-.156	-.096	.093
	Sig. (1-tailed)	.012	.415		.381	.056	.164	.173
Openness to Exp Sub-scale (ξ5)	Pearson Correlation	.099	.070	.030	1.000	.089	-.137	.107
	Sig. (1-tailed)	.157	.239	.381		.180	.079	.135
Motivation Composite (ξ4)	Pearson Correlation	-.138	-.050	-.156	.089	1.000	.246**	-.066
	Sig. (1-tailed)	.080	.304	.056	.180		.005	.247
Total CTTP Score (η2)	Pearson Correlation	.059	.162*	-.096	-.137	.246**	1.000	.145
	Sig. (1-tailed)	.274	.049	.164	.079	.005		.067
Total GSTP Score (η1)	Pearson Correlation	.510**	.325**	.093	.107	-.066	.145	1.000
	Sig. (1-tailed)	.000	.000	.173	.135	.247	.067	

Note. N = 105 to 108 due to missing data.

GSTP – General Soldiering Training Proficiency

CTTP – Core Technical Training Proficiency

**. Correlation is significant at the 0.01 level (1-tailed)

*. Correlation is significant at the 0.05 level (1-tailed)

Correcting for attenuation in criterion unreliability only is favoured since correcting for predictor unreliability makes little sense in selection research (Guion & Highhouse, 2006; Schmitt & Chan, 1998). Guion and Highhouse (2006) state: "when we have an imperfect employment test, we use it anyway, use something else, or improve its reliability; in any case, we use a less than perfectly reliable test…it is useful to know how much of *reliable* criterion variance is associated with predictor variance" (p. 124). The correlation coefficients were corrected for attenuation due to criterion unreliability using the following formula by Schmitt and Chan (1998):

$$r'_{xy} = \frac{r_{xy}}{\sqrt{r_{yy}}}$$

Where:

r'_{xy} = correlation between x and y, corrected for attenuation

r_x = original observed correlation between x and y

r_{yy} = reliability of the criterion

Restriction of Range: When variance on either variable in a bivariate relationship is substantially less than within the population, the observed correlation coefficient underestimates population validity (Guion & Highhouse, 2006). In this study, variances are known for both the unrestricted and the restricted group, so the corrected correlation between x and y for restriction of range can be obtained using the following equation (direct truncation on predictor) by Guion and Highouse (2006):

$$r_n = \frac{r_o \cdot \frac{s_{xn}}{s_{xo}}}{\sqrt{1 - r_o^2 + r_o^2 \cdot \frac{s_{xn}^2}{s_{xo}^2}}}$$

Where:

r_n = new estimate of the coefficient for an unrestricted sample

r_o = old (obtained) coefficient for the available sample

s_{xn} = predictor standard deviation for unrestricted group

s_{xo}= predictor standard deviation for restricted group

In order to determine the predictor standard deviation for the unrestricted group, the following formula by Ghiselli, Campbell and Zedeck (1981) was applied:

$$\sigma^2_c = \sigma^2_1 + \dots \sigma^2_k + 2\sigma_1\sigma_2 r_{12} + \dots + 2\sigma_{k-1}\sigma_k r_{(k-1)k}$$

The effect of the corrections for both unreliability and restriction of range are shown in parentheses in table 4.15. Two coefficients are presented for the relationships involving each predictor and each criterion. The first coefficients are the obtained Pearson product-moment correlation coefficients from the restricted sample of trainees. The second coefficients, presented in parentheses, are the correlation coefficients corrected for unreliability and restriction of range. For the interested reader, the correlation coefficients as corrected for unreliability only are shown in appendix A and are indicated in brackets. The correlations, once corrected for unreliability and restriction of range in the criterion, increased except for training motivation.

Table 4.15
Correlations between the Predictors and Criteria Corrected for Unreliability and Restriction of Range

Correlations

Variable		Total GSTP Score (η1)	Total CTTP Score (η2)
Verbal Composite Raw (ξ1)	Pearson Correlation	.510**	.059
	r_n	{.67}	{.09}
Visual-Spatial Composite Raw (ξ2)	Pearson Correlation	.325**	.162*
	r_n	{.54}	{.29}
Hand-Eye Co-ord Composite Raw (ξ3)	Pearson Correlation	.093	-.096
	r_n	{.13)	{-.13}
Openness to Exp Sub-scale (ξ5)	Pearson Correlation	.107	-.137
	r_n	{.16}	{-.20}
Motivation Composite (ξ4)	Pearson Correlation	-.066	.246**
	r_n	{-.05}	{.19}
Total GSTP Score (η1)	Pearson Correlation	1.000	.145
Total CTTP Score (η2)	Pearson Correlation	.145	1.000

Note. Values indicated in { } are corrected for unreliability and restriction of range in the criterion.

** Correlation is significant at the 0.01 level (1-tailed)

* Correlation is significant at the 0.05 level (1-tailed)

GSTP – General Soldiering Training Proficiency

CTTP – Core Technical Training Proficiency

4.6.3. Regression Results

In the proposed structural model, Figure 2.1 it was hypothesised that verbal intelligence, visual-spatial intelligence, hand-eye coordination, training motivation and conscientiousness can significantly explain unique variance in the endogenous latent variable not explained by the other variables under investigation.

To examine the unique contribution the variables of interest made to the dependent variables they are linked to (Figure 2.1), several multiple regression analyses were performed. In standard regression all independent variables enter the regression equation at once; each one is assessed as if it had entered the regression after all other independent variables had entered. Each independent variable is evaluated in terms of what it adds to prediction of the dependent variable that is different from the predictability afforded by all the other independent variables (Tabachnick & Fidell, 1996).

The hierarchical regression strategy enters the independent variables into the equation in an order specified by the researcher. Logical or theoretical considerations determine the order of entry of variables (Field, 2005; Tabachnick & Fidell, 1996), for example, variables with greater theoretical importance could be prioritised, and each independent variable is assessed in terms of what it adds to the equation at its own point of entry.

4.6.3.1. Standard Multiple Regression of all Predictors on General Soldiering Training Proficiency

Standard multiple regression was performed between general soldiering training proficiency as the dependent variable and verbal intelligence, visual-spatial intelligence, hand-eye coordination, training motivation and openness to experience as the independent variables. The analyses were performed using SPSS REGRESSION. SPSS EXPLORE was used for the evaluation of assumptions. Results of the evaluation of assumptions led to the deletion of a residual outlier and four univariate outliers (N = 100) and the analysis was re-run. A summary of the results of the regression analysis is presented in table 4.16. R for Regression was significantly different from zero, $R = .529$, $F(5, 94) = 7.317$, $p < .001$, with R^2 at .280. The adjusted R^2 value of .242 indicates that 24% of the variability in general soldiering training proficiency is explained by the independent variables of which verbal intelligence makes the largest contribution (beta = .433). As can be seen in table 4.16, only verbal intelligence statistically significantly ($p < .001$) explains unique variance in the criterion not explained by the other independent variables. Given these findings H_{015} is therefore rejected in favour of H_{a15} thus supporting this hypothesis, however H_{a16}, H_{a17}, H_{a18}, and H_{a19} stating that visual-spatial intelligence, hand-eye coordination, training motivation, and openness to experience each explain unique variance in general soldiering training proficiency could not be supported.

4.6.3.2. Standard Multiple Regression of all Predictors on Core Technical Training Proficiency

Standard multiple regression was performed between core technical training proficiency as the dependent variable and verbal intelligence, visual-spatial intelligence, hand-eye coordination, training motivation and openness to experience as the independent variables. Analysis was performed using SPSS REGRESSION and SPSS EXPLORE was used for evaluation of assumptions. Results of the evaluation of assumptions led to the deletion of a residual outlier and three univariate outliers ($N = 101$) and the analysis was re-run. A summary of the results of the regression analysis is presented in table 4.17. R for Regression was significantly different from zero, $R = .459$, $F(5, 95) = 5.067$, $p < .001$, with R^2 at .211. The adjusted R^2 value of .169 indicates that approximately 17% of the variability in core technical training proficiency is explained by the independent variables, with training motivation making the largest unique and statistically significant contribution (beta = .365, $p < .001$)) and openness to experience making a significant yet negative contribution to the variance in the criterion (beta = -.214, $p < .05$). In light of these findings H_{023} is rejected in favour of H_{a23} and H_{024} is rejected in favour of H_{a24}. However H_{a20}, H_{a21} and H_{a22}, stating that verbal intelligence, visual-spatial intelligence and hand-eye coordination each explain unique variance in core technical training proficiency could not be supported.

Table 4.16

Standard Multiple Regression of all Predictors on General Soldiering Training Proficiency

Model Summary[b]

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.529[a]	.280	.242	3.653	.280	7.317	5	94	.000

Note. Predictors: (Constant), Openness to Exp Sub-scale, Hand-Eye Co-ord Composite Raw, Visual-Spatial Composite Raw, Motivation Composite, Verbal Composite Raw
Dependent Variable: General Soldiering Training Proficiency

ANOVA[b]

	Model	Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	488.224	5	97.645	7.317	.000[a]
	Residual	1254.343	94	13.344		
	Total	1742.567	99			

Note. Predictors: (Constant), Openness to Exp Sub-scale, Hand-Eye Co-ord Composite Raw, Visual-Spatial Composite Raw, Motivation Composite, Verbal Composite Raw
Dependent Variable: General Soldiering Training Proficiency

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Model		B	Std. Error	Beta	T	Sig.	Tolerance	VIF
1	(Constant)	63.201	5.126		12.329	.000		
	Verbal Composite Raw	.233	.057	.433	4.116	.000	.691	1.447
	Visual-Spatial Composite Raw	.070	.057	.121	1.214	.228	.765	1.306
	Hand-eye Co-ord Composite Raw	.017	.022	.071	.765	.446	.880	1.137
	Motivation Composite	.003	.049	.006	.063	.950	.939	1.065
	Openness to Exp Sub-scale	.172	.478	.032	.360	.719	.957	1.045

Note. Dependent Variable: General Soldiering Training Proficiency

Table 4.17

Standard Multiple Regression of all Predictors on Core Technical Training Proficiency

Model Summary[b]

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.459[a]	.211	.169	5.156	.211	5.067	5	95	.000

Note. Predictors: (Constant), Openness to Exp Sub-scale, Hand-Eye Co-ord Composite Raw, Visual-Spatial Composite Raw, Motivation Composite, Verbal Composite Raw

Dependent Variable: Core Technical Training Proficiency

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	673.514	5	134.703	5.067	.000[a]
	Residual	2525.599	95	26.585		
	Total	3199.113	100			

Note. Predictors: (Constant), Openness to Exp Sub-scale, Hand-Eye Co-ord Composite Raw, Visual-Spatial Composite Raw, Motivation Composite, Verbal Composite Raw

Dependent Variable: Core Technical Training Proficiency

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Model		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	72.518	7.233		10.026	.000		
	Verbal Composite Raw	.086	.079	.121	1.087	.280	.669	1.496
	Visual-Spatial Composite Raw	.097	.081	.127	1.201	.233	.744	1.344
	Hand-Eye Co-ord Composite Raw	-.048	.032	-.147	-1.522	.131	.889	1.125
	Motivation Composite	.280	.072	.365	3.919	.000	.957	1.045
	Openness to Exp Sub-Scale	-1.503	.647	-.214	-2.321	.022	.976	1.025

Note. Dependent Variable: Core Technical Training Proficiency

4.6.3.3. Hierarchical Regression of all Predictors on General Soldiering Training Proficiency

Hierarchical (Sequential) regression was employed to determine if the addition of information regarding predictors of training performance improved prediction of general soldiering training proficiency beyond that afforded by the predictors individually. Analysis was performed using SPSS REGRESSION and SPSS EXPLORE for evaluation of assumptions. These results led to the deletion of four univariate outliers and one residual outlier to improve linearity, normality, and homoscedasticity. With the use of a $p < .001$ criterion for Mahalanobis distance, no multivariate outliers among the cases were identified and $N = 100$.

Table 4.18 displays the hierarchical regression results. R was significantly different from zero at the end of each step. After step three, with all independent variables in the equation, $R = .529$, F (5, 94) and $R^2 = .280$, F (5, 94) = 7.317, $p < .01$. The adjusted R^2 value of .242 indicates that 24% of the variability in general soldiering training proficiency is predicted by measures of intelligence, training motivation and openness to experience.

After step one, with verbal intelligence, visual-spatial intelligence and hand-eye coordination in the equation R^2 =.279, F_{inc} (3, 96) = 12.388, $p < .001$. After step two, with training motivation in the equation R^2 =.279, F_{inc} (1, 95) = .012, p >.05. The addition of training motivation to the equation resulted in no change in R^2 and the adjusted R^2 decreased. After step three, with openness to experience in the equation, R^2 = .280 (adjusted R^2 = .242), F_{inc} (1, 94) =.130, p >.05 showing that the addition of openness to experience to the equation did not reliably improve R^2.

The pattern of results suggests that the largest proportion (25.7%) of variability in general soldiering training proficiency is predicted by measures of general cognitive ability, i.e., verbal intelligence, visual-spatial intelligence and hand-eye coordination. Verbal intelligence however is the only significant contributor (beta = .433, $p < .001$). Training motivation and openness to experience did not add incremental validity to the intelligence measures. In fact, based on the adjusted R square values, their inclusion decreased the predictive validity of the battery of predictors due to the larger adjustments made for the greater number of variables in the model. These results confirm the findings from the standard multiple regression analyses, in other words general cognitive ability is the best predictor of general soldiering training proficiency and it cannot be incremented by training motivation or openness to experience.

4.6.3.4. Hierarchical Regression of all Predictors on Core Technical Training Proficiency

Hierarchical (Sequential) regression was employed to determine if the addition of information regarding predictors of training performance improved prediction of core technical training proficiency beyond that afforded by the predictors individually. Analysis was performed using SPSS REGRESSION and SPSS EXPLORE for evaluation of assumptions. These results led to the deletion of three univariate outliers and one residual outlier to improve linearity, normality, and homoscedasticity. With the use of a $p < .001$ criterion for Mahalanobis distance, no multivariate outliers among the cases were identified and $N = 101$.

Table 4.19 displays the hierarchical regression results. *R* was significantly different from zero at the end of step two and three. At the end of step three, with all independent variables in the equation, $R = .378$, $F\ (5, 95)$ and $R^2 = .143$, $F\ (5, 95) = 3.165$, $p < .05$. The adjusted R^2 value of .098 indicates that approximately 10% of the variability in core technical training proficiency is predicted by general cognitive ability measures (verbal intelligence, visual-spatial intelligence and hand-eye coordination), training motivation and openness to experience.

After step one, with verbal intelligence, visual-spatial intelligence and hand-eye coordination in the equation $R^2 = .051$, $F_{inc}\ (3, 97) = 1.751$, $p > .05$. After step two, with training motivation in the equation $R^2 = .109$, $F_{inc}\ (1, 96) = 6.165$, $p < .05$. The addition of training motivation to the equation resulted in a significant increase in R^2 and the adjusted R^2. After step three, with openness to experience in the equation, $R^2 = .143$ (adjusted $R^2 = .098$), $F_{inc}\ (1, 95) = 3.786$, $p > .05$. The addition of openness to experience to the equation increased R^2 from .109 to .143 although this change was not statistically significant but marginal ($p = .055$). The pattern of results suggests that overall, the ability measures did not predict the criterion, but the addition of motivation did add incremental validity (beta = .261, $p < .05$). Adding personality to a model already containing ability and motivation also seemed to explain additional variance (marginally insignificant). It is important to note that the openness to experience subscale on the personality measure has a negative beta weight (beta= -.187) meaning that high scores actually correlate with low performance. These findings confirm those obtained through the standard multiple regression analyses however the hierarchical analyses indicate that training motivation and openness to experience explains additional variance in core technical training proficiency when entered into a model already containing measures of general cognitive ability.

Table 4.18

Hierarchical Regression of all Predictors on General Soldiering Training Proficiency

Model Summary[d]

					Change Statistics					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.528[a]	.279	.257	3.617	.279	12.388	3	96	.000	
2	.528[b]	.279	.249	3.636	.000	.012	1	95	.914	
3	.529[c]	.280	.242	3.653	.001	.130	1	94	.719	1.567

Note. Predictors: (Constant), Hand-Eye Co-ord Composite -Raw, Visual Spatial Composite-Raw, Verbal Composite –Raw
Predictors: (Constant), Hand-Eye Co-ord Composite -Raw, Visual Spatial Composite-Raw, Verbal Composite-Raw, Motivation Composite

Predictors: (Constant), Hand-Eye Co-ord Composite –Raw, Visual Spatial Composite -Raw, Verbal Composite -Raw, Motivation Composite, Openness to Exp Sub-scale
Dependent Variable: General Soldiering Training Proficiency

ANOVA[d]

	Model	Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	486.336	3	162.112	12.388	.000[a]
	Residual	1256.231	96	13.086		
	Total	1742.567	99			
2	Regression	486.491	4	121.623	9.199	.000[b]
	Residual	1256.076	95	13.222		
	Total	1742.567	99			
3	Regression	488.224	5	97.645	7.317	.000[c]
	Residual	1254.343	94	13.344		
	Total	1742.567	99			

Note. Predictors: (Constant), Hand-Eye Co-ord Composite -Raw, Visual Spatial Composite -Raw, Verbal Composite –Raw

Predictors: (Constant), Hand-Eye Co-ord Composite -Raw, Visual Spatial Composite -raw, Verbal Composite -Raw, Motivation Composite

Predictors: (Constant), Hand-Eye Co-ord Composite -Raw, Visual Spatial Composite -Raw, Verbal Composite -Raw, Motivation Composite, Openness to Exp Sub-scale
Dependent Variable: General Soldiering Training Proficiency

Table 4.18 Cont

		Coefficients[a]											
		Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B		Correlations			Collinearity Statistics	
Model		B	Std. Error	Beta	T	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	64.307	3.734		17.220	.000	56.895	71.720					
	Verbal Comp –Raw	.235	.055	.437	4.242	.000	.125	.346	.514	.397	.368	.707	1.414
	Visual Spatial Comp –Raw	.070	.057	.123	1.241	.218	-.042	.183	.328	.126	.108	.767	1.304
	Hand-Eye Coordination Comp-Raw	.017	.022	.071	.781	.437	-.026	.060	.195	.079	.068	.905	1.105
2	(Constant)	64.026	4.565		14.025	.000	54.963	73.089					
	Verbal Comp –raw	.236	.056	.438	4.215	.000	.125	.347	.514	.397	.367	.703	1.423
	Visual Spatial Comp –Raw	.070	.057	.123	1.235	.220	-.043	.183	.328	.126	.108	.767	1.304
	Hand-eye coordination Comp-Raw	.017	.022	.073	.784	.435	-.027	.061	.195	.080	.068	.881	1.135
	Motivation Composite	.005	.048	.010	.108	.914	-.091	.101	-.074	.011	.009	.953	1.049
3	(Constant)	63.201	5.126		12.329	.000	53.023	73.379					
	Verbal Comp –Raw	.233	.057	.433	4.116	.000	.121	.346	.514	.391	.360	.691	1.447
	Visual Spatial Comp –Raw	.070	.057	.121	1.214	.228	-.044	.183	.328	.124	.106	.765	1.306
	Hand-Eye Coordination Comp-Raw	.017	.022	.071	.765	.446	-.027	.061	.195	.079	.067	.880	1.137
	Motivation Composite	.003	.049	.006	.063	.950	-.094	.100	-.074	.007	.006	.939	1.065
	Openness to Exp Sub-scale	.172	.478	.032	.360	.719	-.776	1.120	.121	.037	.032	.957	1.045

Note. Dependent Variable: General Soldiering Training Proficiency

Table 4.19

Hierarchical Regression of all Predictors on Core Technical Training Proficiency

Model Summary[d]

					Change Statistics					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.227[a]	.051	.022	5.677	.051	1.751	3	97	.162	
2	.330[b]	.109	.071	5.531	.057	6.165	1	96	.015	
3	.378[c]	.143	.098	5.453	.034	3.786	1	95	.055	2.162

Note. Predictors: (Constant), Hand-eye co-ord Composite -Raw, Visual Spatial Composite-Raw, Verbal Composite –Raw
Predictors: (Constant), Hand-eye co-ord Composite -Raw, Visual Spatial Composite-Raw, Verbal Composite -Raw, Motivation Composite

Predictors: (Constant), Hand-eye co-ord Composite -Raw, Visual Spatial Composite-Raw, Verbal Composite -Raw, Motivation Composite Openness to Exp Sub-scale
Dependent Variable: Core Technical Training Proficiency

ANOVA[d]

	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	169.322	3	56.441	1.751	.162[a]
	Residual	3125.822	97	32.225		
	Total	3295.144	100			
2	Regression	357.938	4	89.484	2.925	.025[b]
	Residual	2937.206	96	30.596		
	Total	3295.144	100			
3	Regression	470.494	5	94.099	3.165	.011[c]
	Residual	2824.649	95	29.733		
	Total	3295.144	100			

Note. Predictors: (Constant), Hand-Eye Co-ord Composite -Raw, Visual Spatial Composite -Raw, Verbal Composite –Raw

Predictors: (Constant), Hand-Eye Co-ord Composite -Raw, Visual Spatial Composite -Raw, Verbal Composite -Raw Motivation Composite

Predictors: (Constant), Hand-Eye Co-ord Composite -Raw, Visual Spatial Composite -Raw, Verbal Composite -Raw Motivation Composite, Openness to Exp Sub-scale
Dependent Variable: Core Technical Training Proficiency

Table 4.19 cont

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	T	Sig.	95% Confidence Interval for B Lower Bound	95% Confidence Interval for B Upper Bound	Correlations Zero-order	Correlations Partial	Correlations Part	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	73.742	5.818		12.674	.000	62.195	85.290					
	Verbal Composite – Raw	.008	.086	.011	.090	.929	-.163	.178	.071	.009	.009	.683	1.463
	Visual Spatial Composite–Raw	.152	.091	.192	1.678	.097	-.028	.332	.193	.168	.166	.743	1.345
	Hand-Eye Co-ord Composite-Raw	-.039	.034	-.121	-1.161	.249	-.107	.028	-.111	-.117	-.115	.904	1.107
2	(Constant)	64.309	6.825		9.423	.000	50.762	77.856					
	Verbal Composite – Raw	.025	.084	.036	.304	.762	-.141	.192	.071	.031	.029	.678	1.474
	Visual Spatial Composite–Raw	.147	.088	.187	1.669	.098	-.028	.322	.193	.168	.161	.743	1.346
	Hand-Eye Co-ord Composite-Raw	-.026	.033	-.081	-.790	.432	-.093	.040	-.111	-.080	-.076	.882	1.134
	Motivation Composite	.182	.073	.245	2.483	.015	.037	.328	.249	.246	.239	.956	1.046
3	(Constant)	71.388	7.649		9.334	.000	56.204	86.573					
	Verbal Composite – Raw	.038	.083	.053	.456	.649	-.127	.203	.071	.047	.043	.675	1.483
	Visual Spatial Composite -Raw	.152	.087	.193	1.747	.084	-.021	.325	.193	.176	.166	.742	1.347
	Hand-Eye Co-ord Composite -Raw	-.025	.033	-.078	-.773	.441	-.091	.040	-.111	-.079	-.073	.881	1.135
	Motivation Composite	.195	.073	.261	2.680	.009	.051	.339	.249	.265	.255	.949	1.054
	Openness to Exp Sub-scale	-1.328	.683	-.187	-1.946	.055	-2.684	.027	-.149	-.196	-.185	.981	1.019

Coefficients[a]

Note. Dependent Variable: Core Technical Training Proficiency

4.7. Conclusion: Chapter Four

The findings from the inter-correlations and regression results revealed that training performance could be predicted by making use of a battery of measures of cognitive ability, motivation and personality. However, there were inconsistencies in the way in which the predictors predicted performance in the two criterion measures. With regard to general soldiering training proficiency, two of the general cognitive ability measures (verbal intelligence and visual-spatial intelligence) were found to correlate with this criterion. In the case of core technical training proficiency, the only measure of general cognitive ability found to correlate with this criterion was visual-spatial intelligence as well as training motivation. The regression results yielded similar findings; general cognitive ability, specifically verbal intelligence, played the largest role in predicting general soldiering training proficiency. The non-cognitive measures, specifically training motivation, played the largest role in predicting core technical training proficiency. Openness to experience was found to play a marginal role in predicting core technical training proficiency.

Analysis of the correlation between the two criterion measures revealed there is in fact no correlation between them $r = .145$, p (one-tailed) $> .05$ (table 4.14), possibly explaining the findings obtained in this study. The implication of this finding is that the underlying common factor of training performance is different for the two criteria, in other words they are measuring different aspects of training performance and hence the reason why the predictors differ in their prediction of the criteria. This finding emphasises the importance of investigating the construct validity of the criterion measures and specifically defining what is meant by training performance. Therefore not all of the hypotheses in this study were supported; further discussion of the findings follows in the next chapter.

CHAPTER FIVE: DISCUSSION OF RESULTS

5.1. Introduction

The research findings of this study were presented in chapter four. This final chapter will discuss these findings as well as general conclusions that can be deduced from the results obtained. This chapter concludes with reference to the limitations of this study as well as recommendations for future research.

5.2. General Conclusions

The aim of this study was to explain variance in training performance by taking a more holistic view of the psychological predictors of training performance. Therefore, we administered a broad scope of measures to assess various psychological predictors of training performance such as measures of general cognitive ability, training motivation and personality and tried to determine how these measures relate to training performance.

5.2.1. Hypothesised Relationships

The results confirm that training performance could be predicted from a battery that consists of measures of cognitive ability, training motivation and personality. The obtained multiple correlations showed that a combination of these measures could explain substantial portions of the variance in training performance. However, the contribution of each measure to training performance was more complex and, hence, deserves further discussion. Even though the majority of the hypotheses could be corroborated in this study, some were not, despite the theoretical foundations upon which these hypotheses were founded. These relationships are discussed below.

5.2.1.1. General Cognitive Ability

In this study three composites operationalising general cognitive ability were formed based on the factor structure which emerged from the dimensionality analysis namely: verbal intelligence, visual-spatial intelligence and hand-eye coordination. These measures of cognitive ability were hypothesised to predict both general soldiering training proficiency and core technical training proficiency. Both measures of training effectiveness are theoretical assessments of the amount learned on training.

The results revealed inconsistent patterns for the prediction of different criterion measures. Verbal intelligence correlated with general soldiering training proficiency (.510, $p < .01$) but the correlation with core technical training proficiency was insignificant. The latter finding is incongruent with the literature on general cognitive ability and training performance which demonstrates that an individuals' ability to learn and acquire new knowledge and skills has a direct influence on training preparation and performance (Tracey & Tews in Nunes, 2003) because cognitive ability predicts learning and job mastery and, in turn, also performance (Hunter, 1986). McHenry et al. (1990) found that general cognitive ability predicted general soldiering proficiency (mean $r = .65$) *and* core technical task proficiency (mean $r = .63$), similar to the criteria as used in this study. Since cognitive ability is highly correlated with job knowledge and performance/technical proficiency a correlation with both theoretical measures would be expected regardless of course content.

Visual-spatial intelligence was found to correlate with both general soldiering training proficiency (.325, $p < .01$) and core technical training proficiency (.162, $p < .05$). Hand-eye coordination was not found to correlate with either criterion which may be logical because the assessments of learning were theoretical in nature and not practical. However, this competency was identified as being critical in the job and competency profile of an armour soldier.

5.2.1.2. Training Motivation

Mixed results were found for the relationship between training motivation and training performance as training motivation was found to correlate with performance in core technical training proficiency (.246, $p < .01$) but not with general soldiering training proficiency. It is possible that training motivation was found to be a significant predictor of only one criterion due to the nature of the tasks. The tasks and learning linked to the core technical training is more focused on specific aspects that a trainee on a particular course is interested in learning, it is more career specific and not general in nature, hence this may result in increased motivation as the course may be perceived as being more instrumental to their careers.

An armour soldier is first required to complete basic military training and then moves on to the technical training. It is important to mention the sequence of training because in answering the training motivation survey (VIEMS), the respondent is asked to think of the last few courses they completed as a reference when answering the items. The recency effect may therefore have played a role in this regard. Furthermore one of the situational factors known to affect motivation is the perceived training reputation. If training is perceived to be a waste of time, individuals may lack motivation irrespective of the quality of the training program (Facteau in Nunes, 2003). This may well be the case with Basic Military Training as the tasks are known to be repetitive and physically intensive which may dissuade soldiers.

The relationship between the predictors and criteria show that a positive correlation between the measures of intelligence and training motivation for both criteria were not confirmed, rather a negative correlation was found between these variables. These findings again are inconsistent with the literature as psychologists have demonstrated that general cognitive ability has a significant impact on trainee success (Ree & Earles, 1994; Schmidt & Hunter, 1998) and interacts with motivation to enhance outcomes (Colquitt et al., 2000; Kanfer & Akerman in Nunes, 2003), implying that trainees who have sufficient ability to master the content of the training course should also be more motivated to learn the content (Nunes, 2003). Furthermore, individuals are aware of their level of cognitive ability which would affect their self-efficacy and hence motivation to learn.

5.2.1.3. Openness to Experience

Personality determines the way an individual thinks, feels and acts and therefore, logically, these characteristics should influence performance, hence trainees' level of openness to experience was expected to play a role in explaining training performance.

The correlation analysis results showed that the correlation between openness to experience and both criteria was insignificant along with the correlation between openness to experience and training motivation. However the standard and multiple regression analyses revealed that openness to experience was found to correlate with core technical training proficiency and hence played a marginal role in predicting training performance in technical tasks but not general soldiering tasks.

Once again this finding could be explained by the nature of the training tasks. For general soldiering training, the training is generic to the defence force and the tasks are basic and repetitive thus, trainees with a high degree of openness to experience would not necessarily perform at their best. However, the core technical training could have been perceived as more interesting and career related, thereby explaining the relationship between openness to experience and performance for core technical training.

Another reason for the low correlation could relate to restriction of range. From table 4.1, it can be seen that that the scores on the openness to experience subscale were found to be negatively skewed, meaning that trainees rated themselves high in terms of this construct. The standard deviation was relatively small (.792) when compared to the standard deviation obtained by the authors for the TIPI model (1.07), which could have deflated the correlation coefficient. Correcting this correlation for restriction of range could indicate that openness to experience does relate to training performance.

Additionally, important individual differences are encoded in language (Goldberg in Anderson et al., 2001) and in this regard perhaps a lack of understanding of the items comprising the TIPI resulted in the disappointing findings for conscientiousness. The low reliability of the subscale confirms this possibility, and therefore, would also lead to a deflation of the correlation coefficient.

The authors of the TIPI caution that despite the evidence of the value of the TIPI, very short measures are subject to limitations, one of them being the psychometric cost associated with using short measures. Compared with multi-item measures of the Big-Five, the TIPI is less reliable and correlates less strongly with other variables (Gosling et al., 2003). The low item correlations found in the item analysis (table 4.10) may have contributed to the reduced predictive validity of this construct.

5.2.1.4. Regression Results

The regression results once again show that the importance of the cognitive versus non-cognitive predictors in predicting each criterion differs. The standard and hierarchical regression models on general soldiering training proficiency reveal a similar picture. For both models, the measures of general cognitive ability, specifically verbal intelligence was found to be the significant contributor (beta = .433, $p < .001$). Multiple correlation coefficients for both the standard regression and hierarchical regression models were $R = .529$, $p < .001$, with the predictors accounting for 24% and 25.7% respectively of the variance in the criterion.

The standard regression model on core technical training proficiency shows that together, the predictors account for 16% of the variance in training performance with training motivation (beta = .365, $p < .001$) and openness to experience (beta = -.214, $p < .05$) contributing significantly to this figure. The multiple correlation coefficient for this model was $R = .459$, $p < .001$. The hierarchical regression model ($R = .378$, $p < .05$) on core technical training proficiency shows that the measures of cognitive ability do not significantly predict training performance but that the addition of training motivation to the model adds incremental validity (R^2 increased from .051 to .109) and while the addition of openness to experience increased R^2 from .109 to .143 the increase is marginally significant as $p = .055$.

In short, these results show that for the criterion of general soldiering training proficiency, measures of cognitive ability play a key role in predicting training effectiveness. The predictive validity of the battery is above .5 ($R = .529$), most of which was contributed by the cognitive measures. In their meta-analysis, Schmidt and Hunter (1998) found the validity coefficient of general mental ability for predicting training performance to be .56, meaning that the results found in this study are indeed satisfactory and consistent with findings in the personnel selection literature.

For the criterion of core technical training proficiency, cognitive ability did not play any role in predicting training performance. On the contrary, non-cognitive measures were better predictors of performance on this type of training. In this study, training motivation seems to play the key role as a predictor with openness to experience being a moderate predictor; in other words, the addition of measures which are not usually used in personnel selection in the military, i.e. personality and motivation, added incremental validity to measures of cognitive ability. This finding supports the findings of Colquitt et al. (2000) showing that motivation can add incremental variance in the prediction of training performance.

The finding that motivation played a role in training performance dependant on the type of training was unexpected and led the researchers to explore alternative reasons for these results. One possibility that was explored was the notion that different person characteristics drive performance in different contexts, but more importantly, the various person constructs (e.g., cognitive and non-cognitive) interact in a complex way to result in ultimate performance. To investigate this possibility, it was decided to dichotomise the verbal intelligence scores of trainees around the mean and plotted training motivation and performance scores on the x and y-axes of a scatterplot, labelling each case by intelligence (e.g., high vs low) (see Appendix C). Interesting findings emerged as an interaction was found between training motivation and training performance based on the cognitive ability of the trainee. The relationship between motivation and performance was stronger for individuals with lower verbal intelligence, but almost zero for higher ability learners.

The scatterplot revealed that for lower ability trainees, higher performance levels were associated with higher motivation. In contrast, for higher ability trainees, performance levels remained relatively constant irrespective of the level of motivation of the trainee. This finding may perhaps explain the negative correlations found between training motivation and the measures of general cognitive ability.

Intelligence may therefore allow an individual with higher ability to pass the course but motivation allows an individual with lower ability to progress further than someone who may have higher ability but lacks motivation. In conclusion, the research evidence shows that motivation, and in this case training motivation, does play a role in predicting training performance, however upon closer scrutiny it was found that this relates to trainees with lower ability or general cognitive intelligence. For smarter trainees, motivation did not play a role. This finding is supported by Maier (in Nunes, 2003) and Noe (in Colquitt et al., 2000) who state that even if an individual possesses the required skills or intellect to learn training program content, performance will be poor if motivation is absent.

It is known that trainability or the degree to which participants can learn and apply what is learnt, is a function of ability and motivation to learn. However, a view which may shed light on the findings is that motivation can be seen as the variability in behaviour not attributable to stable individual differences (cognitive ability) or strong situational coercion (Kanfer in Nunes, 2003). Thus motivation involves a choice by the individual to expend energy toward one particular set of behaviours over another. The scores on the motivation scale were negatively skewed, meaning that individuals rated themselves as having high levels of motivation, thus it seems that these individuals, if given a choice would, exert effort toward more specific career related training, possibly more so if one's level of intellect is lower.

The choice regarding whether or not to exert effort will depend on whether trainees perceive that 1) high effort will lead to high performance in training, 2) high performance in training will lead to high job performance and 3) high job performance is instrumental in obtaining desired outcomes and avoiding undesirable outcomes. Simmering (in Nunes, 2003) found that trainees who valued outcomes linked to learning showed increased motivation levels. Furthermore, individuals rely on their level of ability when forming self-efficacy perceptions and hence rely on their level of cognitive ability when trying to decide whether or not to learn the training programme content or undertake a task (Nunes, 2003).

As it appears from the findings in this study individuals with higher intellect choose not to invest energy in training, possibly due to high levels of self-efficacy (individuals beliefs in ones capabilities) leading them to believe that they will pass as a result of intelligence levels or low valence (they may not find the outcomes particularly attractive) whereas individuals with lower intellect and possibly lower self-efficacy realise that they need to invest effort in training to do well on the course and as such would have higher expectancy levels (perception that effort will lead to mastery).

Overall the results reveal opposite patterns in the way the predictors predict the two criteria even though both courses are necessary for an armour soldier's future employment and career. However the effectiveness of training, the assessment and prediction thereof vary with the outcome measure used (Tziner et al., 2007). Variables found to be uniquely related to one measure of effectiveness are not necessarily the same as those uniquely associated with a different measure of effectiveness (for example, training motivation was found to predict core technical training proficiency and not general soldiering training proficiency). This could be because the training-outcome measures captured distinct facets of the training effectiveness/performance construct, possibly explaining the opposite patterns of results across the two measures of training effectiveness, as it seems that the two criteria are not assessing the same construct – the ability to learn and assimilate new information.

To summarise, our results show that a consideration of both cognitive and non-cognitive measures in explaining training performance has merit and should be considered essential in theoretical research. Our results show that ability, motivation and personality jointly affect performance and, in some cases, produce performance in a complex interaction of these characteristics depending on the situation (e.g., see Mischel, 2004). These results have value for both practitioners that are interested in maximising the performance levels of trainees, as well as scholars that attempt to clarify the factors that lead to training performance.

5.3. Limitations of this Study

Research studies are subject to certain limitations of which this study is no exception. Firstly, the relatively small sample size in this study limits the generalisability of the results to larger populations. A greater degree of confidence can be placed in the results of studies with large sample sizes and, therefore, our results could have benefited from a larger sample size or even cross-validation. A number of correlations were found in the direction anticipated by the researchers but were insignificant and these correlations may improve with a larger sample size. Ideally, sample size permitting, a comprehensive structural model could have been constructed with detailed predictor-criterion relationships and assessed with structural equation modelling (SEM). However, the only feasible alternative in this case was to find logical groupings of predictor and criterion measures in order to conduct the analyses with the sample size that was available.

Secondly, in chapter two of this research study, factors influencing the reliability and validity of a measure were discussed, with range restriction being one of these influences. Range restriction occurs when the full range of scores on the characteristic under study is not present in a sample, thereby reducing the variance in scores on a measure. The sample used in this study is a pre-selected sample, since the Military Skills Development trainees had already undergone a round of selection upon entry into the South African National Defence Force (SANDF). Schmidt and Hunter (1998) argued that sampling error is the most significant artefact and that sampling error accounts for 75% of the variance in validities when in fact the true variance is zero (Hunter & Burke, 1994). The researchers tried to control for this artefact by correcting our observed correlations for restriction of range and unreliability in the criterion and the results showed that the correlations improved satisfactorily in magnitude. These corrected correlations provide a better estimate of the true relationship between the individual differences we studied and training performance.

A common criticism is that the psychometric properties of the criterion measure does not receive equal attention to that of the predictors (Gatewood & Feild, 1994; Guion, 1965), that the criterion measure is not considered behaviour to be explained (Guion, 1965) or that the "criterion remains a Cinderella factor despite the distortion inadequate criteria have on the estimates of the cost-benefit of predictor investment" (Hunter & Burke, 1994, p. 306). Unfortunately the psychometric properties of the criterion measures could not be investigated due to a lack of access to primary source documents (e.g., training rating sheets) and the reliability of these measures had to be estimated from earlier comparable studies.

Finally, the fact that the sample comprises of participants from two different military units could have posed a potential problem. While training content, assessor training and assessment measures are standardised, participants were exposed to different instructors which could have influenced the test scores. As a result this was controlled for by comparing mean criterion and predictor scores of the two groups and findings indicated no significant differences.

5.4 Recommendations for Future Research

A number of recommendations can be drawn from this study. We have shown that measures of cognitive ability, personality and motivation can all be useful to predict training performance, but their relative importance depends on the context of training. In our research, cognitive factors were the primary determinants of performance in general soldiering training proficiency, but non-cognitive factors were the main factors in core technical training proficiency. Therefore, a heavy reliance on cognitive measures (as dictated by the literature) should be avoided as the default option in selection for training and non-cognitive measures should be further investigated as sources of incremental validity. In particular, the role of moderators should be further explored in future studies that take into account both cognitive and non-cognitive measures (Van Iddekinge & Ployhart, 2008). These results should be cross-validated in other samples in order to examine the stability of the obtained regression coefficients (Schmitt & Chan, 1998).

Since our aim was to enhance the understanding of the psychological processes that underlie training performance, other variables that could be linked to performance should be included in prediction models. Self efficacy, as one example, has consistently been shown to relate to training performance (Tziner et al., 2007), which may be due to the fact that self-efficacy plays a motivational role affecting the amount of effort applied to task performance. For example, Kraus (in Alliger et al., 1997) found high correlations between attitude and behaviour, and he explains that this could be because what we think is useful, may correlate with what we use. Attitude is therefore another construct that can be examined in terms of its role in explaining performance.

With regard to construct measurement, there is research to suggest that constructs be investigated at a facet rather than factor level. Vasilopoulos et al. (2007) show that prediction of training performance can be improved by separating out components of a broadly defined scale (i.e., using facet scales and not factor scales) in situations where the components are expected to have different relationships with performance because the use of factor scales can mask the predictive validity of the more relevant single facets and therefore prevent the detection of relationships at the facet level. For example, Vasilopoulos et al. (2007) found more meaningful validity results when splitting conscientiousness into dependability and achievement because the conscientiousness composite masked the effect of the dependability component. Even though the relationship between conscientiousness and training performance could not be investigated in this study, the findings by Vasilopoulos et al. (2007) may be highly applicable in this study and in any training context. In our research, the use of the TIPI to measure personality had less than desirable results. The obtained psychometric properties were not as optimistic as those reported in (Gosling et al., 2003) and, as a result, rendered most of the scales unusable for further analysis. Future use of short scales to measure personality in South African samples should be cautioned.

Since motivation is influenced by individual and situational factors (Colquitt et al., 2000), it is further recommended that the factors which may inhibit one's motivation to learn and apply new skills, such as a lack of organisational commitment (Tannenbaum in Nunes, 2003), the perceived training reputation (Facteau in Nunes, 2003), limited equipment or financial resources, a lack of support or a non-supportive climate should be explored in terms of ways that these can be minimised in measurement and training delivery.

Additionally, there is evidence suggesting that the pre-training environment influences training effectiveness as the pre-training environment contains many cues about training which may come from those in charge, peers, or reflected in organisational policies and practices (Nunes, 2003). Actions may signal whether training is important, for instance, supervisory and peer support, resource availability and post-training follow up. Cohen (in Nunes, 2003) reported that trainees with supportive supervisors entered training with stronger beliefs that training would be useful, while Mathieu et al. (in Nunes, 2003) reported that trainees who experience many situational constraints in their job entered training with lower motivation to learn. Furthermore training effectiveness can be influenced by the post-training environment. For example, factors in the post-training environment can encourage, discourage or prohibit the application of new skills and knowledge on the job such as work atmosphere, stability of the work environment, policies and values, climate etc. (Nunes, 2003). These research findings have practical implications for training instructors who play a key role in influencing trainee's levels of motivation and self-efficacy. The situational constraints present opportunities for instructors to improve training effectiveness. Vicarious experiences and verbal persuasion are means of promoting self-efficacy levels (Gist & Mitchell in Nunes, 2003) as well as increasing valence and expectancy levels.

Lastly, since job performance is the ultimate criterion it would be recommended that these results be replicated in another study by including measures of both training performance and job performance so that a holistic picture of performance can be obtained. One of the valued outcomes of this study was in contributing to the literature on general cognitive ability in predicting training performance because research has focused heavily on the predictiveness of *g* in relation to job performance. However, it is recognised that the inferences made in selection research are made from job performance and hence the recommendation to include both training and job performance in a future study.

5.5. Conclusion

This research study aimed to investigate more inclusive models of predictors of training performance. It was expected that the results would show statistically significant relationships between the predictors and criteria. The researchers hypothesised that the inclusion of motivation and personality measures in a regression model over and above a model containing measures of general cognitive ability would add incremental validity, thereby enhancing the understanding of the underlying factors influencing training performance.

Our results were generally consistent with earlier literature. Our comprehensive models were able to explain substantial proportions of variance in training performance, which lends support to the notion that performance in training can be better explained by considering broader conceptualisations of person characteristics, i.e. models that contain cognitive ability, motivation and personality. In this study, general cognitive ability predicted training performance when using the criterion of general soldiering proficiency. However, this was not the case when regressing core technical proficiency on measures of general cognitive ability. Furthermore, motivation was found to predict training performance and more interestingly, motivation played a more important role for individuals with lower intellect.

This has important implications for training instructors who should explore ways of increasing motivation for trainees with varying levels of cognitive ability. As previously mentioned, vicarious experiences and verbal persuasion are ways in which this can be accomplished in order to promote self-efficacy levels (Gist & Mitchell in Nunes, 2003) as well as increasing valence and expectancy levels.

Furthermore, in informing a potential selection battery in the context of this particular organisation (i.e., the SANDF) it is clear that measures of general cognitive ability need to comprise the primary tests for predicting performance in initial/basic training. In the case of technical training, it could be useful to further explore the ability of measures of personality to predict training performance. However, it is not foreseen that measures of motivation be used for selection purposes but their use for motivational interventions is not precluded.

In conclusion, Cronbach (in Gal & Mangelsdorff, 1991, p. 25) suggested that "because psychological tests often influence who gets what in society… the ultimate consequence is that validation is never finished". In this spirit, it is hoped that this research will inspire future research and ultimately help to allow those most likely to benefit from training opportunities to indeed enjoy these.

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APPENDIX A: Correlations between the Predictors and Criteria corrected for Criterion Unreliability

Correlations

		Total GSTP Score (η1)	Total CTTP Score (η2)
Verbal Composite Raw (ξ1)	Pearson Correlation	.510**	.059
	r'_{xy}	(.570)	(.066)
Visual-Spatial Composite Raw (ξ2	Pearson Correlation	.325**	.162*
	r'_{xy}	(.363)	(.181)
Hand-Eye Co-ord Composite Raw (ξ3	Pearson Correlation	.093	-.096
	r'_{xy}	(.104)	(.-.107)
Openness to Exp Sub-scale (ξ5)	Pearson Correlation	.107	-.137
	r'_{xy}	(.120)	(-.153)
Motivation Composite (ξ4)	Pearson Correlation	-.066	.246**
	r'_{xy}	(-.074)	(.275)
Total GSTP Score (η1)	Pearson Correlation	1.000	.145
	r'_{xy}	1.000	(.162)
Total CTTP Score (η2)	Pearson Correlation	.145	1.000
	r'_{xy}	(.162)	1.000

Note. Values indicated in ( ) are corrected for unreliability in the criterion

* Correlation is significant at the 0.05 level (1-tailed)

** Correlation is significant at the 0.01 level (1-tailed)

GSTP – General Soldiering Training Proficiency

CTTP – Core Technical Training Proficiency

APPENDIX B: Cover Letter and Consent Form for Psychometric Assessment

ARMOUR FORMATION
RESEARCH STUDY

THE VALIDATION OF THE ARMOUR SELECTION BATTERY FOR GENERAL ARMOUR CORPS SOLDIERS

You have been selected to participate in this research project because **you** are a soldier in the Armour Corps. This document aims to explain the research project and your involvement therein.

1. AIM OF THE STUDY

Each soldier in the SANDF requires certain skills and knowledge to execute their duties and tasks. The skills that someone would need in the Air Force would be different to the skills that are needed in the Army, just as, the skills that someone would need in the Armour Corps would be different to the skills needed in the Artillery Corps. Therefore we need to find out exactly what skills a soldier in the **Armour** Corps requires, so that we can select and place the people with these skills in the correct posts. The way that we find out if a soldier has these skills is to ask him/her to complete tests.

This research study is about understanding how well our tests assess the skills that a soldier in the Armour corps should have.

2. PROCEDURES

If you volunteer to participate in this study, we would ask you to do the following things:

a. Read the consent form and sign it; participation in this study is VOLUNTARY, by signing the consent form, you are saying that you are giving your permission to participate in the research study.
b. You will be asked to complete a number of tests. There will be breaks in between so that you are comfortable and able to concentrate while completing these tests.
c. We ask you to complete the tests **to the best of your ability** and answer ALL the questions.

3. POTENTIAL RISKS

There are **no risks** by participating in this study. The results of the tests **will not** affect decisions made about you, or your employment in the SANDF. You are here because you have already been successful in the MSD selection and you have passed the functional training, taking part in this study will not have any impact on this, rather we would like to determine what makes you successful in your work.

4. POTENTIAL BENEFITS TO PARTICIPANTS AND/OR TO SOCIETY

There are NO DIRECT BENEFITS that will be received by you in this study. However, the outcome of this study will benefit the Armour Formation as they will then be able to obtain the right people in the Corps, which will improve the mobility and effectiveness of the Corps.

5. PAYMENT FOR PARTICIPATION

Unfortunately, NO payment will be made to you for participation in this study.

6. CONFIDENTIALITY

This study will be used for research purposes ONLY. The results are not going to be used to make any decisions about you. Information obtained in this study that can be identified as your own WILL REMAIN CONFIDENTIAL and will be disclosed only with your permission. Confidentiality will be ensured by EXCLUDING NAMES OR NUMBERS in any reporting that might identify you as a participant in this study.

In addition, the completed questionnaire will be kept in a locked and access controlled environment at the Military Psychological Institute. Myself (as the researcher), my study supervisor (Lecturer) and co- administering officer will have access to the information. If any part of the information has to be released to any other party for any reason, this will ONLY be done with your permission.

7. IDENTIFICATION OF INVESTIGATORS

If you have any questions or concerns about the research, please feel free to contact myself, Joy Dijkman (082 485 9201) or my supervisor Francois De Kock at the main campus' Industrial Psychology Department, University of Stellenbosch (021-808 3016).

8. RIGHTS OF RESEARCH PARTICIPANTS

You may withdraw your consent at any time and discontinue participation without penalty. You are not giving up any legal claims, rights or remedies because of your participation in this research study. If you have questions about your rights as a research participant, contact any of the above-mentioned persons / numbers.

SIGNATURE OF RESEARCH PARTICIPANT OR LEGAL REPRESENTATIVE

The information above was satisfactorily explained to me by………………………………………………………..

In Afrikaans/English/isiXhosa/isiZulu/seSotho (please specify): …………………………………….. and I am in command of this language. I was given the opportunity to ask questions and these questions were answered to my satisfaction.

In the interests of ongoing, future research and efforts to improve selection decisions, we request permission to use your merit ratings from the PERSAL system, this will only be used for research purposes and will not influence any decisions made about you

Please mark with **a cross [X]** **inside the relevant box:**

You may use my merit ratings from the PERSAL SYSTEM for future research:

Yes	
No	

I hereby consent voluntarily to participate in this study

______________________________ _______________

Signature of Participant **Date**

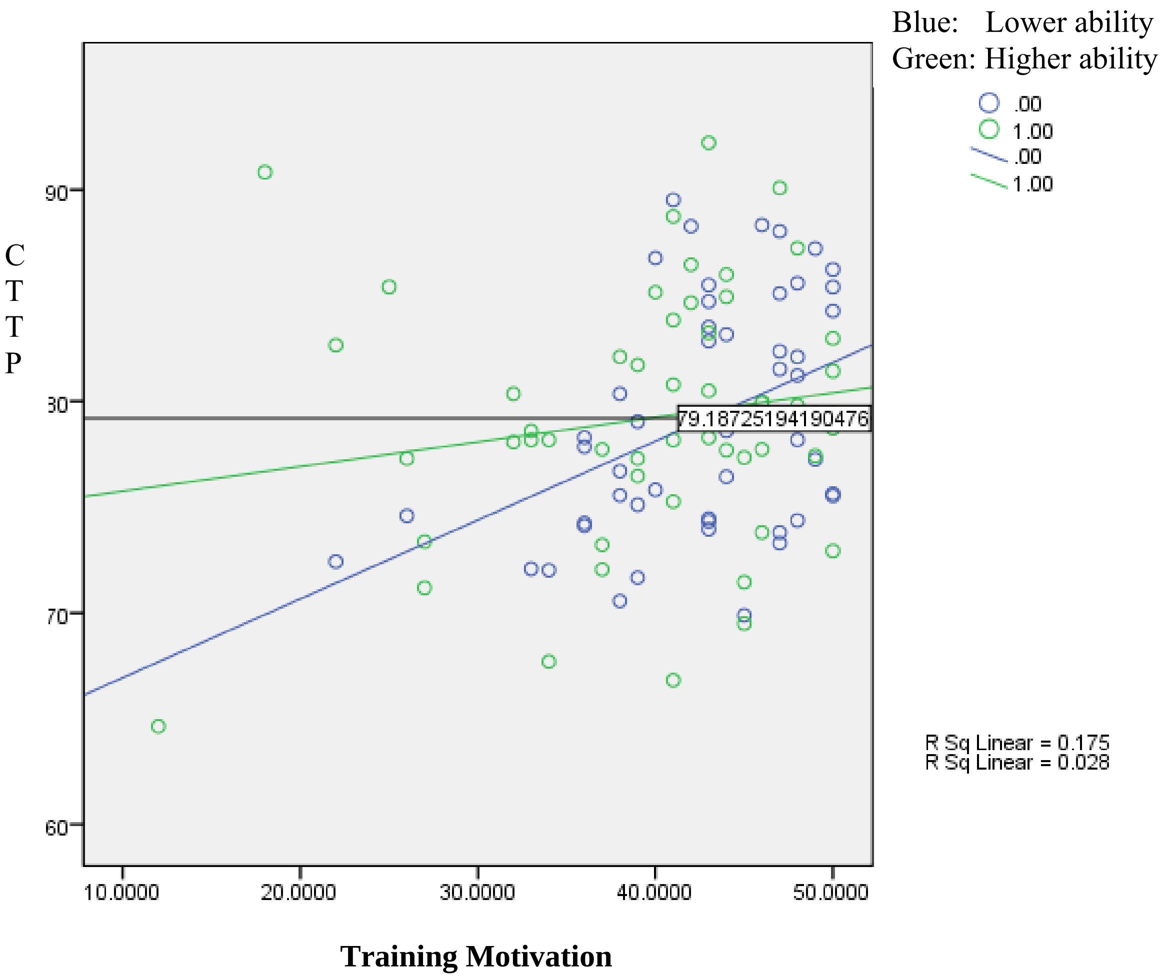
SIGNATURE OF RESEARCHER/INVESTIGATOR

I declare that I explained the information given in this document to the participant. He/she was encouraged and given sufficient time to ask me any questions related to his/her participation thereof.

______________________________ _______________

Signature of Investigator ***Date***

APPENDIX C: Scatterplot Showing the Interaction Effect between Training Motivation, Intelligence and Training Performance.



* CTTP: Core Technical Training Proficiency