MEASURING FEAR OF HEIGHTS (ACROPHOBIA) THROUGH IMPLEMENTING A PSYCHOLOGICAL ASSESSMENT IN THE SOUTH AFRICAN MINING INDUSTRY

by

TRACY COCK

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Declaration

I declare that "Measuring fear of heights (acrophobia) through implementing a psychological assessment in the South African mining industry" is my own work and that all the sources that I have used or quoted, have been indicated and acknowledged by means of complete references.

I further declare that I submitted the dissertation to originality checking software and that it falls within the accepted requirements of originality.

I further declare that I have not previously submitted this work, or part of it, for examination at Unisa for another qualification or at any other higher education institution.

Tracy Cock | 15/10/2021

Signature: Tracy Cock | Date

Abstract

This dissertation presents the findings of a quantitative study on the measurement of fear of heights (acrophobia) through implementing a psychological assessment in the South African mining industry. The study was conducted in the field of psychology and specific emphasis was placed on psychological assessment in South Africa. A positivist paradigm was used. This study was conducted during two phases: The data of Phase 1 were specifically collected in the mining industry, while the data of Phase 2 were collected from the general population. Convenience sampling was used in both phases. Descriptive statistics, correlational analysis, reliability coefficients, and comparative analysis were used to achieve the research objectives. It was found that ACRO psychological measurement can be considered as a viable option to be included in a test battery. However, performance on the ACRO test should at this stage not be used in isolation to make a final decision regarding an individual's employment or career pathing.

Keywords: Acrophobia, ACRO, working at height, mining, selection, psychological measurement, questionnaire, virtual reality, HIQ, vHISS, reliability, validity.

Kakaretšo

Kakanyotherwa ye e hlagiša dipoelo tša nyakišišo bokaakang ya tekanyo ya poifo ya bogodimo (malekelekeng) ka go diriša tekolo ya saekholotši (monagano le maitshwaro) intastering ya meepo ya Afrika-Borwa. Nyakišišo ye e dirilwe ka lefapheng la saekholotši e gateletše kudu tekolo ya mogopolo le maitshwaro go la Afrika-Borwa. Go dirišitšwe sekao sa filosofi ya mmaruri. Nyakišišo ye e dirilwe ka magato a mabedi, tshedimošo ya legato la mathomo e kgobokantšwe go tšwa intastering ya meepo mola tshedimošo legatong la bobedi e tšwa setšhabeng ka kakaretšo. Sampole (ngwatho) ya nolofatšo e dirišitšwe magatong ka moka. Tlhalošo ya dipalopalo, phapanyo ya phetleko, kwekweano yeo e botegago le tlhophollo ya tekanyo di šomišitšwe go fihlelela maikemišetšo a nyakišišo. Go humanwe gore tekanyo ya saekholotši ya ACRO e ka akanywa bjalo ka kgetho yeo e šomago go akaretšwa tekong ya peteri (dikanono), efela, dipoelo tša teko ya ACRO ga tša swanelwa go dirišwa di le noši go tšea sephetho sa mafelelo mabapi le thwalo goba tseleng ya boiphedišo bja motho mošomong.

Samevatting

Hierdie verhandeling gee die bevindinge weer van ’n kwantitatiewe studie oor die meting van angs vir hoogtes (hoogtevrees) deur gebruikmaking van ’n sielkundige evaluering binne die Suid-Afrikaanse mynbedryf. Die studie is uitgevoer binne die veld van die sielkunde, met spesifieke klem op sielkundige evaluering in Suid-Afrika. ’n Positivistiese paradigma is gevolg. Die studie bestaan uit twee fases: Fase 1 se data is spesifiek binne die mynbedryf versamel, terwyl Fase 2 se data van die algemene publiek verkry is. Gerieflikheidsteekproefneming is in albei fases gedoen. Beskrywende statistieke, ’n korrelasionele analise, betroubaarheidskoëffisiënte en ’n vergelykende analise is gebruik om die navorsingsdoelwitte te bereik. Dit het geblyk dat die ACRO psigometriese toetsing beskou kan word as ’n lewensvatbare keuse vir insluiting in ’n toets-battery. Prestasie gemeet deur die ACRO-toets moet egter nie op hierdie stadium in isolasie gebruik word om ’n finale besluit te maak aangaande ’n individu se werk of beroepsloopbaan nie.

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1. Measuring Fear of Heights (Acrophobia) through Implementing a Psychological Assessment in the South African Mining Industry

Acrophobia (fear of heights) is described as one of the most prevalent phobias, affecting as many as one in 20 individuals (Coelho & Wallis, 2010). More or less one-third of the general population, as suggested by epidemiological studies, suffers from a form of debilitating heights intolerance, with a relevant impact on quality of life in many of these cases (Brandt et al., 2019). "Fear of heights" is an expression of a largely sensory phenomenon which can produce strong feelings of discomfort and fear in the case of otherwise calm individuals (Coelho & Wallis, 2010). Some people can control the fear, while others experience this fear so intense that exposure to heights should be avoided altogether. Turner et al. (2002) state that imple-mented practices by many organisations, attempting to reduce costs and increase productivity, favours a mindset of profitability over the welfare of people (Rothmann & Cilliers, 2007). People working in the construction and mining industries risk their lives every day, and even though organisations have gone to great lengths to improve workers' safety, unsafe behaviour presented by workers seems to remain an occurring phenomenon. Unfortunately, workplace injuries and deaths continue, regardless of workplace safety research which involves theories of effectively predicting and limiting workplace hazards (Keiser & Payne, 2017).

Literature suggests that, due to general reluctancy to seek treatment, and excessive treatment costs, there is restricted access to evidence-based therapy (Donker et al., 2018). In many cases treatment includes taking drugs such as tranquilizers and anti-depressants that cause its own dangers at work, particularly working at height or when driving a vehicle. Stransky (1957), Menzies, and Clarke (1995, as cited in Shäffler et al., 2013), and Robinson et al. (2009) argue that up to 30% of patients with fear of heights sometimes use medication or alcohol for relief. It is clearly in the best interest of employers to take all possible precautions to avoid employing acrophobes to work at height in the first place.

Personal experience of and observation by the researcher indicate that the most popular implemented selection procedures for people required to work at height in South Africa include medical examinations, meeting minimum job requirements, self-report methods, interviews, and reference checks. A gap in the body of knowledge was identified as no empirical studies could be found where objective assessments of fear of heights was investigated and it does not seem that an objective measuring tool is currently being implemented.

1.1 Justification for the Research

Precaution must be taken to intercept incidents while working at height, as working at height is a high-risk activity (Pillay et al., 2001). The Occupational Health and Safety Act 190 (South African Government, 2013) states that the term "working at height" includes a place of work, above, at, or below ground level, from which an employee may fall from a height, exceeding two metres. When working at uncomfortable height, people with acrophobia are prone to enter into a state of panic and agitation which can make it very difficult or even impossible for them to get down safely. Worse still, in their state of panic, they may severely endanger the lives of colleagues or safety personnel who attempt to assist them to get down.

Construction industry employers worldwide experience serious injuries and deaths as a result of accidents in complex high-risk systems (Mustapha et al., 2016). Local South African electronic newspapers, such as News 24 and eNCA, have reported mining accidents such as a 12-hour mission by a rescue team to bring 486 mineworkers safely to the surface after they had been trapped by a fire at the Kusasa-lethu Gold mine near Carletonville on 24 February 2014 (Van Niekerk, 2016). Voznenko et al. (2016) state that one of the factors determining the nature of human work, is mental conditions (human psyche) like the existence of conflicts, weariness, exhaustion, illness, and dependence on drugs, alcohol, and nicotine. These factors have a special influence on a person's labour safety. The main cause of injuries and deaths in the workplace are attributed to an impaired mental state of workers while performing duties, as shown by an investigation of occupational injuries (Voznenko et al., 2016).

As stipulated by the South African Occupational Health and Safety Act of 1993, all individuals working at height must be trained to be competent in working at height (South African Government, 2013). This includes the development of fall protection plans that cover matters such as training, equipment, course of actions, and methodology to address fall risks, and the correct use and maintenance of safety equipment and protective clothing used at height.

The researcher noticed, while conducting an internet search, that a large variety of advertised practical courses are available to equip people working at height to do so safely. These are regulated by the South African work-at-height professional body, the Institute for Work at Height (The Institute for Work at Height, 2019). No local evidence, however, could be found to suggest that employers pretest candidates to work at height to determine their psychological and psychometric suitability for such work.

The official unemployment rate in South Africa is 32.5% (Stats SA, 2020a) and therefore employers must be particularly careful not to employ people suffering from acrophobia to work at height. Considering the unemployment rate, people who may be mindful of their fears, would be more likely to hide it from a potential employer in order to find work or to at least "get a foot in the door".

In South Africa, external factors such as the unemployment rate play a role in people's willingness to enter the mining sector even if they understand and are aware of the potential dangers and very harsh conditions they would be exposed to (Roos, 2014). The 32.5% unemployment rate in South Africa increases the possibility for people to apply for a position that includes working at height, regardless of whether they have a fear of heights or not. During a 2007 study, it was found that people who display a preference for less direct coping strategies such as emotional focus coping, increase their accident proneness – especially people who are negatively affected (external factors) and dissatisfied, as they have less control of their tasks resulting in the inability to cope with the use of proper safety practices (Paul & Maiti, 2007).

According to the Sunday Tribune (Buthelesi, 2017), a trainee marine pilot, employed by Transnet, tried to climb to an incoming vessel, became overwhelmed, lost her grip on the ladder, fell into rough seas, and drowned. The victim, aged 33, had a fear of heights. A colleague who did not want to be named, said:

> On the pilot boat, heading out to sea, the victim told her colleagues she was afraid, and they advised her not to board, but she insisted. She always talked about her fears but reasoned that it could be because it was a new experience, and she would eventually get used to it. If she had not been nervous, none of this would have happened (Buthelesi, 2017, news section 11863549).

After working (consulting) in the construction and mining industry for more than a decade, the researcher observed that there appears to be limited objective methods to identify a fear of heights in individuals, especially during the recruitment phase.

One could argue that virtual reality (VR) may be the most practical and obvious method to identify a fear of heights, due to VR offering a mediated environment as if it was real. However, VR mainly focusses on the treatment of a specific phobia and does not identify the actual fear. Currently, VR applications concern the treatment of various mental disorders but not the assessment, which is mainly based on paper-and-pencil tests (Giglioli et al., 2017). The authors add that the observation of behaviour is costly and labour intensive and therefore VR may not be a sustainable solution for South African organisations. Recruitment drives generally involve large numbers, and therefore VR may be difficult to implement due to operational costs and recruitment budgets.

1.1.1 The Mining Sector

The mining industry employs hundreds of thousands of Southern African, as well as many international experts and workers (Barnabas, 2015). The rise of the South African mining industry occurred after the discovery of gold in the former Transvaal and a few years later the discovery of diamonds in Kimberley (Winde & Stoch, 2010). The industries responsible for the greatest contribution to South Africa's Gross Domestic Product also experiences a great loss of life among its employee population (Greef, 2013). South Africa is the world's eighth biggest diamond producer, and the mining industry remains one of the most dangerous, high risk employment sectors (Minerals Council South Africa, 2019). Literature suggests that unsafe conditions are only a contributing factor of incidents experienced, while employee actions or a lack of correct actions (human factors) are contributing to up to 75% of all incidents (Voznenko et al., 2016).

While conducting an internet search, the researcher found that risk assessments, fall protection plans, training and authorisation, height safety equipment specifications, and medical fitness are terms found to be most often used in working at height in South African company policies. However, no mention of psychometric assessments or preselection criteria, for the construct specifically associated with working at height, could be found in policies openly available for public inspection. It may become very expensive for companies to invest in the training of individuals who fail to reach certain performance levels during training or especially individuals who may become anxious when required to physically reach a three-metre level.

Taking the entire South African mining sector into consideration, the recorded amount of people working underground is 243,269. Workers who are expected to work underground, may face dangers such as the risk of falling, limited visibility, workspace constraints (steeply inclined openings), challenging ground conditions, and barriers to effective ventilation in rises (Department of Mines and Petroleum, 2014).

The Minerals Council and member companies, as part of their yearly National Day of Health and Safety in mining, launched the Khumbul'ekhaya (*remember home*) safety and health strategy. The acknowledgement that fatalities have the greatest impact on loved ones at home was emphasised, and encourages mine employees and managers to bear these loved ones in mind while commencing on their daily tasks and the decisions that they make (Minerals Council South Africa, 2019).

1.1.2 Acrophobia (Fear of Heights)

Brandt et al. (2019) and Salassa et al. (2009; as cited in Brandt et al., 2019) state that fear of heights is a distressing phenomenon causing the anxiety to fall, postural imbalance, and vegetative symptoms when looking down from towers, bridges, ladders, or cliffs. The symptoms of individuals suffering from acrophobia include cognitive, behavioural, and physiological patterns (Hüweler et al., 2009). Literature suggests that the three main responses in the case of acrophobia are anxiety, panic, and fear which are manifested through any of the following symptoms: Panic attacks, shortness of breath or rapid breathing, irregular heartbeat, sweating, nausea and dizziness, muscle tension, headaches, overall feelings of dread, and even thoughts of dying. These individuals also experience thoughts of loss of control and negative thoughts that can include fears that the bridge they stand on will collapse, or that they will be tempted to jump off the structure (often even the urge to do so), and a fear that they may suffer a heart attack and fall. These thoughts occur suddenly and automatically and are not anticipated.

As discussed by Regenbrecht et al. (1998), two different types of fear are distinguished: 1) Fear as a personality trait, a stable attribute constant across situations, and 2) state fear, the actual experienced anxiety in the confrontation situation. A correlation between acrophobia and abnormalities in balance control, particularly involving the use of visual information to keep postural stability, is suggested by previous evidence (Coelho & Wallis, 2010). It is also reported by Boffino et al. (2008) that acrophobia is one of the most frequent subtypes of specific phobia associated with depression and other anxiety disorders (Boffino et al., 2008).

1.2 Problem Statement

Inadequate handling of information, under complicated circumstances, can be seen as a major contributing factor for the occurrence of accidents (Li & Poon, 2013). People employed to work at height suffering from acrophobia, pose a risk and danger to themselves, their colleagues, and safety personnel who may attempt getting them down safely. No evidence could be found to suggest that employers in the South African mining industry objectively pretest candidates to work at height to specifically determine their psychological and psychometric suitability for such work. An objective measure of the presence and intensity of acrophobia may be beneficial to provide a reliable and valid measure thereof, and to prevent social desirability and faking. There is a need to determine whether an objective psychological assessment measure can effectively assess a fear of height in a mining context, in an effort to improve the safety of mine workers working at height in South Africa. In addition, it is important to implement an assessment measure which will not evoke anxiety in an attempt to exclude possible public embarrassment and therefore do no harm.

1.3 The Research Question

From the day that humans have been interacting with their environment, errors have helped to create potentially dangerous conditions (Simpson et al., 2009). The goal of any mining company should be to operate its mines efficiently, productively, economically, responsibly, and most importantly, safely (Hebblewhite, 2009). Pressure from the South African government for organisations in the mining industry to operate safely – in that government holds the power in the issuing of the mineral rights and permits – has increased (Greef, 2013). The researcher noticed that currently there seem to be limited objective measurements, if any, for fear of heights, and accordingly the assumption was made that there may be an increased need for an objective measurement for fear of heights.

Therefore, the research question is: *Can an objective psychological assessment measure effectively assess a fear of height in a mining context?*

1.4 The Objectives of the Study

The main objective of this study is to determine the reliability and validity of an objective measure of fear of heights within the mining context.

Specific objectives are to:

- determine the reliability of the acrophobia test: ACRO (fear of heights);
- determine the relation between the ACRO and self-report/objective measures of fear of heights; and
- compare the performance of subgroups on the ACRO.

The hypotheses are:

Hypothesis 1: The reliability of the ACRO test will be acceptable.

Hypothesis 2: There will be a significant relation between the ACRO test and the self-report measures (Phase 1 – mining context).

Hypothesis 3: There will be a significant relation between the ACRO test and the self-report measures (Phase 2 – general population).

Hypothesis 4: Respondents in Phase 1 will perform significantly different on the ACRO test than respondents in Phase 2.

Hypothesis 5: There will be no significant difference in performance on the ACRO test for the different demographic subgroups.

It should be noted that the purpose of this study is not to treat acrophobia, but to determine the presence and the intensity thereof in a state of fear. Response times and the incorrect responses are determined by the ACRO, therefore focusing on how participants respond when confronted with a situation where heights videos were presented.

1.5 The Theoretical and Methodological Paradigm

The paradigm provides a rationale and framework for the research to be conducted (Terre Blanche & Durrheim, 2004). A paradigm can be described as a system of understanding, where the researcher commits to the conceptual, theoretical, instrumental, and methodological procedures of the system or paradigm.

This research is conducted in the field of psychology and specific emphasis is placed on psychological assessment in South Africa. As indicated by the Health Professions Council of South Africa (HPCSA), a psychological act with respect to assessment is defined as being “the use of measures to assess mental, cognitive, or behavioural processes and functioning, intellectual or cognitive ability or functioning, aptitude, interest, emotions, personality, psychophysiological functioning, or psychopathology (abnormal functioning)” (Foxcroft et al., 2001, p. 108).

In a state of fear, the perceptual device focuses the attention of the person directly on the object or the situation that represents the danger, may it be an animal, another person, or a more abstract fear of appearing in front of a crowd, or just the fear to fall. This theoretical assumption rests on the basis of Cooper's research findings (Prieler, 2016). Numerous studies have proven that certain mental processes that function normally under normal conditions can be restricted under stressful conditions that affect cognitive performance and increase the proneness to error as a result of its blind attentiveness. Consequently, there is a reduction in processing efficiency, which may produce impaired performance on updating tasks (Eysenck et al., 2007). If an individual is distracted by fear-driven stimuli such as the sensation of a fear of heights, it can lead to an increased susceptibility to errors and reduced cognitive performance (Prieler, 2016). The above serves as the theoretical foundation of the fear of heights test.

A positivist methodological approach is appropriate, given the objectives of the study. Four features (the first one of five, not mentioned here, does not apply, as this study was not an experiment) of a positivist approach to science (Hayes, 2000) are identified as:

- It emphasises the particular assumptions about causality: Causality is inferred by human senses when particular events are seen as occurring together in space and time, and that cause is replicable.
- It emphasises a belief that the observer is completely independent of what is being observed.
- It holds an ideal of scientific knowledge as being value-free, and as occurring independently of culture and the social context.
- It further maintains that all sciences can and should be conducted by the same overall methodology.

Taking into consideration that the objective assessment of fear of heights can be considered as a relatively new endeavour, as there are limited South African research studies available with regards to identifying this phenomenon, an explorative and descriptive, relational design is used for this study.

The quantitative approach that is used, implies that data are collected in the form of numbers, while statistical data analysis is used to make broad and generalisable comparisons between the predetermined categories (Durrheim, 2004b).

1.6 The Research Strategy

The following section explains the data collection process for the two phases. The study was conducted during two phases as existing South African data have been collected and were available for exploration, as per permission from the developer of the ACRO. The existing data were considered as valuable as it was collected specifically in the mining industry. However, the specific context as well as the fact that the participants were employees at the mine, implied potential preselection which in turn could lead to a limit in the range of performance on the measuring instruments. The researcher therefore also included a general population group, in order to be able to comment on the validity and reliability of the ACRO in a broader context. Two different self-report questionnaires were used in the contexts to make provision for literacy level and potential cultural bias.

1.6.1 Phase 1

As psychometrist, the researcher was involved in a project where participants at a South African diamond mine completed the ACRO and a short self-report questionnaire on fear of heights as part of the data collection process for the standardisation of the ACRO. These participants mainly consisted of operators and people who were in the process of being trained to potentially work at height. It should be noted that the ACRO was not part of the selection criteria, as the sole purpose of the project was to collect data as part of the standardisation of the Acrophobia Test, ACRO (fear of heights). Regarding the researcher's hypotheses, hypothesis 4 may have been more likely to be supported, due to the fact that this sample was context specific, whereas the sample in Phase 2 contained respondents from the general population. The direction of the difference could not at this stage be hypothesized.

1.6.2 Phase 2

A sample of participants were recruited from the general public to participate in this study. The reason for Phase 2 was: Given the potential limited variance as a result of preselection, the researcher had to support the findings in the mining context with data from a general population.

A comparison between the contexts provided additional information about the test's ability to measure the presence and intensity of the phenomenon.

1.7 The Research Method

Each participant completed a biographical questionnaire which included age, gender, level of education, and present occupation. Both participating groups (Phase 1 and Phase 2) completed the ACRO. The ACRO is an assessment tool that is specifically designed to identify the fear of height construct (acrophobia).

Phase 1 participants (n=150) were subsequently asked to indicate either "True" or "False" to seven simple statements related to heights. This self-developed, self-report questionnaire was kept as uncomplicated, short, and straightforward as possible, in an attempt to exclude cultural bias, to include lower literacy level participants and to ensure that production at the mine was not affected during this data collection project.

Participants during Phase 2 (n=59) completed the Heights Interpretation Questionnaire (HIQ) and the Visual Height Intolerance Severity Scale (vHISS).

Internal consistency reliability was determined for the ACRO and the results on the ACRO and the self-report questionnaires were correlated. The latter provided information on the construct validity of the test. This was further explored by means of subgroup comparisons.

The following subgroup data were investigated, obtainable from the completed biographical questionnaires: Age, gender, and level of education. Data were furthermore compared across contexts.

Descriptive statistics included the mean and standard deviations, among others. Correlational analysis, reliability coefficients, and comparative analysis were used to achieve the research objectives.

1.8 Ethical Considerations

To conduct this study, ethical permission was obtained from Unisa's Psychology Department, and ethical clearance from the College of Human Sciences (Appendix 1). Permission was obtained from the HR department at the mine (Appendix 2) and an informed consent form (Appendix 3) was signed by each participant. The rules of conduct, provided by the HPCSA (n.d.) pertaining specifically to the profession of psychology guidelines applicable to research, were followed. The ACRO test is listed on the HPCSA list of classified psychological tests and therefore a suitably trained test administrator was present at all times during the psychometric assessment. The ACRO test developer had been informed of and consented to this intended research (Appendix 4). Participants were notified that the results are confidential. They were also aware that they would not receive individual feedback but that the findings of the study will be generally available. Individual results were also not made available to management, as there were no concerns noted to report. Several ethical considerations such as anonymity, privacy etc. are further mentioned and discussed in detail during chapter 4.

The analysis was conducted at group level and all personally identifiable data were removed before publication of the findings to ensure the privacy of individuals whose data formed part of this study.

1.9 Chapter Outline

Chapter 1 consists of an introduction, the justification for the research, the formulation of the problem statement and the research question. It explains the paradigm perspective and summarises the research design and the research methodology. In addition, the ethical considerations are introduced.

Chapter 2 comprises the theoretical review of acrophobia (fear of heights) and gives an overview of perspectives assisting with insight to the foundation of an integrated model of fear and phobias.

Chapter 3 comprises an overview of literature on fear of heights in the mining industry and the use of psychological assessment measures in organisational contexts in general and in the mining context specifically.

To achieve the objectives of this dissertation, Chapter 4 contains a description of the methodology followed in this study.

In Chapter 5 the data are presented and interpreted.

Chapter 6 discusses the research results, after which recommendations are made on the basis of the data and results. Limitations of the study are noted, and a conclusion is given.

1.10 Summary

In this chapter the justification for the research and the formulation of the problem statement were discussed. The research question was unpacked, and the paradigm perspective, the research design, and the research methodology were introduced. In addition, an overview of the ethical considerations was discussed. The different fear perspectives are discussed in Chapter 2 and an insight to the model of fears and phobias is provided.

2. The Etiology of Acrophobia: Definitions, Theories, and Models

Chapter 1 introduced the study and presented the layout of the planned study as well as the justification for the research. In this chapter a review of the available literature is provided, while the researcher unpacks the definitions of acrophobia. The different theories, perspectives, and models related to acrophobia are also discussed.

2.1 Acrophobia (Fear of Heights)

Fears are fast and adaptive responses that permit a powerful action to imminent threats (Coelho & Purkis, 2009). Many people come to treatment agents, complaining about irrational fears or phobias. These fears are usually linked to certain objects, places, or events. If the intensity of the fear is higher than in most other people, or if the fear is something that most people do not fear, the fear is regarded as irrational (Fourie, 2006).

One of the defining features of phobias is that the victim recognises the fear as excessive and unreasonable. According to Alpers and Adolph (2008), dizziness, or feeling unsteady is a common symptom in states of heightened anxiety. Dizziness has often been associated with agoraphobia; the latter described as an anxiety disorder characterised by symptoms of anxiety in situations where the person perceives the environment to be dangerous with no avenues to get away. However, dizziness is especially typical in the case of fear of heights, or acrophobia. The term "fear of heights" suggests an anticipatory fear that leads to the avoidance of heights and therefore prevents anxiety attacks and disastrous falls (Huppert et al., 2020).

Fear of heights is a distressing phenomenon which may cause anxiety in the following situations: Falling, postural imbalance, and disturbance of a person's functions, when looking down from towers, bridges, ladders, or cliffs (Brandt et al., 2019). Moreover, due to the pervasive and chronic avoidance of a wide range of situations, acrophobia carries an increasing social impact (Coelho & Wallis, 2010). Acrophobia tends to evolve to chronicity largely due to the extensive avoidance of a wide range of height related situations that form part of everyday living (Coelho et al., 2009). Coelho and Wallis (2010) describe acrophobic behaviour particularly involving the avoidance of a variety of height related situations, such as stairs, terraces, apartments, bridges, elevators, plane trips, and offices located in high buildings.

According to Andrews (2007), heights *per se* is not as important as how height is perceived and negotiated by people, both in the moment and throughout life. The findings of Andrews (2007), based on a qualitative study, suggest that in an immediate situation involving height, physical presence can lead to three outcomes: Emotional responses (such as fear and anxiety), physiological responses (including sickness and rapid breathing), and social conflict (with particular social scenarios having equivalent capacity to either magnify and compound, or assist and solve, and to evoke further emotions such as embarrassment).

Epidemiological studies usually focus on a definition of fear of heights as a subtype of specific phobias. When the complexity of phenomena is narrowed down, by organising it into categories according to some established criteria for one or more purpose, it can be described as a classification process. Rosenhand and Seligman (1989, as cited in Huppert et al., 2017) categorised the three specific phobias as follows: Situational phobias (lightning, enclosed spaces, darkness, flying and heights), animal phobias (snakes and spiders), and mutilation phobias (injections, dentists, and injuries). In addition to this categorisation of fear of heights, diagnostic features of anxiety and panic attacks evoked by being exposed to heights, is included in the criteria (Huppert et al., 2017).

More recently, the DSM-5 defines five subtypes of specific phobia: Phobia related to animals, natural environment, blood needle injury, situational, and other (Yalin-Sapmaz et al., 2018). Specific phobias are further classified within anxiety disorder categories and are characterised by being a disproportionate and irrational type of fear, compared to the stimulus that causes such fear (Ruiz-García & Valero-Aguayo, 2020).

A large number of people or patients nevertheless enter the situation which elicits their fear, even after reporting debilitating distress resulting from a particular phobia (Marshall et al., 1992). Research further indicate that there is robust epidemiological evidence, that in about one-third of the general population, fear of heights is not restricted to acrophobia alone, but may also be present in a more or less severe form (Brandt et al., 2019).

Moldovan and David (2014) describe phobias as an exaggerated, irrational fear of specific objects or situations. Phobias are usually characterised by significant avoidance of any *in vivo* or *in vitro* exposure to fear stimuli or, people experience it with great distress when avoidance is not an option. However, there is also a more frequent, less severe, and "nonphobic" fear of heights, with a continuity of symptoms, namely visual height intolerance (vHI).

Schäffler et al. (2013) explained that vHI occurs when a trigger causes the apprehension of losing balance and falling. It is further explained as a common physiological phenomenon experienced by everyone at an altitude of several meters, when the distance between the eye and the nearest objects within the environment becomes large. vHI omits the usual symptoms of panic attacks associated with acrophobia, and transpire when a visual stimulus causes apprehension of losing one's balance and falling from some height (Huppert et al., 2013b). Therefore, acrophobia can be described as the severest form of vHI.

Additionally, there also seems to be confusion regarding acrophobia and vertigo. Brandt et al. (2013) explain that vertigo is not acrophobia but in fact the sensation of movement and a disturbance of equilibrium, according to medical understanding. Furthermore, vertigo is often caused by an infection of the middle ear (Brandt et al., 2013). In other words, vertigo is when someone feels like they are moving, while they are actually not.

The question of whether acrophobia is inborn in humans, what may cause it, and what effects it may have, has had a long tradition of scientific enquiry (Prieler, 2016). An example is found in the Visual Cliff Paradigm (Gibson & Walk, 1960, as cited in Prieler, 2016): Even small children who start crawling, will not move over a glass tabletop that provides an illusion of depth as a result of a check board pattern that is mounted about one meter beneath the glass plate and not directly under it. Whether or what role the fear factor plays in this instance, is still contested and has empirically not clearly been answered (Prieler, 2016).

Findings from a study by Fredrikson et al. (1996) suggest that it is difficult to compare prevalence rates because studies differ in phobia definitions, data collection methods, age, race, different time periods for risk estimation, and the willingness to admit fears and phobias. However, their study (n=500 males and n=500 female participants aged between 18 and 70 years in the Stockholm area) indicates that the prevalence of one or more specific phobia(s) was 26.5% for woman and 12.4% for men (Fredrikson et al., 1996). Later, Fredrikson et al. (1996) have presented results with 3.6% of men and 8.6% of woman diagnosed with acrophobia. Coelho and Wallis (2010) indicate that acrophobia affect as many as one in 20 individuals, and therefore can be seen as one of the most prevailing phobias.

Poulton et al. (1998) conducted a longitudinal study of a large cohort of approximately 1,000 participants. The authors noticed that serious falls resulting in a fracture, dislocation, laceration, or intracranial injury had no positive correlation with fear of heights in later ages. Antony et al. (1997) found that fear of heights (situational fears) occurred at a later age than fears of blood or injection. A more recent study (n=6510 Korean participants aged between 18 and 64 years) found that the age onset for situational phobias is in young adulthood, 26.3 years of age, and that situational phobias are more prevalent in highly educated participants (Park et al., 2013).

Literature suggests that the behavioural models of phobias persevered from the 1920s until about the 1970s, and during the late 1970s vicarious and informative acquisition pathways were added to the model. Initial research (Mowrer's theory) stated that anxiety is a learned response, an occurring conditioned stimulus that serves as a warning for painful situations. Mowrer's theory originated mostly from the writings of Pavlov, Freud, James, and Watson (Rachman, 1977). Three main pathways have been identified by Rachman (1977) regarding the etiology of phobias: Conditioning, vicarious acquisition, and information/instructions.

There are clear indications that even though the phenomenon of fear is accepted, the essence of fear seems to still be controversial. Presumably, there are two well defined and opposite frameworks, namely the associative and non-associative accounts that propose either learning or inherent nature as entirely responsible (Coelho & Purkis, 2009). The associative perspective maintains that fear and phobias occur mainly as a reaction of learning experiences, whereas the non-associative perspective presume that certain fears and phobias reflect a spontaneous reaction, which is inherent to relevant evolutionary signals (Coelho & Purkis, 2009). The non-associative view furthermore assumes that fears constitute evolutionarily applicable threats, evoking fear without the necessity of a critical learning experience, and are usually associated with fears such as fears for heights and water (Coelho & Purkis, 2009).

Phobia can be described and understood as the severest form of fear. In an attempt for more clarity regarding the etiology, theories, and models, the following perspectives are discussed below: The classical, vicarious, and informative pathways for fear acquisition, the preparedness framework, the non-associative theory, the fear model theory, cognitive models, and the fear of heights model.

2.2 The Classical, Vicarious, and Informative Pathways for Fear Acquisition

The emergence of the classical conditioning model for specific phobias originated in animal research laboratories during the first half of the 20th century with the observation by Watson and Rayner (1920): They could train an animal or a child to respond with fear to a harmless situation by repeatedly associating a harmless conditioned stimulus with a terrifying unconditioned stimulus. Later on, theory suggested by Mower (1960, as cited in Coelho et al., 2009), surfaced in which the evolution of avoidance is critical to the perseverance of conditioned anxiety by maintaining subjection to the conditioned stimulus and preventing the extinction of the fear response.

Wolpe (1958, as cited in Coelho and Purkis, 2009) used Mower's theory in phobia treatments, creating the well-known systematic desensitisation treatment and providing a rationale for behavioural therapies. It was explained that fears generalise to stimuli that had related properties (repetitions of neutral and aversive stimuli) and in the late 1970s, more complexity was added to this model with the inclusion of the vicarious and informative acquisition pathways (Coelho et al., 2009).

Rachman (1977) suggests that a predominant component in phobia acquisition is vicarious conditioning (learning by observing the reactions of others to an environmental stimulus) and adds that information and instructions from parents and family members affects the acquisition of fear. Numerous studies indicate that experiences, that were non-traumatic, were progressively regarded as a key part of the models, especially when outlining the etiology of phobias in adolescence (Coelho & Purkis, 2009).

Mineka and Cook's experiments (1986), possibly one of the most important cited contributions to the role of vicarious conditioning in phobia acquisition, comes from where 22 monkeys observed on video how other monkeys of their species react with intense fear to relevant stimuli (snakes or artificial crocodiles) and irrelevant stimuli (flowers and artificial rabbits). The primates that observed the videos had no prior experience with any of the stimuli (Mineka & Cook, 1986). The research confirmed that, whereas observer monkeys did not originally show fear to any of the stimuli, after 12 sessions they had acquired fear of evolutionarily relevant stimuli, but not of non-evolutionary relevant stimuli. Mineka and Cook (1986) note that when they exposed monkeys to other monkeys that interacted with snakes without showing fear, this group did not acquire fear after subsequent exposure to phobic models. This effect was even stronger than the latent inhibition effect (simple exposure to snakes by themselves) (Mineka & Cook, 1986).

A later experiment by Mineka and Cook (1989) indicates that participants acquired a fear of fear-relevant stimuli (toy snakes and toy crocodiles), but not of fear irrelevant stimuli (flowers and toy rabbits) (Cook & Mineka, 1989). Supporting the importance of vicarious learning, a study with 40 children (25 boys and 15 girls) between 9 and 12 years of age (Muris et al., 1996), found a significant positive relation between the mother's and child's fears and a relation with the frequency with which the parent usually expressed her fear in the presence of her child. The parents who showed fear more often had more fearful children, and conversely.

Conditioning, vicarious experience, and information can provide approaches for fear acquisition as reinforced by the research conducted. Ollendick and King (1991) further investigated Rachman's model (1,092 Australian and American children aged between nine and 12), where the results indicated the importance of information and modelling. The majority of cases in which there are high levels of fear in these children resulted from a combination of learning sources, suggesting that fear is expected to develop as a result of synergistic effects of various sources or pathways (Ollendick & King, 1991). Further studies suggested that negative and positive information have dramatic and opposite effects on self-reported fear beliefs, behavioural avoidance, and implicit attitudes; which further supported Rachman's model (Field & Lawson, 2003).

During a 2017 study, Reynolds et al. (2017) further investigated whether fear-related responses to a second-order stimulus could occur, following vicarious fear learning. It was shown that children's fear beliefs for marsupials and caterpillars increase when they see them with fearful faces compared to seeing them with no faces. Seeing someone responding fearfully to a new stimulus increases children's fear beliefs and avoidance preferences for that stimulus, and therefore, avoidance preference results indicated increased avoidance following vicarious learning. The results indicate that fear beliefs and avoidance can increase for a stimulus that has not been directly involved in a learning event but can simply be associated with another stimulus that was previously involved in a fear-related vicarious learning event. This could explain why someone cannot remember a traumatic experience with a "feared stimulus" after developing a particular phobia (Reynolds et al., 2017).

The influence of information in fear acquisition is supported by various studies. In a study by Field et al. (2001), 40 children (aged between seven and nine) were exposed to story book stimuli (dolls/monsters). Before the children were exposed, positive or negative information was given via telling a story or by a video that presented a woman interacting positively or negatively with the monsters. When the children were questioned about the monsters, it was revealed that the type of information given to the children, influenced the children's beliefs regarding the new stimulus (Field et al., 2001). The video presentation was found to be less effective than the verbal information (Coelho & Purkis, 2009). Support was found for the effect of verbal information in terms of the role of verbal fear-related beliefs about social situations by Lawson et al. (2007); especially when the information given was negative.

Visual observation of another individual in relation to fear acquisition is also undeniable. Olsson and Phelps (2004) substantiated the pioneer work of Bandura (1965; 1971; 1977, as cited in Olsson & Phelps, 2004) in vicarious learning, that no direct consequences need to be delivered to the observer for acquisition to occur and that the principles of reinforcement and punishment operate when consequences are delivered to another individual (Coelho & Purkis, 2009). It was also shown by Olsson and Phelps (2004) that directed awareness does not necessarily need to go hand in hand with fear learning after observation.

In summary, this model reinforces that conditioning, vicarious experience, and information can provide possibilities or explanations for fear acquisition. Even though the conditioning models show considerable face validity, the conditioning theory was criticised as to its generalisation to humans and to situations outside the laboratory (Coelho & Purkis, 2009). The authors further mentioned the following criticism of the model: First, a significant number of participants with phobias do not remember traumatic or conditioning events; second, a small number of stimuli (e.g., heights, snakes, blood, etc.) consist of mostly all the phobias, without any consistency in distribution; third, not all individuals who are exposed to encounters with stimuli, develop a phobia; and finally, phobias have proven difficult to train in laboratory settings, and the effects of training tend to be weak and temporary.

2.3 The Preparedness Framework

Seligman (1971) reformulated the conditioning model which initially proposed that specific stimulus configurations are evolutionally susceptible to summon fear responses in certain animals. This can also be seen as the biological point of view of preparedness. According to Seligman, (1971) ontogenetic and phylogenetic selection creates tendencies to respond with fear to certain threatening stimuli, favouring the survival of certain characteristics of given species through the course of evolution (Seligman, 1971). In 1877, Charles Darwin, while observing his two-year-old son being afraid of large animals in a zoo, noticed that certain fears may appear by natural selection. Darwin started questioning whether fears in children, that appears to be independent of experience, are consequences of the inertness of actual dangers during prehistoric times (Darwin, 1877).

A more recent perspective by Rachman (2002) indicates that the child slowly acquires the abilities needed to deal with the existent predispositions and actual fears by habituation and experience, and therefore the remaining fears are those that are most resistant to extinction, and those acquired through the conventional learning process, the uncommon or rare fears (Rachman, 2002). The three-route theory of Rachman supports and agrees with Seligman's theory in that people who are presented with opportunities of harmless feared stimuli should be less fearful than individuals who never, or very seldomly have to deal with the same stimuli.

Certain authors disputes Seligman's perspective regarding the identification and discrimination of reasonable prepared fears. Awareness was drawn by Muris et al. (2002) and they explained that formulating probable evolutionary scenarios to justify the appearance of prepared fears, may accompany their own set of dangers. The fear of insects could be regarded an evolutionary relevant fear; however historians remind us that the role of insects in spreading diseases was only discovered around 1900 (Coelho & Purkis, 2009).

Furthermore, Coelho and Purkis (2009) mention that Seligman's model requires conditioning episodes for the development of prepared fear, which allows for the criticism levelled at the conditioning theory. Soon, an alternative view of preparedness was presented, known as the non-associative theory of fear acquisition, suggesting that numerous fears appear from the very first time that the living organism meets the stimulus (Coelho & Purkis, 2009).

2.4 The Non-Associative Theory

The non-associative theory hypothesises that fears may occur without direct or indirect experiences (e.g., information) with the phobic stimuli. The theory assumes that fear of heights, water, spiders, strangers, separation, and so forth presents evolutionary-relevant fears that occur without critical learning experiences involving these feared objects (Muris et al., 2002). Learning is an adaption that enables organisms to adapt their behaviour to a fluctuating environment. Action guided by emotional reactions, when the organism encounters objects and events that should be avoided or approached, can be seen as an important element of learning depending on their potential impact on the organism's survival (Olsson & Phelps, 2004).

Menzies and Clark (1993) reported the first studies supporting the non-associative model while investigating the origins of water phobia. Later, researchers assessed groups of children with and without fear of water and concluded that the groups did not differ significantly in the incidence of aversive experiences related to water (Graham & Gaffan, 1997). The authors further mentioned that, according to the children's mothers, most of children with a fear of water (seven of nine), had displayed the fear since their very first contact with water. Poulton et al. (1998) report that in their study, participants with less fear of heights seem to be those who have sustained more injuries due to falling.

At some stage, associative learning is still required of the species' and organism's learning, but with an appropriate match between conditioned stimuli and unconditioned stimuli for fear acquisition, while the non-associative theory omits the need for this ontogenetic learning for certain fears such as water or heights (Coelho & Purkis, 2009).

Poulton and his co-workers, however, disregarded the critical dynamics of children's fear development that have a strong influence on the results of any learning experience (Öhman & Mineka, 2001). Methodological concerns regarding the questionnaire (used to assess the origins of phobias by Menzies and Clarke), include the fact that the questionnaire allows a response choice such as "I was always this way", which strengthens the hypothesis of non-associative etiology. This specific style of questioning inflates estimations of non-associative etiology. Since the studies done by Nisbet and Wilson (1977, as cited in Coelho & Purkis, 2009), verbal reports are clearly not very helpful to divulge causal processes, particularly when learning and conditioning can occur without awareness. Coelho and Purkis (2009) further explain that phobias to stimuli such as water and heights may be the result of the accumulation of subtle, non-traumatic experiences (e.g., bathing and small falls at young ages) that are not very momentous but can model and influence long-term behaviours.

2.5 The Fear Model Theory

Öman and Mineka (2001) state that, on the basis of a study done by Razran (1971), it is argued that higher levels of learning (e.g., cognitive and contingency learning) have emerged after evolutionary development, generating separable emotional and cognitive learning pathways. According to the fear model theory, more detailed information about the stimulus enters the temporal cortex to confirm or unconfirm the activation that is on its way through the subcortical route (Coelho & Purkis, 2009). Coelho and Purkis (2009) further explain that the conscious mind can therefore be used to retrospectively inspect the unconscious information and provide some meaning to the information.

A relative selection of stimuli, automaticity, encapsulation, and a specific neuronal circuit are four characteristics of the fear model as explained by the authors. Selectiveness concerns the extent to which a certain stimulus is effective in activating the model and varies with both evolutionary relevance and the former aversive experiences with the situation (Coelho & Purkis, 2009). Basically it can be explained as the device for activating the defensive behaviour (e.g., immobility or flight-fight) and associated psychophysiological responses and emotional feelings to threatening stimuli (Öhman & Mineka, 2001). When fast, reflective activation of defence responses, independent of the neocortex in a fast process that prefers to risk false positives than false negatives, it can be described as automatism. (Coelho & Purkis, 2009). Therefore, the behaviour is likely to be evoked whether a person wants it or not. There may be triggered responses in the absence of any conscious awareness of the stimulus event (Öhman & Mineka, 2001). The somewhat independence and resistance of the fear response, once initiated by conscious cognitive control, is defined by encapsulation (Öhman & Mineka, 2001). Öhman and Mineka (2001) explain that once the stimulus is activated, a model tends to run its course with few possibilities for other processes to interfere with it or stop it. Particularly, evolutionarily shaped models will be resistant to conscious cognitive influences because their origin typically precedes recent evolutionary events such as the emergence of conscious thought and language (Öhman & Mineka, 2001).

It is suggested that at a neuronal level the fear model is controlled by a specific circuit and this is regarded as the last domain of the model (specific neural circuitry). Öhman and Mineka (2001) mainly based this aspect of their work on amygdala-related findings. It has been reported that patients with bilateral amygdala lesions (usually responsible for emotions, survival instincts, and memory), generally demonstrate selective deficits for recognising facial expressions of fear and anger, in spite of a normal recognition of other emotional expressions (Young et al., 1995). Amygdala damage is also known to produce deficits in fear conditioning in humans, as fear is considered to be an emotion. Projections from the amygdala to the brainstem are involved in the expressions of fear responses, and projections from the amygdala to the cortex are assumed to contribute to the experience of fear and other cognitive aspects of emotional processing (Coelho & Purkis, 2009).

Automatic behaviours are hesitant to change even when coupled with negative consequences, and research results suggest that automatism is a far too inflexible characteristic to provide humans with an adaptive fear response. Therefore, the distinction made by Coelho and Purkis (2009); that whereas low-pass information may be enough to discriminate images to allocate attention, it may not be enough for an emotional response. Humans usually see more happy expressions than angry expressions, more flowers than snakes, and it may therefore be more difficult to associate a happy face or flower with fear. The before mentioned is therefore reported as the implication of latent inhibition to the fear model.

2.6 Cognitive Models

When a cognitive process occur, during which a person learns that a determined event or stimulus precedes an aversive outcome, it can be conceptualised as conditioning (Coelho & Purkis, 2009). The cognitive perspective explains that fear is related to not only the biological preparation of stimulus-response association, but also to the attributions regarding the safety and danger of the stimulus, the perception of control over the situation, and the attribution made about the bodily alarm signal that the stimulus evokes (Coelho & Purkis, 2009). The results of Öhman and colleagues (1974; 1975; 1976, as cited in Coelho & Purkis, 2009) on the basis of expectations arising from experience, instructions, and vicarious learning, that is, when there is a strong expectation of covariation between two events, people frequently overestimate their contingency, could explain cognitive models (Coelho & Purkis, 2009).

By introducing various uncorrelated stimuli across trials, Tomarken et al. (1989) implemented an illusory correlation paradigm. Flower, mushroom, snake, and spider stimuli were randomly paired with aversive (shock) and non-aversive (nothing/tone) outcomes. Highly fearful participants of snakes and spiders overestimated the number of trials on which the fear-relevant stimulus had been paired with shock, but were relatively accurate in estimating the other stimulus probabilities (Tomarken et al., 1989). Mineka (1992) proposes that phobias are an enduring example of a fear or danger schema, but that a short-term activation of a fear or danger schema in non-phobic participants may result in a similar covariation bias as is observed with phobic participants. Coelho and Purkis (2000) explains that according to Davey's findings (1989; 1992; 1995, as cited in Coelho & Purkis, 2000), should participants have reason to believe that the stimulus is dangerous, rapid learning allows expectancy bias to occur. Phelps and Ledoux (2000, as cited in Coelho and Purkis, 2000), report that after freezing or expressing a physiological response to a dangerous stimulus or situation, cognitive processes will have authority over behaviour, considering the prediction regarding what is more likely to happen next, in view of past experiences in similar situations. Overestimation, regarding the predictive relation between a particular stimulus and its probable outcome, is a tendency found in people diagnosed with phobia (Coelho & Purkis, 2009).

It is reported by Davey (1995) that the speed with which certain stimuli are associated with aversive results is related to the existence of biases in information processing of threatening stimuli rather than with associative phylogenetic predispositions. It is reported that cognitive biases are present in the cognitive model consisting of a high presumption that aversive results will transpire with a fear-relevant stimulus. Öhman and Soares (1993) who demonstrated pre-attentive processing of fear relevant stimuli, are criticised by Davey and Craigie (1997), who argue that there is no reason to assume that information related to expectations cannot be quickly assessed and determined by the pre-attentive processes of fear relevant stimuli.

Lang (1971, as cited in Baker et al. 2011) unpacks the concept of fear by reporting that a "fear structure" is a set of concepts about stimulus (e.g., spider), response (e.g., racing heart), and its connotation (e.g., "I will be poisoned") that are stored in memory. The fear structure is activated by inputs that match a part of the structure which generalises to activate other parts of the structure (Lang 1971, as cited in Baker et al., 2011).

Muris et al. (2002) ask the question why most new stimuli only elicit a brief orientation reaction, whereas some (e.g., heights and separation) provoke fear. According to Gray's theory (Gray 1996), fear can best be regarded as the product of a subcortical circuit, named the Behavioural

Inhibition System (BIS). The BIS constantly compares new information from the outside world to what is already stored in memory, attempting to predict events. Fear arises when a person is confronted with aversive, novel, and/or unpredictable stimuli, and the BIS is activated. It is further assumed that stimuli that are characterised by higher levels or aversiveness, novelty, and/or unpredictability will elicit a greater BIS activity, and therefore higher levels of fear (Muris et al., 2002).

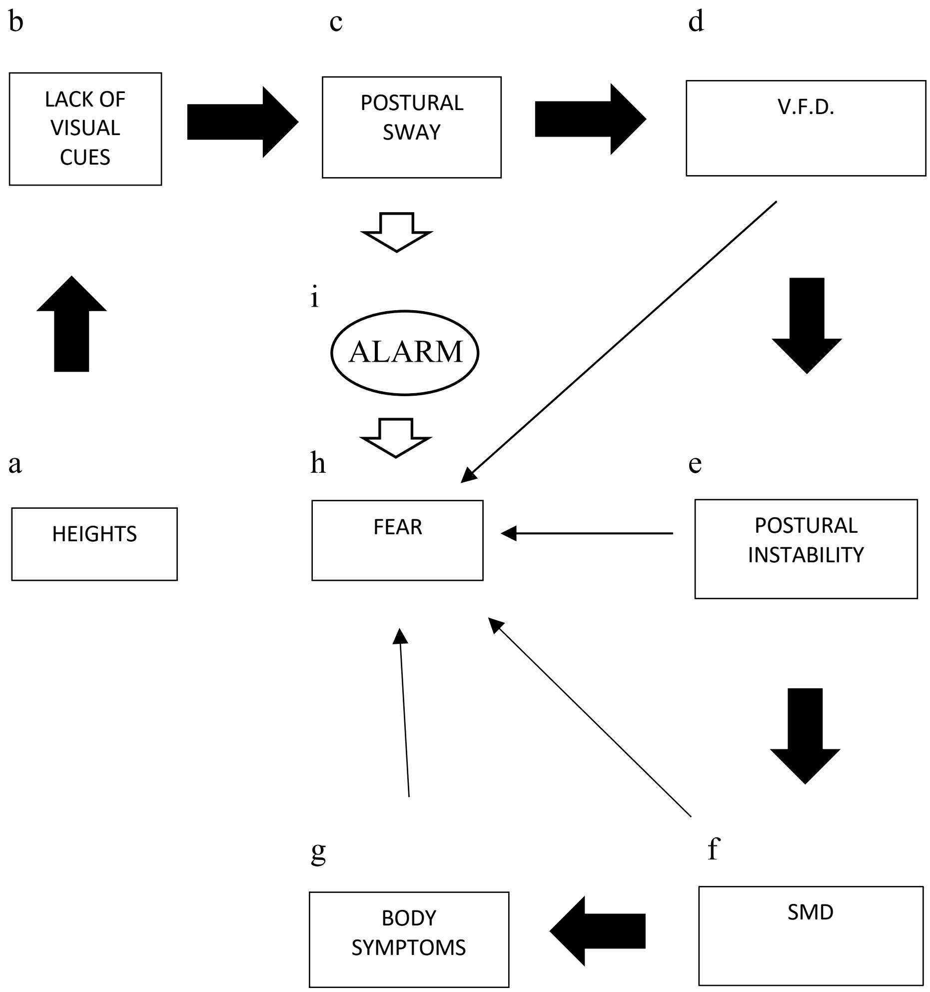
2.7 Fear of Heights Model

The categorisation of height-induced behavioural reactions into non-phobic vs. phobic, has been challenged by recent research, as indicated by literature. Accordingly, individual reactions to height exposure appear to be a result of a complex composition of a broad physiological height imbalance that reflects the extraordinary situation for visual control of balance at heights and a set of fear-induced cognitive and vegetative reactions provoked by height stimuli (Brandt et al., 2019). However, “distance vertigo” can be considered as a physiological height imbalance, induced by a discrepancy between visual distance cues and the perception of self-motion when the distance between the eyes and nearest objects in the environment becomes critically large. This unsettling of posture at heights is usually experienced by most people, however, it is reported that the actual stimulus-response relation in fear of heights, excluding occasional observations, has not been fully investigated yet.

Coelho and Wallis (2010) tested a range of factors thought to be related to a fear of heights. The aim was to generate a unified model of how these factors interrelate and contribute to acrophobia (see Figure 2.1). They found that people with acrophobia are showing higher visual field dependence errors that reduce visual feedback, create postural destabilisations, and that participants with acrophobia have higher scores of space and motion discomfort. They report that postural control relies on multisensory processing and motor responses that seem to be automatic and occur without conscious awareness. Coelho and Wallis (2010) have found a high correlation between measures of acrophobia, and a tendency to interpret internal body sensations of anxiety as threatening.

Figure 2.1

An explanation of the unified model of Coelho and Wallis (2010) of how these factors interrelate and contribute to acrophobia



Note. According to Coelho and Wallis (2010, p. 869), when exposed to heights (a), the lack of visual cues (b) creates a natural increase in postural sway (c), aimed at reactivating visual control. In visual field-dependent individuals (d) with poor nonvisual postural control, the lack of visual cues will result in postural instability (e) and a feeling of being off-balance resulting in a moderate level of fear. For those individuals who tend to feel disorientated and sick through such instability (f), more fear will result. However, some individuals may experience a thrill or excitement through disorientation rather than a debilitating fear. It is only those who experience discomfort in the presence of dizziness and disorientation (g) who will go on to experience a strong fear response (h). These findings suggest that cognitive biases increasingly lead the individual to interpret bodily sensations as threatening, and that this may be a mechanism through which chronic acrophobia is acquired.

In a state of fear, the perceptual apparatus focuses the attention of the person directly on the object or the situation that represents the danger, be it an animal, another person, or a more abstract fear of appearing in front of a crowd, or just the fear to fall. The above theory rests on the basis of Cooper's research findings (Prieler, 2016).

Prieler (2016) states that it is beyond dispute that feelings of anxiety impair cognitive performance. A number of studies has proven that certain mental processes that function normally under normal conditions can be restricted under stressful conditions that affect cognitive performance and increase the proneness to error as a result of blind attentiveness. As a result, there is a depletion in processing efficiency, which may create impaired performance on updating tasks (Eysenck et al., 2007). If an individual is distracted by fear-driven stimuli such as the sensation of a fear of heights, it will lead to an increased susceptibility to errors and reduced cognitive performance (Prieler, 2016). The theoretical foundation of the fear of heights test (ACRO) rests on this paradigm.

The present study is based on the model of Coelho et al. (2009) in which cognitive factors (e.g., fear of falling and catastrophic interpretations), perceptual factors (e.g., visual dependence), learning factors (e.g., prior exposure to heights), and biological factors (e.g., heredity) can interconnect, eliciting either habituation or extreme fear of height-related behaviour.

What is not yet clear, is the impact that these factors may have on people who are required to work at height, as their proneness to error will increase, should they be prone to acrophobia. Their physiological factors alone may significantly increase the risk, especially in an emergency, or unexpected working conditions.

Although specific phobia is highly prevalent and associated with impairment (an important risk factor for the development of other mental disorders), cross-national epidemiological data are scarce, especially from low and middle income countries (Wardenaar et al., 2017). The life-time prevalence of acrophobia ranges from 3.1% to 6.4% (Huppert et al., 2013b). Acrophobia often appears in the absence of any direct aversive conditioning episodes, while the age of onset varies across studies from mid-teens to mid-twenties, affecting both genders almost equally (Wiederhold & Bouchard, 2014).

Earlier studies found that the most common phobias for both men and women involve spiders, bugs, mice, snakes, and heights (Bourdon et al., 1988). During a cross-sectional epidemiological study (n=3,517 individuals representative of the general population), it was found that the life prevalence of vHI was 28%, which was higher in females (32%) than in males (25%), and increased with age (Huppert et al., 2013a).

More recently, Wardenaar et al. (2017) found in their epidemiological study (n=124,902) that the cross-national lifetime and 12-month prevalence rates of specific phobias are respectively 7.4% and 5.5%, being higher in females (9.8% and 7.7%) than in males (4.9% and 3.3%) and higher in high/middle income countries than in low/lower income countries. Wardenaar et al. (2017, p. 2) also state that "importantly, specific phobia often precedes the onset for other mental disorders, making it a possible early-life indicator of psychopathology vulnerability".

During a 2017 study, findings suggested that the education level of participants did not significantly impact how they perceived a VR environment. Furthermore, it was found that the educational level of participants did not significantly influence how realistic and immersive participants found their VR experiences (El-Rawas & Kazımoğlu, 2019). It was, however, important to include education to this specific study as the study by El-Rawas and Kazımoğlu (2019) found a non-significant result with regards to VR, and not specifically for identifying acrophobia.

The relation between age and safety performance has been an issue since the beginning of the 20th century and the national academy of sciences investigated the relation between the age and various accident rates for 15 of the largest underground coal producing companies in the USA, finding strong negative correlations between age and work injuries in coal mining (Paul & Maiti, 2007).

In the present study, the population race groups were not included as a stratification variable, as the original studies where the ACRO was used as a measurement (Prieler, 2016) did not include this variable. Furthermore, based on the above discussion that the research is not conclusive regarding the impact of the demographic variables, the researcher made the hypothesis that age, gender, and level of education will not influence performance in terms of fear of heights.

2.8 Summary

In this chapter, the researcher, based on the existing body of knowledge, unpacked the defining features of phobias. The etiology of acrophobia was discussed and the different fear perspectives, structures, and models of fears and phobias were described. Epidemiological studies were discussed and the definitions of acrophobia and vHI were unpacked. In Chapter 3, working at height in the mining industry, as well as psychological assessments and instruments in the industry will be discussed. The selection process will be unpacked, and VR will also be touched on.

3. Slips, Trips, and Falls in the Mining Industry

Chapter 2 covered the different theories, perspectives, and models related to the etiology of acrophobia. In the present chapter, working at height in mining, psychological instruments and assessments, and the ACRO test are elaborated on.

3.1 Working at Height

South Africa's mining industry initialised itself as the backbone of the South African economy when gold was discovered at the turn of the 19th century (Greef, 2013). According to the Department of Mineral Resources (2020), South Africa is known for its diverse mineral wealth, but even better known for a very well-regulated mining industry.

Ergonomics, the work environment, work organisation, process safety and abnormal working situations is seen as external factors which contributes to incidents. It is further said that it is the employer's responsibilities to ensure that safe working environments and safe systems are provided to ensure workers safety (Hermanus, 2007). With regards to mining, Canada, Australia, Germany, and the USA, is seen as less labour intensive than South African mining activities, the latter often described as being more labour intensive, a result of a greater number of workers being exposed to health and safety risks (Van Wyk, 2015).

One of the objectives created by the South African Mine Health and Safety Act (MHSC, 1996) is that before assigning a task, the employer has to consider as far as it is reasonably practicable, an employee's training and capabilities in terms of health and safety, and thereby insuring a culture of health and safety (Van Wyk, 2015). Numerous factors pose a safety risk in mining including unforeseen natural events, engineering flaws, and human error. Van Wyk (2015) adds that the MHSC was further amended in 2010 and the financial penalty which can now be imposed for a breach of safety procedures, appeals cannot be lodged against these fines, is an administrative fine of R1 million per incident. Additionally, a criminal prosecution of individuals who contribute to the accident may follow.

Historically, health and safety officers and investigators focused on improving engineering flaws for a safer working environment. Safety knowledge, safety motivation, the ability to predict dangerous outcomes, and an internal locus of control for influencing safety in the work environment contribute to the positive prediction of safety related workplace behaviour (Aguilera-Vanderheyden, 2013).

The South African mining industry achieved a 24% injury reduction during its 2010 financial year, after a 2003 agreement was implemented, attempting to improve mining safety (Mineral Resources and Energy, 2017). The National Census of Fatal Occupational Injuries of 2017 stated that 887 construction labourers lost their lives due to job-related accidents, while 38% were due to falling. Mine accidents are very traumatic, and the mining industry is one of the most dangerous work environments where the occurrence of psychological trauma is frequent (Van Niekerk, 2016).

In South Africa, as reported by the quarterly labour force survey stats of 2020, the current unemployment rate is 32.5% (Stats SA, 2020a). It is therefore hypothesised that people suffering from acrophobia will consider applying for positions advertised by employers to work at height, regardless of their fear. They may consider facing the fear or implement tactics to enable them to enter the height situation. However, findings by Marshall et al. (1992) suggest that implemented tactics or distractions simply converted their treated patients into courageous, but still fearful acrophobics.

Working at height in the mining industry largely includes working underground. Established from observations, the work environment when underground can be described as dirty, dark, wet, noisy, hot, uncomfortable, and dangerous (Van Wyk & De Villiers, 2009). Hazards related to the work environment can entail working in confined spaces, working in steeply inclined excavations, handling heavy material and equipment, and working in the proximity of moving machinery (Van Wyk & De Villiers, 2009).

Table 3.1 indicates that in South Africa, an estimated total recorded number of 5,190 people worked underground in the diamond mining sector during 2017, where duties include working at height. Taking the entire South African mining sector into consideration, the recorded amount of people working underground in 2017 was 243,269. Most recent published figures suggest that overall, the mining sector employs 455,000 people, an increase of 0.7% from December 2019 to March 2020 (Stats SA, 2020b).

Table 3.1

Labour at work summary, period from January to March 2017

Provinces in South Africa	Total Underground Workers in Diamond Mining Sector (Contractors Included)
Northern Cape	2293
Free State	735
Limpopo	449
Gauteng	1697
North West (Rustenburg)	16
TOTAL	5190

Note. These are indications of the amount of people employed in 2017 according to each province, as per the Department of Mineral Resources Labour at work summary, during the period from January to March 2017.

It is expected of underground workers to work in steeply inclined openings and these circumstances mean that working underground at height can mean more than simply addressing the risk of falling. Their work may also be affected by limited visibility, workspace constraints, challenging ground conditions and barriers to effective ventilation in rises (Department of Mines and Petroleum, 2014). A research study in 2010 found that working underground was significantly associated with grave occupational injuries and certain conditions increased the risk for severe occupational injuries (Chimamise et al., 2013). The study found that inadequate lighting and high temperatures negatively affect workers' alertness, leading to lower concentration levels.

Mining companies implement working procedures, and a large South African mining group's working at height procedure describes the minimum acceptable requirements for activities where a worker or objects can fall from heights (Anglo-American Policy, 2019). The procedure applies wherever there is potential for any person to fall two meters or more, or to gain access to within two meters of an open edge from where there is potential to fall two meters or more, including working from various forms of portable and moveable elevated work platforms, cages, ladders, scaffolding, and where objects could fall and cause injuries. The major cause of occupational death and injury in construction can be attributed to accidental falls, which includes slips, trips, and falls from heights (Yang et al., 2016).

The first introduction of the terms psychological wellbeing featured in the South Africa Construction Regulations, section 15(12)(a), and the section was also included in the Occupational Health and Safety Act (Act No. 85 of 1993) (South African Government, 2013). In this Act, psychological wellbeing is referred to as psychological fitness. Employees working at heights function in extremely hazardous working conditions, and therefore the Act aims to regulate and create a legal framework to ensure higher levels of health and safety (Mostert et al., 2012).

Despite the importance of safety considerations in the mining industry, validity studies regarding working at height safety assessments and criteria are limited. This may be due to the complexity of obtaining safety criteria that are reliable, as accidents seem to be infrequent events, and near misses may generally not be reported or documented. A near miss is defined as an event that could have materialised into an actual accident in a slightly different environment, but at the time of the occurrence, did not cause loss or damage. Near miss data have been widely used to reduce the likelihood of future accidents in diverse industries such as airlines, railroads, medicine, and construction (Yang et al., 2016).

3.2 Personnel Selection and Psychological Assessment

The purpose of personnel selection is to strengthen the performance of employees by managing the flow of employees into the organisation, and to only allow those applicants to enter organisations that would perform satisfactorily in their appointed positions (Theron, 2013).

The performance of employees can be regarded as an important, if not the most important factor related to the success of an organisation. The contributing factors of work injuries through structural equation modelling was investigated by Maiti et al. (2004). They found that emotionally unstable and dissatisfied individuals contributed significantly to safety problems at the mine where the research were conducted (Maiti et al., 2004).

Since the 1950s, researchers have emphasised the importance of psychological testing, expressing their dissatisfaction with the fact that professional recruiters still highly rely on the often unstructured interview, as field studies provided evidence suggesting that valid instruments and methods are favoured to “gut-feeling” methods (Bäckström & Björklund, 2017).

As time progressed, there was a shift from unstructured gut-feel interviews to structured interviews that focus on job competencies (McDaniel et al., 1994). During the nineties, the most common method implemented for personel selection was biographical data, the second, being interviews (Schmidt & Rader, 1999).

According to Cornelius (as cited in De Beer et al., 2008), interviews on their own are not good predictors of future behaviour, even though interviews are commonly implemented to assess information about candidates. The basic causes for high injury experience rates are unsafe conditions, unsafe acts, or both, while unsafe acts mainly arise through behavioural related causes (Paul & Maiti, 2007). Psychometric tests have proven to be valid and fair, and studies have demonstrated the significant role psychometric assessments can play in the refinement of the selection process in terms of recruitment and development (Van der Merwe, 2002).

The assessment of psychological constructs is, however, influenced by socio-cultural factors. These include a number of closely interrelated variables that are almost impossible to separate, including language usage and reading ability, the level and quality of educational achievement, socio-economic position, and home and schooling socialisation experiences (Shuttleworth-Edwards et al., 2004). Shuttleworth-Edwards et al. (2004), further explain that culture dictates what is, and what is not relevant and provides models for ways of thinking, acting, and feeling.

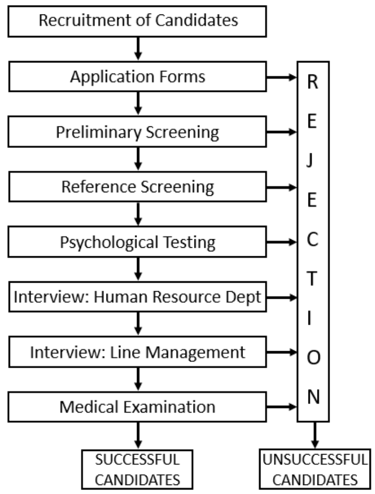
It should be taken into consideration that phenomena such as a fear of heights may differ between cultures, and different groups may perceive or even understand these concepts or expressions differently. It is currently unclear whether people in South Africa truly comprehend the phenomena when answering self-report questionnaires with the intent to identify a fear of heights.

Assessment results may also be susceptible to "faking". When applicants attempt to make themselves look more appealing to a company, in an effort to maximise their chance of being hired by misreporting their responses to self-report measures, it is described as applicant faking (Donovan, Dwight & Schneider, 2014). The results of the study by Donovan et al. (2014) indicate that applicant faking may be a frequent phenomenon in selection environments. Roughly a half (49.7%) of the applicants (n=162) were classified as fakers on at least one of the three dimensions of goal orientation in their study.

Numerous sources of data such as interviews, psychometric tests, references, biodata, and performance data should be included as part of a sound selection process (Hoffman & McPhail, 1998). There is no fixed, generally accepted, standard selection procedure that is presently used by organisations. However, a vast majority of employee selection programmes are based on the successive-hurdle technique, meaning that to be hired, applicants must successfully pass various screening steps (Van der Merwe, 2002). It should, however, always be remembered that psychometric assessments play only a part, or serve as an aid, in the entire selection process. Figure 3.1 presents the comprehensive strategy for the selection process by Van der Merwe (2002).

Figure 3.1

The selection process (Van der Merwe, 2002)



Note. Current selection strategies at organisations may include similar elements, even though the number of steps in the process and the order thereof might vary.

During his study, Van der Merwe (2002) also comments that it appears that organisations who implement psychometric assessments, are not only using these assessments for selection purposes, but also for placement, promotion, transfers, training, and development.

Cognitive assessments and personality questionnaires are generally highly relied upon with regards to the selection of personnel. Personality assessments are more predictive of contextual performance than task performance, whereas ability assessments tend to be predictive of task performance (De Beer et al., 2008).

Psychological assessments in South Africa are a controversial topic primarily, but not entirely, because of its links to South Africa's troubled past. However, it is still argued by certain critics that regardless of certain flaws, testing remains more reliable and valid than any of the limited number of alternatives (Laher & Cockcroft, 2013). South Africa largely comprises of two economical groups: One that is not too different to Western contexts, generally with an educated, employed population, and one in which most people are unemployed, have little access to quality education and largely live in poverty (Leibbrandt et al., 2010). Therefore, the assessment field is likely to be divided into similar categories. Communities with no or little access to education and low literacy levels have unique challenges with regards to assessments (Laher & Cockcroft, 2013). Traditional pen and paper assessments from the West are often unsuitable in these settings, where most people's first language is not English.

A psychological test is classified when the aim of the test results in the execution of a psychological act (Foxcroft et al., 2001). Developing a psychometric assessment is not an endeavour that can happen overnight. While many people are able to compile a questionnaire and deliver results to people, constructing a valid and reliable psychometric assessment is a different world of complexity. According to the HPCSA, there are specific guidelines for assessment tools to comply with, which includes that the tests must be objective, standardised, reliable, predictive/ valid, unbiased, and scientifically researched.

The development and implementation of psychometric instruments may become an expensive and time-consuming exercise, especially when conducting large selection sessions. Therefore, organisations may preferably not assess candidates and rather attempt to mitigate the risk. It can be argued that neither the organisation nor the candidate being selected for a specific position, benefits if comprehensive recruitment methods are not being implemented during the selection process.

Habibnezhad et al. (2020) state that, from a micro standpoint, task performance directly affects the stakeholder's satisfaction of a project by enabling a safe, high-quality delivery of tasks. Psychological assessments are not only there to match the person with the task, but to try and keep people safe as far as humanly possible.

3.3 Psychological Assessment in the Mining Context

Psychometric and/or psychological assessments are directly linked to the prediction of behaviour and therefore, certain mining companies in South Africa have welcomed and successfully implemented the use of psychometric assessments to assist with recruitment and selection of workers.

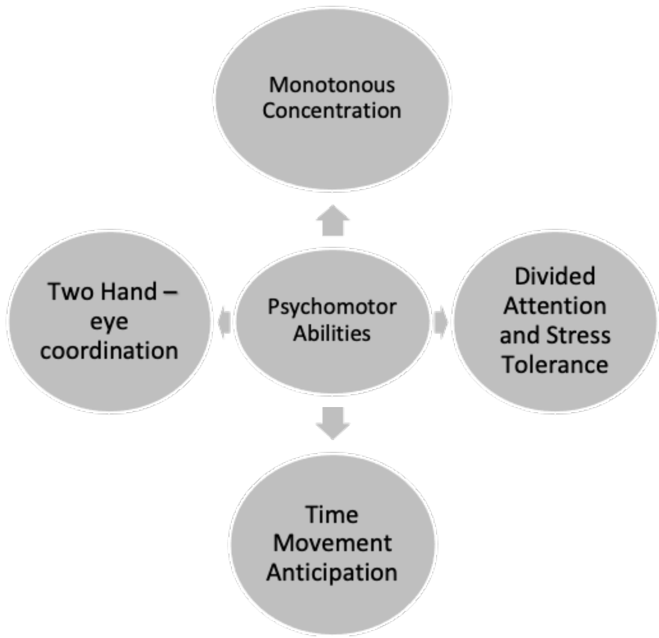
The Employment Equity Act 55 of 1998 (RSA, 2004) clearly states that the use of psychological tests and other similar assessments of an employee are prohibited, unless the test user can show that the test has been scientifically proven to be valid and reliable, can be applied fairly to all employees, and is not biased against any employee or group. Furthermore, the MHSC (Regulation 8.10.23.1) states: "The employer must take reasonably practicable measures to ensure that procedures are implemented for the selection, training, appointment and licensing of trackless mobile machine operators, which procedures must include physical and psychological preselection criteria" (MHSC, 1996, p. 191). This becomes relevant for a position in working at height, as working at height is also considered as working or operating in confined spaces.

According to De Beer et al. (2008), different assessment methods are implemented by organisations to assist with selection, promotion, and development. Most of these selection methods are updated and adapted to the specific position on offer, therefore matching the candidate with the task. Job descriptions and identifying the specific abilities required for each position are therefore of critical importance and will assist with the mitigation of the risk, especially in high risk working environments.

Kanjee (2004) explains that in the mining sector, tests that historically constituted violations of basic human and civil rights of workers, were conducted by the now discontinued National Institute for Personal Research. Bulhan (1993, as cited in Kanjee, 2004) describes one such test where a heavy weight is carried up a flight of five steps and dropped down one of three shafts. In combination with pulse rate, this yields a score which gives a reasonable prediction of above or below average performance in shovelling rock (Kanjee, 2004, p. 289). Currently, the mine where the present study was conducted, implements the Vienna Test System (VTS) to assess critical psychomotor ability, as indicated in Figure 3.2, on their trackless mobile operator and drivers (De Beers, 2018).

Figure 3.2

Psychomotor abilities for trackless mobile operators (see CPRD n.d.)



The VTS is an internationally developed computerised psychological assessment, adapted for South African use, that consists of various personality, intelligence, and special ability assessments (Schuhfried, 2013). The system was developed by the Schuhfried Company in the early 1980s and has years of research supporting the test system internationally (Keyser, 2012). Keyser (2012) found that psychomotor ability is a statistically significant or valid predictor of safety behaviour of operators in a South African mechanised platinum mine (n=200).

Psychomotor performance can be described as a person's ability to perceive information from the environment, to process the perceived information (cognitively) and to act correctly after processing the information by using one's limbs. The term "psychomotor" therefore refers to both the controlling process and the motor (muscular) behaviour of a particular person. The assessment of psychomotor performance is concerned with determining the quality of readily observable muscular actions of a person and the quality of the controlling process contributing to the effectiveness of a person's motor performance (Maree, 1995).

According to the senior training officer at the mine, with regards to support vehicles and lifting equipment at the mine (Mr X, personal communication, 17 February 2020), the following procedure is followed when recruiting people to work at height: The personal job specification is usually completed prior to a medical fitness examination. They then book for a recertification assessment with the senior training officer. This involves an induction by means of a computer-based training course which covers the basic procedural requirements of the mine. They then attend a one-day certification assessment, acting as a prerequisite for this prior training and certification against SAQA Unit Standard 229998. It includes a theory assessments and donning (put on or climb into) a harness with foot straps. They are then authorised by the responsible engineer by means of a declaration of competence declaration statement.

According to the personal job specification document mentioned above, the following physical requirements are mentioned and seem to be critical: Clear speech ability, good hearing, eye/hand/ foot coordination, use of both arms, fine hand movements, use of both legs, depth perception, colour distinction, and balance. The HR officer/line manager, occupational hygienist, occupational health nurse, occupational medical practitioner, and the employee then have to sign this document.

On-the-job observations are also implemented to observe workplace behaviour to ensure that the training that was undertaken, was effective. One universally accepted and most widely used measure of an employee's safety performance is the supervisor's ratings. The ratings are assumed to be suitable for assessing the safety performance of workers, as it is assessed by the immediate supervisor who usually have direct control over employees through first-hand observation and supervision (Paul & Maiti, 2007). The Anglo-American working at height procedure specifically mentions that workers selected for the task performance should not suffer from fear of heights, and the supervisors must ensure that competent personnel are selected (Anglo-American Policy, 2019). However, no mention is made of how exactly supervisors must objectively assess/observe if a person is prone to having a fear of heights.

In a study conducted by Diemer et al. (2016), two groups of healthy and acrophobic people were exposed to elevation stimulated VR technology and the results clearly showed that both groups, regardless of acrophobia, exhibited physiological arousals such as an increased heart rate or skin conductance level (Diemer et al., 2016). Therefore, it is questionable how effective it may be when supervisors only observe physiological indicators in order to identify if someone may be prone to having a fear of heights.

Elevation (height above or below a fixed reference point) can cause complicating physiological and physical responses due to elevation-induced anxiety and instigate a visual mismatch. These bodily reactions may not only affect postural control, but it can significantly influence task performance (Habibnezhad et al., 2020). Habibnezhad et al. (2020) indicate that internationally, construction workers' performance, especially for research, is generally assessed by the following two tests: A hand steadiness test and a pursuit task. These tests usually focus on psychomotor coordination ability, and do not specifically indicate if actual fear is present.

According to Voznenko et al. (2016), human safety behaviour depends on the following factors:

- The state of unconditioned reflexes, which people unconsciously use to respond to various dangers that threaten the organism (e.g., automatic hand movement away from a hot object).
- Psycho-physiological (psychomotor) qualities of humans appear in their sensitivity to the signal of danger in its high-speed response capability to these signals, and in the emotional reactions of danger when determining a dangerous situation and responding to it. The emotional, mental, and physical conditions effect human behaviour, while the state of anxiety sharpens the sense of danger, and the state of weariness reduces the human ability to identify and counteract the danger.
- Professional qualities and experiences of the person, that is, knowledge of the profession and safety rules, and life experience.
- Motivation to work safely and compliance of technological process performance.

People working at height in the mining industry are selected and employed for different positions, such as boilermakers, electricians, fitters, millwrights, and instrumental technicians (Mr Y, personal communication, 4 March 2020). Taking only an electrician's job description into consideration, the task execution involves dynamic movements of objects, requiring a high level of skills and concentration. Having a fear of heights and the symptoms associated with the phobia, is likely to have an impact on task performance when the person is required to work in an elevated environment.

It is not only necessary to improve the quality of staff training and briefing on labour safety, but to first carry out the proper psychological work, in order to highlight the psychology of safe work in the worker's conscience, so to evaluate every step and every action from the point of view of safe performance, in compliance with standards (Voznenko et al., 2016).

As already mentioned, no local evidence could be found that the use of performance data was implemented during selection or recruitment drives for people applying to work at height, as it may be a time-consuming and expensive task.

3.4 Virtual Reality (VR)

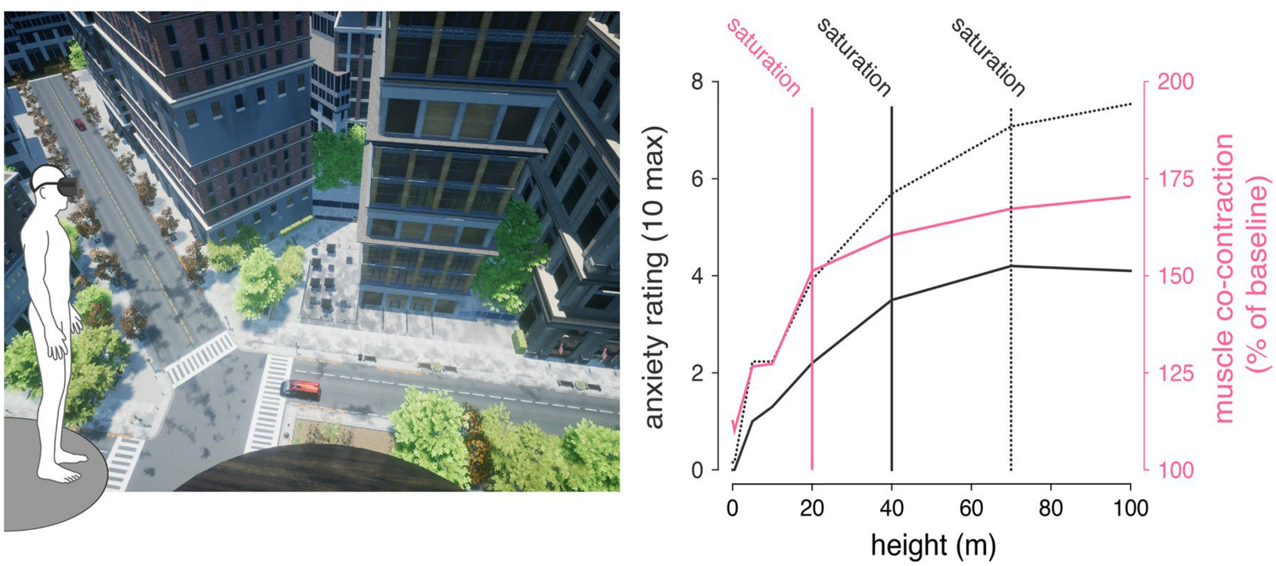
Literature suggests that Behaviour Therapy, Cognitive Therapy, and Cognitive Behavioural Therapy are the standard phobia treatment approaches. Principles of operant conditioning are used in Behaviour Therapy, since the traumatic symptoms are regarded as classical (Pavlov's work) and operant (Skinner's work), and therefore conditioned responses can be unlearned (Schurian, 2013).

As a fairly new development, the effectiveness of VR is still being investigated. However, VR technology presents a novel and powerful tool for behavioural research in psychological assessments (Giglioli et al., 2017). Virtual reality is a simulated experience formed by a synthetic computer-based environment, creating the sensation of undergoing real experiences through the incorporation of real-time computer graphics, body tracking devices, visual displays and other sensory input devices, to immerse a participant in a computer-generated virtual environment (Rothbaum et al., 1995).

Limited studies present findings on the influence of the increasing heights above ground on the severity of signs and symptoms of vHI (Huppert et al., 2020). In a study by Brandt et al. (1980), the previous observations of fear of heights, being at its highest on the fourth floor of a building (seemingly saturated at a height of about 20m), was later re-examined in more detail by means of VR technology in a comprehension cohort of individuals with different degrees of susceptibility. As indicated in Figure 3.3, insusceptible or susceptible up to acrophobic level were differentiated by the vHISS (Brandt et al., 2019).

Figure 3.3

The dependency of anxiety and postural responses on absolute height above ground as studied, using VR technology (Brandt et al., 2019)



Note. As explained by Brandt et al. (2019, p. 238), left panel: Exemplary view of the virtual scene at 40m above ground. Subjects were exposed to virtual heights ranging from 0 to 100m via a head-mounted display. Right panel: anxiety ratings (grey solid line); non-acrophobic individuals (grey dotted line). Acrophobic individuals initially increase with increasing height above ground but saturate for heights above 40m in non-acrophobic individuals, and heights above 70m in acrophobic individuals. In contrast, bodily responses, e.g., muscle co-contraction (pink solid line) already saturate for heights above 20m in both acrophobic and non-acrophobic individuals (Brandt et al., 2019).

During a twofold cohort study in Germany, 23 individuals where exposed to the virtual scene at eight different discrete elevation levels. Results indicated that the effectiveness of virtual height exposure relies on the extent to which participants actually become immersed and feel present in the virtual scenery. In addition, it was also found that short-term repeated virtual exposure led to a general reduction of subjective fear and physiological arousal. In contrast, tonic immobilisation (paralysis) at heights is of significance, as motor reaction significantly constrains the flexibility of postural adjustments and thereby increases the risk for falls from high places (Brandt et al., 2019).

In clinical psychology, VR has been applied for the treatment of different anxiety disorders, post-traumatic stress disorder, and body image disturbances in patients with eating disorders (Giglioli et al., 2017). According to the theory of behavioural psychology, human behaviour is always the outward manifestation of a certain psychological status as external intervention often affects human behaviour through mental factors (Guo et al., 2017).

Literature indicates that there is limited research focussing on VR, specifically in the mining industry. Desktop-based systems such as simulators seem to be more customary than VR in the South Africa mining industry (Stothard et al., 2015). According to Stothard et al. (2015), without international collaboration and the commitment of the mining industry and academia, it is implausible that the advanced technology of VR and simulators will reach its full potential.

On-site psychological data are commonly collected through on-site observations, questionnaires, interviews, and scene simulations, to name a few, but it has the following drawbacks: It is not objective enough, it is time-consuming and involves high cost. VR could eliminate some of these drawbacks, but not all, as it still remains time-consuming, and the cost for this technology still seems to remain high. According to literature, VR is mostly regarded as a training tool and not a psychological assessment tool.

It is assumed that when creating more realistic items, one can more closely mimic what actually happens at work and one will therefore improve the accuracy of the measurement (Ryan & Derous, 2019). However, Hawkes et al. (2018) state that when one transforms one's items to other media rich descriptions, one may actually be adding more noise and even systematic error to it.

3.5 Measuring Fear of Heights

Prior empirical evaluations are limited regarding the proposal that fear may be interconnected with a biased perception of the feared object, even though it has been anecdotally noted in clinical work (Teachman et al., 2008). Literature suggests that the fear of heights construct is generally assessed or identified through implementing face-to-face interviews and self-report questionnaires. Conventional questionnaires to validate the susceptibility to fear of heights either compare self-reports and overt-behavioural procedures, or measure height-relevant interpretation biases to assess the relation between interpretation biases and symptoms of acrophobia (Steinman & Teachman, 2011). Steinman and Teachman (2011) further state that, although no published questionnaires measuring height-relevant interpretation biases is known to them, a limited number of studies have used height-relevant anxiety provocations (e.g., climbing ladders, looking over balcony railings) as a method of evaluating individuals' anticipatory and on-line judgements of physical danger, and their ability to cope with anxiety.

Task performance is one of the principal factors of any activity, usually measured by the completion of time and accuracy (Habibnezhad et al., 2020). The aim of the response time process is the differentiation of the general argument regarding the cognitive pace demands by speed type with regards to certain stages of action regulation. Prieler (2016) explains that these refer to the stages of 1) perception, 2) cognitive processing, and 3) motor response selection. Tasks that demand reaction, as well as visual perception are used. Reaction time analysis is a type of methodology aimed at detecting stages of action regulation. This methodology relies on Sternberg's model (1969) of additive factors (a procedure for analysing reaction-time data to determine whether two variables affect the same or different processing stages).

The acrophobia test, ACRO, is an assessment tool that is specifically designed to identify the fear of heights construct. Objectivity is ensured by a standardised instruction procedure, while evaluation objectivity is ensured by the automatic calculation of the parameters. Interpretation objectivity is ensured, as the automated analysis delivers a numeric value (percentile rank, sten-value) that clearly defines the outcome. Unless otherwise proven with empirical evidence, there is nothing to suggest that the ACRO works against the principles of fairness, that is, that it discriminates against certain subjects.

It is unlikely that people without computer experience will be at any disadvantage as the test consists of video clips and only a few questions asked, in English, of what was seen after the video. Responses (motor activity) are required by means of pushing a button, and there is a practice phase included before the actual test starts to ensure that participants understand the instructtions.

ACRO meets the criterion of reasonableness as subjects are only briefly placed under limited mental and physical stress. The test can be used without hesitation for people without motor disorders of the musculoskeletal system, and without considerable vision impairment.

3.6 Summary

In this chapter, the researcher investigated the research that is currently available, even though fairly limited due to numerous reasons, on fear of heights and working at height in the mining and construction industry. Psychological assessment in general was presented. The current selection process in the mining industry was inspected and the usefulness of VR, specifically for the implementation of selection for people working at height in the mining and construction industry, was touched on. In Chapter 4, the researcher will discuss the methodology followed for the current study.

4. Research Methodology

In Chapter 3, working at height in the mining industry and assessment in this context were reviewed. In this chapter, the operationalisation of the research is discussed. It includes the research paradigm, the research design, the population and the sample, the measuring instruments used in the study, the data collection procedures, and the data processing approaches.

4.1 Objectives

As reported in Section 1.4, the main objective of the study was to determine the reliability and validity of an objective measure of fear of heights within the mining contexts.

Specific objectives were to:

- determine the reliability of the acrophobia test – ACRO (fear of heights);
- determine the relation between the ACRO and self-report/objective measures of fear of heights; and
- compare the performance of subgroups on the ACRO.

4.2 Hypotheses

Hypothesis 1: The reliability of the ACRO test will be acceptable.

Hypothesis 2: There will be a significant relation between the ACRO test and the self-report measures (Phase 1 – mining context).

Hypothesis 3: There will be a significant relation between the ACRO test and the self-report measures (Phase 2 – general population).

Hypothesis 4: Respondents in Phase 1 will perform significantly different on the ACRO test than respondents in Phase 2.

Hypothesis 5: There will be no significant difference in performance on the ACRO test for the different demographic subgroups.

4.3 Research Paradigm

The positivist paradigm became known as a scientific method which features are shared across varied disciplines including mathematics, physics, sociology, biology, and psychology is reported as the traditional and integrated method of enquiry (Breen & Darlaston-Jones, 2010). The positivistic research tradition argues that the ontology of the "nature of reality or truth" exists in the physical and social environments (Kekeya, 2013). The epistemology of positivism asserts that knowledge is objective and value free (or neutral) and is obtained through the application of a scientific method (Breen & Darlaston-Jones, 2010). The positivistic research paradigm asserts that the nature of understanding and the creation of knowledge, is obtained by means of employing quantitative research methods (Kekeya, 2013).

Researchers working in qualitative psychology tend to centralise the examination of meanings within an iterative process (analysing data by identifying patterns tied to instances of phenomena) of the evolving findings, and viewing subjective descriptions of experiences as legitimate data for analysis (Levitt, 2019). Levitt (2019) states that fewer, but more detailed, rich, and heavily contextualised descriptions are drawn from limited sources (e.g., participants) than typically drawn from quantitative studies.

In juxtaposition, quantitative psychology asks questions about patterns of relations between variables. Whether it is possible to recognise some faculty, some ability, and some cause that underlies observed behaviour, is the main question to be answered by such analyses (Toomela, 2010). Findings can be generalised to a specific population, while the research framework and standardised approaches enable the study to be replicated over time.

Durrheim (2004b) states that quantitative research entails the collection of data in the form of numbers and the use of a statistical data analysis. Quantitative methods initiate with a series of preset categories usually embodied in standardised quantitative measures and use data to make broad and generalisable comparisons. De Vos et al. (2002, p. 79) define a quantitative method as

> based on positivism which takes scientific explanation to be nomothetic. Its main aims are to measure the social world objectively, to test hypotheses and to predict and explain human behaviour. A quantitative study may therefore be defined as an inquiry into human problems based on testing a theory composed of variables, measured with numbers and analysed with statistical procedures in order to determine whether the predicative generalization of the theory holds true.

The construction of accurate and reliable measurements that allow for a statistical analysis, is one of the central goals of quantitative research. This type of research is most relevant at answering the "what?" or "how?" of a given research. Questions are direct, quantifiable, and often contain phrases such as "what percentage?", "what proportion?", "to what extent?", "how many?", and "how much?" (Luczun, 2017). It aims to be objective, it represents complex problems through variables, and the results can be summarised, compared, or generalised.

Researchers wishing to investigate if a test truly measures the concept that it claims to measure, have the following statistical procedures at their disposal: Interscale correlations, factor analysis, and item response theory (Rasch model). Validity is explained as when the concepts, conclusions, or measurements are well-founded and likely to correspond to the real world (Campbell, 1957). According to Borsboom et al. (2004, p. 1061) the concept of test validity is explained as follows: "A test is valid for measuring an attribute if a) the attribute exists and b) variations in the attribute casually produce variations in the measurement outcomes" (Borsboom et al., 2004). As discussed in Foxcroft and Roodt (2005), reliability is the overall consistency of the measurement, therefore, producing similar results over a certain period of time and consistent conditions. The positivist paradigm and quantitative methodology were therefore appropriate in the case of the present study.

4.4 Research Design

The plan or blueprint according to which data are to be collected, to investigate the research hypothesis or question in the most reasonable way, is defined as the research design. Laher et al. (2019) state that randomisation, a participant assignment to control, and experimental groups are not always possible, and therefore researchers rather use non-experimental research designs, which are typically descriptive and correlational (Laher et al., 2019).

The present study was conducted to determine if an objective psychological assessment measure could effectively assess fear of height in a mining context. This research study was conducted within the field of psychology and included the implementation of psychometric measurements.

Defined formally, measurement consists of rules of assigning numbers to objects in such a way as to represent quantities of attributes (Durrheim, 2004a). Kanjee (2004) describes assessments as collecting information from individuals, groups, and organisations with a view to practical issues of problem solving. The primary purpose of conducting assessment is to obtain additional information, such as information beyond the immediate interactive situations (Kanjee, 2004). According to Marshall and Jonker (2010, p. 4),

> [i]t is essential to clarify the appropriate type of data needed to answer the research question at the design stage of the research project, so it can be gathered. The level of measurement needs to be identified, allowing identification of the statistical procedure to be used and decision making on the sample size.

This study was non-experimental. An explorative, descriptive, and relational design was used. The aim of the design is to describe phenomena through accurate observation and by measuring relations. Correlational statistics, in an attempt to describe and measure the degree or association (or relation) between two or more variables or sets of scores, is applied by the researcher (Creswell, 2009).

4.5 Population and Sample

The type of statistical analysis planned, accuracy of the results required, and the characteristics of the population are the three factors which to a great extent determine the sample size in a study (Van Heerden, 2020).

Huysamen (1981) defines a population as the total collection of individuals who are potentially available for observation and who have characteristics in common that a specific research hypothesis examines. Huysamen (1981) further explains that it may not be practically feasible, if not entirely impossible, to get hold of all the members that a particular research hypothesis examines. Consequently, the behavioural and social scientists have to rely on a sample from a population. The sample is then a relatively small subgroup of cases from the population. In this study, the population consisted of South African working adults.

Practical issues and the aims of the present study determined the nature of the samples which were selected for Phase 1 and Phase 2 of the study. A sample from the general population as well as a sample from the mining context were specifically included. There were limitations in terms of geographical area, and inclusion criteria related to the measuring instruments were stipulated. Participants from both genders, a wide range of age groups and various levels of education were included. Occupation was determined by the context of each sample.

As already mentioned, this study was conducted during two phases on account of existing South African data, collected and available for exploration, as per permission from the developer of the objective assessment tool, ACRO. The existing data (Phase 1), collected specifically in the mining industry, were relevant to the aim of the study. However, it was of great importance to also include a general population group (Phase 2) to be able to provide for the potential limited variance as a result of preselection and thus comment on the reliability and validity of the ACRO within the South African context.

Convenience sampling was used in both phases. Meltzoff and Cooper (2018) state that there are two major sampling methods, namely probability and non-probability methods. Non-probability sampling techniques or methods do not allow the researcher to estimate the probability that each member of the target population has of being added in the sample. The members of a sample being chosen, using non-probability sampling, might have differing chances of being selected to be in the study. There are several different techniques for drawing a non-probability sample of which convenience sampling is one such technique. In convenience samples, also known as samples of opportunity, the researcher typically studies a pool of participants who are available to him/her. In convenience sampling, researchers may obtain participants from an organisation such as a school, hospital, or organisation that has enough people to meet the requirements of the research (Meltzoff & Cooper, 2018).

4.5.1 Phase 1

As psychometrist, the researcher was involved in a project where 150 participants at a diamond mine in Limpopo, South Africa, completed the ACRO and a short self-report questionnaire on the fear of heights construct, as part of the data collection process for the standardisation of the ACRO. The researcher obtained permission from the Human Resource (HR) manager at the mine and access to the participants was granted. The researcher and the HR manager have a working history, as the researcher has assisted the mine with psychological assessments since 2008 to date, specifically for psychomotor assessments for trackless mobile operators. The HR manager was one of the first technical training practitioners to identify the need in the mining industry to assess workers for fear of heights, using an objective assessment without exposing people to any possible danger.

For this study, convenience sampling was used to select the participants, before they attended their formal training to work at height, provided by the mine. The participants were already recruited and selected by the mine to work at height, and they were asked by the training manager to volunteer for the research. It should be noted that there were no respondents who did not meet the inclusion criteria who volunteered for or participated in the study, and therefore no respondents were turned away during Phase 1 or Phase 2. As with most companies, the mine places high value and importance on the development of its employees. At the time, these participants were employed in a full-time capacity at the mine in Limpopo.

The criteria for inclusion were:

- Sufficient proficiency in English to complete the various instruments.
- The age range should be between 19 and 70.
- No diagnosed psychiatric disorders.

- No physical disability.
- No motor disorder of the musculoskeletal system.
- No serious vision impairment.

These factors are termed "inclusion criteria" to ensure that the data will not be confounded by factors that may have deleterious effects on reaction time and quality. It was important that participants should not be diagnosed with psychiatric disorders to ensure that no harm was caused during this study. High levels of anxiety and panic attacks, along with excessive and unreasonable fear due to either exposure or anticipation of exposure to a feared stimulus, may be a common occurrence in patients (Samra & Abdijadid, 2019). The ACRO test requires participants to physically push a button with their hands while actively watching height related videos on a computer screen, therefore respondents with a serious motor or physical disability were excluded. The age range of 19 to 70 was included, based on the original validation study of the developer of the ACRO.

The demographic variables (gender, age, education level, and occupation) are set out in Tables 4.1, 4.2, 4.3, and 4.4 below:

Table 4.1
Gender

Gender	Frequency	Percentage
Male	126	84
Female	24	16
Total	150	100

The demographics of the South African population indicate that the sample is not representative in terms of gender. Table 4.1 demonstrates that 84% of the sample were males and only 16% were females.

The sample for this phase was disproportionate in terms of gender, which was to be expected, as mining has mostly been regarded as a male dominant profession. However, this perception is changing as the mining industry has started implementing development programmes for females during the last decade.

During 2019, the number of women in the diamond industry was 15%, compared to the previous year's 14%. However, in absolute terms there were 2,229 women in 2019, 133 fewer, compared to the previous year. Nationally and internationally, 2019 was a difficult year for the diamond industry, the outcome of direct competition from synthetics (Minerals Council South Africa, 2019).

Table 4.2

Age

Category	Frequency	Percentage
21-30	49	33
31-40	63	42
41-50	28	19
51-60	8	5
Older than 60	2	1
Total	150	100

The minimum age was 22 and the maximum age was 63, with an average age of 35.25 in the sample.

The determining attribute of a ratio scale is the presence of an absolute origin or zero point, and therefore age can be described as a ratio scale (Lewis-Beck, Bryman & Liao, 2004). During a recent development in the intervention of specific phobia among adults study, the mean age of participants from the study included ranged from 19.12 to 65.72 (Thng, Lim-Ashworth, Poh & Lim, 2020). The legal work age sets the general minimum age for admission to employment for work at 15 years and the minimum age for hazardous work at 18 years (The South African Labour

Guide, n.d.). As previously mentioned, the participants were already employed in a full-time capacity at the mine and they mainly consisted of employees who had previous work experience at the mine, therefore the minimum age of 22. According to the HR Manager (HR Manager, personal communication, 27 July 2020), the retirement age at the mine is 60 years, as further development during this mature age is generally limited, even though certain employees still stay on as contract workers.

Table 4.3

Education

Level of Education (Years of Completion)	Frequency	Percentage
Completed 12 years or more	125	83.2
Completed 11 years	17	11.3
Completed 10 years	5	3.3
Less than 10 years	3	2.2
Total	150	100.0

Table 4.3 indicates that 125 participants completed 12 years of education, 17 completed 11 years of education, while five completed 10 years of education. Only three participants indicated less than 10 years of education in the sample.

Findings of a 2017 study suggested that the intensity of immersion, how participants perceived the VR environment, and how realistic participants found their VR experiences, was not significantly impacted by their level of education (El-Rawas & Kazımoğlu, 2019). It was, however, important to include education to this specific study as the study by El-Rawas and Kazımoğlu (2019) found a non-significant result with regards to VR, and not specifically for identifying acrophobia.

Table 4.4

Occupation

Occupation	Frequency	Percentage
Blasting assistants	4	3
Boilermakers	6	4
Electricians	6	4
Engineers	8	5
General workers	11	7
Learnerships	23	15
Managers	4	3
Mechanics	10	7
Operators	36	24
Supervisors	10	7
Technicians	5	3
Other	27	18
Total	150	100

4.5.2 Phase 2

As psychometrist, the researcher made use of an existing client database from different industries (rail, retail, human resources, electrical, and a community church) and asked 59 individuals (who were sent by their organisation to do a psychometric assessment battery, unrelated to fear of heights), if they were willing to partake in the study. All individuals volunteered to take part. The person in charge of the booking procedure at the organisations was telephonically informed of the research or via e-mail correspondence, when booking assessments for various HR, administrative, or health and safety related positions were made. The researcher was not aware of exactly who walked through the door at the psychometric assessment session, as the names of candidates attending were not asked in advance. However, the participants being at the assessment session were not attending a random event, as it was booked in advance by the receptionist of the company. Although this sampling procedure (convenience sampling) uses a system that does not contain an explicit bias that is easy to identify, it does not mean that it produces a random sample, but rather a systematic, non-probability sampling. The data were collected over a period of four months.

The criteria for inclusion were:

- Sufficient proficiency in English to complete the various instruments.
- Age range should be between 19 and 71.
- No diagnosed psychiatric disorders.
- No physical disability.
- No motor disorder of the musculoskeletal system.
- No serious vision impairment.

All 59 participants in the sample were from the same area in Gauteng. The demographic variables (gender, age, education level, and occupation) are set out in Tables 4.5, 4.6, 4.7, and 4.8 below.

Table 4.5
Gender

Gender	Frequency	Percentage
Male	34	58
Female	25	42
Total	59	100

The sample for Phase 2 was more proportionate in terms of gender than Phase 1, which was to be expected, as the sample consisted of respondents from the general public and not specifically from a group who was trained to work at height at a specific organisation. Table 4.5 demonstrates that 58% of the sample were males and 42% were females.

Table 4.6

Age

Category	Frequency	Percentage
Under 20	2	3
21-30	13	22
31-40	25	42
41-50	11	19
51-60	5	9
Older than 60	3	5
Total	59	100

Table 4.6 demonstrates that the age of the sample group was analysed. The minimum age was 19 and the maximum age was 71, with an average age of 38.72 in the sample.

As already mentioned, the legal work age sets the general minimum age for admission to employment for work at 15 years and the minimum age for hazardous work at 18 years (The South African Labour Guide, n.d.). The maximum age can be explained as respondents who were simply interested in the study and found the phenomenon of fear of heights interesting, volunteered to take part in the study.

Table 4.7

Education

Level of Education (Years of Completion)	Frequency	Percentage
Completed 12 years	51	86
Completed 11 years	5	9
Completed 10 years	2	3
Less than 10 years	1	2
Total	59	100

Table 4.7 indicates that 51 participants completed 12 years of education, five completed 11 years of education, while two completed 10 years of education. Only one participant indicated less than 10 years of education in the sample.

Table 4.8

Occupation

Occupation	Frequency	Percentage
Finance and sales	6	11
Human resources	9	15
Management	9	15
Operations	22	37
Other	13	22
Total	59	100

The category named “operations”, includes the following occupations: Storeman, receptionist, housekeeping, general worker, stock controllers/storeman, strategy practitioner, multimedia specialist, operator, conductor, security officer, administrator, caretaker, admin clerk, and a personal assistant. The category named “other”, includes a pastor, graphic designer, musical director, intern, writer, photographer, and a Pilates instructor. It further includes one unemployed respondent and three respondents who did not indicate their occupation.

4.6 Measuring Instruments

The researcher should be allowed to identify the similarities and differences between test results; and therefore the researcher should ideally use multiple methods of measurement, and not depend on only a single instrument when attempting to accurately measure a psychological construct (McClure, 2020).

The study consisted of two phases, and convenience samples were used during both phases. Phase 1 consisted of respondents at a specific diamond mine in South Africa and Phase 2 consisted of respondents of the general public.

The demographic variables of age, gender, education level, and occupation were received through a biographical information sheet which needed to be completed before taking the tests during both phases. The psychometric test, ACRO, was used to measure fear of heights during both phases. A short self-report questionnaire was used during Phase 1 and the vHISS and HIQ were used during Phase 2.

Both participating groups (Phase 1 and Phase 2) completed a biographical questionnaire (Appendix 5). In addition, participants during Phase 1 completed the self-report questionnaire as a criterion on height relevant interpretation. Participants during Phase 2 completed the HIQ and the vHISS. Participants of both phases completed the ACRO psychometric assessment.

4.6.1 Phase 1

4.6.1.1 Acrophobia Test (ACRO [Fear of Heights Test]).

Acrophobia test, ACRO (fear of heights) is an objective assessment tool that is specifically designed to identify the fear of height construct (Prieler, 2016). Permission was obtained from the developer, Dr Joerg Prieler, to use the test in this study (Appendix 4).

According to the ACRO user manual (Prieler, 2016), a motor activity is performed by means of pushing a button (with your hand). Apart from the execution of the response to the stimuli presented, these activities do not present any significant difficulty. Next is a flowchart of the stimuli:

- A white rectangle with illuminating circles appears (baseline).
- Video clip 1 appears (forest).
- Video clip 2 appears (beach promenade).
- Video clip 3 appears (park-like landscape).

Video clips 1 to 3 are neutral (no altitude conditions presented) and are used to measure the reaction time under normal conditions (“distractibility of the subject under normal conditions”). In addition to the video footage presented, participants are subsequently asked questions about the contents of the videos. In doing so, deliberate focus on the target stimuli only can be prevented.

Questions about the contents of the three clips:

Which video did you like the most?

- Forest.
- Beach front.
- Garden.

In which video did you see the most people?

- Forest.
- Beach front.
- Garden.

In which video did you see a bicycle?

- Forest.
- Beach Front.
- Garden.
- Video clip 4 appears (mountain bike).
- Video clip 5 appears (building climbing).
- Video clip 6 appears (mountain climbing).

Video clips 4 to 6 present altitude conditions and are used to measure the reaction time under stressful conditions (“distractibility of the subject under height presented conditions”).

Questions about the contents of the three clips:

Which video did you like the most?

- Mountain bike race.
- Tower climbing.
- Mountaineering.

In which video did you see a tall building?

- Mountain bike race.
- Tower climbing.
- Mountaineering.

In which video did you see a woman?

- Mountain bike race.
- Tower climbing.
- Mountaineering.

ACRO requires candidates to use the following cognitive skills:

- Reacting to stimuli.
- Memorising the relevant characteristics of stimulus configurations.
- Memorising the relevant characteristics of response buttons and assignment rules.
- Selecting the relevant responses according to the instruction rules and/or rules acquired during the test.

According to Eysenck et al. (2007), exposure to a second visual stimulus causes distraction, requesting simultaneous demands on the subject, leading to stronger or weakened cognitive limitations.

The degree of difficulty depends mainly on two variables:

- The location where the stimulus presents itself (left, right, top, or bottom of the screen); and
- individually stressful video footage.

As described in the test user manual, administrative objectivity is ensured by a standardised instruction procedure. The participant can perform the altitude test without the aid of a test supervisor or test administrator being present. However, the researcher and/or a trained administrator was/were present during the assessment.

Scoring

The ACRO assessment report indicates the following for each individual:

- Acrophobia detected (red light).
- Acrophobia cannot be excluded (yellow light).
- No acrophobia detected (green light).

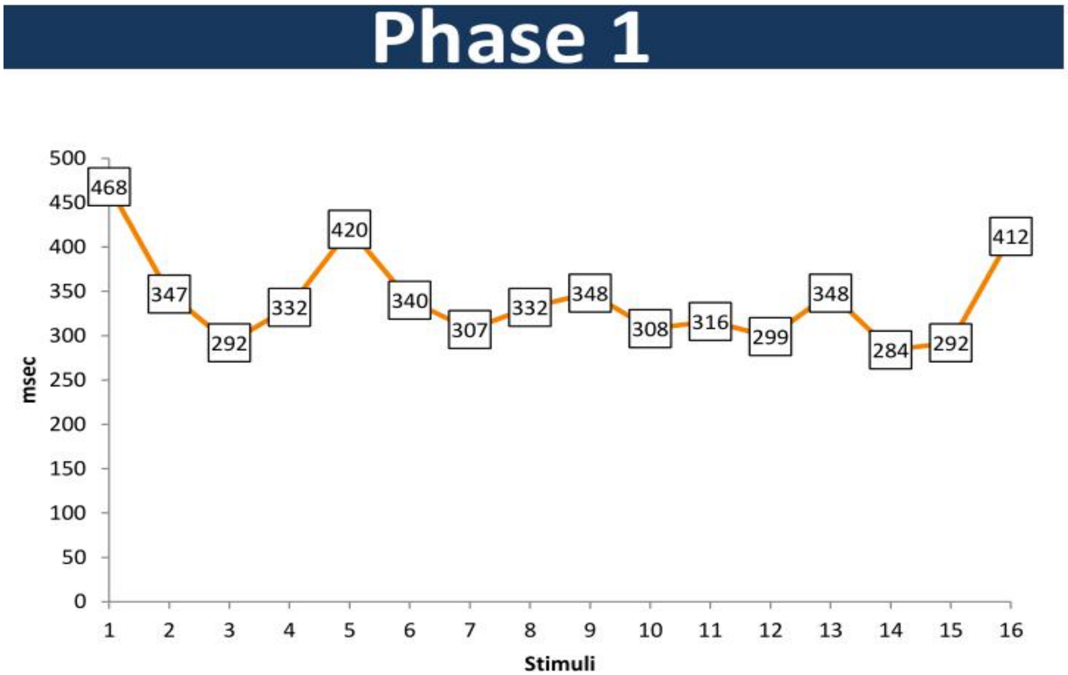
The scoring comprises of four parts:

Part 1 of scoring

The progress of the reaction times on all the stimuli (white circles) is displayed in milliseconds under the baseline conditions as indicated in Figure 4.1.

Figure 4.1

Phase 1 scoring



The test consists of three phases, namely phase 1 (baseline), phase 2 (neutral distraction), and phase 3 (fear of heights simulation). The results of each phase are provided in the form of raw scores and sten-values for the response times and the errors. Reaction times (top, right, bottom, and left), as well as the number of errors (top, right, bottom, and left), are shown in sten-values on a table. In the translation into sten-values, high values indicate fast reactions and fewer errors respectively.

A norming exercise in the classical sense was done, which was only used to calculate cut-off values. These values are included in the automatic evaluation programme. They are deliberately not displayed (see the new test manuals of Hogrefe and Schuhfried [as cited in Prieler, 2016], where no norms are presented any longer due to copyright reasons. As is the case with the Air Traffic Controller Test, these are now included in the evaluation software). The calculation of the norm values was used to determine the formation of the mean percentile rank PR_x for each raw score x according to the formula (Lienert & Raatz, 1994, as cited in Prieler, 2016):

$$PR_x = 100 \cdot \frac{cum\, f_x - f_x/2}{N}$$

- cum f_x corresponds to the number of subjects who achieved the raw score x or a smaller value;
- f_x is the number of subjects with the raw score x; and
- N indicates the sample size.

The norms for ACRO were calculated over the period between 2015 and 2016 (n=419) (Prieler, 2016, p. 20).

Part 2 of scoring

The overall average (total) of phase 1, phase 2, and phase 3 are calculated and shown in tabular format. The overall average of each phase (phases 1-3) includes both the average response times and the number of errors (the errors are weighted more heavily than the response times).

Part 3 of scoring

The overall average of each phase (phases 1-3) is then used for the rule chain:

Rule chain (Algorithm)

- p1 > p2 = green = no acrophobia detected.
- p1 < p3 = green = no acrophobia detected.
- p2 > P3 = green = no acrophobia detected.
- 95% of p3 < p2 = green = no acrophobia detected.
- 91-94% of p3 > p2 = yellow = acrophobia cannot be excluded.
- 90% of p3 > p2 = red = acrophobia detected.
- If the overall average of phase 1 is bigger than the overall average of phase 2 or if the overall average of phase 1 is less than the overall average of phase 3 = green light = no acrophobia detected.
- If the overall average of phase 2 is bigger than the overall average of phase 3 = green light = no acrophobia detected.

- When 95% of the total average of phase 3 is less than or equal to the overall average of phase 2 = green light = no acrophobia detected.
- When 95% of the total average of phase 3 is bigger than the total average of phase 2 = yellow light = acrophobia cannot be excluded.
- When 90% of the total average of phase 3 is bigger than the total average of phase 2 = red light = acrophobia detected.

Part 4 of scoring

The ACRO assessment report indicates the following for each individual:

- No acrophobia detected (green light).
- Acrophobia cannot be excluded (yellow light).
- Acrophobia detected (red light).

Reliability

The following information is based on communication with Prieler (Dr J. Prelier, personal communication, 10 July 2018), the developer of the ACRO and author of the test user manual. The statistical information was based on data submitted by a psychological consultancy company in South Africa for test classification at the HPCSA.

In a study with Austrian subjects (n=443), the Cronbach Alpha coefficients ranging from 0.89 to 0.93 were determined for the individual characteristics (response times and incorrect reactions). In a study of South African subjects (n=258) (normal population, men and women between 19 and 63 years, no fear of heights based on subjective self-assessment), the Cronbach Alpha coefficients for the reaction times were calculated for the three phases and the overall test. Phase 1: 0.88 (16 items), phase 2: 0.94 (24 items), phase 3: 0.94 (24 items). Total: 0.95 (64 items). The reliability for the South African sample therefore corresponds to that of the original sample.

Validity

A first validation study using 261 Austrian subjects, aged 22 to 54, showed that ACRO could differentiate between people with and without a fear of heights. The experimental group (EG; n=124) consisted of subjects who, on the basis of a subjective self-assessment, suffered from fear of heights. The control group (CG; n=137) consisted of subjects who, on the basis of a subjective self-assessment, were not afraid of heights. The results of this validation study are presented in Table 4.9.

Table 4.9

Validation stage 1 (2016): Subjective self-assessments

Validation Study	EG (n=124)	CG (n=137)
Reaction time	421 (391; 476)	337 (290; 384)
Error total	8 (10; 6)	3 (1; 5)
Omissions	4 (5; 3)	1 (2; 0)

Note. Median (Q1; Q3). The median and total errors of the third trial (video clips with altitude representations) are shown.

Both groups mentioned above completed the ACRO test as individual tests.

A second validation study with Austrian subjects aged 19 to 49 (n=98) also showed a very good differentiation ability. As indicated in Table 4.10, the experimental group (EG; n=32) consisted of subjects who were diagnosed with acrophobia, and who were receiving therapeutic treatment, but who are otherwise free of impairment, and who achieved normal response times in a previous conducted reaction test (VTS – Schuhfried, 2013).

Table 4.10

Validation stage 2 (2015-2016): People with diagnosis of acrophobia vs. sport climbers vs. normal people

Validation Study	EG (n=32)	CG1 (n=30)	CG2 (n=36)
Reaction time	453	298	331
Error total	9	1	4
Omissions	6	0	3
Visual field	3	0	1

Table 4.10 gives the averages and number of errors in the first trial (video clips with altitude presentation are shown). The median "Reaction time" and the "Error total" reflect the responses to the total of 24 stimuli of phase 3 (video clips with altitude representations). The visual field includes the number of critical circular segments.

The small sample size was a result of Prieler (2016), finding it difficult to find subjects who fit the diagnostic criteria as there are hardly any treatment centres, therapists, institutions, or specialists for acrophobia available in Austria. The control group 1 (CG1; n=30) consisted of subjects who actively participate in the sport of climbing competitively. Control group 2 (CG2; n=36) was the normal group.

Again, both groups were given the ACRO as individual tests. The median "Reaction time" and the "Error total" show the responses to the 24 stimuli of phase 3 (video clips with altitude representations).

All values have been confirmed by variance analysis investigations to be significant (5%) outside the visual field.

It is not about the reaction time or the number of errors at any stage in comparison with other individuals, as is common in typical existing psychological tests. It is rather about the individual's deviation from the base reaction time or number of errors arising from acrophobia.

This induces video material, i.e., the analysis of the difference between the two baseline phases as opposed to the phase with acrophobia inducing video. However, the ACRO is an exception in the huge pool of psychological tests.

Psychometric cut-off values were determined, which in terms of the current state of science, can be considered as valid to identify fear of heights in people. Specific rules were determined (as indicated in the scoring section of the ACRO), independent of a specific country or culture, and the validation studies indicated that there was no significant difference in the reaction times and number of errors.

4.6.1.2 Self-Report Questionnaire on Height Relevant Interpretation.

Collecting information from respondents or participants, by utilizing a group of written questions, defines a questionnaire and can be regarded as one of the most frequently used tools for gathering data in the social sciences (Vogt, 1993). When individuals complete an instrument by answering questions about themselves, it is described as a self-report instrument (McClure, 2020).

The participants were asked to indicate either "True" or "False" to seven simple statements related to heights in a self-report questionnaire. McClure (2020) states that this can be classified as a forced response format, providing specific options for responding where subjects choose the response that best describes their experience. Individuals can describe their emotions and thoughts accurately, and therefore this type of instrument is especially beneficial when conducting the mentioned research. However, the drawbacks are that the level, intensity, or frequency of one's experience is subjective, for example, how I perceive and describe my fear of heights, may not be the same as another person's perception or level of fear of heights.

Identification of the questions asked in the questionnaire were based on the following guidelines: 1) Clarify the reason for the study or exercise; 2) determine the information required from the participants; 3) list the research questions answered in the questionnaire; and 4) identify any additional information (demographic) required to address the research question (Kanjee, 2004).

This self-report questionnaire was kept as uncomplicated, short, concise, and relevant as possible. This was in an attempt to exclude cultural bias, to provide for lower literacy level participants and to ensure that production at the mine was not affected during this data collection project. The questions were based on discussions with the developer of the ACRO psychometric test and information that were gathered from literature, specifically for the mining and construction industry. Dichotomous questions were used with only two alternatives to choose from ("True" or "False"), in an attempt to obtain factual information from the participants (see Appendix 5).

Scoring

Factor analysis on the self-report questionnaire was done on a South African sample (n=258) when the test was previously submitted to the HPCSA for test classification. The factor analysis revealed that the higher the raw score in the self-report questionnaire, the higher the subject's fear of heights was. There was a relation between highly fearful self-report (high raw score), a high (i.e., slow) reaction time, and a high number of errors in subtest 3 of the ACRO. Subtest 3 records the reaction time and accuracy of observation with simultaneous exposure to video material that is stressful for acrophobias.

The self-report questionnaire provides a total score (Q Score) that can be interpreted as the participant having a possible tendency to having a fear of heights. The following formula was implemented to calculate the questionnaire's total score, indicated as the Q Score: Question 1 + Question 2 - Question 3 - Question 4 + Question 5 - Question 6. The range is -3 to 3, where -3 = no tendency to acrophobia and 3 = tendency to acrophobia.

4.6.2 Phase 2

4.6.2.1 Acrophobia Test (ACRO [Fear of Heights Test]).

Acrophobia test (ACRO) fear of heights test as discussed in section 4.6.1.1.

4.6.2.2 Heights Interpretation Questionnaire (HIQ).

Participants from the general population (Phase 2) were given the HIQ, which is a 16-item self-report questionnaire designed to measure height-relevant interpretations. Modifications were made from the Spider Interpretation Questionnaire (Steinman & Teachman, 2011). The HIQ requires participants to read and imagine themselves in two height-relevant scenarios (climbing a ladder and standing on a balcony), common in fear of heights phobic individuals. According to Anthony et al. (2006) the scenarios were designed to be somewhat unclear in terms of how dangerous the heights are, and to determine if the individual will be able to cope with their anxiety (Steinman & Teachman, 2011). A Likert scale of 1 (not likely) to 5 (very likely) of eight interpretations related to each scenario (e.g., “You will fall”) are presented to the participants, in order for them to rate likelihood. During previous studies the questionnaire was utilised as an online assessment. However, during this particular study, the researcher (and/or a trained administrator) was present during the assessment, which was only conducted in a pen and paper method.

Four meaningful factors namely: Dangerousness of being on a balcony, dangerousness of climbing a ladder, physical consequences of anxiety, and emotional consequences of anxiety, were revealed by factor analysis during a series of three studies (Steinman & Teachman, 2011). Study 1 (n=553) and study 2 (n=308) established the scale’s factor structure, as well as the convergent and discriminant validity among two large undergraduate samples. Study 3 (n=48) evaluated the predictive validity of the HIQ by examining how well the scale predicted subjective distress and avoidance on actual heights (Steinman & Teachman, 2011).

Strong reliability and validity across the studies were demonstrated for the HIQ. Additionally, the HIQ is a strong predictor of fear and avoidance in actual heights, beyond a traditional measure of acrophobia symptoms. The three studies by Steinman and Teachman (2011) demonstrate that individuals who are afraid of heights interpret heights to be dangerous and they doubt their ability to cope with their anxiety. Steinman and Teachman (2011) state that the HIQ provides clinicians and researchers with a means to access height-relevant interpretations without the need for a special, or a potentially dangerous scenario. Designed to be somewhat ambiguous, the questionnaire enables participants to apply their own interpretive styles related to heights when responding to the scenarios.

Steinman and Teachman (2011) indicate that evaluation of the HIQ in a treatment-seeking acrophobic sample or in other types of anxiety samples, has not been conducted yet. The inclusion of past used online judgement questions would have provided another useful check for convergent validity. Despite the limitations, these studies suggest that the psychometric properties of the HIQ are robust and that the questionnaire is a strong predictor of fear and avoidance in actual heights. In terms of investigating cognitive processing biases in acrophobia, the new HIQ tool, shows promise.

Scoring

The researcher used the same cut-off score applied in the treatment trial by Arroll (as cited in Freeman et al., 2018), which indicates at least a moderate fear of heights if subjects had a total score of more than 29. The total score was calculated by adding the scores assigned to the Likert scale: 1 (not likely), 2 or 3 (somewhat likely), 4 or 5 (very likely), of eight interpretations related to each scenario. A total score of more than 29 on the HIQ predicts subjective distress and avoidance of heights (Steinman & Teachman, 2011).

4.6.2.3 Visual Height Intolerance Severity Scale (vHISS).

Constructed and validated by Huppert et al. (2017), intended as a short, manageable questionnaire, the vHISS can be used for the reliable evaluation of susceptible individuals.

The initial 16-item questionnaire was created from two more extensive questionnaires used in earlier representative epidemiological studies: One (n=3517) on the prevalence and determinants of vHI and the other (n=2012) on clinical characteristics and psychiatric comorbidity patterns. A total of 1,960 participants were included in the validation study of Huppert et al. (2017). A total of 640 participants indicated that they had experienced vHI. This corresponds to a prevalence of 32.7%. The most frequent triggers of vHI were towers, scaffolding, roofs, and ladders in about

70% of vHI susceptible participants, whereas everyday situations like standing on a balcony, a staircase, or looking out of a window elicited vHI in only 25% to 40% of vHI susceptible participants. It was further revealed that 70% to 80% of the participants cope with vHI by avoiding possible situations that elicit distressing vHI or fear of heights, although 24% reported that at least occasionally they expose themselves intentionally to heights.

For objectivity of the items on the scale, Huppert et al. (2017) conducted the Rasch analysis of 11 items on severity, symptoms, and triggers resulting in an eight-item scale. To establish the diagnoses of acrophobia, questions 9 and 10 should be added to the basic eight-question questionnaire. The scores differentiated well between individuals with and without acrophobia. The distribution of scores of the metric scale of the questionnaires of those individuals with acrophobia is separate and distinct from that of vHI susceptible participants without acrophobia, although there was some overlap.

The vHISS allows a continuum of severity of visual height intolerance within a metric interval scale from zero to 13. By including two additional questions, the detection of acrophobia can be established.

Scoring

The scale is based on a set of eight questions for determining the severity of vHI. Two of the questions are lists – one of symptoms and one of triggers. Two additional questions (questions 9 and 10) are included in order to assess acrophobia specifically. The scoring and the cut-off scores are explained as per the test developer: To determine the severity of vHI, the total of the scores on items 1 to 6 is calculated, whereupon the number of symptoms reported from list A (item 7) are summed. If there are less than four symptoms, 0 is added to the total score; if there are four or more symptoms, 1 is added to the total score.

Likewise, the number of triggers from list B (item 8) was added. If there were less than four triggers, 0 was added to the total score; if there were four to six triggers, 1 was added to the total score. For seven to nine triggers, 2 was added to the total score. For 10 or more triggers, 3 was added to the total score. The sum of items 1-6, plus items of list A, plus items of list B yielded the total severity score. The severity score ranges from 0 to13.

In order for a subject to meet the DSM-V criteria for the diagnosis of acrophobia, the following scoring procedure is followed:

Yes = subject must have at least one of the vegetative symptoms (questions a to d from List A) and two other additional symptoms from List A. Additionally, a positive response to item 6 of the severity scale and a positive response to items 9 and 10 are needed. No = subject did not meet the above criteria.

4.7 Data Collection Procedure

Sufficient detail of all steps taken when conducting the research should be described, in order for the study to be exactly reproduced and to allow an external evaluation of whether or not the test findings can be considered scientifically robust (Laher et al., 2019).

4.7.1 Phase 1

The data were collected over an approximate three-month period at the mining company in Limpopo. The participants attended the assessment sessions according to a specific roster, planned by the training department of the mine. The sample consisted of 150 participants (126 males and 24 females) and the instructions for the ACRO and the questionnaires were given in English. All of the 150 participants in the sample were from the same area in Limpopo. The age of the participants ranged between 22 and 63.

After giving informed consent, each participant completed both the biographical questionnaire and the self-report questionnaire. The biographical and self-report questionnaires were completed by each participant and took approximately five minutes to complete. Then, each participant was moved to a computer to complete the ACRO. The assessment was administered by a trained administrator, working in the Human Resource Department, trained by the South African ACRO test distributer. The ACRO test takes approximately 15 to 20 minutes to complete. Participants were then thanked for their participation.

4.7.2 Phase 2

The data were collected over a four-month period in Gauteng. As psychometrist, the researcher made use of an existing client data system of various organisations. As previously mentioned, the person who was in charge of the booking procedure at the organisation, was telephonically or via e-mail correspondence informed of the research when booking assessments for various HR, administrative, sales and health, and safety orientated industries. The researcher asked 59 participants who were sent by their company to do a psychometric assessment battery for development purposes, unrelated to fear of heights, if they were willing to take part in the study. The data collection assessments only took place after the participants completed their development assessments. Participation was voluntary and no incentives were offered to participants who were willing to take part in the data collection.

Volunteering participants completed the informed consent document, the biographical questionnaire, the HIQ, and the vHI. The duration was approximately 10 to15 minutes. Then, each participant was moved to a computer to complete the ACRO. The ACRO test takes approximately 15 to 20 minutes to complete. The researcher administered the assessments in most situations. Due to logistical constraints, a trained administrator (HPCSA registered psychometrist) assisted with a limited number of administrations. Participants were then thanked for their participation.

4.8 Data Analysis

Descriptive and inferential statistics have a role to play in making principled arguments, assisting the researcher in making decisions about the nature of reality, and are thus central to the positivist enterprise of science (Durrheim, 2004a). Statistics can be used descriptively to illustrate the characteristics of a group of observations, that is the raw data; this is called descriptive statistics of which the two main categories of data are called “categorical data” and “continuous data” (Marshall & Jonker, 2010). Not answer questions about how/when/why the characteristics occurred, descriptive research is implemented to describe the characteristics of a population or phenomenon being studied. The “what?” question (“What are the characteristics of the population or situation being studied?”) is rather addressed. When a researcher wants to understand a certain topic better, descriptive research is mainly done and can therefore be seen as the exploration of phenomena (Shields & Rangarajan, 2013).

Inferential statistics differ from descriptive statistics in that they demonstrate the relation between variables (Marshall & Jonker, 2010, p. 6). The authors state that “inferential statistics [are] statistics that can be used to infer from the sample group generalisations that can be applied to a wider population”.

Taking into consideration that identifying fear of heights can be considered as a relatively new phenomenon, as there are limited South African research studies available. However, descriptive and explorative statistics were suitable. In addition, relations were determined, and comparative analyses done.

Data were captured onto Microsoft Excel, while IBM SPSS version 25 was the statistical program used. The performance on the ACRO and the three self-report questionnaires were described in terms of frequencies, means, standard deviations, and minimum and maximum scores. Cronbach’s Alpha coefficient was calculated to determine the internal consistency of the ACRO.

Spearman’s correlations were calculated to determine the relation between performance on the ACRO and the three self-report measures of fear of heights. A statistical relation/correlation is a pattern or an association which exists between two or more variables. To summarise, in a single number, the nature of this patterned relation or association between two variables, researchers utilize the statistical concept of correlation. The sophistication of the analysis, nor how many variables are involved, matters; all correlational procedures depend on measuring and then analysing the relation between pairs of variables (Cooksey, 2020).

Durrheim (2004a) states that, in order to mathematically represent the relation between variables, researchers must calculate the correlation coefficient. The correlation coefficient is a numerical estimate of the degree to which the points on a scatterplot cluster around the regression line are situated, which represents the strength of covariation between two variables by means of a number that can range from -1 to 1 (Spearman's correlation). The correlation coefficient for a strong relation is likely to be around r=0.90, while for a weaker relation it is in the region of r=0.20.

Performance on the ACRO is measured categorically. The relations with the self-report measures were therefore also determined by means of Analysis of Variance (Anova). T-tests and Anovas were furthermore used to compare performance on the ACRO across contexts, gender, age, and level of education. Cooksey (2020) states that procedures such as t-tests and analyses of variance can be employed in different hypothesis testing situations and research designs to inform the judgements of significance. When two independent group means are compared, there are two specific cases in which variances are either equal or unequal for the two groups, which correspond to the t-test (Fu et al., 2020). An analysis of variances (Anova) allows researchers to assess the effects of categorical predictors on a continuous outcome variable and are generally conducted using frequentist statistics, where p-values decide the statistical significance in an all-or-none manner: if $p < 0.05$, the result is deemed statistically significant and the null hypothesis is rejected; if $p > 0.05$, the result is deemed statistically nonsignificant, and the null hypothesis is retained (Van den Bergh et al., 2019).

4.9 Ethical Considerations

Ethics, simply explained, pertains to matters of right and wrong. For the purpose of this study, a number of ethical considerations needed to be met that typically apply to human research, including but not limited to the following: Assurance that participation in the study was voluntary; that the participants may withdraw from the study at any stage; that the information gained was de-identified and used only for the purpose of group analysis; and that the participants were required to sign informed consents having been fully briefed about their role in this study (Laher et al., 2019). In addition, all ethical guidelines as stated by the HPCSA in their Act 56 of 1974 (HPCSA, 1974) and Unisa were followed throughout this research study.

4.9.1 Ethical Clearance and Permission from the Mine

Before conducting this study, ethical permission was received from the Psychology Department and ethical clearance was received from the College of Human Sciences of Unisa. Communication was sent to the mine describing the aim of the study and indicating the availability of the individual information, should a major concern be identified. It was indicated that the findings of the study will be shared in the form of a dissertation. Permission was obtained from the HR manager at the mine (Appendix 2).

4.9.2 Informed Consent and Respect for Participants

Obtaining informed consent is of utmost importance for ethical research. For this study, participants did not only sign the consent form, but they also additionally received a full, non-technical and clear explanation of the tasks expected of them in order for them to make an informed decision to participate voluntarily in the research. The researcher and team members treated all participants in a professionally acceptable way and with respect, consideration, and courtesy.

The researcher also ensured that, at all times, no harm was done to any research participant, by carefully considering the potential risks that the research may have inflicted physically, emotionally, socially, or in any other form. The participants were debriefed after the session, ensuring that dignity and recognition were upheld. The researcher additionally ensured that participants and the organisations, during both phases, understood that even though the study does not necessarily benefit the participant individually, that it will benefit people working at height in general.

4.9.3 Data Security and Publication of Results

Participants were informed regarding the recording, the storage, and the processing of the data. The computers used for the ACRO were password protected and only the research team was given the password. The levels of access were also limited as the administrators were only allowed to perform limited administrative functions such as running and explaining the test and data export, which were encoded. All assessment results and reports were only seen by the research team, as stipulated in the informed consent form that each participant signed, while the ACRO electronic reports were password protected.

An analysis was conducted at group level, while all personally identifiable data were removed before the publication of the findings to ensure the privacy of individuals whose data form part of this study. Should publication arise from the research, close adherence to anonymity will be followed.

The researcher realised that the stakeholders were likely to be curious about the results and therefore they were informed in advance that individual results would not be made available, and calculations were to be used for group analysis only. Participants were, however, informed that the overall research findings will be available in the form of a dissertation and should they be interested, it can be shared with them. South African psychology professionals are obliged to store psychological assessment results securely for five years and it was explained to the stakeholders that the data will be kept safe for five years, and then destroyed.

4.9.4 Professional Competence

The researcher conducted herself in a professional manner at all times as expected and required of her by the HPCSA. The administrators of the test were sensitive to the presence of excessive test-taking anxiety or other signs of distress in participants, even though the test taking itself was not expected to be harmful and were prepared to discontinue the testing if necessary. Fortunately, no such incident occurred. Tredoux (2013) states that certain individuals may have a disinclination to computers, and it is therefore important that the assessment practitioners are observant when testing subjects on computers, even after they are given the opportunity to accustom themselves with it.

The test administrators were formally trained in the ethical issues pertaining to the administration of psychometric tests in general, and they were either registered with the HPCSA as a psychology practitioner, or they were part of the HR department at the mine, formally trained, and carried out administration under remote supervision of such a practitioner. It is not an uncommon practice to accredit HPCSA unregistered individuals in computerised test administration, as it was previously done by test distributers such as Neethling, SHL, and Thomas International, in line with their organisation's international practices (Tredoux, 2013).

4.10 Summary

This chapter provided a discussion of the research methodology, and the aims and hypotheses were mentioned again. It gave an outline of the research paradigm and the plan or blueprint according to which the data were collected. The population and sample were presented and discussed for Phase 1 and Phase 2 for this study. The measuring instruments were unpacked in terms of reliability, validity, and scoring methods, and the data collection procedures were explained. Finally, the ethical considerations followed during this study were discussed. In Chapter 5, the data will be presented and discussed, and the findings with regards to the analysis of the data which were collected from the participants during Phase 1 and Phase 2 of this research study, will be explained. The combined sample (n=209) of this study will also be presented.

5. Results

The research methodology was discussed in detail in Chapter 4. In Chapter 5, the data for Phase 1 (n=150), Phase 2 (n=59), and the combined sample (n=209) of this study are presented.

The empirical study involved a quantitative investigation to determine the following:

- The reliability of the acrophobia test, by determining the reliability coefficients for the individual characteristics (response times and incorrect reactions) as well as the total score on the ACRO test.
- The relation between the acrophobia test and self-report measures of fear of heights.
- The difference in the performance of subgroups on the acrophobia test.

The data will be presented for each phase in the following order:

Descriptive statistics: Frequencies, means, standard deviations, and minimum and maximum scores were determined to describe the data for each measurement in this study. The internal consistency reliability of the ACRO was determined.

Inferential statistics: T-tests and analysis of variance (Anova) were conducted and Cronbach Alpha reliability coefficients and Spearman's correlations were calculated. Parametric techniques are based on assumptions about the distribution of underlying populations from which the sample was taken. The most common parametric assumption is that the data are approximately normally distributed (Hoskin, 2010). Non-parametric techniques do not rely on this assumption: "Non-parametric techniques focus on the order or ranking of scores (or merely the classification function of numbers) and ignore the numerical properties of numbers at interval and ratio scale" (Durrheim, 2004b, p. 118). Parametric and non-parametric techniques apply to this study, as the techniques which were applied, considered the variables which were measured on the nominal and ordinal scales, and inferences that were drawn concerning the relation between categorial variables (Durrheim, 2004a). The subgroups were compared to determine if there were any significant differences in terms of fear of heights.

5.1 Phase 1

The two measuring instruments used during this phase were the ACRO and the self-report questionnaire (Q Score). In the following subsections, the descriptive statistics for both questionnaires will be presented, followed by a discussion on the reliability of the ACRO and analyses of the relation between the two questionnaires.

5.1.1 Descriptive Statistics

Below, the descriptive statistics are provided for the ACRO measurement (section 5.1.1.1) and the self-report questionnaire (Q Scores, section 5.1.1.2). This includes frequency tables for each questionnaire, a graphic representation of these frequencies, and the minimum, maximum, mean, and standard deviation for the self-report questionnaire.

5.1.1.1 ACRO.

As discussed in Chapter 4, the results for each phase of the ACRO are provided in the form of raw scores and sten-values for the response times and the errors. Reaction times (top, right, bottom, and left), as well as the number of errors (top, right, bottom, and left) are shown in sten-values on a table. In the translation into sten-values, high values indicate fast reactions and fewer errors respectively.

The ACRO assessment report indicates the following for each individual:

- Acrophobia detected (red light).
- Acrophobia cannot be excluded (yellow light).
- No acrophobia detected (green light).

In Table 5.1, the frequencies and percentages for the three categories on the ACRO are presented. The results for each category are based on the rule chain criteria as explained in Chapter 4. It should be noted that only categorial statistical values were used for the ACRO, in accordance with the concept and design of the test, and there are only three possible results (acrophobia detected, acrophobia cannot be excluded, and no acrophobia detected). The ACRO is specifically designed to measure time and errors, as the calculations would be too complex to calculate as continuous values. This will be further discussed in the limitation section in Chapter 6 of the study.

Table 5.1

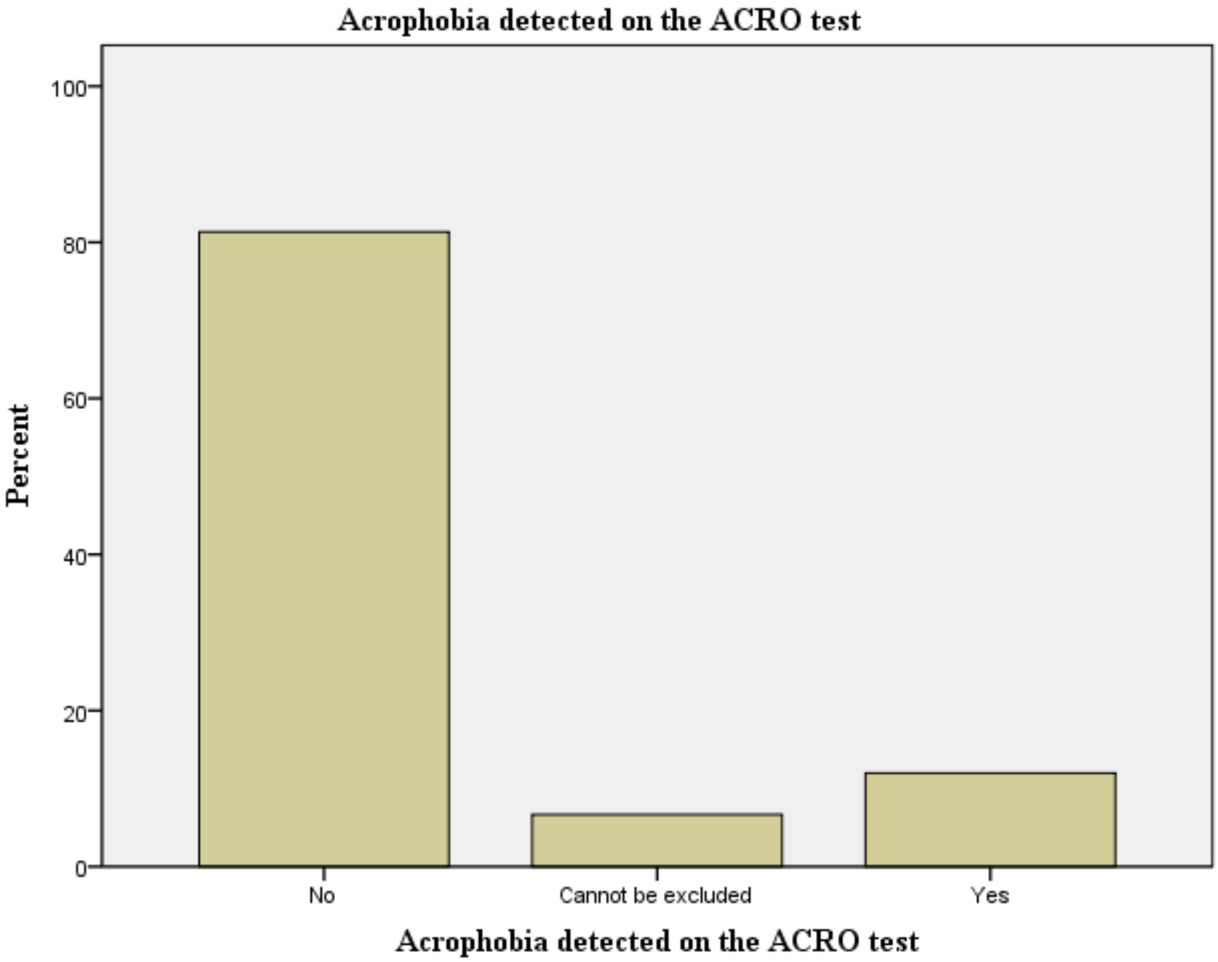
Frequency table for the ACRO categories

ACRO Test	Frequency	Percentage
No acrophobia detected	122	81.3
Acrophobia cannot be excluded	10	6.7
Acrophobia detected	18	12.0
Total	150	100.0

The table above indicates that for the majority of the respondents (81.3%) there was "no acrophobia detected" on the ACRO according to the rule chain. "Acrophobia cannot be excluded" was detected for 6.7% of the respondents and "Acrophobia detected" for 12% of the respondents. A visual presentation of this table is presented in Figure 5.1.

Figure 5.1

Frequencies for the ACRO categories



5.1.1.2 Self-Report Questionnaire (Q Score).

The respondents could only give two answers on this short self-report questionnaire of six questions, namely "True" or "False". "True" and "False" were recoded and given a score of 1 (true) and 0 (false) after which a total score was calculated. Frequencies for each of the six questions are presented in Table 5.2.

Table 5.2

Frequency table for each item on the self-report questionnaire

	Q1-Q6	Frequency	Percentage
Q1	I know I have a fear of heights.		
	False	138	92.0
	True	12	8.0
Q2	I think I have a fear of heights.		
	False	138	92.0
	True	12	8.0
Q3	I know I don’t have a fear of heights.		
	False	34	22.7
	True	116	77.3
Q4	I think I don’t have a fear of heights.		
	False	40	26.7
	True	110	73.3
Q5	Diagnosed with acrophobia.		
	False	148	98.7
	True	2	1.3
Q6	I am someone who actively participate in sports of climbing.		
	False	77	51.3
	True	73	48.7

The table above indicates that Question 6 was the only question in the questionnaire that had an almost equal amount of true and false answers, as opposed to the other questions indicating less acrophobia in terms of false answers to positively worded questions, and true answers to negatively worded questions.

The following formula was implemented to calculate the questionnaire’s total score: The Q Score is the sum of the 6 questions: Question 1 + Question 2 - Question 3 - Question 4 + Question 5 -

Question 6. The questions which indicate acrophobia are counted as 1 and the questions that do not indicate acrophobia are counted as -1.

In Table 5.3, the frequencies and percentages for the total score (Q Score) on the self-report questionnaire are presented.

Table 5.3

Frequency table for the self-report questionnaire (Q Score)

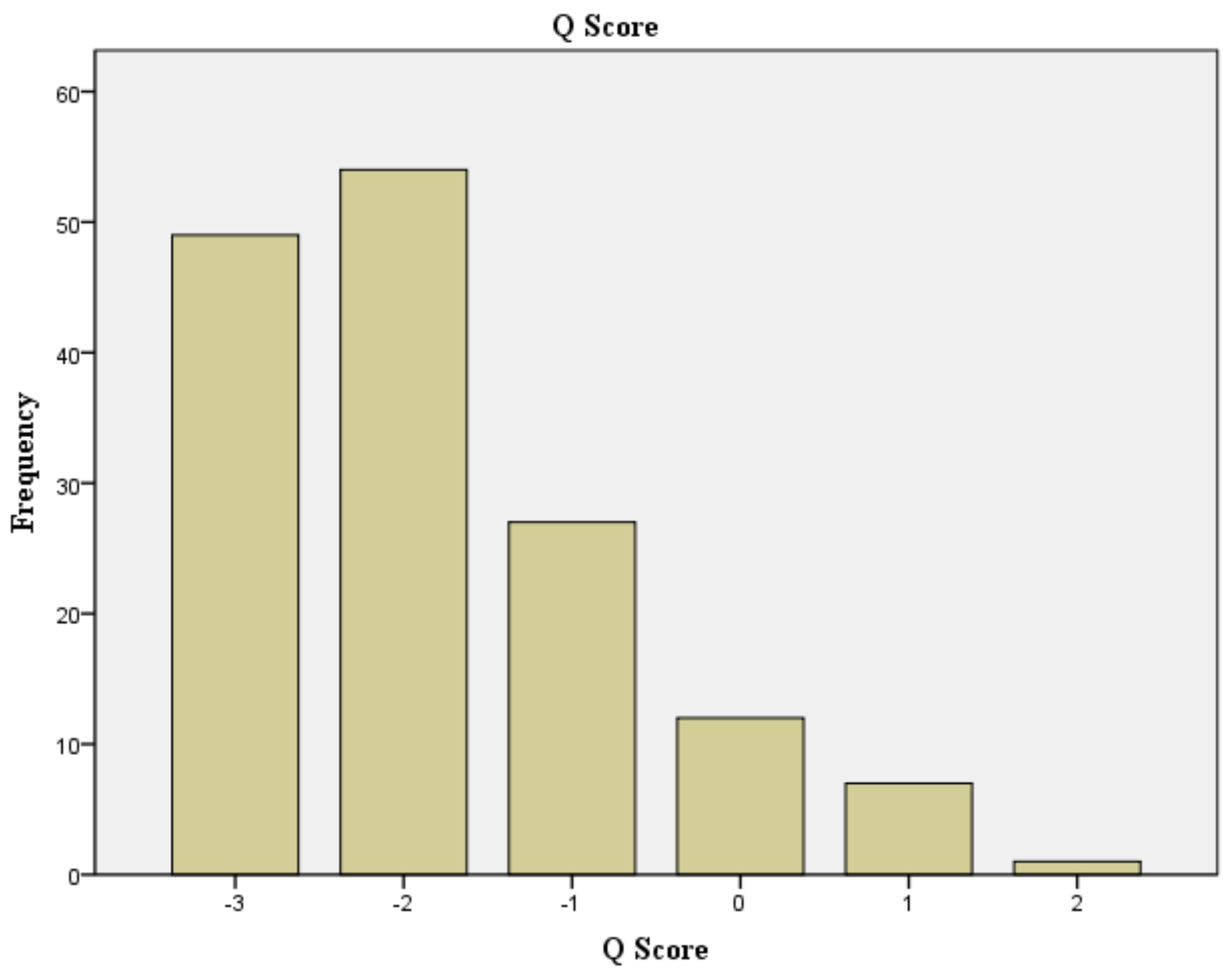
Q Score	Frequency	Percentage
-3	49	32.7
-2	54	36.0
-1	27	18.0
0	12	8.0
1	7	4.6
2	1	0.7
Total	150	100.0

In the table above, the range of the variables are -3 to 2, where -3 = no indication of possible acrophobia, and 2 = possible indication of acrophobia. No indication of acrophobia was reported by 32.7% of the respondents and in the case of 0.7% of the respondents there was an indication given of possible acrophobia.

A visual presentation of this table is given in Figure 5.2.

Figure 5.2

Frequencies for the self-report questionnaire (Q Score)



Descriptive statistics for the total score on the self-report questionnaire are provided in Table 5.4.

Table 5.4

The minimum, maximum, mean, and standard deviation for the total score on the self-report questionnaire (Q Score)

	n	Minimum	Maximum	Mean	Std. Deviation
Q Score	150	-3	2	-1.81	1.153

The minimum of this variable is -3 and the maximum is 2 with a standard deviation of 1.153 and a mean of -1.81.

5.1.2 Reliability of the ACRO

During phase 1 of the test, there were 16 stimuli that the respondents had to react to. In phase 2, there were 24 stimuli to react to, and in phase 3 there were again 24 stimuli. The reliability for the total (the entire test) indicates the consistency of the test. For the ACRO, internal consistency was used which was calculated by using Cronbach's Alpha. In Table 5.5, the reliability for each phase on the ACRO and the total score are displayed.

Table 5.5
Cronbach's Alpha reliability coefficients for the three phases and the total score of the ACRO

Reaction Times	Cronbach's Alpha
Phase 1 (baseline – 16 items/responses required)	0.88
Phase 2 (neutral – 24 items/responses required)	0.90
Phase 3 (fear of heights simulation – 24 items/responses required)	0.95
Total (64 items)	0.92

The table above indicates that for phase 1, the reliability of ACRO baseline was 0.88. For phase 2, the reliability of ACRO neutral was 0.90, and for phase 3 the reliability of ACRO height simulation was 0.95. For the identification of ACRO on the entire test, the internal consistency is 0.92.

5.1.3 Relation between Performance on the ACRO and Performance on the Self-Report Questionnaire

The mean score on the self-report questionnaire is reported in Table 5.6 for each of the three ACRO categories. This relation is presented graphically in Figure 5.3.

Table 5.6

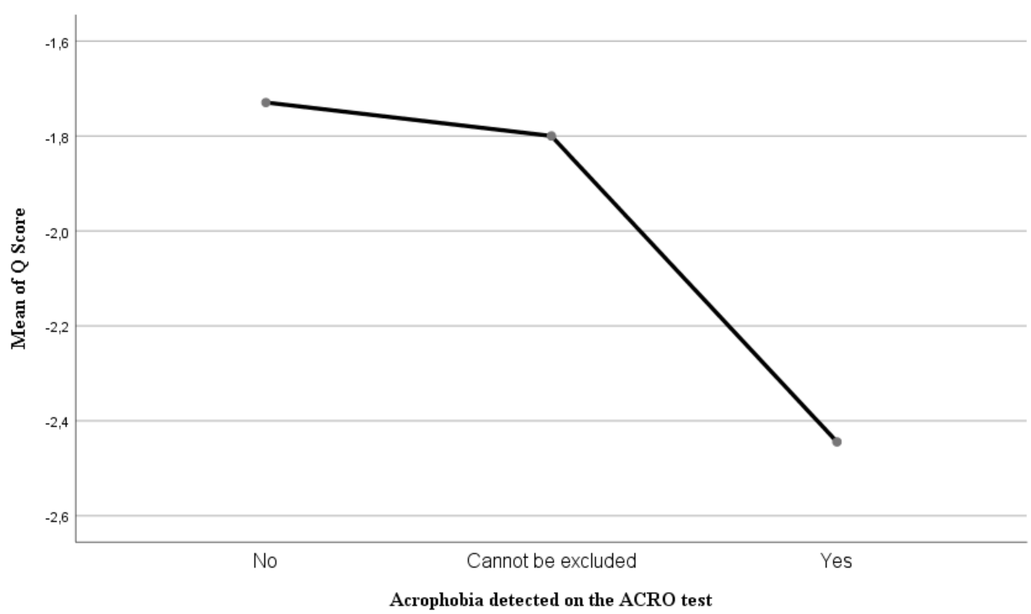
Descriptive statistics for the total score on the self-report questionnaire for each ACRO category

ACRO Category	n	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
No	122	-1.73	1.14	0.10	-1.93	-1.52	-3	2
Cannot be excluded	10	-1.80	1.39	0.44	-2.80	-0.80	-3	1
Yes	18	-2.44	0.92	0.22	-2.90	-1.99	-3	0
Total	150	-1.82	1.15	0.09	-2.01	-1.63	-3	2

This table indicates that for the category of "No acrophobia detected", the Q Score mean is -1.73. This is bigger than for the other two categories with means of -1.80 and -2.44. A visual presentation is given in Figure 5.3 for the table above.

Figure 5.3

A visual presentation for the total score on the self-report questionnaire for each ACRO category



Spearman's correlations were calculated, using a two-tailed test between acrophobia detected on the ACRO, and the self-report questionnaire's total score (Q Score). The results are presented in Table 5.7.

Table 5.7

Spearman's correlations between ACRO and Q Score

		Q Score	Acrophobia Detected on the ACRO Test
Q Score	Correlation coefficient	1.00	-0.211*
	Sig. (2-tailed)		0.010
	n	150	150
Acrophobia detected on the ACRO test	Correlation coefficient	-0.211*	1.00
	Sig. (2-tailed)	0.010	
	n	150	150

* Correlation is significant at the 0.05 level (2-tailed)

The correlation uses all three of the possible categories/results of the ACRO test (acrophobia detected, acrophobia not excluded, no acrophobia detected). In SPSS it was coded in the following manner: 0 = no acrophobia detected, 1 = acrophobia cannot be excluded, and 2 = acrophobia detected. The table above indicates that there was a numerically small negative correlation. The correlation between the ACRO and the Q Score (rho = -0.211; n=150; sig = 0.010) is significant at the 0.05 level (2-tailed). The possible reason for the unexpected direction of the correlation is given in section 6.1.2.

Because the ACRO as categorical variable presents a restriction in range in the case of a correlation, group comparisons were also done to explore this relation. An Anova was conducted which included all three categories on the ACRO (0 = no acrophobia detected, 1 = acrophobia cannot be excluded, and 2 = acrophobia detected). The results are presented in Table 5.8. The aim was to support the previous conclusion on a potential relation between the ACRO and the self-report questionnaire. The overall, rather than the between-category patterns were therefore of interest and post-hoc tests were not conducted in the case of significant results.

Table 5.8

Anova to compare scores on the self-report measure (Q Score) across the ACRO categories

		Sum of Squares	df	Mean Square	F	Sig.
Q Score	Between groups	8.02	2	4.01	3.10	0.048*
	Within groups	190.12	147	1.29		
	Total	198.14	149			

* Significant at the 0.05 level (2-tailed)

The table above indicates that there was a small significant difference identified between the mean Q Score ($p < 0.05$) on the ACRO categories. This supports the previous findings on a relation between performance on the ACRO and performance on the self-report questionnaire ($F[2.147] = 3.10$. $p=0.048$). In Table 5.6 the mean scores were reported.

5.2 Phase 2

The three measuring instruments used during this phase were the ACRO, the HIQ, and the vHISS. In the following subsections, the descriptive statistics for the ACRO, the HIQ, and the vHISS will be presented, followed by a discussion on the reliability of the ACRO and analyses of the relation between the ACRO and each questionnaire.

5.2.1 Descriptive Statistics

Below, the descriptive statistics are provided for the ACRO measurement, the HIQ, and the vHISS (severity scale and the DSM criteria). This includes frequency tables for each questionnaire, graphic representations of these frequencies, and the minimum, maximum, mean, and standard deviation for the self-report questionnaires.

5.2.1.1 ACRO.

In Table 5.9, the frequencies and percentages for the three categories on the ACRO are presented. The results for each category are based on the rule chain criteria as explained in Chapter 4.

Table 5.9

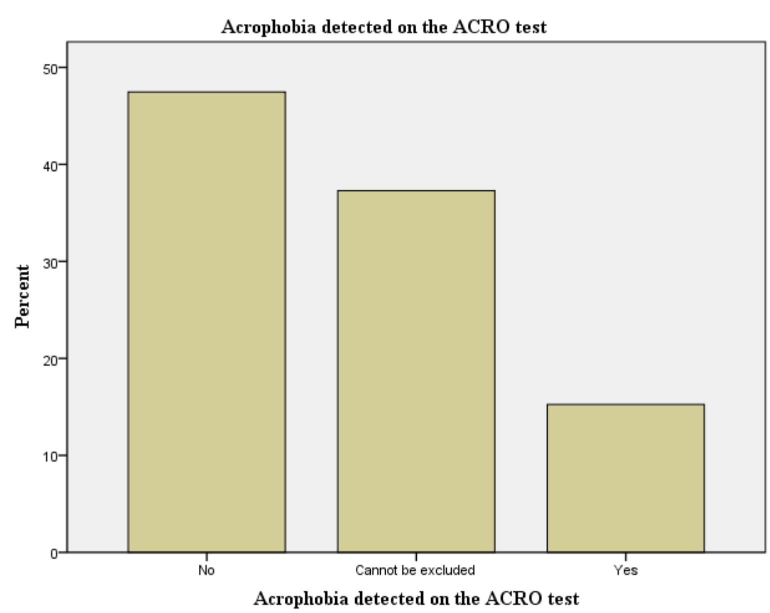
Frequency table for the ACRO categories

	Frequency	Percentage
No acrophobia detected	28	47.4
Acrophobia cannot be excluded	22	37.3
Acrophobia detected	9	15.3
Total	59	100.0

The table above indicates that for 47.4% of the respondents there was no acrophobia detected and in the case of 15.3% of the respondents, acrophobia was detected. A visual presentation of this table is presented in Figure 5.4.

Figure 5.4

Frequencies for the ACRO categories



5.2.1.2 HIQ Questionnaire.

The researcher used the same cut-off score as was used in the treatment trial by Arroll (as cited in Freeman et al., 2018), which indicates a moderate fear of heights if respondents had a total score of more than 29. In Table 5.10, the frequencies and percentages of acrophobia which were detected on the HIQ (score > 29) as categorial variable are presented.

Table 5.10

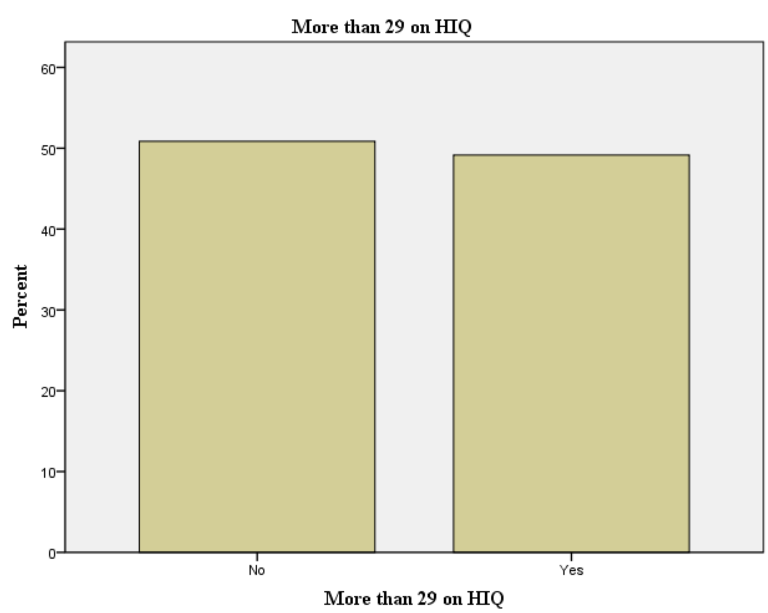
Frequency table for the HIQ categories

More than 29 on HIQ	Frequency	Percentage
No	30	50.8
Yes	29	49.2
Total	59	100.0

The table above indicates that 50.8% of the respondents scored < 29 on the HIQ scale and 49.2% scored > 29. A visual presentation of this table is presented in Figure 5.5.

Figure 5.5

Frequencies for the HIQ



The descriptive statistics for the total score on the HIQ are presented in Table 5.11.

Table 5.11

The minimum, maximum, mean, and standard deviation for the HIQ

	n	Minimum	Maximum	Mean	Std. Deviation
HIQ	59	16	59	31.76	12.08

The table above indicates that the scores for acrophobia detection on the HIQ ranged from a minimum of 16 to a maximum of 59, with a standard deviation of 12.08 and a mean of 31.76. Even though the possible maximum is 80, the empirical maximum is 59 due to no subject scoring more than 59 on the HIQ.

5.2.1.3 vHISS Questionnaire.

This self-report questionnaire consists of two sections/parts:

- Severity of vHI;
- DSM-V criteria for the diagnosis of acrophobia.

As discussed on pages 74 and 75, to determine the severity of vHI, the total of the scores on items 1 to 6 is calculated, whereupon the number of symptoms reported from list A (item 7) are summed. If there are less than four symptoms, 0 is added to the total score; if there are four or more symptoms, 1 is added to the total score. Likewise, the number of triggers from list B (item 8) was added. If there were less than four triggers, 0 was added to the total score; if there were four to six triggers, 1 was added to the total score. For seven to nine triggers, 2 was added to the total score. For 10 or more triggers, 3 was added to the total score. The sum of items 1-6, plus items of list A, plus items of list B yielded the total severity score. The severity score ranges from 0 to13.

In Table 5.12, the frequencies and percentages of the severity of vHISS are presented.

Table 5.12

Frequency table for the total score on the vHISS

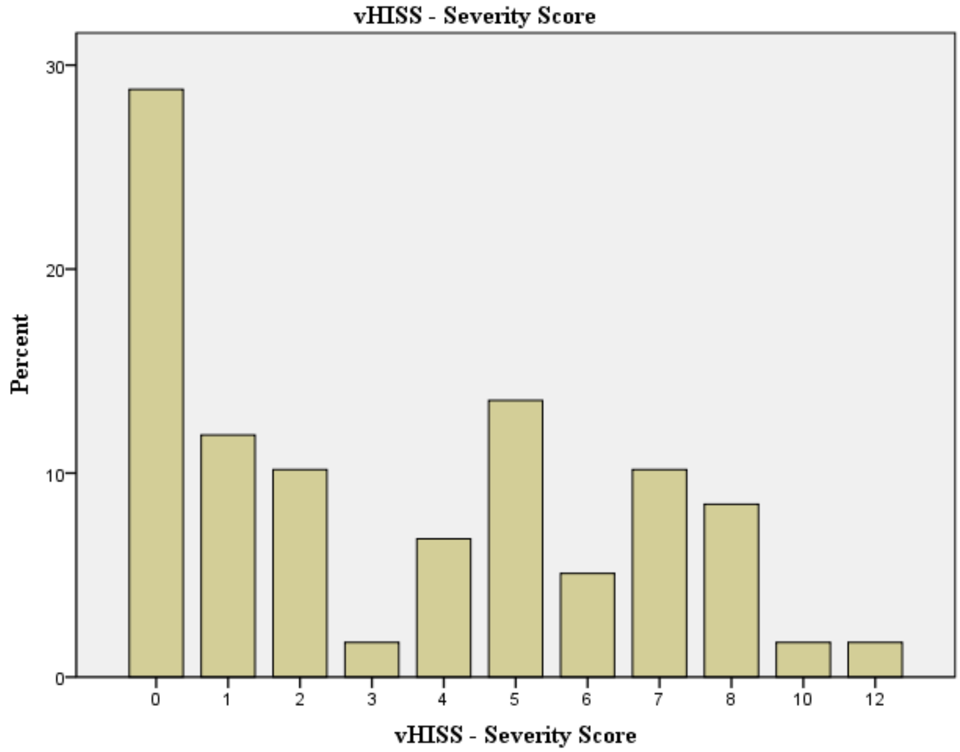
Score on vHISS	Frequency	Percentage
0	17	28.8
1	7	11.9
2	6	10.1
3	1	1.7
4	4	6.8
5	8	13.6
6	3	5.1
7	6	10.1
8	5	8.5
9	0	0.0
10	1	1.7
11	0	0.0
12	1	1.7
13	0	0.0
Total	59	100.0

The table above indicates that the severity score ranged from 0 to 13. For the majority of the respondents (28.8%) there was no indication of vHI as only 1.7% of respondents reported vHI.

A visual presentation of this table is offered in Figure 5.6.

Figure 5.6

Frequencies for the total score on the vHISS



In Table 5.13, the frequencies and percentages of visual height intolerance detected on the DSM criteria are presented.

Table 5.13

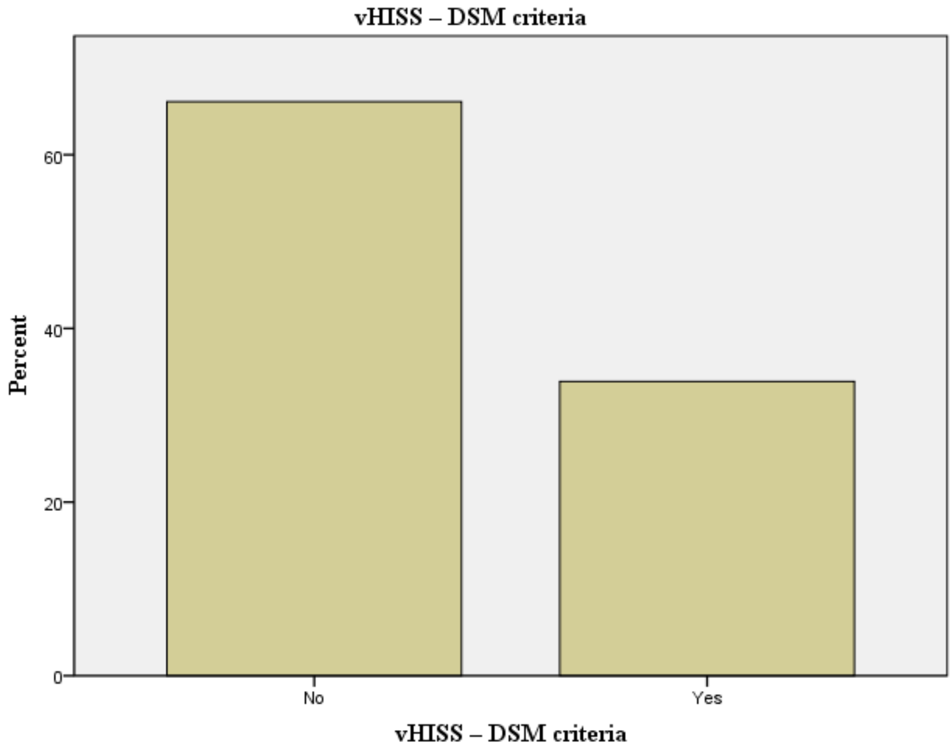
Frequency table for the vHISS – DSM criteria

	Frequency	Percentage
No	39	66.1
Yes	20	33.9
Total	59	100.0

The table above indicates that 66.1% of respondents did not meet the DSM criteria for the detection of visual height intolerance, while 33.9% did meet the DSM criteria. A visual presentation of this table is presented in Figure 5.7.

Figure 5.7

Frequencies for the vHISS – DSM criteria



The descriptive statistics for the total score on the vHISS are presented in Table 5.14.

Table 5.14

Minimum, maximum, mean, and standard deviation of the scores on the vHISS

	n	Minimum	Maximum	Mean	Std. Deviation
vHISS	59	0	12	3.39	3.19

The standard deviation of the severity scale is 3.19 and the mean is 3.39.

5.2.2 Reliability of the ACRO

During phase 1 of the test, there were 16 stimuli that the respondents had to react to. In phase 2 there were 24 stimuli to react to, while in phase 3 there were again 24 stimuli. The reliability for the total (the entire test) indicates the consistency of the test. For the ACRO, internal consistency was used which was calculated by using Cronbach's Alpha.

In Table 5.15, the reliability for each phase on the ACRO and the total score is displayed.

Table 5.15
Cronbach's Alpha reliability coefficients for the three phases and the total score of the ACRO

Reaction Times	Cronbach's Alpha
Phase 1 (baseline – 16 items/responses required)	0.88
Phase 2 (neutral – 24 items/responses required)	0.94
Phase 3 (fear of heights simulation – 24 items/responses required)	0.94
Total (64 items)	0.95

The table above indicates that for phase 1, the reliability of the ACRO baseline was 0.88. For phase 2, the reliability of Acro neutral was 0.94. For phase 3, the reliability of ACRO height simulation was 0.94. For the identification of ACRO on the entire test, the internal consistency was 0.95.

5.2.3 Relation between the Performance on the ACRO and the HIQ

The mean score on the HIQ is reported in Table 5.16 for each of the three ACRO categories. This relation is presented graphically in Figure 5.8.

Table 5.16

Descriptive statistics per ACRO category for the HIQ

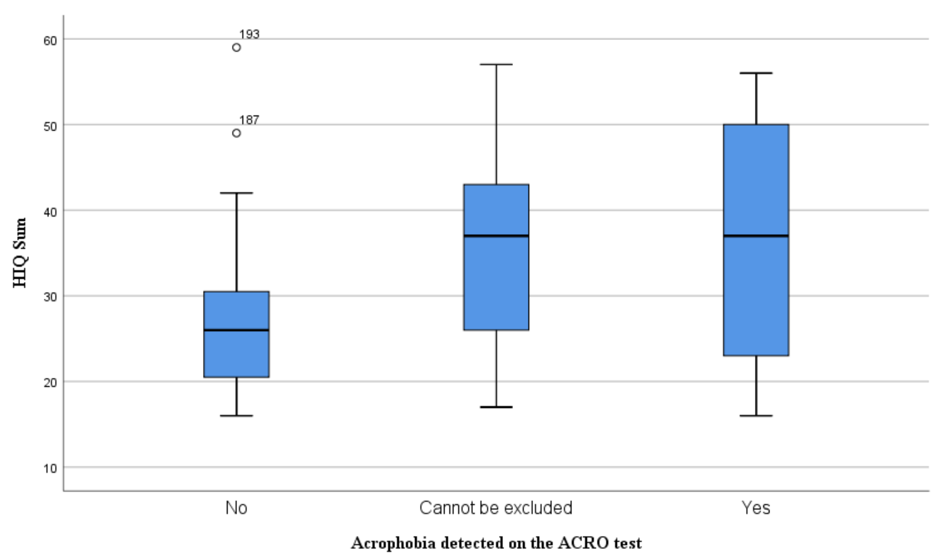
ACRO Categories	n	Variance	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval for Mean Lower Bound	Upper Bound	Min	Max	Range	Median
No	28	100.52	27.68	10.03	1.89	23.79	31.57	16	59	43	26
CBE*	22	134.28	35.09	11.59	2.47	29.95	40.23	17	57	40	37
Yes	9	254.25	36.33	15.94	5.32	24.08	48.59	16	56	40	37

* CBE: "Cannot be excluded"

The table above indicates that the mean score for the category of "No acrophobia detected" is 27.68. For the category of "Acrophobia cannot be excluded", the mean is 35.09. For the category of "Acrophobia detected", the mean is 36.33. A visual presentation of this table is presented in Figure 5.8.

Figure 5.8

Descriptive statistics per ACRO category for the HIQ



Spearman's correlations were calculated using a two-tailed test between acrophobia which was detected on the ACRO, and the HIQ. The results are presented in Table 5.17.

Table 5.17

Spearman's correlation between the ACRO and the HIQ

		HIQ Sum	Acrophobia Detected on the ACRO Test
HIQ Sum	Correlation coefficient	1.00	0.28*
	Sig. (2-tailed)	0.03	
	n	59	59

* Correlation is significant at the 0.05 level (2-tailed)

The table above indicates that there was a moderate positive correlation between the HIQ score (p=0.03; n=59) and acrophobia detected on the ACRO. Therefore, there was a significant relation between acrophobia detected on the HIQ, and acrophobia detected on the ACRO test. Because the ACRO as categorical variable presents a restriction in range, group comparisons were also done to explore this relation. An Anova was done, including all three categories on the ACRO (0 = no acrophobia detected, 1 = acrophobia cannot be excluded, and 2 = acrophobia detected). The results are presented in Table 5.18. As previously mentioned, the overall pattern was explored.

Table 5.18

Anova for the ACRO scores on the HIQ (continuous)

		Sum of Squares	df	Mean Square	F	Sig.
HIQ sum	Between groups	898.75	2	449.38	3.33	0.043*
	Within groups	7567.93	56	135.14		
	Total	8466.68	58			

** Significant at the 0.01 level (2-tailed)

* Significant at the 0.05 level (2-tailed)

The table above indicates that there was a small significant difference identified between the mean of the HIQ ($p < 0.05$) of the ACRO categories. This supports the previous findings on a relation between performance on the ACRO and performance on the HIQ ($F[2.56] = 3.33$; $p=0.043$).

5.2.4 Relation between the Performance on the ACRO and the vHISS

The mean score of the severity scale and the DSM criteria for the vHISS is reported in Table 5.19 for each of the three ACRO categories. This relation is presented graphically in Figure 5.9 and Figure 5.10.

Table 5.19

Descriptive statistics per ACRO category for the vHISS (a) and (b)

					95% Confidence Interval for Mean			
a) ACRO Categories	n	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
No	28	1.46	2.17	0.41	0.62	2.31	0	8
Cannot be excluded	22	4.27	2.80	0.60	3.03	5.51	0	8
Yes	9	7.22	2.44	0.81	5.35	9.10	5	12
Total	59	3.39	3.20	0.40	2.56	4.22	0	12
b) ACRO Categories								
No	28	0.07	0.26	0.05	-0.03	0.17	0	1
Cannot be excluded	22	0.45	0.51	0.11	0.23	0.68	0	1
Yes	9	0.89	0.33	0.11	0.63	1.15	0	1
Total	59	0.34	0.48	0.06	0.21	0.46	0	1

a) The table above indicates that the mean score for the category of "No acrophobia detected" is 1.46. For the category of "Acrophobia cannot be excluded", the mean is 4.27. For the category of "Acrophobia detected", the mean is 7.22. A visual presentation of this table is presented in Figure 5.9.
b) The table above indicates that the mean score for the category of "No acrophobia detected" is 0.07. For the category of "Acrophobia cannot be excluded", the mean is 0.45. For the category of "Acrophobia detected", the mean is 0.89. A visual presentation of this table is presented in Figure 5.10.

Figure 5.9

Descriptive statistics per ACRO category for the vHISS

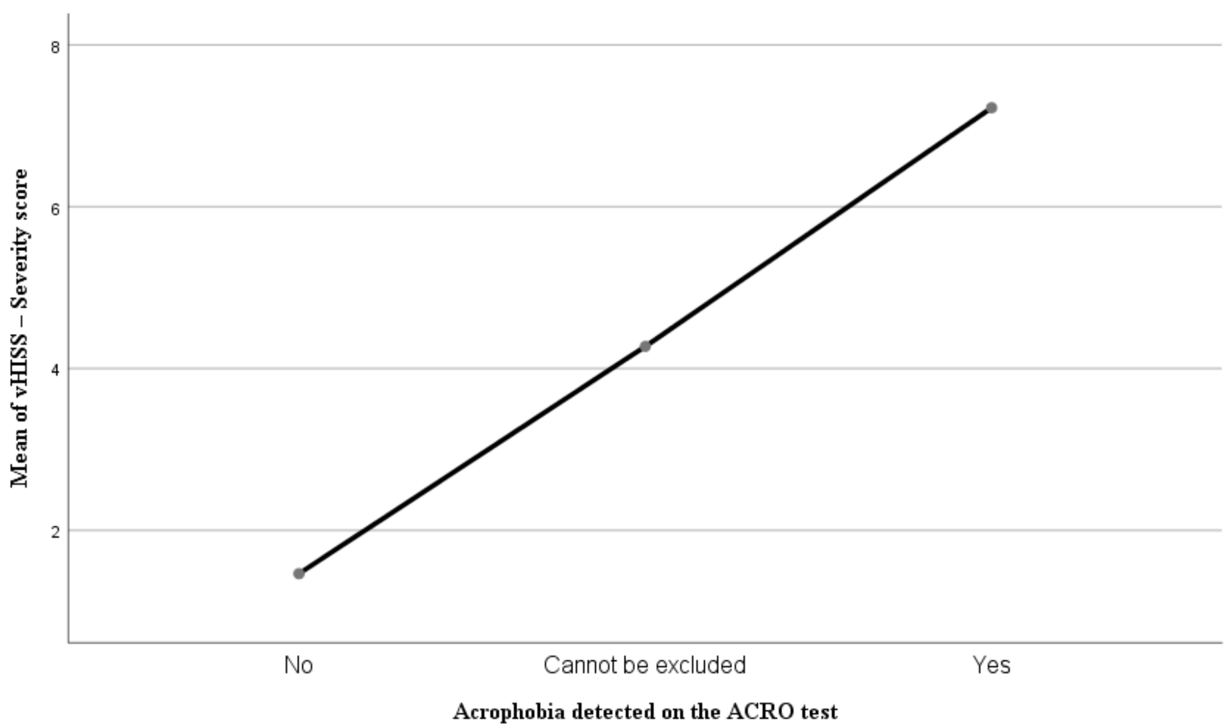
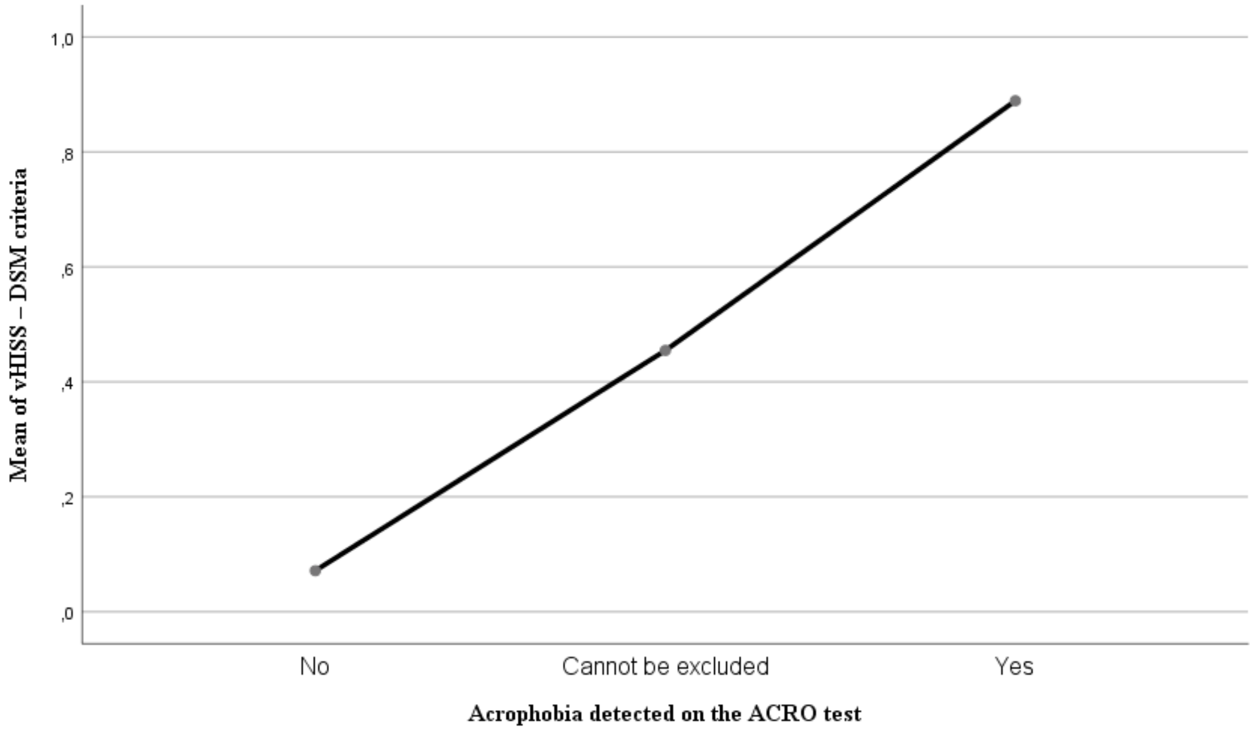


Figure 5.10

Descriptive statistics per ACRO category for the vHISS – DSM criteria



In the table below, the correlations between the ACRO and the self-report measurement vHISS are presented, using Spearman's correlation.

Table 5.20

Correlations between the ACRO and the vHISS (severity scale and DSM criteria)

		vHISS	vHISS – DSM Criteria	Acrophobia Detected on the ACRO Test
vHISS	Correlation	1	0.760**	0.636**
	Sig. (2-tailed)		0.000	0.000
	n	59	59	59
vHISS – DSM criteria	Correlation	0.760**	1.00	0.606**
	Sig. (2-tailed)	0.000		0.000
	n	59	59	59
Acrophobia	Correlation	0.636**	0.606**	1.00

		vHISS	vHISS – DSM Criteria	Acrophobia Detected on the ACRO Test
detected on	Sig. (2-tailed)	0.000	0.000	
the ACRO test	n	59	59	209

** Correlation is significant at the 0.01 level (2-tailed)

There was a strong positive correlation between the vHISS severity score (r=0.636; n=59; p=0.000), the vHISS – DSM criteria (r=0.606; n=59; p=0.000), and acrophobia detected on the ACRO.

As categorial values were used for the ACRO, variance analysis is the recommended statistical procedure. An Anova was conducted including all three categories on the ACRO, the vHISS (a) and the vHISS – DSM criteria (b). The results are presented in Table 5.21. The overall pattern was explored.

Table 5.21

Anova for the ACRO scores on the vHISS (severity scale and DSM criteria)

		Sum of Squares	df	Mean Square	F	Sig.
vHISS	Between groups	253.15	2	126.57	20.92	0.00**
	Within groups	338.88	56	6.05		
	Total	592.03	58			
vHISS – DSM criteria	Between groups	5.02	2	2.51	17.14	0.00**
	Within groups	8.20	56	0.146		
	Total	13.22	58			

** Significant at the 0.01 level (2-tailed)

The table above indicates that there was a significant difference between the means on the vHISS for the ACRO categories (F[2.56] = 20.916; p=0.000). There was also a significant difference in the case of the DSM criteria ($F[2.56] = 17.139$; $p=0.000$). Therefore, when fear increased on the vHISS, fear was identified on the categories of "acrophobia detected" and "acrophobia cannot be excluded" on the ACRO. In Table 5.19 the mean scores were reported.

5.3 Statistics for the Combined Sample (n=209) and Comparison of Subgroups

5.3.1 Descriptive Statistics for the ACRO for the Combined Sample

Only one measuring instrument, namely the ACRO psychometric test, was used to assess the predictor variable during both Phase 1 and Phase 2 of this study. During the combined phase, ACRO was regarded as the dependant variable, as the researcher wanted to investigate the performance on the ACRO per phase (n=150 and n=59) and for the demographic subgroups. The frequencies for the ACRO categories are presented in Table 5.22.

Table 5.22
Frequency table for the ACRO categories

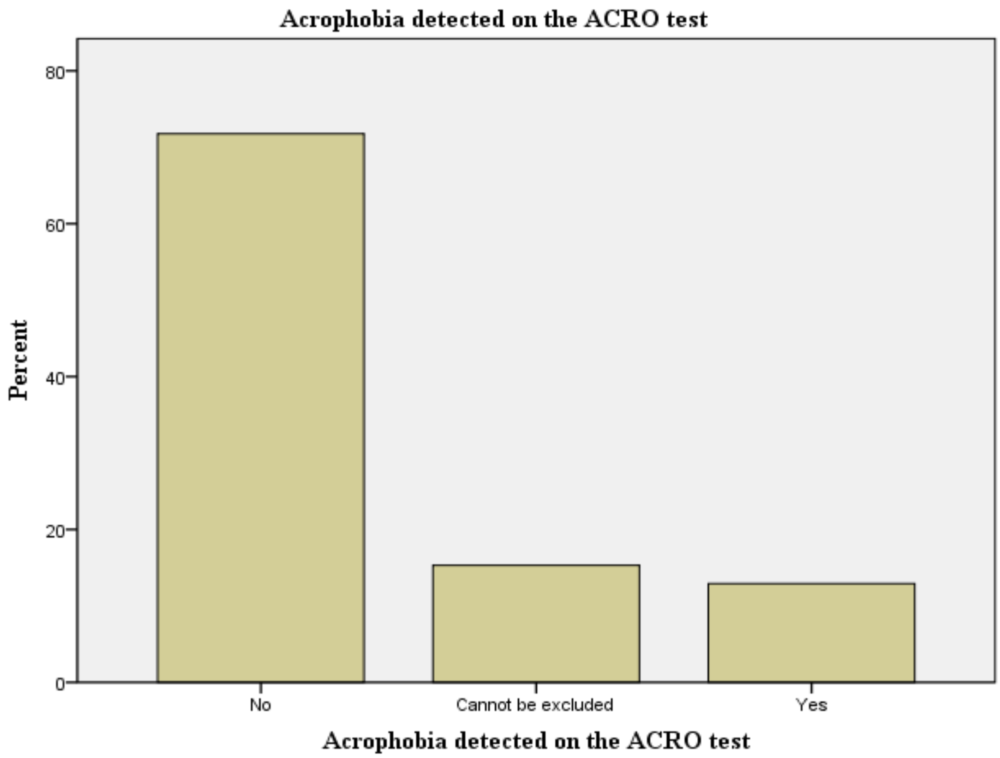
Acrophobia Detected	Frequency	Percentage
No	150	71.8
Cannot be excluded	32	15.3
Yes	27	12.9
Total	209	100.0

The table above indicates that for 71.8% of respondents there was no acrophobia detected on the ACRO test. Acrophobia could not be excluded was 15.3% and acrophobia was detected at 12.9% of the respondents.

A visual presentation of this table is presented in Figure 5.11.

Figure 5.11

Frequencies for ACRO categories



5.3.2 Group Comparisons on the ACRO

A t-test was conducted to compare the performance on the ACRO for the two samples (Phase 1 and Phase 2) in this study. The descriptive statistics are presented in Table 5.23 and the t-test results in Table 5.24.

Table 5.23

Descriptive statistics for acrophobia detected during Phase 1 and Phase 2 of the study

	n	Minimum	Maximum	Mean	Std. Deviation
Acrophobia detected on the ACRO test (Phase 1)	150	0	2	0.31	0.67
Acrophobia detected on the ACRO test (Phase 2)	59	0	2	0.68	0.73

The mean in the table above was based on the following categories: 0 indicates "No acrophobia detected", 1 indicates "Acrophobia cannot be excluded", and 2 indicates "Acrophobia detected". The table above indicates the scores for acrophobia which were detected during the two different phases of the study. The standard deviation for Phase 1 is 0.67 and the mean is 0.31. The standard deviation for Phase 2 is 0.73 and the mean is 0.68.

Table 5.24

Independent samples test comparing performance on the ACRO between Phase 1 and Phase 2 (n=209)

		Levene's Test for Equality of Variances		T-Test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Acrophobia detected on the ACRO test	Equal variances assumed	4.954	0.027	-3.498	207	0.001**	-0.371	0.106	-0.581	-0.162
	Equal variances not assumed			-3.381	99.242	0.001**	-0.371	0.110	-0.589	-0.153

** Significant at the 0.01 level (2-tailed)

* Significant at the 0.05 level (2-tailed)

The table above indicates that there was a statistically significant difference between the performance on the ACRO for Phase 1 and Phase 2 of this study; $t(207) = -3.49$, $(0.001 < 0.01)$.

5.3.2.1 Gender.

A t-test was conducted to compare the performance on the ACRO in terms of gender. The descriptive statistics are presented in Table 5.25 and the t-test results in Table 5.26.

Table 5.25

Descriptive statistics for acrophobia detected for gender

	Gender	n	Mean	Std. Deviation	Std. Error Mean
Acrophobia detected on the ACRO test	Male	160	0.38	0.708	0.056
	Female	49	0.51	0.711	0.102

The table above indicates that the standard deviation for the male category is 0.708 and for the female category is 0.711. The mean for the male category is 0.38 and the mean for the female category is 0.51.

In the table below, the calculations for the independent sample test are presented.

Table 5.26

Independent samples test comparing performance on the ACRO for gender (n=209)

		Levene's Test for Equality of Variances		T-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Gender	Equal variances assumed	11.613	0.001	1.881	207	0.061	0.122	0.065	-0.006	0.250
	Equal variances not assumed			1.754	92.869	0.083	0.122	0.070	-0.016	0.260

The table above indicates that gender had no significant effect on the subject's performance on the ACRO in this study; $t(207) = 1.881$, $(0.083 > 0.05)$.

5.3.2.2 Age Categories.

An Anova was conducted to compare performance on the ACRO for different age categories. The descriptive statistics are presented in Table 5.27 and the results of the Anova in Table 5.28.

Table 5.27

Descriptive statistics for acrophobia detected for age

	Age	n	Mean	Std. Deviation	Std. Error Mean
Acrophobia detected on the ACRO test	Under 20	2	0.50	0.707	0.500
	21-30	61	0.43	0.741	0.095
	31-40	88	0.33	0.638	0.068
	41-50	39	0.49	0.756	0.121
	51-60	13	0.54	0.776	0.215
	Older than 60	5	0.40	0.894	0.400

The table above indicates that the standard deviations ranged between 0.638 and 0.894 and the means ranged between 0.33 and 0.54.

Table 5.28

Analysis of variance (Anova) comparing performance on the ACRO for age (n=208)

		Sum of Squares	Df	Mean Square	F	Sig.
Age	Between groups	0.24	2	0.12	0.12	0.88
	Within groups	203.68	205	0.99		
	Total	203.92	207			

The table above indicates that, because there was no significant difference between the mean ACRO scores of the age categories, age had no significant effect on the identification of fear categories on the ACRO ($F[2. 205] = 0.12$; $p=0.88$).

5.3.2.3 Education Categories.

An Anova was conducted to compare performance on the ACRO for education categories. The descriptive statistics are presented in Table 5.29 and the results of the Anova in Table 5.30.

Table 5.29

Descriptive statistics for acrophobia detected for education

	Education	n	Mean	Std. Deviation	Std. Error Mean
Acrophobia detected on the ACRO test	Completed 12 years and more	176	0.40	0.694	0.052
	Completed 11 years	22	0.41	0.796	0.170
	Completed 10 years	7	0.86	0.000	0.340
	Less than 10 years	4	0.00	0.000	0.000

The table above indicates that the standard deviations ranged between 0.0 and 0.796, and the means ranged between 0.0 and 0.86.

Table 5.30

Analysis of variance (Anova) comparing performance on the ACRO for education (n=208)

		Sum of Squares	df	Mean Square	F	Sig.
Education	Between groups	0.29	2	0.15	0.41	0.67
	Within groups	74.68	206	0.36		
	Total	74.97	208			

The table above indicates that, because there was no significant difference between the educational groups on the ACRO categories, education had no significant effect on the identification of fear categories on the ACRO (F[2.206] = 0.41; p=0.67).

5.4 Summary

In Chapter 5, the data for Phase 1 (n=150), Phase 2 (n=59), and the results for the combined sample (n=209) of this study were presented. Tables and figures were given for the descriptive statistics, the reliability of the ACRO and the relation between the ACRO and the self-report questionnaires for each phase. In addition, group comparisons were presented for the combined sample on the ACRO in terms of context, gender, age, and education.

In Chapter 6, the findings and conclusions are discussed, and recommendations are made on the basis of the data and the hypotheses. Limitations of the study will also be noted.

6. Discussion, Limitations, and Recommendations

People who are employed to work at height but who are suffering from acrophobia, pose a risk and danger to themselves, their colleagues, and safety personnel who may attempt getting them down safely. No evidence could be found to suggest that employers in the South African mining industry objectively pretest candidates to work at height to specifically determine their psychological and psychometric suitability for such work. The need was identified to determine whether an objective psychological assessment measure can effectively assess a fear of height in a mining context, in an effort to improve the safety of mine workers who are working at height in South Africa.

6.1 Interpretation of Research Results

The main objective of this study was to determine the reliability and validity of an objective measure of fear of heights within the mining contexts.

The specific objectives were to:

- determine the reliability of the acrophobia test: ACRO (fear of heights);
- determine the relation between the ACRO and self-report/objective measures of fear of heights; and
- compare the performance of subgroups on the ACRO.

In order to achieve the objectives of the study, the researcher formulated the following hypotheses:

Hypothesis 1: The reliability of the ACRO test will be acceptable.

Hypothesis 2: There will be a significant relation between the ACRO test and the self-report measures (Phase 1 – mining context).

Hypothesis 3: There will be a significant relation between the ACRO test and the self-report measures (Phase 2 – general population).

Hypothesis 4: Respondents in Phase 1 will perform significantly different on the ACRO test than respondents in Phase 2.

Hypothesis 5: There will be no significant difference in performance on the ACRO test for the different demographic subgroups.

6.1.1 Findings on Hypothesis 1 – The Reliability of the ACRO test will be Acceptable

Durrheim and Wassenaar (2004) state that reliability is a key concept in positivist measurement because it addresses the problem of objectivity. Reliability indicates the overall consistency of the measurement, and if the measurement produces similar results over time during similar conditions. A correlation coefficient varies between 0 and ±1, and the closer the result is to 1 and preferably over 0.8, the more reliable the scale is (Bryman & Cramer, 2002). As discussed in Foxcroft and Roodt (2005), standardised measures should have reliabilities in the 0.80 and 0.90 range (Wolfaardt & Roodt, 2005). Wolfaardt and Roodt (2005) further indicate that it is suggested that reliability coefficients should be 0.85 or higher if measures are used to make decisions about individuals, while it may be 0.65 or higher for decisions about groups.

Alpha coefficients were determined for the individual characteristics on the independent variable, for the ACRO (response times and incorrect reactions), as well as the total score.

Cronbach's Alpha values for the individual characteristics ranged between 0.88 and 0.95 for Phase 1 and 0.88 and 0.94 for Phase 2. These values are regarded as high. The internal consistency value for the total score of the ACRO for Phase 1 (n=150) was 0.92, and for Phase 2 (n=59) the coefficient was 0.95. Acceptable reliability was therefore found for both the mining context, the focus of the present study, and the general population group.

According to the studies done by Prieler (2016) in the case of Austrian subjects (n=443), an internal consistency of 0.93 was found, and during the South African study (n=258), an internal consistency of 0.95 was determined. The reliability for the Austrian sample, the previous South African sample, and the findings of the current study, are therefore similar.

Hypothesis 1 stated that the reliability of the ACRO test will be acceptable. The ACRO will most likely form part of the recruitment process and will therefore be used to make important decisions regarding individuals. For this purpose, the internal consistency is deemed as acceptable, and the ACRO was furthermore found to be reliable in both contexts.

The researcher cannot comment on the reliability of the test over time, and therefore the retest reliability should be determined in future studies.

6.1.2 Findings on Hypothesis 2: There will be a Significant Relation between the ACRO Test and the Self-Report Measures (Phase 1 – Mining Context)

Spearman's correlations and an Anova were conducted to identify if one measurement had any effect on the other measurement, and if there was any relation between the two measurements when measuring the construct "fear of heights".

The correlation coefficient (denoted as p) indicates the relation, which varies between 1 and -1, the direction of the relation, denoted by the positive or negative sign, and the strength of the relation by the numerical following the sign (Gilmore, 2008). If p is found to be closer to 1, it indicates a strong positive relation between the two variables and if p is found to be closer to -1, it indicates a strong negative relation between the two variables. Zero indicates no linear relation between the two variables.

In order to further evaluate the relation between the two variables, an analysis of variance (Anova) was utilised to provide for the categorical nature of the ACRO scores. The purpose of using Anova is to compare more than two means on a dependent variable (Tredoux & Smith, 2006).

A small negative correlation was found between the subjects' scores for ACRO categories ("Acrophobia detected", "Acrophobia cannot be excluded", and "No acrophobia detected") and the self-report questionnaire's total scores, Q Scores ($p=-0.211$; $p=0.010$). These results indicate that an increase in the ACRO score (increased fear) implies a decrease in the Q Score (less fear).

The correlation coefficient was significant at the 0.05 level (2-tailed). The small negative reported correlation could be attributed to the context – the respondents were from the mining environment, and this might have resulted in response bias – or even fear – in giving truthful answers to the questions asked on the self-report questionnaire.

The non-standardised questions in the self-report questionnaire may also have resulted in a negative correlation. This questionnaire was kept as uncomplicated, short, and concise as possible, in an attempt to exclude cultural bias, to provide for lower literacy level participants, and to ensure that production at the mine was not affected during this data collection project. It would therefore have been easy for the respondents to provide what they perceived as a desirable response. As noted in the frequency table (Table 5.2), question 6 was the only question in the questionnaire that had an almost equal amount of true and false answers, as opposed to the other questions, indicating less fear in terms of false answers to positively worded questions, and true answers to negatively worded questions.

The Anova results indicate that the resulting F-value for the ACRO and the Q Scores (3.10) was statistically significant at $p < 0.05$ level (0.048). This implies that there was a significant difference between the mean Q Score of respondents who selected the different "fear identification" categories, when the two abovementioned measurements were given to respondents in Phase 1 of this study. This implies that the mean Q Score differences between the ACRO fear categories could not be attributed to chance. Hypothesis 2 was accepted, although the direction of the relation was unexpected.

Although only a small inverse relation was found between the independent variable (ACRO) and the dependant variable (Q Score), it should be noted that the responses on both instruments were skewed towards "No acrophobia detected". A restriction in the range of scores could thus have affected the results.

6.1.3 Findings on Hypothesis 3: There will be a Significant Relation between the ACRO Test and the Self-Report Measures (Phase 2 – General Population)

The three measuring instruments used during Phase 2 were the ACRO, the HIQ, and the vHISS (which includes a severity score and a DSM criteria score). As indicated below, the findings supported this hypothesis.

6.1.3.1 HIQ and the ACRO.

The correlation coefficient was significant at the 0.05 level (2-tailed). The results suggest that there was a moderate positive correlation (p=0.28; p=0.03) between the HIQ score and "Acrophobia detected" on the ACRO. This indicates similarity in performance on the two tests. When acrophobia is detected on the ACRO, the scores on the HIQ questionnaire indicate increased fear.

The Anova results show that the resulting F-values for the ACRO and the HIQ scores (3.33) were statistically significant at $p < 0.05$ level (0.043). The results imply that there was a significant difference between the mean HIQ scores of respondents in the different "fear identification" categories, when the two abovementioned measurements were given to respondents in Phase 2 of this study. The mean HIQ score differences between the ACRO fear categories could not be attributed to chance.

The results indicate that there was a relation between the independent variable (fear categories on the ACRO) and the dependent variable (HIQ questionnaire) when identifying fear of heights. The HIQ is a standardised questionnaire and it has been proven to be a reliable and valid measure of fear of heights (Steinman & Teachman, 2011). Although some skewness towards lower fear responses was also observed in Phase 2, the range of responses was somewhat bigger than in the case of Phase 1.

6.1.3.2 vHISS and ACRO.

The correlation coefficient was significant at the 0.01 level (2-tailed). The results indicate that there was a strong positive correlation between the vHISS (p=0.636; p=0.000), the vHISS DSM criteria (p=0.606; p=0.000), and acrophobia detected on the Acro. This implies that the performance on the two questionnaires is similar. Respondents who indicated "Acrophobia detected" on the ACRO, also showed increased fear on the vHISS questionnaire.

The Anova results indicate that the resulting F-value for the ACRO and the vHISS (20.92) and the vHISS – DSM criteria (17.14) was statistically significant at $p < 0.01$ level (0.00). This implies a significant difference in the vHISS results for respondents in the different ACRO "fear categories", when the two abovementioned measurements were given to respondents in Phase 2 of this study. The mean score differences on the vHISS between the ACRO fear categories could not be attributed to chance.

The results suggest that there was a relation between the independent variable (ACRO) and the dependent variable (vHISS questionnaire) when identifying fear of heights. The vHISS is a standardised questionnaire and, as indicated, the range of responses was bigger than in the case of Phase 1.

6.1.4 Findings on Hypothesis 4: Respondents in Phase 1 will Perform Significantly Different on the ACRO Test than Respondents in Phase 2

In Phase 1, 81.3% of the respondents scored in the category "No acrophobia detected" whereas 47.5% of the respondents scored in this category in the case of Phase 2. Acrophobia could also not be excluded for a relatively large percentage (37.3%) of the respondents in Phase 2.

A t-test was used to determine the statistical significance of the difference between the means of the two independent samples performance on the ACRO.

Levene's test is significant if p is equal or less than 0.05. The test found that the variances of Phase 1 and Phase 2 were not statistically different (p=0.027). The significance value associated with the t-value based on equal variances was less than 0.01 (p=0.001). The results indicate that there was a significant difference between the means regarding the identification of fear categories, when the two samples were compared. Hypothesis 4 was accepted. The results implies that the mean differences between the two phases did not occur by chance.

The standard deviation of Phase 2 (0.73) was slightly higher than that of Phase 1 (0.67), which indicates that more variances occurred in Phase 2 respondents. At first glance, the findings may appear to be a cause of concern, but it is necessary to consider the context of the two research samples. The sample for Phase 1 was homogenous due to the fact that the respondents are all from the same mining environment. Preselection is implied in that the respondents selected an occupation in this environment, and from the outset they could be less inclined to experience acrophobia.

6.1.5 Findings on Hypothesis 5: There will be no Significant Difference in Performance on the ACRO Test for the Different Demographic Subgroups

The researcher also investigated the identification of fear according to the ACRO fear categories, in terms of gender, age, and education level.

The independent sample test indicates that there was no statistical difference in terms of performance on the ACRO for gender ($p=0.083 > 0.05$). The results for age ($p=0.88 > 0.05$) and education ($p=0.67 > 0.05$) were also not significant. This implies that the differences could only be attributed to chance, as there was no significant difference in the performance on the ACRO in terms of gender, age, and education level when identifying fear of heights. This provides support for Hypothesis 5.

These results imply that there was no relation between the dependent variable (ACRO) and the independent variables (gender, age, and education) when identifying fear of heights.

6.2 Discussion of the Research Results

Working at height remains an important safety issue across all mine sites (Stothard et al., 2015). Accidents in the mining sector is higher when compared to other sectors, negatively affect a country's economy by wasting domestic resources and causing losses of both labour force and working days (Kasap, 2011). Mining employees face various, often unpleasant, and excessive, working demands which includes number of hours working with heavy duty machines and explosives for blasting purposes with intense underground temperatures (Calitz, 2004).

Working at height in the mining industry is dangerous, with very limited room for error. Mine workers risk their lives when required to work underground, as working at height in the mining industry largely includes working underground. The main risks associated with working at height are falling from that height as well as falling objects from above, which can cause severe injuries including death, brain damage, broken bones, and permanent disabilities (Kambadur, 2020). Working in confined spaces, working in steeply inclined excavations, handling heavy material and equipment, working in the proximity of moving machinery in an environment that can be described as dirty, dark, wet, noisy, hot, uncomfortable, and dangerous are dangers related to the underground work environment (Van Wyk & De Villiers, 2009).

Furthermore, in South Africa, people are more willing to enter the mining sector due to the high unemployment rate, regardless of the potential dangers and very harsh conditions that they would be exposed to (Roos, 2014). According to Thulani Kuzwayo, operational and process safety manager at Eskom, "Employees who are desperate for work will not hesitate to lie or cover up medical conditions that would exclude them from the work they desperately need" (Fuller, 2015, p. 79). Fuller (2015) further explains that medical conditions such as epilepsy, vertigo, hypertension, diabetes, or a fear of heights will compromise workers' safety at height.

A number of studies has proven that certain mental processes that function normally under normal conditions, can be restricted under stressful conditions that affect cognitive performance and increase the proneness to error as a result of blind attentiveness. As a result, there is a decline in processing efficiency, which may incite impaired performance on updating tasks (Eysenck et al., 2007). If an individual is distracted by fear-driven stimuli such as the sensation of a fear of heights, it will lead to an increased susceptibility to errors and reduced cognitive performance (Prieler, 2016).

The cognitive perspective explains that fear is related, not only to the biological preparation of stimulus-response association, but also to the attributions regarding the safety and danger of the stimulus, the perception of control over the situation, and the attribution made about the bodily alarm signal that the stimulus evokes (Coelho & Purkis, 2009).

Literature suggests that the three main responses in the case of acrophobia are anxiety, panic, and fear which are manifested through symptoms such as panic attacks, shortness of breath, irregular heartbeat, nausea and dizziness, muscle tension, headaches, overall feelings of dread, and even thoughts of dying. These thoughts occur suddenly and automatically and are not anticipated. The symptoms of individuals suffering from acrophobia, include cognitive, behavioural, and physiological patterns (Hüweler et al., 2009).

The present study is based on the theoretical model of Coelho and Purkis (2009) in which the interaction of cognitive factors, perceptual factors, learning factors, and biological factors can provoke either a habituation or extreme fear of height-related behaviour.

Regarding the selection process of people who are working at height, VR is thought to be the most obvious technology to implement in terms of identifying a fear of heights. However, the researcher identified limitations regarding VR, such as high costs, being time consuming, and the fact that VR is also generally regarded, according to literature, as a training/therapy tool, and not a psychological assessment tool. It should also be noted that VR simulations can trigger emotional, psychological, and physical reactions such as anxiety and excessive sweating similar to reactions to real-life dangers (Martens et al., 2019). In a study conducted by Diemer et al. (2016), two groups of healthy and acrophobic people were exposed to elevation simulated VR technology and the results clearly showed that both groups, regardless of acrophobia, exhibited physiological arousals such as an increased heart rate or skin conductance level. Exposing workers to these triggers during a selection or recruitment process is not to the advantage of the worker, especially if there is no psychologist, psychiatrist, or a trained, skilled medical practitioner available, should such a situation occur.

Regarding a fear of heights and how it is measured, the researcher found limited literature available on the topic – nationally and internationally. In South Africa, desktop-based systems, such as simulators, appear to be more customary than VR in the mining industry (Stothard et al., 2015). According to Stothard et al. (2015), VR and simulators form part of an evolving technology, and without international collaboration and the commitment of the industry and academia, it is unlikely that it will reach its full potential within the mining industry.

Risk assessments, fall protection plans, training and authorisation, height safety equipment specifications, and medical fitness are terms which are most often used in working at height company policies. The Anglo-American working at height procedure specifically mentions that supervisors must ensure that competent personnel are selected for the task to be performed, and that they do not suffer from fear of heights (Anglo-American Policy, 2019). However, no mention is made of how the supervisors must objectively assess/observe if a person is prone to having a fear of heights. It remains important that employers make an effort to establish a worker's mental state during the selection process, especially for workers required to work in higher risk environments. This enables employers to make a holistic, informed decision regarding the worker's prediction of future behaviour.

Mittner (1998, as cited in Van der Merwe, 2000) mentions that, if psychometric measurements are handled with insight and sensitivity, they remain the most effective means of predicting behaviour. Kemp (1999) states that tests serve as an aid in the selection process and supply invaluable information which is not easily derived from interviews.

The researcher identified a need to determine whether an objective psychological assessment measure can effectively assess fear of heights in a mining context, in an effort to improve the safety of mine workers working at height in South Africa. In addition, it was important to implement an assessment measure which would not evoke anxiety in an attempt to exclude possible public embarrassment and therefore do no harm.

The internal consistency coefficients were found to be high, in both the mining context sample and the general population, and therefore it can be concluded that the reliability of the ACRO during this study was found to be acceptable. The ACRO may, therefore, be regarded as an objective and reliable psychological assessment measurement when attempting to identify a possible fear of heights in candidate selection for working at height positions in the mining industry. It is, however, important that ACRO should only be regarded as a role player in a test battery. No assessment tool should ever be used in isolation, and should always form part of a complete, comprehensive, and fair process of selection and profiling when attempting to predict future behaviour. Psychological tests are useful if they are used in combination and together with other methods, as the tests provide a total picture of the individual (Foxcroft et al., 2004).

There were positive relations found between the ACRO and the vHISS, and the ACRO and the HIQ, as predicted by the researcher. These two questionnaires have been used in previous studies and are standardised measurements. The relation between the ACRO and standardised measures of fear of heights provide support for the construct validity of the ACRO in the sample for the general population.

However, similar support was not found for the mining context. This sample was significantly different from the general population sample, in terms of the identification of fear of heights on the ACRO. Preselection could explain the skewed performance of the respondents in the mining context in terms of performance on the ACRO. A small negative correlation was found between the subjects' scores for ACRO categories and the self-report questionnaire in Phase 1 (the mining context). The possible reason could be the non-standardised nature of the criterion questionnaire, preselection that potentially excluded respondents with acrophobia, and response bias. Individuals may have hidden their fear of heights intentionally on the self-report questionnaire, as the participants were employees at the mine at the time of the study. The above in turn could lead to a limit in the range of performance on the measuring instruments.

Finally, as discussed in Chapter 2, there are limited previous studies to be found regarding the relation between gender, age, education level, and acrophobia. The two studies that the researcher could investigate, indicated that the life prevalence of vHI was higher in females (32%) than in males (25%), and increased with age (Huppert et al., 2013b). Wardenaar et al. (2017) found that specific phobias were higher in females (9.8% and 7.7%) than in males (4.9% and 3.3%) and higher in high-middle income countries than in low/lower income countries. These results, however, do not provide strong support for the role of demographic variables. The results of the present study implied that there was no relation between the dependent variable (ACRO) and the independent variables (gender, age, and education) when identifying fear of heights. Further investigation regarding the above mentioned may produce interesting results.

6.3 Limitations and Recommendations

Several limitations of this study should be considered when interpreting the results.

The study could have been influenced by the sample size, as it was limited to 209 respondents. The difference between the size of the two sub-groups that were assessed should also be noted. The general population sample was small and therefore the positive results in terms of the reliability and validity of the ACRO are tentative. Future research should include a larger sample and it may be interesting to compare a sample from people working at heights outside of the mining industry. Furthermore, the researcher cannot comment on the reliability of the test over time, and therefore the retest reliability should be determined in future studies. The sample size also limited the number of demographic variables that could be explored. A population group was, for example not used to stratify the sample.

An important limitation of this study is that respondents in the sample in Phase 1 were homogenous due to the fact that they were all from the same mining environment, which falls within the diamond mining industry. This might have resulted in response bias, or even “fear” in giving truthful answers to the questions asked on the questionnaire. The findings of this study can therefore not be generalised to all mining companies in the country, as environments and company cultures differ. The fact that the participants were employees at the mine, implied potential preselection which in turn could have led to a limit in the range of performance on the measuring instruments. From the outset, respondents might have been less inclined to experience acrophobia.

The study would have benefited from two different groups of respondents, completing the same standardised self-report questionnaires, and the ACRO psychometric test. It was, however, very difficult for the researcher to find such a self-report questionnaire, especially for the mining context group, due to limited published research.

The non-standardised questions in the self-report questionnaire used in Phase 1 of the study may also have affected the negative relation found with the ACRO. This questionnaire was kept as uncomplicated, short, and concise as possible in an attempt to exclude cultural bias, to accommodate lower literacy level participants, and to ensure that production at the mine was not affected during data collection. It would therefore have been easy for the respondents to provide what they perceived as a desirable response. The self-report questionnaire could be further developed and researched in order to produce a South African standardised self-report questionnaire. This limitation should be addressed in future research, as it is important and best practice to use measurements standardised for the South African population and conditions.

The language of the test administration during Phase 1 could possibly be regarded as a restriction. Even though the official business language is English at the mine, the self-report questionnaire could have placed some respondents at a disadvantage. The phenomenon known as "fear of heights" may be an unknown term to respondents, due to numerous reasons such as language, expression of feelings due to cultural believes or bias, and fear of not being selected for certain work opportunities. Taking the abovementioned into consideration, questionnaires remain vulnerable to social desirability and faking.

As mentioned in Chapter 5, only categorial values were used for the ACRO, in accordance with the concept and design of the test. The ACRO is specifically designed to measure time and errors, whereas the calculations for this specific study would have been too complex to calculate as continued values. The conception and design of the test indicate three possible results ("acro-phobia detected", "not detected", and "cannot be excluded"). Regarding the calculations, if time measured in phase 2 is bigger or smaller than the time measured in phase 3, the calculation is too complex to calculate on its own, and therefore also considers the mistakes that were made during the test. For this study, it would have been too complicated to calculate continued values from these scores. As the aim of this research study was to compare the ACRO to other identification of fear questionnaires, future research may want to, more specifically, investigate the complex result-structure of the ACRO test.

Based on the findings of this study, the researcher further recommends that future studies include safety records to be compared with ACRO and self-report questionnaire data. This could provide a robust measure, as a criterion variable, for work and safety. If possible, information should be obtained from the participants' supervisors or training managers at companies, which should ideally include information such as accident records and training information/outcomes. Furthermore, population group was not included as a stratification variable in this study, and future researchers may consider including this variable. The impact of age, gender, and level of education on the performance in terms of fear of heights may also be more conclusive with a bigger sample size.

Limited published research studies and available literature regarding working at height in the mining context, and more specifically, the measurement of fear of heights in this industry, are available. The researcher further noticed that no local evidence could be found to suggest that employers are pretesting candidates to work at height to determine their psychological and psychometric suitability for such work. There is a need for more literature and published research studies regarding working at height, and more specifically, assessment of fear of heights in the mining and construction industries.

Working at height can and should be regarded as important in terms of the current trend in mining and construction – nationally and internationally.

6.4 Summary

This chapter discussed the main findings of the empirical study. Limitations of the research were highlighted and suggestions for possible future research were given.

There is tentative support for the reliability and validity of the ACRO in terms of a South African population. There is, however, only partial support for the feasibility in using the test specifically in the mining context, and further research is required. The mining industry is dangerous, and any attempt or effort made to keep workers safe, should not be disregarded. The benefits of using an objective measure of acrophobia should be kept in mind, and the ACRO can be considered as a viable option to be included in a test battery for the identification of acrophobia. However, performance on the ACRO test should at this stage not be used in isolation to make a final decision regarding an individual's employment or career pathing.

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Appendix 1

UNISA university of south africa

COLLEGE OF HUMAN SCIENCES RESEARCH ETHICS REVIEW COMMITTEE

30 April 2019

NHREC Registration # : Rec-240816-052

CREC Reference # : 2019-CHS-Depart-63265605

Dear Tracy Cock

Decision:
Ethics Approval from 30 April 2019 to 01 May 2023

Researcher(s): Tracy Cock

Supervisor(s): Prof Rene van Eeden

(012) 4298252

Prediction of safety through implementing a psychological assessment for people working at height in the South-African mining industry

Qualification Applied: Masters in Psychology

Thank you for the application for research ethics clearance by the Unisa Department of Psychology College of Human Science Ethics Committee. Ethics approval is granted for three years.

The ***low risk application*** *was* ***reviewed and* expedited** by Department of Psychology College of Human Sciences Research Ethics Committee, on the **(30 April 2019)** in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment.

The proposed research may now commence with the provisions that:

1. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the Department of Psychology Ethics Review Committee.

3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
4. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.
5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data require additional ethics clearance.
7. No fieldwork activities may continue after the expiry date **(01 May 2023).** Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

The reference number **2019-CHS-Depart- 63265605** *should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

Yours sincerely,

Signature :

Prof I. Ferns
Ethics Chair: Psychology
Email: fernsi@unisa.ac.za
Tel: (012) 429 8210

Signature :

Dr Suryakanthie Chetty
Ethics Chair : CREC
E-mail: chetts@unisa.ac.za
Tel: (012) 429 6267

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

Appendix 2

PERMISSION LETTER

Request for permission to conduct research at the mine

Title: Prediction of safety through implementing a psychological assessment for people working at height in the South-African mining industry.

2018/08/29

Mr [redacted]

[redacted]

Dear Mr [redacted]

I, Tracy Cock am doing research with Professor Rene van Eeden a professor, in the Department of Psychology towards a MA, at the University of South Africa. We have funding from Unisa. We are inviting you to participate in a study entitled: Prediction of safety through implementing a psychological assessment for people working at height in the South-African mining industry.

The aim of the study is to identify whether an objective psychological assessment measure, can effectively assess a fear of height in a mining context, in an effort to improve the safety of mine workers working at height in South-Africa.

One of the objectives of this study is to determine the relationship between the ACRO and self-report/objective measures of fear of heights. It is hypothesized that the relationship between the ACRO and self-report measures will hold a certain degree of significance.

During late 2017 and early 2018 your department kindly assisted CPRD with the data collection exercise with regard to establishing the validity of the ACRO.

I hereby ask permission, to utilize the data gathered in my above-mentioned study. If at all possible, I will aim to obtain information from the mine such as training information/outcomes. Analysis will be done at group level and all personally identifiable data will be removed from the datasets to insure the privacy of individuals whose data forms part of this study. No individual data or follow-up will be available, however, should a major concern be identified, a feedback session with the appropriate manager/supervisor will be arranged and the options to seek help will be explored.

Your company has been selected because you employ and train people to work at heights.

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
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The benefits of this study are that in a society that battles high unemployment, employers must be particularly careful not to employ people suffering from acrophobia to work at heights. Candidates for employment who may or may not be aware of their fears are more likely to hide it from potential employer in order to find work or to "get a foot in the door". An objective measure of the presence and intensity of acrophobia may be beneficial to provide a reliable and valid measure thereof, and to prevent social desirability and faking. In many cases treatment for Acrophobia includes taking drugs such as tranquilizers and anti-depressants that cause their own dangers at work; particularly at heights or when driving. It is clearly in the best interest of employers to take all possible precautions to avoid employing acrophobes to work at heights in the first place. People employed to work at height suffering from acrophobia, pose a risk and danger to themselves, their colleagues and safety personal who may attempt getting them down safely.

Once ethical clearance is received from UNISA, (November) the official documentation will be forwarded to you.

Yours sincerely

Tracy Cock
Researcher

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

Subject: FW: Prediction of safety (Fear of Heights)
Date: Tuesday, 28 September 2021 at 14:59:52 South Africa Standard Time
From: Tracy
Attachments: image001.png

From: [redacted]
Date: Wednesday, 29 August 2018 at 09:29
To: Tracy <Tracy@cprd.co.za>
Subject: RE: Prediction of safety (Fear of Heights)

Dear Mrs Cock
Approved.

Regards

[redacted]

HR Manager: Technical Training

[redacted]

From: Tracy <Tracy@cprd.co.za>
Sent: 29 August 2018 09:25 AM
To: [redacted]
Subject: Fw: Prediction of safety (Fear of Heights)

Good day [redacted]

I am a Research Psychology Master's degree student at the University of South-Africa, currently in the proposal writing phase for my full dissertation. My research title is: Prediction of safety through implementing a psychological assessment for people working at height in the South-African mining industry.

One of the objectives of this study is to determine the relationship between the ACRO and self-report/objective measures of fear of heights. It is hypothesized that the relationship between the ACRO and self-report measures will hold a certain degree of significance.

During late 2017 and early 2018 your department kindly assisted CPRD with the data collection exercise with regard to establishing the validity of the ACRO.

I hereby ask permission, to utilize the data gathered in my above mentioned study. If at all possible, I will aim to obtain information from [redacted] mine such as training information/outcomes. Analysis will be done at group level and all personally identifiable data will be removed from the datasets to insure the privacy of individuals whose data forms part of this study. No individual data or follow-up will be available, however, should a major concern be identified, a feedback session with the appropriate manager/supervisor will be arranged and the options to seek help will be explored.

Once ethical clearance is received from UNISA, (November) the official documentation will be forwarded to you.

Please feel free to discuss any concerns or uncertainties with me at any time.

Kind Regards

Tracy Cock

CPRD CONSULTING

ECO FUSION 6
BLOCK A - UNIT 3
WITCH HAZEL AVE
CENTURION, 0169
POSTNET SUITE 240
PRIVATE BAG X2
RASLOUW, 0109

WEB: WWW.CPRD.CO.ZA

Appendix 3

PARTICIPANT INFORMATION SHEET

Ethics clearance reference number: 2019-CHS-Depart-63265605

06 September 2018

Title: Prediction of safety through implementing a psychological assessment for people working at height in the South-African mining industry.

Dear Prospective Participant

Student research project

My name is Tracy Cock and I am doing research with Professor Rene Van Eeden, a professor, in the Department of Psychology towards a MA at the University of South Africa. We have funding from Unisa for the research project. We are inviting you to participate in a study entitled: Prediction of safety through implementing a psychological assessment for people working at height in the South-African mining industry.

WHAT IS THE PURPOSE OF THE STUDY?

This study is expected to collect important information that could identify whether an objective psychological assessment measure, can effectively assess a fear of height in a mining context, in an effort to improve the safety of mine workers working at height in South-Africa. People employed to work at height suffering from acrophobia (a fear of heights), pose a risk and danger to themselves, their colleagues and safety personal who may attempt getting them down safely.

WHY AM I BEING INVITED TO PARTICIPATE?

You are invited to participate as you responded to the advertisement on the internet or as you were sent by your company to complete another psychometric assessment. The approximate number of participants that will participate in this study is 50.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

The study involves you to complete a short psychometric assessment and a questionnaire. Video footage will be presented to you on a computer screen and you will be asked to push a button with your hand. In addition to the video footage presented, you will subsequently be asked questions about the content of the videos. The questionnaire is a 16 -item self-report questionnaire designed to measure height-relevant interpretations. You will also rate the likelihood on a scale of 1(not likely) too 5 (very likely) of eight interpretations related to each scenario. The maximum expected duration of participation will be 45 min to an hour.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

Your participation will not have a direct effect on you, however, we hope that others in the community/society in general will in future benefit by means of doing a psychometric test, rather than actually being exposed to heights, to identify this extreme fear of heights.

ARE THEIR ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

There will be minimal inconvenience and/or discomfort to you as the participant. However, as already mentioned, you are free to withdraw at any time and without giving a reason.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

You have the right to insist that your name will not be recorder anywhere and that no one, apart from the researcher and identified members of the research team, will know about your involvement in this research. Your answers will be given a code number and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings.

Your answers may be reviewed by people responsible for making sure that research is done properly, including members of the Research Ethics Review Committee. Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records. Your results will be treated in a confidential manner, for the purposes intended as well as for research and development.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

Hard copies of your answers will be stored by the researcher for a minimum period of five years in a locked cupboard/filing cabinet in an Psychometric assessment company (CPRD) Centurion for future research or academic purposes; electronic information will be stored on a password protected computer. After five years, hard copies will be shredded, and electronic copies will be permanently deleted from the hard drive of the computer through the use of a relevant software program.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

You will not receive payment for your participation, however, light refreshments should be available at the site where you will be participating.

HAS THE STUDY RECEIVED ETHICS APPROVAL

This study has received written approval from the Research Ethics Review Committee of the department of Psychology, Unisa. A copy of the approval letter can be obtained from the researcher if you so wish.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

If you would like to be informed of the final research findings, please contact Tracy Cock on tracy@cprd.co.za. The findings are accessible for a five-year time frame.

Should you have concerns about the way in which the research has been conducted, you may contact Professor Rene van Eeden at Veeder@unisa.ac.za. Contact the research ethics chairperson of the Psychology department, Prof I. Ferns at (012) 429 8210 or Dr Chetty at (012) 429 6267 if you have any ethical concerns.

Thank you for taking time to read this information sheet and for participating in this study.
Thank you.

Tracy Cock

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CONSENT TO PARTICIPATE IN THIS STUDY

I, __________________ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty.

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree to completing a short psychometric assessment and a questionnaire.

I have received a signed copy of the informed consent agreement.

Participant Name & Surname.. (please print)

Participant Signature...Date....................

Researcher's Name & Surname...(please print)

Researcher's signature..Date....................

TEMPLATE PERMISSION LETTER

Request for permission to conduct research at

Title: Prediction of safety through implementing a psychological assessment for people working at height in the South-African mining industry.

2018/08/29

Mr

Dear Mr

I, Tracy Cock am doing research with Professor Rene van Eeden a professor, in the Department of Psychology towards a MA, at the University of South Africa. We have funding from Unisa. We are inviting you to participate in a study entitled: Prediction of safety through implementing a psychological assessment for people working at height in the South-African mining industry.

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During late 2017 and early 2018 your department kindly assisted CPRD with the data collection exercise with regard to establishing the validity of the ACRO.

I hereby ask permission, to utilize the data gathered in my above-mentioned study. If at all possible, I will aim to obtain information from mine such as training information/outcomes. Analysis will be done at group level and all personally identifiable data will be removed from the datasets to insure the privacy of individuals whose data forms part of this study. No individual data or follow-up will be available, however, should a major concern be identified, a feedback session with the appropriate manager/supervisor will be arranged and the options to seek help will be explored.

Your company has been selected because you employ and train people to work at heights.

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it from potential employer in order to find work or to "get a foot in the door". An objective measure of the presence and intensity of acrophobia may be beneficial to provide a reliable and valid measure thereof, and to prevent social desirability and faking. In many cases treatment for Acrophobia includes taking drugs such as tranquilizers and anti-depressants that cause their own dangers at work; particularly at heights or when driving. It is clearly in the best interest of employers to take all possible precautions to avoid employing acrophobes to work at heights in the first place. People employed to work at height suffering from acrophobia, pose a risk and danger to themselves, their colleagues and safety personal who may attempt getting them down safely.

Once ethical clearance is received from UNISA, (November) the official documentation will be forwarded to you.

Yours sincerely

Tracy Cock
Researcher

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www.unisa.ac.za

Appendix 4

INVESTIGATION, RESEARCH & CONSULTING CENTER
Dr. JOERG PRIELER
Clinical- and Healthpsychologist & Biofeedbacktherapist
STEINWEG 5, 7051 GROSSHOEFLEIN, AUSTRIA
Tel.: +43 2682/72906
Mobil: +43 664/196 98 63
E-mail: office@irc-consult.at
Web: www.irc-consult.at

Grosshoeflein, 25th July, 2018

To whom it may concern

I, Dr J Prieler, grant the following Masters in Research Psychology (MARC) student at the University of South Africa:

Tracy Cock

Student number: 63265605

Proposed study title: "Prediction of safety through implementing a psychological assessment for people working at height in the South-African mining industry".

Permission to use the psychological test/instrument that I developed named: Acrophobia Test ACRO (Fear of heights test), in her proposed study for data collection purpose.

I will be assisting her with the automated report generation and I will also be assisting her with the statistical analysis as per her request. I am aware that the student will be applying for funding from UNISA and I am convinced that she will carry out the study in accordance to the approved proposal, the ethics policy of UNISA and the ethical policy of the Health Professions Council of South Africa.

Dr. Jörg Prieler

Dr. Joerg Prieler

Appendix 5

CPRD CONSULTING
MIND YOUR PROFILE
ECO FUSION 6
BLOCK A - UNIT 3
WITCH HAZEL AVE
CENTURION, 0169
POSTNET SUITE 240
PRIVATE BAG X2
RASLOUW, 0109
WEB: WWW.CPRD.CO.ZA
VAT NO: 4300272277
REG NO: 2015/406285/07
TEL: (012) 666-8527 / 8528
076 910 7185
FAX: 086 731 9906
E-MAIL: ina@cprd.co.za
tracy@cprd.co.za
reception@cprd.co.za

Dear Candidate

The CPRD Consulting Services team is conducting a data collection process as part of the requirements of the Health Professions Council of South-Africa to submit a psychometric test for certification and classification and we would like to invite you to participate.

The test is called – ACRO – FEAR OF HEIGHTS. If you decide to participate, you will:

1. be asked to choose between True or False for a few simple statements and
2. undergo a computerized assessment by means of performing a test based on general instructions. You will watch videos and then be asked to press a button as soon as possible when a white circle appears, but at the same time asked to remember the details of the video clips. I am aware that computers can be frightening for some people so try to remain relaxed as these tests do not require you to have any knowledge about computers.

Taking part in this process is your decision. You do not have to participate if you do not want to. Participation or non-participation will not affect your employment in any way.

Surname:		
Initials:		
Full names:		
Identity Number:		
Gender:	**Male**	**Female**

There is no right or wrong answer to the below statements. Just give an answer that is true to you. Please mark your answer with a X:		
Statement:	**TRUE**	**FALSE**
I know I have a fear of heights.		
I think I have a fear of heights.		
I know I don't have a fear of heights		
I think I don't have a fear of heights		
A psychologist/Psychiatrist or a medical Doctor has diagnosed me as someone who has fear of heights.		
I am someone who actively participate in sports of climbing.		
I do not do not participate in any sports of climbing.		

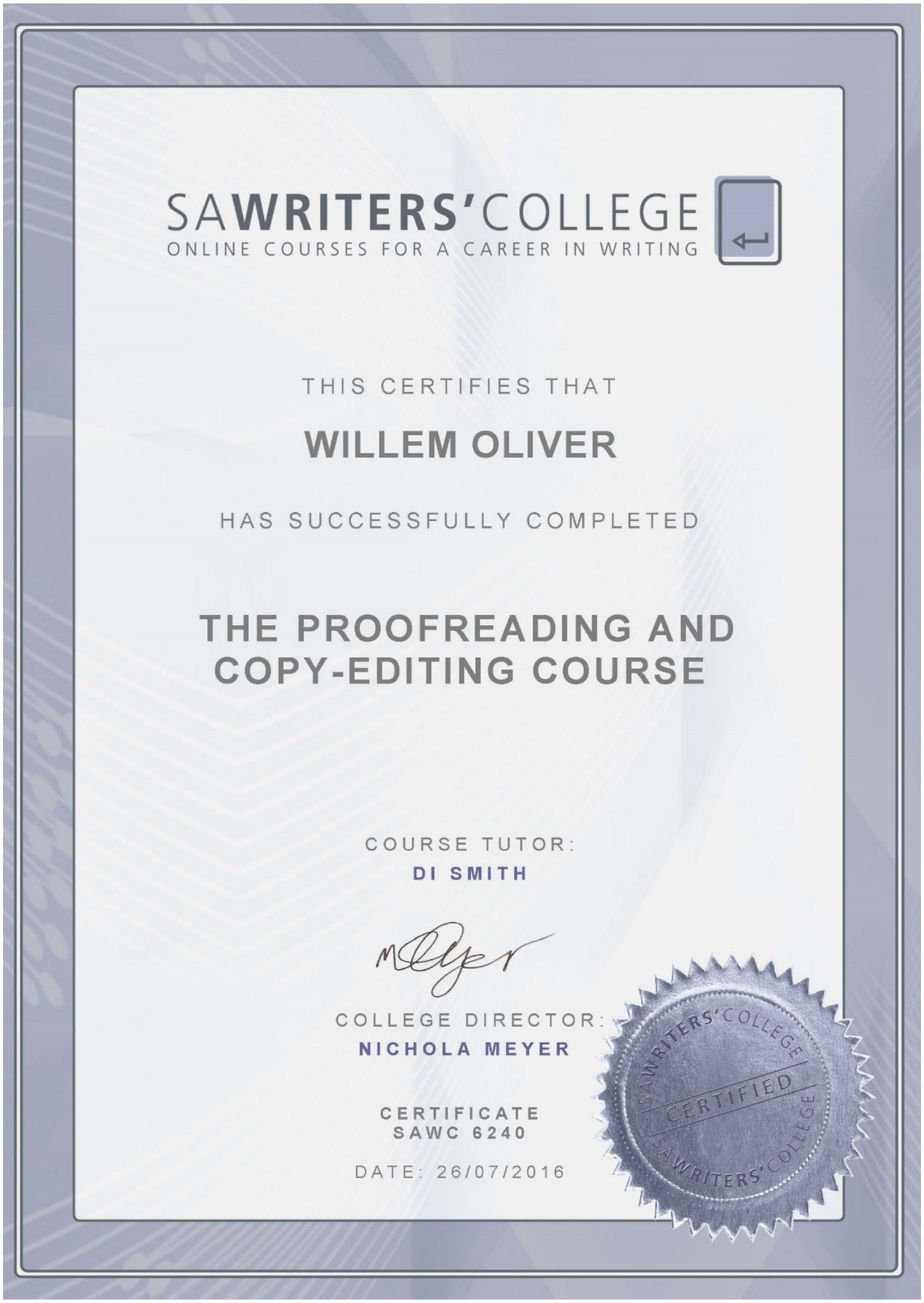
Thank you for taking the time to read and complete this document. Your participation will not have a direct effect on you, however, we hope that others in the community/society in general will benefit by means of doing a psychometric test to identify this extreme fear of heights.

I,______________________________declare that I understood all the questions asked of me and that all information given by me in this document is true. I also undertake to ask questions regarding the assessment, should I not understand. I also agree, with no reservations, to undergo the assessment and allow the HPCSA Practitioner to use the results in a confidential manner, for the purposes intended as well as for research and development.

Signed ______________________ on ______________ at _____________________

Appendix 6

Certificate of the Editor



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