THE CORRELATION BETWEEN POLYGRAPH RESULTS AND NONVERBAL BEHAVIOUR

by

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Submitted in the fulfilment of the requirements for the degree of

Master of Arts in Psychology: Research

in the

Faculty of Health Sciences

at the

Nelson Mandela University

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April 2018

Declaration

I, *Ian Carl Ferreira* (student number: 213314118) hereby declare that the *dissertation for Master in Arts: Psychology* to be awarded is my own work and that it has not previously been submitted for assessment or completion of any postgraduate qualification to another University or for another qualification.

…….

Ian Carl Ferreira

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Abstract

The long history, serious and multiple negative consequences, and the global prevalence of human deception inspired the current correlational study. According to certain researchers and practitioners, the polygraph has emerged as one of the most promising methods to detect deception. Although its use has not been without controversy, it is still one of the most frequent means used to detect human deception. In an attempt to address the continued reliance on the polygraph, often in the absence of other evidence, the current study aimed to explore and describe the relationship between final polygraph test results and nonverbal behaviour observations during the pre-interview of the polygraph test. The research design was a correlational study, which explored and described the relationship between specified nonverbal behavioural observations, and deceptive and non-deceptive indicator results, of the participants taking the polygraph test. The nonverbal movements of the head, shoulders, hands and feet were the focus of the study.

The research hypothesis of the study was that participants who were identified as deceptive on the polygraph would demonstrate significant statistical differences in specific nonverbal behaviours compared to non-deceptive participants. The results indicated significant statistical difference between the hand movements between the deceptive and the non-deceptive groups who participated in the study. The nonverbal behaviour related to the two groups' hand movements was found to show significant differences, specifically related to five specific domains, hand hold symmetrical action, right arm/hand still, left hand/finger actions, touch behaviour, and thumbs up and downwards movements. The data were described and analysed by means of descriptive and inferential statistics and significant correlational findings were discussed in relation to the relevant published literature.

Keywords: Correlation, deception detection, nonverbal behaviour, polygraph.

Acknowledgements

I would like to extend my sincere gratitude to the following people:

- To God, for giving me the ability to persevere, and maintaining my motivation and passion for this subject.
- To my wife Susan Louise Ferreira for her unconditional support and love.
- To my children, Kathryn and Donovan for their understanding and support.
- To Kobus and Engela Van Heerden who opened their Polygraph practice to me in gaining access to participants in the tedious data collection process. Without your help Kobus this project would have been impossible.
- To my supervisor, Professor Chris Hoelson for his patience, advice, expertise and incredible support.
- To Dr. Danie Venter, for assisting me with the statistical analysis of the results.
- To Dr. Tanya Defferary, for language and technical editing.
- To Nicholas Blom for his assistance in IT support in creating a computer program, which enabled me to code the captured video recording data.
- To all the participants who consented to participate in this study. Thank you for giving of yourselves and making this study possible.

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Chapter 1

Introduction

This chapter conveys a broad-spectrum orientation to the present study by introducing the relevant background and context of the research field. It also describes the research approach, aim, and the motivation for undertaking the study.

The Context of the Study

The context of this study was to explore the field of detecting deception, with a specific focus on the role that nonverbal behaviour might play in this regard. The detection of deception is a significant, complex, and highly challenging process, even in the contemporary technological context. In such a context, it is incumbent on researchers to investigate all avenues, particularly those that are able to utilise technology, towards dealing more effectively with the detection of deception. The ability to determine truthfulness is an intriguing process, deeply dependent on our ability to interpret nonverbal behaviour (Vrij, 2008).

The importance of the focus on deception detection is supported by the need for current research in this field, as highlighted by the pervasive state of corruption, deception, criminal, and unethical behaviour, both globally and in South Africa. It is essential and urgent in such a context, to discover processes and techniques that will aid in the detection of deception. The present high level of crime, that includes fraudulent and corrupt practises in South Africa, provides the motivation for the current research. The impact that such deceptive processes and behaviour have on the socio economic conditions, business activities, and within government departments, as well as the escalation of internal theft within companies and sensitive business negotiations, have been documented (Olver, 2017; Vrij, 2008).

According to crime statistics, South Africa has some of the highest rates of criminal activity in the world, which includes corruption and fraud (Murtagh, 2011). The high crime rates in business fraud prevents international business from growing within South Africa (Murtagh, 2011). The high levels of fraud and corruption directly impact upon the stunting of new business development and growth. This in turn results in escalating security costs and the loss of government aid which is aimed at stimulating business development (Murtagh, 2011). Government finances are instead directed at curbing crime, with a large amount of financial aid being allocated to law enforcement activities (Murtagh, 2011). The after-effects of corruption and fraud can be seen in the discouraged reaction of foreign investors into South Africa. This in turn has been found to lead to a reduction in tourism, a loss of jobs, and an increase in poverty in the country (Murtagh, 2011).

Although various approaches and methods have been used to detect and reduce human deception, no final solution for this dynamic human problem has been found (Ekman, 2003; Gordon & Fleisher, 2011; Vrij, 2008). The advent of modern technology, instead of limiting deception, has resulted in an even more rapid, wider, and increasing incidence of deception on a global scale, particularly through global electronic means, such as the Internet and cell phone technology (Hesterman, 2013).

While steps have been taken to develop technology to assist in discovering deception, it still remains largely a human effort. From attempting to determine if a friend is lying, or uncovering a terrorist plot, to finding a suspecting murderer who is evading discovery, a human element is still needed. Globally, uncovering truth and deception is of great relational, economic, and security importance (Ekman, 2003; Neuman, 2006). It is in therefore in the interests of society to obtain more information on all behaviours associated with this complex process of deception (Vrij, 2008). The detection of deception is no easy task and requires a

multidimensional approach, which often includes the use of sophisticated technology such as the polygraph.

Aim of the Study

The primary aim of the study was to determine the relationship between certain nonverbal behaviours and the polygraph results of two groups of participants, referred to as the Deception Indictor (DI) group, and the Non-Deception Indictor (NDI) group. The participant's nonverbal behaviours were observed during an individual face-to-face pre-polygraph interview which was conducted by a polygraph examiner. The polygraph testing was conducted by the polygraph examiner, the same person who interviewed the participants during the pre-interview. The polygraph examiner was also responsible to analyse the polygraph test and conclude the results. Once the polygraph tests were concluded, the polygraph examiner presented the results which were used in the correlation process of the nonverbal behaviour between the two groups (DI and NDI). The current study set out to add value to the extant literature on human deception and its relationship to certain nonverbal behaviours, and hoped to enable more effective recognition of deception which often accompanies criminal activities (Hesterman, 2013).

According to Ekman (2003), Navarro (2008) and Vrij (2008), nonverbal behaviour refers to body movements, micro facial expressions, gestures, physical movements, body distance, touching, and posture. The autonomic nervous system and the limbic system of the brain have been found to play a critical role in the display of nonverbal behaviour and gestures, which is relevant to the observations made during the pre-interview of the polygraph test (Navarro, 2008). The autonomic nervous system's responses were of particular importance in the current research, with specific focus on the sympathetic and

parasympathetic nervous systems' functions, which display behaviour linked to comfort and discomfort through nonverbal actions of freeze, fight, and flight (Navarro, 2008).

In the past, different observations, tools and techniques have been utilised to measure and detect deception and test for truthfulness in four general domains (Canter, 2012). These include the physiological, behavioural, legal, and semantic assessment domains. One of the tools utilised in these assessments is the polygraph. It measures physiological responses which can be correlated with the observation of nonverbal behaviour during the pre-interview. Polygraph testing is usually employed for three main investigative purposes: event-specific investigations (e.g. after a crime), employee screening, and pre-employment screening (Stern, 2003). Event-specific investigations have been found to demand more direct answers, compared to employee and pre-employment tests, which demand longer ambiguous test periods (Stern, 2003).

A preliminary literature search revealed no empirical study that examined the relationship between nonverbal behaviour during face-to-face interviews and polygraph test results. Therefore, the current study focused on understanding deception by observing two of the four domains, the behavioural and the physiological. These were observed during the polygraph testing and pre-interview. Furthermore, nonverbal observations were specifically focused on event-specific investigations.

Outline and Structure of the Dissertation

The outline below indicates how the following five chapters of the dissertation are structured. Chapter 2 is a theoretical overview of the detection of deception, and discusses the status of research conducted on the topic. Furthermore, it explores the anatomy of deception by explaining the functioning of the limbic brain system in relation to involuntary nonverbal behaviour linked to the emotional expressions of humans. Chapter 3 discusses the

techniques employed to detect deception, and describes nonverbal behaviour relevant to the current study. The chapter also includes an historical overview of the polygraph, discusses its use in South Africa, and describes the pre-polygraph interviewing process. Chapter 4 describes the research methodology utilised in the study. This includes the aim, the research hypothesis, research design and sampling methods that were used to gather and analyse the data. This chapter concludes with the ethical considerations that informed the current study. Chapter 5 discusses the results in relation to the published literature, while Chapter 6 deals with the conclusions and limitations of the current study, and offers certain recommendations for future research in this field.

Conclusion

This chapter provided a general orientation to the study, and brief background to the South African context regarding the escalation of crime and the value of research within this field, highlighting the necessity of developing the ability to detect deception. Brief reference was made to the polygraph and its relevance to the current research, and the nonverbal behavioural focus of the pre-interview in the correlation to the polygraph test results. The specific aim of the current study was also introduced. The following chapter provides a literature review of the theories of deception detection, an overview of relevant research, and a detailed discussion on the anatomy of deception.

Chapter 2

Deception Detection: A Theoretical Overview

Introduction

Most humans are familiar with deception. The majority of people seek to be truthful and steer clear from deceiving others, however, deception is part of human nature (Vrij. 2008). Human deception and its detection have a long history. Diogenes of Sinope, a cynic in ancient Greece, can be referred to as a classic example of the historical urgency and efforts in the search for the truth. Diogenes walked the streets of Athens holding a lamp in front of him in search of a truthful man (Clifton, 1991). Deception has also been recorded in the Bible. One example was recorded when God confronted Cain, after he killed his brother Abel. Cain attempted to deceive God when he replied that he was not his brothers' keeper and that he had not seen him.

For the past 45 years' research has also dealt with the detection of deception. Researchers such as Ekman (2003), have dispelled the popular myth that a Pinocchio sign for deception exists. An exploration into the meaning of nonverbal and verbal behaviour in relation to the behavioural differences that could differentiate truth from deception have been attempted, without much success (Ekman, 2003; Vrij, 2008). Furthermore, studies have confirmed that there is no single behavioural sign linked to deception (Morris, 2002; Vrij, 2008). According to Driver (2012), Ekman (2003), Givens (2002), Morris (2002), Navarro (2008), and Vrij (2008), deception detection will become more accurate if researchers look for clusters of behaviour and group nonverbal and verbal anomalies, and observed changes together, instead of looking for one specific signal indicating deception.

The search to equip and enable humans to detect deception through various means, including nonverbal behavioural analysis and the polygraph test, has not been without shortcomings and critical reviews (Ekman, 2005; Verschuere, Prati, & De Houwer, 2009;

Vrij, 2008). The present chapter provides an overview of theories of deception detection, and addresses the status of such research. In addition, it describes the anatomy of deception by exploring the psychophysiological links in the brain, as well as the involuntary and voluntary expressions of it, which are signalled through the human body (Zillmer, Spiers & Culbertson, 2008).

Theories of Deception Detection

Three prominent theories of deception detection are reviewed in this section. The theories are: (1) Zuckerman, De Paulo, and Rosenthal's Multi-Factor Model (1981), (2) De Paulo's Self-Presentational Perspective (1992), and (3) Buller and Burgoon's Interpersonal Deception Theory (IDT) (Buller and Burgoon, 1996; Vrij, 2008). In addition to discussing each theory, references to relevant behavioural actions associated with psychophysiological responses caused by external stimuli, if applicable, are traced regarding each theory. The paragraphs to follow explore the different theories, starting with the Multi-Factor Model formulated by Zuckerman, De Paulo, and Rosenthal (Vrij, 2008).

Zuckerman, De Paulo and Rosenthal's Model (1981). The Multi-Factor Model (as cited in Vrij, 2008) states that individuals, who are deceptive, will experience an emotional or cognitive overload, and will show subsequent body movements and nonverbal behavioural responses in their face and body, that correlate with their internal experiences. When experiencing an emotional overload, an individual might show increased movements due to feelings of anxiety. Conversely, a decrease in movement is usually detected when cognitive overload is experienced. Cognitive overload occurs when a person's thought processes become over occupied with the problem at hand, and no other thought is given to normal behavioural actions (Vrij, 2008). The resulting decrease in movement is experienced due to

the over control of behaviour, and failure to use normal body language. This is due to the complex process of maintaining the deception in progress (Vrij, 2008).

Three behavioural components have been identified in the Multi-Factor Model when deception takes place. These are: (1) emotional reaction, (2) cognitive effort, and (3) attempted behavioural control (Vrij, 2008). Firstly, during *emotional reaction*, Ekman (1992, 2003) and Vrij (2008) identified that emotions of guilt, fear, and delight, are often expressed during deception. An individual will either express guilt, fear, or delight, while deceiving another person (Vrij, 2008). Secondly, deception requires *cognitive effort*, which results in an increased mental load. This means that the individual has to put in extra cognitive effort to produce and maintain his/her deception (Vrij, 2008). Thirdly, a deceiver will attempt *behavioural control*, whereby behaviour is inhibited, which he/she believes may make an honest impression on observers (Vrij, 2008). As such, deceptive individuals tend to be more inclined to monitor and control their own behaviour, in order to appear honest (De Paulo & Kirkendol, 1989).

The over-control of behaviour and the overload resulting from cognitive process signals different responses. These have the potential to influence the investigator conducting the observation in a negative or positive manner towards the person being observed (Vrij, 2008). In other words, arousal may lead to an increase in hand movements, resulting in more prominent and emphasised hand movements being observed. This is in contrast to the movements observed when a person is experiencing cognitive overload, which may lead to a decrease in hand movements, as well as static and freezing behaviour (Vrij, 2008).

In the next section the Self-Presentational Perspective will be discussed. This focuses on the way deceivers attempt to manage impressions, and influence what others think about them.

Self-Presentational Perspective. The Self-Presentational Perspective (De Paulo, Lindsay, Malone, Muhlenbruck, Charlton, Cooper, 2003) implies that truth tellers and deceivers often display the same nonverbal cues (Vrij, 2008). According to this theory, truth tellers may also express and experience emotions and cognitive overload as described in Zuckerman et al's (1981) Multi-Factor Model (Vrij, 2008). Therefore, truthful individuals are not immune to experiencing emotional reactions or exerting cognitive energy (Vrij, 2008). This phenomenon is explained by De Paulo's (2003) Self-Presentational Perspective (Kebbell & Davies, 2006; Vrij, 2008), because both guilty and innocent individuals may be afraid of not being believed and therefore they may display the same nonverbal cues.

According to Driver (2012), this can be neutralised if the observer is able to differentiate between behaviour that is aimed at convincing the individual being deceived, versus behaviour that is merely aimed at conveying a message. Deceivers become more convincing in their expressions as the stakes become higher for them. Therefore, to ensure that they are believed, they aim to convince the receiver. In contrast, truth-tellers are not inclined to provide evidence about the truth as it already exists in their mind (Driver, 2012). Truth-tellers therefore take their credibility for granted (De Paulo et al., 2003) and they assume their honesty (Kassin, 2005; Kassin & Gujonsson, 2004; Kassin & Norwick, 2004). The next section will explore the Interpersonal Deception Theory. This theory deals with the complexities of coping with, and controlling, emotions, dialogue, and behaviour, during the deception process.

Interpersonal Deception Theory. The Interpersonal Deception Theory (Buller & Burgoon, 1996) states that deceivers encounter numerous simultaneous communication tasks during a conversation with a partner, and must maintain credible nonverbal behaviour in various modes. This includes managing their emotions, dialogue, and responding appropriately to communication cues (Vrij, 2008). This theory implies that deceptive

behaviour may be influenced through the attitude and suspicions raised by the interrogator (Vrij, 2008). The Interpersonal Deception Theory embraces the core aspects of the Multi-Factor Model (Vrij, 2008).

The Interpersonal Deception Theory claims that people in communication will mirror each other's behaviour. This will influence behavioural displays, and may cause behavioural adjustments during conversation (Vrij, 2008). For example, in a case where the interrogator expresses opinions of disbelief in the person being interviewed, this attitude of the interrogator will force the interviewee to adapt his behaviour and mime that of the interrogator, in order to show sameness, in the hope that he/she will be believed (Vrij, 2008).

The theory also points to individuals who are timid in nature; who may show feelings of guilt without being guilty. If these individuals are placed in front of an aggressive interviewer, they often show emotional responses that either mirror the behaviour of the interrogator or show false responses of guilt. This could result in them being perceived as deceptive (Vrij, 2008). These attempts to adjust behaviour will either cause them to move more or to become less animated and avoid fidgeting (Buller, Comstock, Anne, & Strzyewski, 1989; Buller, Strzyzewski, & Comstock, 1991). Detecting deception is a complex matter and it is important to address the status of research in this fast developing field.

The Research Status of Deception Detection

The concept of developing human abilities capable of accurately detecting deception is an ongoing process, which deals not only with the different theories discussed in the previous section, but continues to deal with concepts of nonverbal behavioural actions. To develop an understanding of the nonverbal behavioural research field, it is important to understand the different concepts referred to in this section, namely the meaning of

deception, nonverbal behaviour, signals, gestures and signs. These concepts are discussed below.

a) Deception can be described as a premeditated action. It is a process whereby the communicator deliberately, and to their advantage, avoids sharing the truth in a situation where the he/she possess foresight that what he/she is sharing is actually false and misleading to the receiver (Ekman, 2003; Vrij, 2008).
b) Nonverbal behaviour and communication are often referred to by the lay term: *body language,* and includes the bodily position and movements used during communication with others (Givens, 2002; Morris, 2002).
c) Nonverbal signs are referred to as the bodily gestures, postures, and facial expressions, used in daily nonverbal communications (Givens, 2002; Morris, 2002).
d) Nonverbal gestures, in the study of nonverbal behaviour, refer to information given through body movement and posture. They communicate a concept and motivate a mood, and can be described as a signal providing information about the words a person is using. They can also be expressed without words to relay information (Givens, 2002; Morris, 2002). The shoulder shrug is a good example of a nonverbal gesture. Here an individual gestures by lifting his/her shoulders upwards into a shrug. This is done to indicate that something is not known. This gesture can be used with or without words and it will relay the same information to the observer (Givens, 2002).
e) Nonverbal signals are messages or intentions emitted through nonverbal behaviour, and include body movements, by directing a specific message, need or intention (Givens, 2002; Morris, 2002).

Previous research, which focused on developing human abilities capable of accurately detecting deception through specific nonverbal signs or signals, has proved to be fruitless, as no specific or isolated signal exists which identifies deception in humans (Ekman, 2003).

However, in recent years, research efforts aimed at understanding human deception through nonverbal and verbal behavioural analysis have increased, and this is reflected by the expanding literature in this field (Bellis, 2012; Cote, 2016; Dael, Mortillaro, & Scherer, 2012; Driver, 2012; Ekman, 2003; Meijer, Verschuere, Gamer, Merckelbach, & Ben-Shakhar, 2016; Navarro, 2008, 2011).

Exploring the link between nonverbal behaviours and deception is an important step in deception detection. This is highlighted by Ekman (2003) and Vrij (2008), who state that individuals are incapable of effectively controlling certain aspects of their nonverbal behaviour in contrast to their verbal messages (De Paulo & Kirkendol, 1989; Ekman, 1992; Ekman & Friesen, 1969, 1974; Vrij, 2005, 2008). People are more aware of their verbal communication than their nonverbal behaviour, this is why it can be extremely informative to understand nonverbal cues to assist with detecting deception. Ekman (1992) found that automatic links exist between emotions and nonverbal behaviour, and that no such links exist between verbal communication and emotions. People automatically nonverbally reflect emotions, such as dislike and disgust, when they experience something they do not like, by contorting their face or leaning their body away from the undesirable object (Givens, 2002). Whereas, they do not automatically say something specific, when they experience these emotions (Vrij, 2005), as they are more able to control their verbal responses.

Added to this, Vrij (2005) states that people cannot be nonverbally silent. He states that most people are not cognisant of their habitual nonverbal behaviours. As a result of this, during emotional experiences, such behaviour is potentially a valuable source of information in detecting deception. As stated there is no single or specific nonverbal signal that can be isolated to indicate deception, however, the research continues to investigate if a specific cluster or group of nonverbal behaviour exists as an indicator of deception (Vrij, 2005, 2008).

In more recent research (for example, functional magnetic resonance imaging fMRI and positron emission tomography PET), the focus has moved from finding that one specific nonverbal tell-tale signal, towards using modern neuroimaging techniques, in the attempt to detect deception. Such advanced technology includes positron emission tomography (PET), and functional magnetic resonance imaging (fMRI), which are utilised by neuroscientists to explore measurements during brain functioning, that could lead to detecting deception (Gamer & Ambach, 2014). However effective the use of the PET and the fMRI might be, they are highly expensive tools and not available to ordinary investigators. The PET, fMRI, and the polygraph, all respond to measuring physiological responses, with the PET and fMRI measuring brain responses, while the polygraph measures the physiological variants. However, the same principles are at play when using these different measures. In each case, questions are posed to the interviewee, and their responses are measured. It remains the investigator's responsibility to link the imaging and physiological signals to determine whether deception is present (Meijer, Verschuere, Gamer, Merckelbach, Ben-Shakhar, 2016). Research on neurological and physiological signals to detect deception will be discussed in the next section.

Research on Deception Detection

Future research in deception detection aims to discover neurological and physiological signals, and not merely focus on nonverbal behavioural signals. However, the challenges remain the same; to link the responses to the specific stressor or factors causing the responses observed (Vrij, 2008). New studies use brain imaging techniques to differentiate between deceptive and truthful responses (Gamer, Klimecki, Bauermann, Stoeter, & Vossel, 2009), compared to the traditional polygraph research, which focusses on measuring the physiological changes and autonomic signals of skin conductance, respiration

and heart rate (Vrij, 2008). These new brain imaging techniques will be explored in greater detail below.

Neurological and Central Nervous System Monitoring. The processes utilised in monitoring and measuring brain responses linked to emotions or external stimulation, are being researched for application to the detection of deception. The most prominent techniques currently researched will be briefly mentioned in the paragraphs to follow. They include: the functional Magnetic Resonance Imaging (fMRI) scanning, brain fingerprinting (brain waves measuring), and Infra-red scanning.

Functional Magnetic Resonance Imaging (fMRI) Scanning. fMRI scanning that measures brain structure and activity, is the newest tool in measuring deception (Vrij, 2008). Research is presently being conducted with the fMRI scanner to explore the areas in the human brain that are activated when a lie is told (Gamer et al., 2009). This is achieved through the measurement of changes in the blood flow and oxygen use within specific brain structures (Vrij, 2008). Vrij (2008) describes this as an expensive, uncomfortable, and lengthy lie detector tool. Furthermore, the analysis process is complicated. The person being tested must remain completely immobile and lie flat on his/her back with his/her head strapped in. This is a great disadvantage and counts against the fMRI scanner to be used as a day-to-day lie detector (Vrij, 2008).

Brain Fingerprint. The brain fingerprint is a modern approach to measuring brain responses in deception detection. This is an approach which was developed by Dr Farwell (Farwell & Smith, 2001). It measures the brain waves of both liars and truth-tellers. The results are then compared and significant changes are noted (Farwell & Smith, 2001). However, this research had not been subjected to peer review for scrutiny, and is viewed by other researchers, such as Vrij (2008) and Wolpe, Foster, and Langleben (2005), as

unconvincing. This is due to the small sample size used in testing, and the lack of thorough investigation (Vrij, 2008).

Infra-red Scanner. The infra-red scanner measures neurological changes in the heat resonating around the eyes of an individual during deception (Vrij, 2008). Detecting deception by measuring the changes in blood flow patterns around the eyes of a participant, becomes measurable through thermal imaging, photographed with heat detecting cameras (Vrij, 2008). Increased blood flow occurs around the eyes when an individual experiences the physiological arousal of flight and fight. These neurological responses do not indicate deception per se, but could in the same manner indicate stress factors, such as high stress and discomfort (Pavlidis, Eberhardt, & Levine, 2002; Vrij, 2008).

It is important for researchers and investigators to be knowledgeable of the scientific processes involved in nonverbal behavioural actions and responses. The following section explores the brain functions and the corresponding anatomy connected to deception and nonverbal behaviour.

The Anatomy of Deception

Emotions, multifaceted physiological functioning, cognition, and motor action processes within the human brain, are a complex and integrated system. They are responsible and involved in expressing thoughts, intentions and behaviour (Zillmer et al., 2008). The limbic system, the autonomic nervous system, and functions between the sympathetic and parasympathetic nervous systems, are crucial to understand for purposes of this study. The next section will explore the limbic system, specifically its functioning and anatomy, which is linked to involuntary behavioural responses, resulting from emotional reactions. These behavioural responses can be observed and decoded, and are used as tools in discovering behaviour that could indicate deception.

The Limbic System. The limbic system (Figure 1) is situated within the human brain, and is strongly linked to involuntary nonverbal signals. It stands central in the integrated functioning described above, and acts as a warning system, which serves to keep us out of danger. It reacts automatically to our environment, and transmits signals and responses relating to our present emotional state to the rest of our brain and body (Navarro, 2008). This results in a number of observable nonverbal responses, which reflect our intentions and emotions. These can be observed physically through the movement of our head, shoulders, arms, hands, feet, upper body, and facial expressions (Navarro, 2008). The limbic system is also our emotional brain, and manifests our true emotional feelings and intentions (Navarro, 2008; Zillmer et al., 2008).

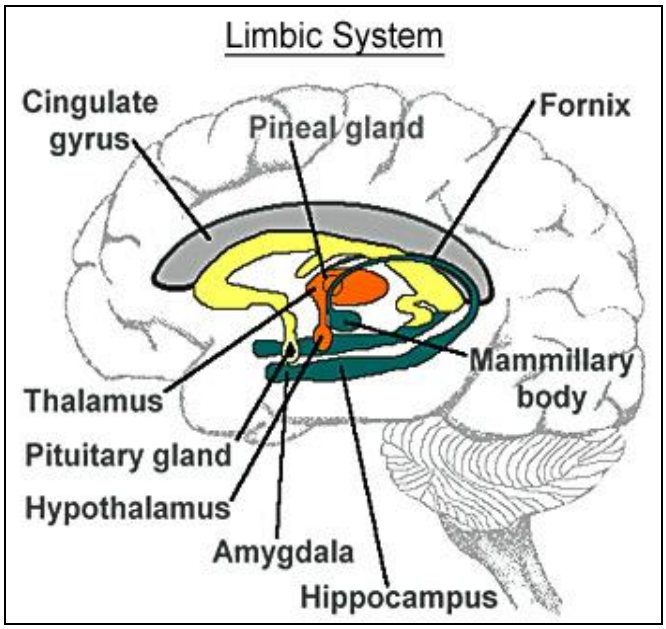

Figure 1. Basic Structure of the Limbic System in The Human Brain (IndiaNetzone, 2017).

The limbic system has been described as essential in relaying emotional behaviour (Zillmer et al., 2008). Progressively, throughout the history of neuropsychology, supporting findings have emerged linking the limbic system to emotions (Meijer et al., 2016; Navarro,

2008; Zillmer et al., 2008). The limbic system is also referred to as the mammalian brain, as it is most developed in mammals (Zillmer et al., 2008). This vastly interconnected structure is a highly debated topic within neuropsychology, particularly concerning the set of brain structures, which belong to it. However, the major structures acknowledged as forming part of it include the amygdala, hypothalamus, fornix, corpus callosum, hippocampus, mammillary body, olfactory bulb, septum, and anterior nucleus of the thalamus (Zillmer et al., 2008).

The hypothalamus and the amygdala, which reside within the limbic system, have been identified as the main areas responsible for the autonomic process associated with the expression of behaviour, emotions, and emotional learning (Zillmer et al., 2008). Memory has been ascribed mainly to the hippocampus (Zillmer et al., 2008). Primary emotions such as fear, disgust, anger, surprise, happiness, and contempt, are processed through the limbic system, and are expressed automatically (Ekman, 2005; Zillmer et al., 2008). These primary emotional responses are described as "immediate, automatic, preconscious, and unconscious" (Zillmer et al., 2008, p.262). Secondary emotions are not automatic and require cognitive processing. This is because these emotions are not linked directly to sensations or feelings in our body, but are linked to our learning experiences and cognitive manipulations (Zillmer et al., 2008).

According to Zillmer et al. (2008, p. 262) our "secondary emotions require higher cortical processing". These secondary emotional experiences travel through the "higher cortical processes and arrive at the limbic system over a different route", compared to our primary emotions, which are caused by sensory experiences (Zillmer et al., 2008, p. 262). Therefore, observations of nonverbal behaviour, which can be specifically linked to either primary or secondary emotional expressions, are of cardinal importance to research that is focused on discovering cues to deceptive behaviour. This is because these nonverbal

behaviours occur involuntarily and subconsciously for primary emotional expressions, whereas secondary emotional expressions are controlled (Zillmer et al., 2008).

Having reviewed the fundamentals of the limbic system, attention is now directed specifically to the functioning of the autonomic nervous system. Particular focus will be on the activities and links between the sympathetic and parasympathetic nervous systems, and their role in nonverbal behaviour.

The Autonomic Nervous System. The autonomic nervous system resides within the structures of the nervous system. This system is particularly important to the study of nonverbal behaviour, because it regulates the internal environment of the body's reactions to emotions. The placement of the autonomic nervous system will be described here, and set out in the following structure, in order to explain where it fits within the functioning of the whole nervous system structure (Zillmer et al., 2008).

Principal divisions of the nervous system described by Zillmer et al. (2008) are the:

a) Central nervous system (CNS)
   - The brain and spinal cord
b) Peripheral nervous system (PNS)
   - Incudes the somatic nervous system, cranial nerves and spinal nerves.
c) Autonomic nervous system (ANS)

The Sympathetic and Parasympathetic Nervous Systems. The following figure (Figure 2) was created by the researcher in order to simplify and explain the functioning of the ANS in relation to its two main divisions, the sympathetic and parasympathetic nervous systems.

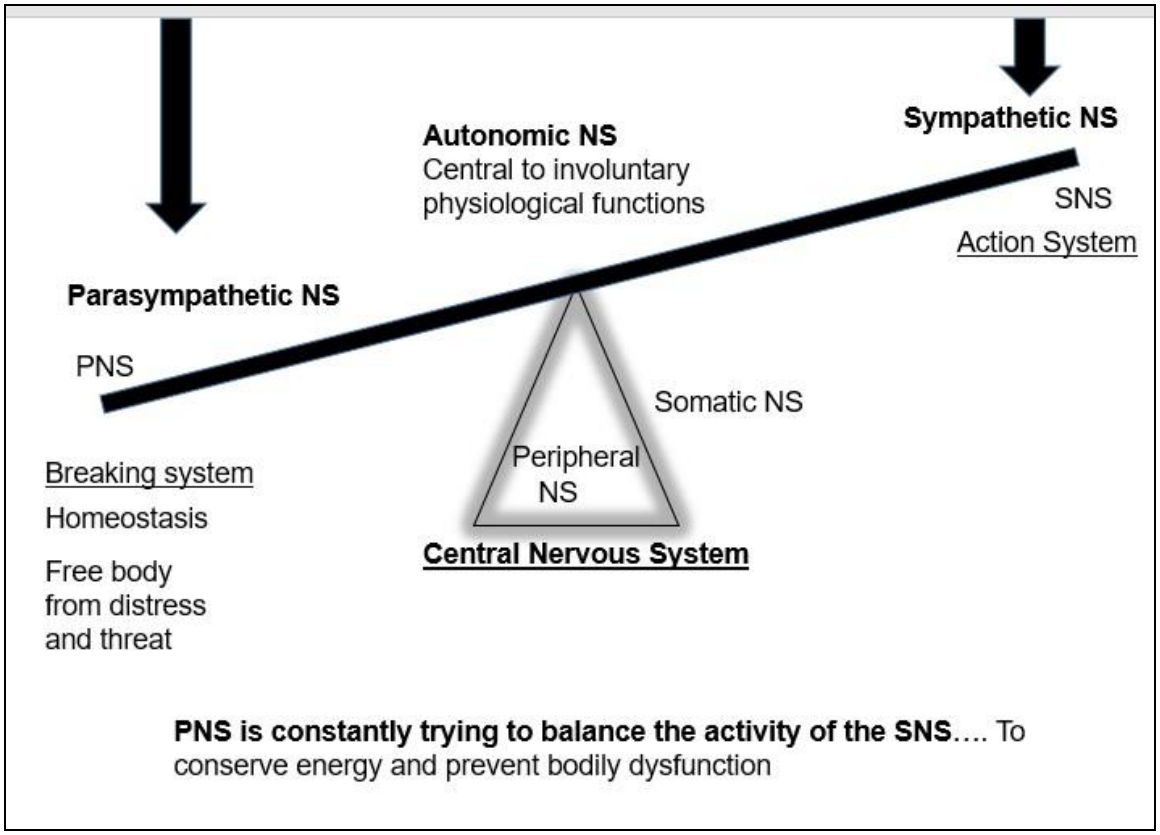

Figure 2. The Organisation of the Nervous System (Researcher's Own Design)

The autonomic nervous system houses the sympathetic (SNS) and parasympathetic nervous systems (PNS). The divisions between the SNS and the PNS are delineated by the different functions and properties of neurons in the two systems (Zillmer et al., 2008). The autonomic nervous system is responsible for the functioning of involuntary muscles, the cardiac muscle, and glands (Noback, Strominger, & Demarest, 1996; Zillmer et al., 2008). It forms part of the somatic nervous system, but functions to control the influences of the visceral activities, by maintaining the body's equilibrium or homeostasis through the functioning of the parasympathetic nervous system.

In contrast to the PNS, the ANS regulates the body's reactions to a perceived threat through the SNS (Zillmer et al., 2008). While the ANS regulates the body's internal environment, the somatic motor nervous system focuses on regulating the body's posture and movements, influenced by the external environment of an individual (Noback, Strominger,

Demarest, 1996; Zillmer et al., 2008). Both the sympathetic and parasympathetic nervous systems work simultaneously in support of the physiological functioning of the ANS, and both nervous systems cause and produce nonverbal signs, as reflected by emotional changes in a particular emotional experience. The importance of the SNS in relation to this study, and in nonverbal behaviour, will be discussed in the paragraph to follow.

The Sympathetic Nervous System. The sympathetic nervous system (SNS) is responsible for actions orientated directly to ensure that the body can function when a perceived threat is experienced. For example, by triggering the release of adrenalin during an emergency or stress situation. In this situation the body responds with behaviours that are categorised as freeze, flight or fight responses (Navarro, 2008; Noback et al., 1996; Zillmer et al., 2008). Freezing is a SNS reaction which is often overlooked in human behaviour, yet it is an automatic response to face-to-face confrontations with life threatening situations (Vrij, 2008). In different contexts of threat, we may display freeze, flight, or fight responses. Therefore, if an individual is deceptive and fears that an interrogator will discover this, the body sees this as a threat, and the SNS responds by either freeze, flight or fight. As a response to external threats the SNS also controls the secretion of blood sugar and the acceleration of the heart rate, which results in increased blood pressure (Noback et al., 1996; Zillmer et al., 2008). The SNS is also known as the adrenergic or thoracolumbar system due to its preganglionic fibre connection in the "thoracic and upper two lumber levels" (p.281) and "the neurosecretory transmitter released by the post ganglionic fibres is norepinephrine, which propels the body into action" (Noback et al., 1996, p. 281; Zillmer et al., 2008).

The Parasympathetic Nervous System. The parasympathetic nervous system (PNS), in contrast to the SNS, restores the body's resources, and frees the body from distress, ensuring the body remains in a state of homeostasis. The SNS energises the body and prepares it for fight and flight. In contrast, the PNS ensures the body functions are reset to

normal functioning levels by releasing acetylcholine, and is therefore also referred to as the cholinergic system. The PNS's preganglionic fibres are linked to the cranial nerves III, VII, IX, X at the sacral spinal levels S3 and S4 (Noback et al., 1996; Zillmer et al., 2008).

The SNS and PNS are continually engaged in opposing actions which maintains and protects the body from harm, both externally and internally. The interlinked functions of these two powerful regulating systems, enables the body to adapt and adjust both biologically and physiologically. The fact that the body displays very specific signals associated with these two opponent nervous systems, is of particular importance to the current study. For example, an increase in heart rate caused by the SNS, will activate the PNS, to calm the heart rate through involuntary nonverbal movement, that will stimulate the vagus nerve located between the face, neck, and the heart (Ekman, 1992, 2003; Navarro, 2008; Noback et al., 1996; Vrij, 2008). In this case, an individual may touch or stroke his or her neck or face subconsciously, when confronted with a problematic situation. This movement is subconsciously focused on pacifying the heart via the stimulation of the vagus nerve (Navarro, 2008). Such pacifying behaviour includes a specific set of behaviours and movements, that are controlled by the PNS (Navarro, 2005).

The significance of the ANS is largely related to the functioning of the limbic system as a holistic unit. Another important functioning part, crucial to the identifying of anomalies through the responses of the autonomic system within the limbic system, is the hypothalamus. The direct relationship to the ANS and the limbic brain responses connected to the hypothalamus, will be discussed in the next section.

The Hypothalamus Linked to Primary Emotional Responses. The limbic system and the hypothalamus function together by relaying nonverbal messages to the body. The hypothalamus signals and communicates messages received from the limbic system to the body in milliseconds. This process begins with information received from an external

stimulus, either in a visual or auditory form. This is processed by the amygdala and relayed directly to the hypothalamus which is responsible for autonomic responses connected to the primary emotions (Noback et al., 1996; Zillmer et al., 2008). The amygdala, via the central nucleus, relays messages to three different areas, namely: (1) the hypothalamus, which is responsible for automatic responses, (2) the periaqueductal, the grey matter in the brain stem responsible for behavioural reaction, and (3) the cerebral cortex, which is responsible for emotional experiences (Zillmer et al., 2008).

In contrast, our secondary emotions are not autonomic and are a function of cognitive processes, which occur in the prefrontal cortex (Noback et al., 1996; Zillmer et al., 2008). The prefrontal cortex is described as the area of the brain that is capable of deception and is known as the 'thinking brain'. The limbic system is referred to as the 'honest brain', because it signals true emotional responses automatically to our body (Navarro, 2008).

Conclusion

This chapter discussed the theoretical overview and theories of deception detection, as well as the current research status regarding deception. The anatomy of deception was explored through an explanation of the functioning of the limbic brain system, the autonomic nervous system, and related neurological functioning involved in nonverbal behavioural analysis. Furthermore, the neurological aspects of this chapter introduced the operational differences between the SNS and the PNS, which can be referred to as a scientific approach to analysing nonverbal behaviour, which forms the basis of this research.

To enhance the scientific approach, the methods applied to deception detection will be discussed in Chapter 3, which includes detailed aspects of nonverbal behaviour and the polygraph. It will also explore the nonverbal behavioural indicators of the head, shoulders, hands and feet, related to the focus and aims of this study. Detailed information about the polygraph, and the pre-interview leading up to the polygraph test will be included, as this

forms a large part of the research project, and relates directly to the data capturing process and observation focus of this study.

Chapter 3

Deception Detection Methods

Introduction

The methods employed to detect deception have evolved into a highly specialised field. This chapter will discuss the different approaches employed in the process of detecting deception. The different approaches to detect deception refer to the use of indicators that show deceit during behavioural anomalies, within the scope of nonverbal, verbal, and physiological behaviours. Relating to the aims and scope of the current study, this chapter will specifically deal with the nonverbal and physiological methods used in detecting deception. Therefore, this chapter will discuss the approach used to observe anomalies in the polygraph pre-interview regarding nonverbal behaviour and the physiological indicators. This chapter has two main sub-sections: (1) nonverbal behavioural analysis, and (2) the polygraph, as methods employed to detect deception.

Nonverbal Behavioural Analysis

Nonverbal behavioural analysis refers to the observation actions implemented in identifying nonverbal indicators and movement, executed by an individual within a certain context. An observer then ascribes specific pre-established meaning to the behaviours that are observed (Givens, 2002). Researchers, such as Ekman (2003), Givens (2002), Navarro (2008), and Vrij (2008), have identified nonverbal behaviour that can be linked to deception and will be discussed in the sections below.

The section to follow will progressively unpack what is meant concerning nonverbal behaviour in general. Thereafter, specific details will be mentioned which relate directly to nonverbal behaviour in the context and focus of this study.

Nonverbal Behaviour. Nonverbal behaviour refers to body movements, micro facial expressions, gestures, physical movements, body distance, touching, and posture (Givens, 2002; Navarro, 2008; Vrij, 2008). Nonverbal behaviour also includes the physiological responses that are recorded by the polygraph, which monitors the individual's blood pressure, heart rate, palmar sweating, and breathing rate (Vrij, 2005). As discussed in the previous chapter, the brain, and more specifically the central nervous system, autonomic nervous system, and limbic brain system, signal speechless signs that form nonverbal communication (Givens, 2002).

It is this nonverbal communication that Navarro (2008) links to behavioural analysis and deception detection, by differentiating between comfort and discomfort. Nonverbal behaviour associated with behavioural cues of comfort, originate within the parasympathetic nervous system, which keeps the body free from distress. Whereas, the nonverbal behaviours linked to movements of discomfort, are caused by the sympathetic nervous system (Vrij, 2008; Zillmer et al., 2008).

Therefore, Navarro's (2008) point of view regarding the differentiation between nonverbal signals of comfort and discomfort when attempting to detect deception, is an important starting point in monitoring nonverbal behaviour (Vrij, 2008). Due to the fact that the limbic system, and more specifically the sympathetic and parasympathetic systems, are always functioning and never shut down to rest or sleep, the limbic brain will reflect the true state and level of feelings and experiences at all times (Vrij, 2005, 2008; Zillmer et al., 2008). The limbic system is also responsible for involuntary nonverbal expressions and behaviour, this will be explored in the paragraph to follow.

Involuntary Nonverbal Behaviour. The amygdala and the hypothalamus are specifically responsible for displaying involuntary nonverbal behaviour (Navarro, 2008; Noback et al., 1996; & Zillmer at al., 2008). This section will explore and explain the

meaning of involuntary nonverbal behaviour related to the focus areas of this study, which are the head, shoulders, hands and feet.

Human beings have specific involuntary built-in response tendencies. For example, leaning towards something that is liked and leaning away from something that is disliked, a hand being immediately withdrawn from a hot object, or instinctively protecting our eyes when an object is thrown at our face (Navarro, 2008). In the same manner when we enjoy what we see, we involuntarily tilt our heads to the side, exposing our neck and showing a degree of vulnerability and softness (Givens, 2002). We tilt our heads sideways when we are in favour of something (Givens, 2002; Navarro, 2008) and we raise both shoulders when we do not know an answer to a question, this displays a signal of "I don't know" (Givens, 2002).

The same nerves that are linked to our head and shoulder movements simultaneously control the movement of the hand shrugs. They move in synchrony when we shrug our shoulders upwards, in turn our hands and palms shrug and turn into the upwards position, indicating the nonverbal communication, "I don't know" (Givens, 2002; Navarro, 2008; Vrij, 2005, 2008). The one shoulder shrug is of great importance during deceptive behaviour. According to Givens (2002) and Navarro (2008), this is done when an individual is unsure about what they are saying or thinking. The one shoulder shrug is also seen when someone makes a declarative statement, if they are not convinced about the authenticity of their statement (Givens, 2002; Navarro, 2008). The hand that corresponds to the shoulder that is being shrugged, will move in the same manner as it moves when both shoulders are raised (Givens, 2002). This is done when an individual is uncertain about the accuracy of the verbal declaration (Givens, 2002; Navarro, 2008). This is not a deceptive signal, yet it is a clear indication that an individual is unsure about something at that specific moment, concerning the statement they made (Navarro, 2008).

Our feet are also implicated in involuntary movements. One way that this happens is that our feet point in the direction of our focus; individuals do this without thinking about the position or movement of their feet (Givens, 2002; Navarro, 2008). Feet are seen as the most honest part of the body according to Navarro (2008). Givens (2002) confirms these sentiments when he speaks about the integrated neural connections of the feet in the parietal lobe on the sensory strip, where the feet cover a larger area of neural connections, compared to the neural connections of the whole upper body (Givens, 2002; Navarro, 2008; Vrij, 2008; Zillmer et al., 2008).

The feet have sensitive and intense neural connections within the brain and are well connected to relay emotional responses and express intention accurately (Givens, 2002). For example, the toes rise, pointing upwards, with the heels firmly on the ground, and the ball of the foot in the air, to indicate happiness and enjoyment (Givens, 2002; Navarro, 2008). When an individual is in a hurry, the feet tap automatically, showing the agitation or irritation (Navarro, 2008). To enable accurate observations, detect and measure deviations in nonverbal behaviour and involuntary indicators, the observer needs a starting point to gauge movement that will enable accurate measure of changes, variances, and anomalies in behaviour. The tool that will enable an observer to make accurate behavioural deductions lies in the accuracy of establishing baseline behaviour. This provides the observer with a starting point from where to gauge changes from the baseline behaviour that has been established. The following section will discuss the term baseline behaviour.

Baseline Behaviour. Baseline behaviour refers to the root behaviour of an individual (Navarro, 2008), or the body actions which are specific to an individual (Vrij, 2008). These are the foundation or starting point of a person's posture and movements, before a specific behavioural action is displayed (Givens, 2008). Baseline behaviour is the behaviour that is idiosyncratic to an individual in a specific context or environment. It can be further

explained as the everyday behaviour of an individual when their body movements and functions are static, before reacting to a stimulus (Givens, 2008).

In deception detection the starting point is to first measure or observe an individual's nonverbal behavioural baseline behaviours. This is important as it helps to detect behavioural changes in the moment that they occur, and to observe deviations from the original resting behavioural position, as it moves into the behavioural action position which is caused by a specific stimulus (Navarro, 2008).

Baseline behaviour is established by observing the following nonverbal behavioural actions or non-actions according to Navarro (2008, p. 12):

> Note what people look like normally, how they typically sit, where they place their hands, the usual position of their feet, their posture, common facial expressions, the tilt of their heads, where they generally place or hold their possessions, you need to differentiate between their normal face and their stressed face, by examining what's normal, we begin to recognize and identify what's abnormal.

Establishing an individual's baseline behaviour is the essential goal in conducting a thorough nonverbal behavioural analysis (Navarro, 2008). The next step in analysing behavioural differences lies in detecting calming–down behaviour. This is initiated by the parasympathetic nervous system (PNS), and referred to as pacifying behaviour, and will be discussed in the next section.

Pacifying Behaviour During Nonverbal Expression. Specific automatic calming behaviour has been identified by researchers and investigators, such as Ekman (1992), Navarro (2008), and Vrij (2008). These automatic behaviours are described as calming or pacifying reactions caused by the body's PNS. It is the body's way of keeping itself in a state of homeostasis (Navarro, 2008). When the body experiences a threat or stress event, a

calming action is immediately triggered (Knapp & Hall, 2010). This action or body movement can be observed directly after a stressor has been experienced, and can be noticed as a distinct calming action or referred to as a pacifier (Navarro, 2008).

The various autonomic calming techniques, employed by the body after events of stress, anxiety, or discomfort are: scratching behaviours, adjusting clothing, blocking the eyes with the hands, earlobe rubbing, self-hugging, whistling, exhaling, as well as, touching the face, neck, or lips (Knapp & Hall, 2010; Navarro, 2008; Vrij, 2008). Pacifying behaviour can be noticed in the movements of the hands and feet, and will be explained in the next paragraph.

Previous research indicates that emotional and automatic responses will directly affect most of the hand movements observed (Vrij, 2008). Displays of stress and anxiety are indicated by self-touching, neck touching, and scratching behaviour which is referred to as pacifying behaviour (Navarro, 2008; Vrij, 2008). In leg movement previous research shows that pacifying behaviours will be noticed in the movement of the feet forward and backwards, feet moving away from a perceived threat, or withdrawn when we feeling insecure and unsure about something (Navarro, 2008; Vrij, 2008).

The previous sections contained the general overview including details about nonverbal behavioural analysis, nonverbal behaviour, involuntary nonverbal behaviour, baseline behaviour, and pacifying behaviour, these concepts form the basis of interpreting nonverbal behaviour. The following section will enter into more specific nonverbal behavioural analysis and deals with nonverbal actions in the domains of freeze, flight and fight, which are expressed after a perceived stressful event has been experienced.

The Domains of Freeze, Flight and Fight in Nonverbal Gestures. The human reaction, after exposure to a stressor, or an immediate threat to its wellbeing, is experienced and expressed through the reactions of freeze, flight or fight (Navarro, 2008). The importance

of the three domains in relation to this study will be conceptualised in the following paragraphs.

Freeze. An immediate threat imposing a potential harm, injury, or insult to an individual's personal wellbeing, results in an autonomic emotional reaction (Givens, 2002; Zillmer et al., 2008). The primary emotional response is automatic; therefore, the initial freeze movement or expression will be automatic (Navarro, 2008; Vrij, 2008; Zillmer et al., 2008). Sudden stillness in the movement of the head, shoulders, hands and feet are significant displays of this emotion (Givens, 2002; Navarro, 2008; Vrij, 2008; Zillmer et al., 2008). Not only will movement decrease, but a complete halt in movement will be noticed (Givens, 2002).

Flight. Once an individual expresses signals of freezing in an attempt to escape the immediate threat, the body follows a specific sequence and enters the second reactive domain, referred to as flight (Givens, 2002; Navarro, 2008). Immediate withdrawal will be noticed in movements of the head, dipping of the chin, and a backward movement of the head (Givens, 2002). The shoulders will rise, as to tuck the head away; this is referred to as the 'turtle-effect' (Navarro, 2008; Vrij, 2008). Givens (2002) views such reflexive movements as an escape motion, aimed at removing a body part from potential danger. This movement in the shoulders is different in comparison to a shoulder shrug. The turning away of the shoulders and raising them, is a more accurate gesture of a flight response (Givens, 2002). The hands will either withdraw, self-touch, or be folded in under the arms (in an arm fold or self-hug), or will result in a passive holding of the hands (Givens, 2002). The feet will express flight by moving and pointing in a specific direction. Feet are described as the most honest part of the human body (Givens, 2002; Navarro, 2008; Vrij, 2008). Feet signal direction intention. Feet will either be pulled backwards, or hooked in around the legs of a

chair, or the heels will lift up as to get ready to run, referred to as the starting block position (Givens, 2002; Navarro, 2008).

Fight. The previous two domains are aimed at avoiding danger. The fight domain is entered when the individual perceives that the freeze and flight domains have failed to keep him or her safe (Givens, 2002; Navarro, 2008; Morris, 2002). An individual reaching this stage will take a physical response towards the threat (Givens, 2002; Navarro, 2008; Vrij, 2008). Head movement will now lean forward, the shoulder and hands will also be in forward positions, either pointing or in fist formation (Givens, 2002). Foot movement will escalate into kicking action and verbal responses could form part of the reactions in this phase (Givens, 2002).

The nonverbal reaction path is illustrated in Figure 3, below:

Figure 3. A Simplified Illustration of the Nonverbal Reaction Path .

In summary, this section discussed the scope of nonverbal behaviour relating to behavioural changes and anomalies. This discussion explained the application of nonverbal behavioural analysis. This was done by conceptualising the behavioural path whereby anomalies are noted, as this is crucial in the detection of behavioural changes that are useful during the deception detection process. The conceptualisation of nonverbal behavioural responses was dealt with by explaining nonverbal behavioural analysis, nonverbal behaviour, involuntary nonverbal behaviour, baseline behaviour, pacifying behaviour, and how the behaviour is expressed through the action domains of freeze, flight and fight.

The following section formulates the aspects concerning the polygraph testing environment, its history, research related to the polygraph, the polygraph questioning system

utilised during testing and its relation to the pre-interview. Furthermore, the relevance of the polygraph will be discussed in relation to this study.

The Polygraph

The polygraph will be discussed in this section of the chapter dealing with polygraph history and development, the uses of the instrument, the procedures and question applications, as well as the reliability, accuracy, and validity of the polygraph. Each of these aspects will be linked with the fundamentals of detecting deceptive behaviour. This section follows on from the previous section which dealt with nonverbal behaviour analysis as a tool utilised to uncover deception.

Introduction to the Polygraph. The polygraph, frequently referred to as the lie detector test, has a lengthy history as the most frequently used tool in an attempt to detect deception. The word polygraph derives from the Greek language and means ‘many writings’. It is an instrument whose effectiveness remains divided by opinions of those who view it as accurate, compared to other circles where it is viewed as a controversial forensic tool (National Research Council, 2003).

Over the past 20 years, increased usage in the polygraph instrument, has been seen in South Africa (Volyk, 2016). It has been employed in a variety of contexts including, government and private sectors, in specific crime related investigations, pre-employment screening, and in general integrity testing (National Research Council, 2003). In its functional capacity, the instrument measures the physiological reactions of the body’s autonomic nervous system and does not detect deception as a specific entity (Cote, 2016). Rather, it measures the discrepancies and deviations within the body’s responses and nervous system (Bellis, 2012). More specifically, as referred to in chapter 2, it measures changes in blood pressure, breathing patterns, and palm-sweating associated with the sympathetic and

parasympathetic nervous systems (Granhag & Stromwall, 2004). The responsibility rests with the polygraph practitioner to correctly link the physiological arousal detected by the instrument to determine the truthfulness of the test-taker (Vrij, 2008).

Utilizing the polygraph, remains a sensitive and controversial practice in the science of detecting deception. Therefore, it is inevitable that issues relating to validity, reliability, and adequacy are being questioned in relation to the use of the polygraph and other methods of detecting deception mentioned previously (Vrij, 2008).

The History of the Polygraph in Deception Detection. Since the start of civilization, humankind has sought out a variety of ways to distinguish between expressions of truth and dishonesty (Ekman, 2003). Over the centuries various inventions and techniques were created; many of which were cruel and irrational (Knapp & Hall, 2010). However, these techniques were primitively based on assuming some form of physiological reaction to indicate deception. These reactions were caused by a response produced by the person under suspicion, due to the introduction of a stressor (Bellis, 2012). Deductions were thus made concerning the person's physiological reactions, which in turn were interpreted as being deceptive or honest (Galianos, 2012).

Scientific measures first emerged in 1878, when the Italian physiologist Angelo Mosso (Cote, 2016), constructed the plethysmograph. This tool was used in an attempt to distinguish truth from deception (Cote, 2016). Mosso (1878), researched the effects of several stimuli on emotions and fears, while a suspect was being interrogated he would observe changes in their blood circulation and breathing patterns.

Further research, relevant to the development of the polygraph, occurred in 1879 when a French electrotherapy specialist, Dr. Marie Gabriel Romain Vigouroux, designed an electrodermal measuring tool (Cote, 2016). This tool measured the electro-dermal responses and the skin's involuntary changes in electrical resistance when external stimuli were applied

(Galianos, 2012). It was not until the end of the 19th century that this research paid off, and an Italian physician, psychiatrist, and pioneer criminologist, Cesare Lombroso, modified an existing instrument called the hydrosphymograph, to measure the physiological changes of a crime suspect's blood pressure and pulse rate, during the suspect's interrogation (Cote, 2016). Lombroso's device matched the cardiosphygmograph to a similar component in the contemporary polygraph instrument (Cote, 2016). It was not until 1914 that Italian psychologist, Vittorio Benussi (Cote, 2016), introduced the pneumatic aspect to monitor respiratory changes. This aspect calculated the time differences between inhalation and exhalation, and was used as a means of verifying the truth from deception. During the same period, in the United States of America (USA), Dr. William Marston, an attorney and psychologist, was credited with designing the early form of the polygraph as we know it today (Cote, 2016).

Figure 4. John A. Larson Operating the Polygraph (Cote, 2016, p. 2).

In 1921, John A. Larson (Figure 4), a Canadian psychologist, developed and refined the instrument, and named it the polygraph. During interviews, he was the first person to simultaneously measure the three physiological changes: pulse rate, blood pressure, and

respiratory rate (Bellis, 2012; Cote, 2016). Larson later refined the testing method by developing a specific interviewing technique he referred to as the 'relevant/irrelevant' (p. 2) (R/I) procedure. In this procedure he mixed relevant questions (related to the crime committed) with completely irrelevant questions (not linked to the crime being investigated) (Cote, 2016).

In 1938, the polygraph design was completed as it exists today, when Leonarde Keeler added the psycho galvanometer, which measures the skin's electrical resistance during questioning (Bellis, 2012; Galianos, 2012). Between 1945 and 1947, John E. Reid, who was practising as a lawyer from Chicago at the time, developed the Control Question Technique (CQT). The CQT was found to arouse emotions when administered to people who were not deceptive and the relevant questions in comparison showed less emotional arousal in the deceptive subjects (Cote, 2016).

In 1958, a quantification system was introduced by Cleve Backster, who was a former Central Intelligence Agency (CIA) polygraph examiner. His chart analysis method made the polygraph measurements more objective and reliable (Cote, 2016). Since then, the numerical evaluation system was implemented as the standard procedure for polygraph testing (Cote, 2016).

The 1980s saw the emergence of the computerised polygraph, from research conducted at the University of Utah, where Drs. John C. Kircher and David C. Raskin, developed the Computer Assisted Polygraph System (CAPS). It was not until 1992, that the algorithm used in evaluating physiological data for diagnostic purposes, made its official entrance into the computer world (Cote, 2016).

In 2003, a committee was formed in the USA to review the scientific evidence on the polygraph. The Governing Board of the National Research Council of the USA approved this committee. The members that conducted the review were from the councils of the National

Academy of Science, the National Academy of Engineering, and the Institute of Medicine (National Research Council, 2003). The review committee found that although alternative methods existed to determine truth from deception, none was better than the polygraph at the time. The polygraph therefore remains the most reliable means of measuring physiological responses in the attempt to determine truth from deception (National Research Council, 2003).

The Use of the Polygraph in the Rest of the World

The USA is the world's most active user of the polygraph. Several well-known state departments employ the polygraph, including the Department of Defense and its many investigative agencies in the Army, Navy, Marines and Air Force, as well as the National Security Agency (NSA), Central Intelligence Agency (CIA), United States Secret Service, Federal Bureau of Investigation (FBI), Internal Revenue Service (IRS), the Department of Energy, and the Drug Enforcement Administration (DEA; Volyk, 2016). Apart from these major organisations in the USA, their local and state law enforcement agencies, district attorney offices, public defenders, lawyers, parole and probation departments, and public and private companies, also make frequent use of the polygraph (Volyk, 2016). In the rest of the world, approximately 90 countries are known to use the polygraph. These are, Mexico, Israel, Ukraine, Russia, South Africa, Colombia, Japan, South Korea, Singapore, Canada, India, Romania, Hungary, Bulgaria, Slovenia, Croatia, Serbia, Poland, Czech Republic, Slovak Republic, Lithuania, Turkey, Saudi Arabia, United Arab Emirates, Australia, Philippines, Malaysia, Indonesia, El Salvador, Panama, and Guatemala (Volyk, 2016).

In 1997 the polygraph was introduced to Ukraine by Dr Adriy Volyk, who after visiting the Lafayette Instrument Company in the USA, developed the Ukraine's polygraph market. He became the representative of the polygraph suppling Lafayette Instruments in

Azerbaijan, Armenia, Belarus, Estonia, Georgia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan. The ARGO-A company, established by Dr Volyk, has grown into Lafayette Instrument Company's most popular agency in Europe (Volyk, 2016).

The Polygraph Industry in South Africa

The polygraph industry in South Africa is governed by two polygraph associations or federations, namely: (1) the South African Polygraph Federation (SAPFED), and (2) the South African Professional Polygraph Association (SAPPA).

The South African Polygraph Federation. The South African Polygraph Federation (SAPFED), provides an oversight platform both in South Africa and in the greater Southern African context. Ensuring that members adhere to strict ethical and operational codes of conduct promoting honesty, unity and integrity (SAPFED, 2017). According to the SAPFED website, 65 polygraph examiners practice under its protective cover, however, this is possibly not an accurate reflection, as website information is not regularly updated (Sapfed.org, 2017). SAPFED members are trained to deal with the multi-cultural nature of forensic work in South Africa, and to deliver scientific and meaningful practice in psycho-physiological detection of deception (SAPFED, 2017). Polygraph examiners registered with SAPFED are subjected to a strict code of ethical conduct and a code of standards of practice policies. This ensures that practitioners keep within the ethical and professional polygraph testing boundaries in their service to the public (SAPFED, 2017).

The South African Professional Polygraph Association. The South African Professional Polygraph Association (SAPPA) (Polygraph, 2017) is another body that regulates polygraph use in South Africa. SAPPA members are divisional members of the World Polygraph Body, known as the American Polygraph Association, and adhere to the

ethical, technical, and moral standards of practice that are consistent with the American Polygraph Association (APA), and the American Society for Testing and Materials (ASTM – International; Ryneveld, 2017). The APA is the world's largest professional polygraph body with more than 2500 polygraph practitioner members. ASTM – International, has a Memorandum of Understanding with South Africa and 66 other countries (Ryneveld 2017).

The Polygraph Instrument

The Lafayette Instrument Company in Lafayette, Indiana, in the USA, manufactures the polygraph instrument. The company has been manufacturing polygraphs since the 1950s, and dominates the global sales market of lie detectors. The Lafayettte Instrument Company was established in 1947, by Max Wastl, and supplies instruments to polygraph examiners in 90 different countries (Cote, 2016).

The Lafayette Instrument Company provided their first polygraph instrument in 1973, since then they have continued to provide all the types of measuring tools required by polygraph examiners. In 2007, they invented the first wireless computerized polygraph in the world named the LX5000-SW. They also produced the modern portable lie detector (PCASS) for the Pentagon in 2008. Currently the LX4000-SW is recognized as the most reliable polygraph instrument in use (Cote, 2016).

Krapohl, Handler, and Sturm (2012) describe the polygraph as follows:

> By definition, an instrument that simultaneously records two or more channels of data. The term now most commonly signifies the instrument and techniques used in the psychophysiological detection of deception (PDD), though polygraphs are also used in research in other sciences. In PDD the polygraph traditionally records physiologic activity with four

> sensors: blood pressure cuff, electrodermal sensors, and two respiration sensors (p. 47).

An instrument that is used as adjunct to the polygraph during testing is called the photoplethysmograph (PPG). It uses the reflection of red light on the skin to detect the change in the volume of blood in the upper layer of the skin. This is recorded at the finger tips when conducting a polygraph test (Krapohl et al., 2012).

The purpose of the polygraph is to measure and record the physiological arousal that signals reaction between the sympathetic and parasympathetic nervous system. To do this the polygraph is equipped to measure four sensory or bodily responses: shallow respiration, deeper respiration, blood pressure, and skin conductance, which are recorded simultaneously and then analysed by the polygraph examiner (Krapohl et al., 2012; National Research Council, 2003). This is achieved by sensors which are attached to the subject's body, that records breathing rate, pulse, blood pressure, and perspiration. These four recordings form the basis of all polygraph tests. Some examiners add two more measures to the test and monitor responses of blood flow through the legs and the maximus gluteal muscle. This is done by placing a sensory pad on the subject's chair upon which they sit. This pad is sensitive to movement of the muscles and blood flow (Krapohl et al., 2012; Noback et al., 1996; Zillmer et al., 2008).

The Different Procedures in Polygraph Testing

The polygraph is mainly used for three different test procedures, these include: (1) *the pre-screening test*, which is used by companies when they recruit new employees. This is referred to as pre-employee screening and employee screening, (2) *event-specific investigative testing*, here polygraph testing is conducted in cases where specific crimes or misconduct are alleged to have taken place, and (3) *sex-tests*, here the polygraph test is

utilised in cases where a partner in a relationship is being questioned to determine if they were unfaithful or not (Krapohl et al., 2012).

The focus of the current study concerns the pre-interview, directly related to the polygraph test done in event-specific investigative testing, described in the previous paragraph. The pre-interview is utilised to clarify the specific event under scrutiny, to explain the procedures to the individual undergoing the test and in turn reduces anxiety (National Research Council, 2003). The same questions that are asked during the polygraph test are asked during the pre-interview, in order to reduce anxiety and remove reactions of surprise that could produce arousal in emotions, and cause heightened physiological responses during the actual polygraph test (Krapohl et al., 2012; National Research Council, 2003). The pre-interview in relation to the event-specific investigation will be discussed further in relation to the aim and purpose of the current study.

The Pre-Interview Relating to the Event-Specific Investigation. The event-specific investigation test is also referred to as the specific issue polygraph examination, and focuses investigative questions on a single-issue aimed at the psychophysiological detection of deception (PDD) (Krapohl et al., 2012). Event-specific polygraph testing is predominantly administered during criminal investigations or in cases where a single issue is explored, and referred to by polygraph examiners as *'a specific'* (Krapohl et al., 2012, p. 12). The event-specific test differs from the pre-employment and screening tests, due to the nature of the test having a single purpose focus, to uncover a single criminal act, in comparison to the pre-employment and screening of employee suitability to a certain job requirement, which is cumbersome and is multi-purposed focused (National Research Council, 2003). The National Research Council (2003) has found that the event-specific test has a higher accuracy rate in validity and reliability, compared to the pre-employment and employee screening tests. A

specific question procedure is followed in the pre-interview and will be discussed in the next paragraph, known as the Air Force Modified General Question Test.

The Air Force Modified General Question Test. The Air Force Modified General Question Test (AFMGQT) procedure is discussed as it was used by the polygraph examiner during the duration of this research project for the purposes of psychophysiological detection of deception (PDD). The term 'psychophysiological detection of deception' (PDD), is a scientific term used by polygraph examiners to refer to diagnosing deception (Krapohl et al., 2012).

The AFMCQT is a polygraph question format frequently used by the USA's Federal Government (Senter, Waller, & Krapohl, 2008). Krapohl et al., (2012) evaluated the validity aspects of the AFMCQT during a controlled laboratory study, and found that the format and method produced "definitive accuracy rates that significantly exceeded chance levels for both truthful and deceptive participants" (Kapohl et al., 2008, p. 174). The AFMCQT questioning format is widely and effectively used during polygraph testing in a variety of criminal investigations (National Research Council, 2003).

The AFMGQT is defined as follows by Krapohl et al. (2012):

> This method of questioning make use of the comparison question testing format. The comparison question, used primarily within the U.S. Government, with flexible question orderings and numbers of relevant questions. The AFMGQT can be used in single-issues, multiple-facet, and multiple-issue PDD examinations. The AFMGQT uses relevant, probable-lie, sacrifice relevant, and irrelevant questions. Symptomatic questions are not used. (p. 2)

The comparison question testing format mentioned in the definition of the AFMGQT above contains a set of five questions. These questions are used

systematically during the interviewing and polygraph testing time (Krapohl et al., 2012). The question set will be discussed in the paragraph below.

The comparison question testing format. The question format utilised within the AFMGQT during polygraph testing will be summarised and explained here as it relates to the approach and formulation of the questioning technique during the pre-interview, and then used in full during the polygraph test. The question format includes the following questions: (1) relevant questions, (2) probable-lie questions, (3) sacrifice relevant questions, (4) irrelevant questions, and (5) control questions.

Relevant questions refer directly to the specific criminal issue being investigated. For example: "Did you do it?" type questions (Krapohl et al., 2012). *Probable-lie questions* refer to questions that are focused on issues about which the participant would be untruthful or unsure. Krapohl et al. (2012) describe these questions as follows:

> Their intended purpose is to create a competition of salience such that the anxious innocent examinees will expend more of their physiologic responses on them than the relevant questions, but the guilty examinees will still find the relevant questions more arousing than the probable-lie question (p. 49).

The examinee who is deceptive believes that he/she must pass the probable-lie questions to pass the polygraph test as a whole. However, the probable-lie questions are different from a direct-lie questions. An example of a probable-lie question is: "Have you ever stolen anything in the past 5 years?", compared to a direct-lie question: "Did you steel the Samsung J5?". *Sacrifice relevant questions* intend to establish a basis of truthfulness in the test taker. The examinees are asked specifically if they intend to answer all the questions related to the relevant issue being investigated in a truthful manner. This question however is not scored and is built into the method to evoke moral values in the examinees, to answer questions put to them in a truthful manner (Krapohl et al., 2012).

The purpose of *irrelevant questions* are to ensure that the participant's physiological responses return to baseline levels and are built into the process to follow the *relevant questions* in a set of questions. For example: "Is it Tuesday today?" or "Is your name Fred?" (Krapohl et al., 2012). *Control questions* are also referred to as comparison questions. They are questions designed to produce greater physiological responses from an innocent test taker, compared to the responses produced during the relevant questions (Krapohl et al., 2012).

The main purpose underlying the questioning system within the polygraph test, is to compare physiological responses to questions which are put to the examinee, and to measure the responses received from questions that are directly relevant to the crime committed or the current investigation, to irrelevant matters (National Research Council, 2003). This raises the issue of how accurate the polygraph is, and if the measured responses are scientifically reliable and valid. The next section will discuss the reliability, accuracy and validity of the polygraph.

The Reliability, Validity and Accuracy of the Polygraph

The polygraph test directly measures physiological responses and indirectly indicates if an examinee was deceptive or truthful, according to the interpretation of their physiological responses in relation to the questions answered (National Research Council, 2003). Firstly, the reliability of the polygraph will be discussed, followed by its validity and accuracy.

Reliability. The term reliability, regarding the polygraph test, infers that the same results should be produced when the same measurement and questioning procedures are used (National Research Council, 2003). An added factor in the reliability of polygraph testing is that different examiners operate the polygraph in different settings on a daily basis in the world, with the same reliability (Senter et al., 2008). The term used to refer to different examiners arriving at the same conclusions concerning a given topic or investigation, is

called inter-rater reliability (National Research Council, 2008). The inter-rater reliability issue, within the polygraph environment, is the focus of consistently completing the chart scoring when a polygraph examiner conducts the test (National Research Council, 2003). In other words, will each polygraph examiner complete the score chart in the same manner every time?

The National Research Council (2003) set out to investigate the reliability of the polygraph. It identified the following five variables which have been found to influence the reliability of the testing: the type of questions being asked, the manner these questions were put to the examinee, the setting or conditions the tests were administered in, and the emotional attitude of the polygraph tester. A higher reliability is ensured if the polygraph is to be applied in a consistent manner across the range of examinees being tested (National Research Council, 2003). The deduction is made that the polygraph will have a higher reliability level during the use of the same question format, stable and calm setting, and environment in which the testing takes place. This is also affected by the examiner, who should be relaxed, and not under pressure to rush the test (Stern, Slavkovic, Cutchen, & Johnson, 2003). The reliability may be a high requirement for a scientific conclusion, but if the polygraph tester measures something completely different from what it is supposed to measure, the validity of the results will be affected (National Research Council, 2003). The next section deals with the issue of validity and accuracy of the polygraph.

Validity and Accuracy. Polygraph results are valid if the polygraph measures what it sets out to measure (Krapohl et al., 2012). The polygraph is seen as being accurate if the test results match the physiological responses with the relevant questions asked, and indicates deception or non–deception (National Research Council, 2003). The term accuracy is often used as synonym when polygraph validity is discussed (Vrij, 2008). The term accuracy is generally used when the polygraph results relate directly to the number of correct judgments

made by the polygraph examiner. The National Research Council (2003) found that the polygraph is more accurate in testing criminal investigations, compared to employee screening. This is important and relevant in the current study, as participants undertook the polygraph test in the category of event-specific testing, and were investigated for alleged involvement in criminal activity. The second important factor regarding validity in polygraph testing, is the presence of a supporting theory. This is referred to as construct validity, as it explains the concepts involved in the performance of a test (National Research Council, 2003). Such a theory has been verified by the National Research Council (2003) which states that deception "leads to psychological arousal, which in turn creates physiological arousal" (p. 32). The polygraph measures the physiological responses, which are the galvanic skin response, respiration, heart rate, and relative blood pressure (Krapohl et al., 2012). Therefore, according to this theory, accurate measures of psychological arousal will produce a higher validity.

The Difference Between the Terms Deception or Non-Deception Indicators

The polygraph is designed to indicate the psycho-physiological changes of the body (Krapohl et al., 2012). These are measured by the polygraph instrument and recorded for audit purposes. The terminology used when a test taker fails a polygraph test is referred to as a DI result, which means Deception Indicator. On the other hand, when a person passes the polygraph test it is called a NDI, meaning Non-Deceptive Indicator (Krapohl et al., 2012).

Conclusion

This chapter dealt with the deception detection methods in two major divisions: (1) nonverbal behavioural analysis, and (2) the polygraph. The nonverbal behavioural section covered the nonverbal behavioural responses by explaining nonverbal behavioural analysis, involuntary nonverbal behaviour, the importance of baseline behaviour, pacifying behaviour, and how the behaviour is expressed through the action domains of freeze, flight and fight.

This pattern of behavioural analysis provides a format by which an observer can measure nonverbal responses and uncover the truth.

The second half of this chapter addressed the polygraph and explained facets of the instrument relating to this study. An overview was provided by discussing the origin and historical development of the polygraph. Various aspects of the polygraph instrument were discussed in relation to its utilization, including the questioning system used during polygraph tests, and its relation to the pre-interview and the relevance to this study. The psychophysiological measures recorded by the polygraph were discussed, as well as its reliability, validity, and accuracy.

In the next chapter, a thorough description of the research design and methodology is provided. The primary aims, research hypothesis, the design and methodology, the participants and detailed description of the Body Action Posture (BAP) coding system used in analysing the data captured, the method whereby the body movements are measured, counted and coded, is included. This provides a structure for the research process, and forms a basis from which the research findings were discussed.

Chapter 4

Research Design and Methodology

Introduction

This chapter provides a comprehensive and descriptive overview of the research design and the research method employed in this study. This chapter follows two major paths, which are the combination of the nonverbal behavioural observations (from the pre-interview), and the data received from the polygraph testing. These two paths, the collection of the nonverbal data and retrieving the polygraph results, followed a parallel process during the capturing of the data. These concepts form the basis of this correlational study, between the data captured from the participant's pre-interview, and the results from the polygraph test. The primary aim of the current study, the research hypothesis, research design and methodology, participants and sampling, data collection methods, and the measures conducted with the data recorder are discussed in this chapter. Furthermore, explanations concerning the coding system referred to as the Body Action and Posture coding system (BAP), the reliability and validity issues regarding the BAP measuring tool, the pre-interview procedures, the data collection procedures, and the ethical considerations, are all consolidated within this chapter.

Primary Aim of the Study

The primary aim of this study was to explore and describe the relationship between the observational nonverbal data collected from participants during polygraph pre-interviews and their polygraph test results. The objectives of the study were to describe the relationship between specific non-verbal behaviours, as well as positive and negative polygraph results linked to deception. The purpose of the study was not to generalise the results to a larger population, but to generate hypotheses regarding the relationship between nonverbal

behavioural signals in the deceptive indicator (DI), and non-deceptive indictor (NDI) groups of the polygraph results. The polygraph was utilised as a tool to measure participants' physiological signals and to designate their results as indicative of deceptive behaviour. Figure 5 below, illustrates the process and path of the current study.

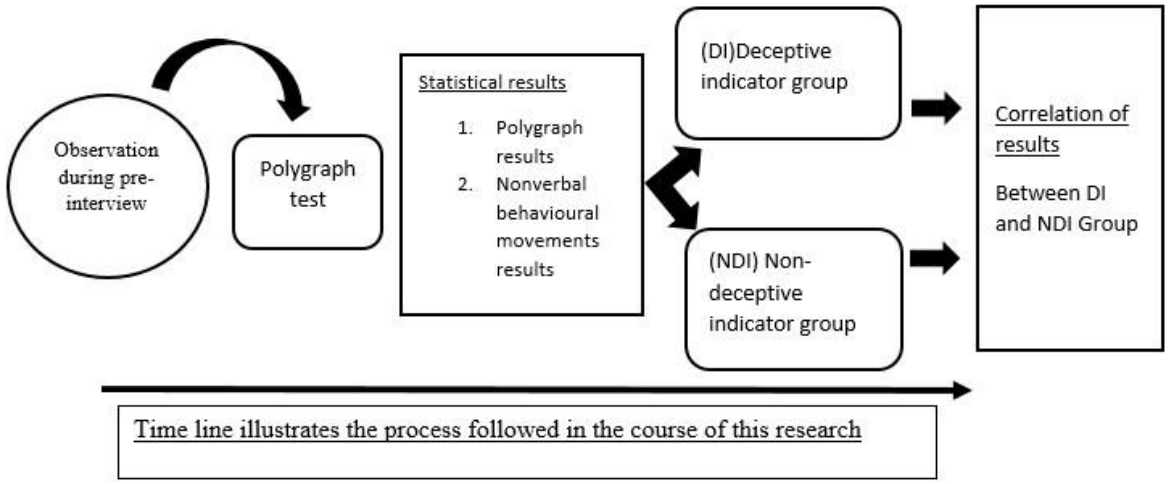

Figure 5. The Process of the Current Study.

Research Hypothesis

There are significant statistical differences in the relationship between the nonverbal behaviour of participants in the deceptive indicator (DI) group, compared to the non-deceptive indictor (NDI) group.

Null Hypothesis

There are no significant statistical differences in the relationship between the nonverbal behaviour of the participants in the deceptive indicator (DI) group, compared to the non-deceptive indicator (NDI) group.

Research Design and Methodology

The research design was a quantitative correlational study, which explored and described the relationship between specified nonverbal behavioural observations, as well as the deceptive and non-deceptive indicator results of the participants taking the polygraph test. De Vos, Strydom, Fouche, and Delport (2005), refer to the work of Graziano and Raulin, (2000), and state that they brought clarity to the nature of correlational research. It is important to note that a correlational study does not describe causality in scientific research, but describes consistent existing relationships that can be used to predict future actions (De Vos et al., 2005). Predictions are possible without being able to explain the reason for the relationship between two variables (De Vos et al., 2005). The further value concerning a correlational study is that the data provided can shed light in support of a theory, or show inconsistencies concerning a specific related theory and refute it (De Vos et al., 2005). This research is not concerned with the cause-effect relationship between the two groups (the DI and the NDI group), but rather on the nature of the relationship between the two groups (De Vos et al., 2005). This research study is quantitative in nature, and aimed to establish application to detecting deceptive behaviour by appling the data to real life situations (De Vos et al., 2005).

This quantitative study utilised the Body Action and Posture (BAP) coding system to develop measurable data from the nonverbal behaviour of the participants in order to count it, and conduct a correlational study between the two groups (Dael, Mortillaro & Scherer, 2012). The next section will provide more clarity on the sampling procedure, participant selection, and participation.

Participants and Sampling Procedure

Participants were identified through non-probability purposive sampling. Purposive sampling is based entirely on the judgment of the researcher, as samples chosen contain characteristics and representative attributes of the population that serve the purpose of the study (De Vos, Strydom, Fouche, & Delport, 2011). The inclusion criteria for this study were that the participants had to be adults who were in command of basic written and spoken English. Furthermore, they voluntarily gave their informed consent to participate in the study, and granted the researcher access to the results of their polygraph test, and permission of their nonverbals to be recorded during the pre-interview. Potential participants included all those who were referred to a polygraph truth verification service provider in Port Elizabeth by their employers for polygraph testing due to possible involvement in criminal activities.

The sample consisted of 36 participants in the deceptive indictor (DI) and 32 participants in the non-deceptive indicator (NDI) group. Once all the participants took part in the study, after their pre-interview and taking their polygraph test, the researcher was ready to conduct the study. De Vos et al. (2005) stated that 30 participants are sufficient to perform basic statistical procedures. The total of 68 participants in the current study were seen as sufficient, as the sample size presented above the minimum requirement made by De Vos et al. (2005). The next section will review the data collection phase within the scope of this study.

Procedure

The Faculty Research Technology and Innovations (FRTI) and the Research Ethics Committee, Human (REC-H) of the Nelson Mandela University (NMU) approved the present study. Permission was also obtained from the polygraph service provider to conduct the study at the company, see Appendix L in the Letter of agreement between the researcher and the researcher to access participants being tested.

The researcher approached participants who were referred for polygraph testing by the service provider. Only potential participants who arrived to undertake the event-specific investigation polygraph test were approached. On the days that data were collected the researcher was present at the service provider's venue. These potential participants were approached by the researcher in the reception area on arrival for their pre-set appointment time, before they entered the examination room. At that time the researcher informed them of the study by giving them background information about the study being conducted, and asked if they would be interested to participate. The researcher then handed them a letter informing the participant about the study (see Appendix F). The contents of the letter providing information concerning the study being conducted and the role the participant could play in the study where explained to each participant.

The following aspects were then explained to the participant: The aim, procedure, risks, possible benefits, confidentiality, access to findings and their voluntary participation, of which each participant had to undersign that these points were explained to them. The potential participants were also informed that the researcher would observe their nonverbal behaviour and movements during the pre-interview, before the polygraph test was administered. Thereafter, the researcher would be given their polygraph test results. Furthermore, the participants were informed that their identity and personal information would be kept anonymous. The participants were given the opportunity to ask questions concerning the study and their involvement. The researcher's expectations were discussed, as were the risks, benefits, and the rights of each participant. The participants were informed that they would be required to give written informed consent to participate in the study.

Further explanation about the voluntary nature of their participation was provided, and they were informed that they could withdraw from taking part at any time, without penalty. The participants were informed that the results of the study might be presented at

scientific conferences, or in special publications and were assured that if this was the case, their anonymity would be protected. The participants were informed that the Research Ethics Committee (Human; REC-H) of the Nelson Mandela University approved the study.

Once the participant indicated that they were willing to take part in the study, the researcher then handed the participant a consent form (see Appendix G). The researcher then read through each aspect in the consent form with the participant who indicated that it was understood and acknowledged and signed at each point.

After the participant signed the consent form, the polygraph examiner conducted the pre-interview. Prior to this, the researcher entered the pre-interview room together with the participant, and placed the video camera in the room, which recorded the movements of the participant during the pre-interview only. Once the pre-interview had been concluded the camera was removed from the room and the participant continued with the polygraph test. No audio sounds were recorded during the pre-interview, and only the participant's movements were recorded. The consent form of each participant was not linked by any means in writing, or with a number, to the participant's recording. This was done to ensure that neither the identity, nor the name and addresses of participants, could be linked to the video footage captured.

The consent forms of the participants were filed in a special file and only the researcher has access to it. The video recordings of each participant was kept in a video file on the computer of the researcher that was protected with a password. The strictest caution was taken to ensure each participant's confidentiality and privacy was maintained.

Data Collection

The data was collected from two focus areas concerning this research: (1) the nonverbal behaviour in the pre-interview, before the polygraph test was taken by the

participant, and (2) the results collected by the polygraph test. The data collection process and methods will be discussed by first reviewing the collection process of the nonverbal behaviour, and secondly the data collected through the polygraph. Data collected from the participant's nonverbal behaviour during the pre-interview were conducted through observations in a real life setting, by extracting the nonverbal behaviour from the participants through video recording of their movements. The recorded data were then viewed in a 'data recorder' that will be described in detail in a paragraph below. The nonverbal movements of the participants were noted, and specific codes were allocated to each movement relevant to the focus of the study. These observations focused on the head, shoulders, hands and feet.

The data collection method that was applied during the observations of the participant's movements were done manually, by applying a technique referred to by Cohn and Ekman (2004) as manual coding. Manual coding is a term used to describe the physical, non-automotive manner, utilised in noting and ascribing values to specific movements observed (Cohn & Ekman, 2004). According to Cohn and Ekman (2004) manual coding is most frequently used to study body movements during physical observation, and is especially relevant in conducting analysis of pre-recorded digital images. All the relevant data (see Appendix A) were recorded on a spreadsheet indicating the case identification number, the polygraph test result, time of day, cultural group, gender, age, the duration of each digital recorded interview, manually coded, and the four body parts observed including an indication of their movements. The Body Action Posture (BAP) (Deal, Mortillaro, Scherer, 2012) coding system was used to code the movements manually. The next section introduces the nonverbal behavioural focus of this study in relation to the observations completed.

Nonverbal Movements in the Pre-Interview. The movements of the head, shoulders, hands and feet, were recorded during the observational stage of the study. Body movements were observed according to two groups that originated from the results of the

polygraph test, and will be discussed after the nonverbal movements of the head, shoulders, hands, feet and legs are dealt with here.

Nonverbal Movements.

The nonverbal movements of the head, shoulders, and hands are always visible and can be monitored during normal conversation without effort. The feet, which are described by researchers, Givens (2002), Navarro (2008), and Vrij (2005, 2008) as the most honest part of our nonverbal intentions, as they indicate our true direction of interest. The feet are also a visible body part that can be monitored. From an early age humans learn how to manage and control their upper body because of its primary functions, as a result their primary focus is not directed at controlling their feet, and it is for this reason that feet are referred to as the most honest part of the body (Givens, 2002; Navarro, 2008; Morris, 2002; Vrij, 2008).

The nonverbal behavioural patterns that were observed for the purposes of this study were derived from focusing on the movements of the head, shoulders, hands (arms and fingers) and feet. The reason for selecting these areas was decided upon because these are specific movements regulated by the autonomic nervous system (ANS), and connected via the cranial nerves, linked to the head, shoulders and hands (Givens, 2002). Specific movements or non-movements were anticipated during this study, especially movements directly linked to the reactions elicited from ANS responses.

The cranial nerves regulate and control the automatic movement of the head, shoulders and hands, therefore this cluster will move in unis, yet due to the same nerve origin and trigger generated by an event, an observer will either see one of these parts (head, shoulder and hands) move, or will notice them all moving at the same time (Givens, 2002). The body actions and posture of the head, shoulders, hands and feet will be recorded and observed during the participant's pre-interviews of their polygraph tests, and these results will be correlated, compared and analysed specific movements linked to the final result of the

polygraph test (Dael et al., 2012). In other words, how the movements of these areas correlate with a pass or fail polygraph test results.

The Head. Head movements related to this study and observed during the pre-interview included six movements of the head: facing the interviewer, turned away from the interviewer, tilted to the left, tilted to the right, moving vertically upwards, and moving vertically downward (Dael et al., 2002). Detailed descriptions of these movements can be viewed in Appendix B, and will only be briefly described here. The head movements are structured according to the Body Action and Posture (BAP) coding system designed by Dael et al. (2002). They are set out within the coding systems in three categories: the BAP code, the behavioural variable, and a short description. Prior to explaining the head movements, the directions of the movements in their anatomical planes or axis in which the different positions are expressed, will be described. It is important to be orientated in the direction how the body moves in its anatomical lanes.

The three movement directions are explained below (Iazzetti & Rigutti, 2006):

1) The sagittal axis: The direction of movement on this axis is referred to as movement that occurs from left to right.
2) The vertical axis: The direction of movement on this axis is back to front movement.
3) The transverse axis: The direction of movement on this axis is horizontal or rotational movements

Figure 6 below, illustrates the three planes described above.

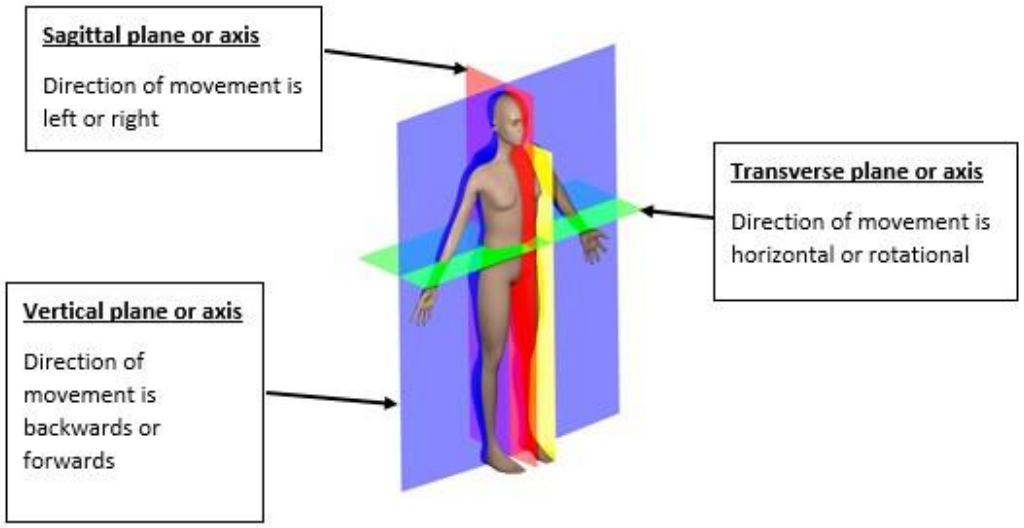

Figure 6. Anatomical Planes and Axis of Body Movement, Direction and Rotation (Iazzetti & Rigutti, 2006, p. 19).

The Body Action and Posture coding system describes the following movements of the head. The head facing and is oriented towards the interviewer. When the head is oriented away from the interviewer it is referred to as being averted (Dael et al., 2002). The head can tilt either to the right or the left. These movements are observed when there is a lateral head tilt to the left position, this is seen when there is a rotation of head around the sagittal axis resulting in the head tilting laterally towards the left shoulders (Dael et al., 2002). The head tilt to the right position, describes the head when rotating around the sagittal axis and tilts laterally towards the right shoulder (Dael et al., 2002). The last two movements of the head observed are the head vertical up or down movements. Head vertical up, is when the head tilts towards an upward position, which infers a rotation of the head around the transversel axis resulting in the lifting of the head relative to its standard resting position (Dael et al., 2002). The final head movement observed was the head tilting towards a downward position. The downward tilt of the head is seen as a rotation of the head around the transversel axis,

resulting in the head dropping down below and relative to its standard resting position (Dael et al., 2002).

Neurologically head movements are controlled by the visceral nerves originating from the cranial XI, which have a strong relationship to the vagus nerve in the cranial X (Zillmer, Spiers, & Culbertson, 2008). The head motions are linked by nerves to the trapezius, shoulders, and voice box, and produce not only shoulder movement but also voice tone differences, such as the agreement sounds of, “hmm” and “uh huh”, when we nod our heads in cognitive response indicating agreement or rejection (Givens, 2002; Zillmer et al., 2008).

Head movement studies show that head tilts, like lowering of the head, indicate submissiveness, and when the chin is tucked inwards and down towards the chest it is an indication that confidence is low. During freeze and flight, the head will respond by turning away or move backwards (Givens, 2002). We lean away from something we see as a threat, or when we do not enjoy an experience, and we lean forward to indicate emphasis or interest (Givens, 2002; Navarro, 2008).

During the data collection phase special observational attention was given to a number of head movements during manual observations of the participants. One of these was the head tilt to the left or right side, which has been found to show openness, friendliness and is seen as a submissive signal (Givens, 2002). Participants will tilt their heads when they are perceptive or open to a question (Givens, 2002; Navarro, 2008). However, the head tilt, together with the shoulder shrug, is a clear indicator of being unsure, and signals a low confidence response (Navarro, 2008).

The head facing and averting were important nonverbal signals noted in this study. The head facing the interviewer indicates attentiveness and engagement (Givens, 2002), whereas the head averting is an avoidance signal, depending if it is illustrating or emphasising what is being said (Navarro, 2008). Head movements do not show deception,

but can be linked to indicators of engagement and comfort, or avoidance and discomfort, or show the opposite to what the context requires (Givens, 2002; Navarro, 2008). The next section will discuss the shoulder movements.

The Shoulders. Shoulder movements included the following movements: left shoulder up, left shoulder down, right shoulder up, right shoulder down, both shoulders up, and both shoulders static (Dael et al., 2002). Detailed descriptions of these movements can be viewed in Appendix C. Shoulder movements are categorised according to the Body Action and Posture coding system designed by Dael et al. (2002) and described here in the three categories of the BAP code. The shoulder movements will now be discussed in terms of how the BAP coding systems describes the different movements that could potentially be observed.

The shoulder movements that could be observed are described as follow: the left and right shoulder move up, when the shoulder is lifted up in a position relative to its anatomical, resting or static position. (Dael et al., 2002). The left and right shoulder move down, when the shoulder is dropped or lowered to the ground relative to its static and normal position, both shoulders are drawn upwards from their resting position, and when both shoulders remain static and are not moving (Dael et al., 2002).

The shoulders are very flexible, sensitive and are described as a visual part of the body (Givens, 2002). Their movements orientate strongly towards an individual's emotional expressions, feelings and moods (Navarro, 2008; Vrij, 2008). When a person's shoulders bounce upwards they are happy, and when they dip downwards it expresses depression (Navarro, 2008). The emotional expression relayed to the shoulders is due to the special visceral nerves controlling the upper trapezius (Givens, 2002).

There are three distinct and very noticeable shoulder signals. These are: (1) the one shoulder-shrug, (2) when both shoulders shrug upwards (the two shoulder shrug), (3) when

both shoulders freeze in the top position, an upwards movement with the shoulders remaining in the top position, and can be described as if the shoulders are swallowing the head (Givens, 2002). With the one shoulder shrug, the one shoulder moves upwards, while the opposite shoulder remains static. This signal remains a power sign and expresses a strong emotional sense of being unsure in a dubious manner (Givens, 2002; Navarro, 2008). The second shoulder movement is the two shoulder shrug. This happens when both shoulders are lifted upwards. This is a universal signal and is expressed when we do not know, or are not sure, about something we have stated verbally (Givens, 2002). Shoulder shrugs can also be expressed without a connection to words, in this instance they relay the message that we are unsure (Navarro, 2008). The third shoulder movement can be seen when both shoulders are kept in an upward freeze position. This has been found to express a strong emotional reaction and is linked to hiding away from danger (Givens, 2002; Navarro, 2008).

The Hands, Arms and Fingers. Hands are described as the most expressive part of our body, as they are seldom completely still (Givens, 2002). Hand movements include the hand shrugs showing palm up and palm down actions, hands held in a symmetrical and asymmetrical position, left arm still, right arm still, left hand and finger movements, right hand and finger movements, self-touch behaviour, and thumbs moving up and downwards. The full description of the BAP coding system for the hands can be viewed in Appendix D (Dael et al., 2002).

The hand and arm movements are described according to the BAP coding system. Firstly, hand and arm movements are observed systematically and start with the left and right hand shrugs. These shrugs can be described as hand-wrist articulation behaviour, resulting in the whole hand moving with the palms facing into an upwards position (Dael et al., 2002). Secondly, the handhold, symmetrical or asymmetrical. This handhold is seen when both hands are held in front of the body. For the symmetrical hold, both hands/arms hold each

other in an equally balanced position, and for the asymmetrical hold, the one hand holds the other hand, where one hand either holds the other hand or one arm rests on the other arm (Dael et al., 2002). Thirdly, observation of arm movement, when one arm was kept still in an action hold. Here one arm is kept static while the other arm or hand is performing an action. (Dael et al., 2002). Fourthly, finger movements can be observed. These are referred to as finger articulations, meaning one or more fingers on the right and left hand will point, tap or move (Dael et al., 2002). Fifthly, touching behaviour is where one body part touches another body part, or an object, and forms part of an action (Dael et al., 2002). The sixth action concerns the thumbs. The focus were the hands when they were held in a symmetrical position in front of the body, and specific notice was taken concerning the movement of the thumbs, specifically if they moved into un upward or downward position (Dael et al., 2002).

Further explanations concerning hand movements are explored in the next section according to the BAP coding system, and a connection is made between hand movements, and how these expressions can be linked to emotional and cognitive processing.

In palms down gestures, the hand rotates downward and shows confidence, assertiveness, and control (Givens, 2002). However, during aggressive behaviour, where beating signals are seen, palms down then indicate convincing gestures, with the aim of adding volume and enhancing a strong verbal statement (Givens, 2002).

With palms up the hand rotates into an upward position. This is seen as a begging or appealing gesture (Givens, 2002). Uplifted palms suggest a vulnerability, a begging to be believed, and reflects emotions of uncertainty (Givens, 2002). Darwin (1872) noted that the palm up sign is part of the shoulder shrug gesture, reflecting the emotion of uncertainty. Rotating the palm upwards, tilting the head and shrugging the shoulder is the full formation of the reflection of the emotional expression of uncertainty (Givens, 2002). The rotation of the hand occurs through the action of the 6th cervical nerve controlled through the brachial

plexus (Givens, 2002). The open, palm-up hand-shrug, is a sign of helpless uncertainty and confusion (Ekman & Friesen, 1968). Given's (2002) identified this as a gesture inferring deception.

Self-touching cues reflect sympathetic nervous system arousal levels linked to the flight response (Givens, 2002; Navarro, 2008; Vrij, 2008). We touch ourselves, especially our faces, to calm ourselves when emotions run high, and when we experience increased levels of anxiety (Navarro,2008). According to Givens (2002), self-touch, massaging a hand, scratching, and rubbing, increase when stress factors are present, and may signal deception, disagreement, fear, or uncertainty. This behaviour is referred to as displacement behaviour, and is caused by high levels of anxiety, which is displaced into sporadic and impulsive movements. This is referred to as discharging nervous energy (Givens, 2002). An increase in scratching behaviour will be observed when anxiety increases (Vrij, 2008). Arm rubbing, neck touching, face touching, earlobe pulling, and scratching behaviour, are all identified as pacifying behaviours, which are controlled by the parasympathetic nervous system to keep the body free from stress during high anxiety (Navarro, 2008). Self-touch can safely be identified as a signal of discomfort and self-soothing behaviour (Givens, 2002; Navarro, 2008).

The Feet and Legs. The feet are described by Givens (2002) as being neurologically gifted. Feet are extremely sensitive and are well linked to diverse areas of the brain's parietal sensory strip on the homunculus; this causes them to play a large part in the nonverbal behavioural communication world (Givens, 2002). Feet not only indicate our direction of intended movement, but also show how we feel (Givens, 2002). Happy feet are shown by anti-gravity movements, like dancing and lifting of the toes pointing upwards (Navarro, 2008).

When a threat is imminent our feet are the first to freeze when a threat presents itself, then they turn to point in the direction of flight (Givens, 2002). Navarro (2008) observed that people who are having a conversation, often mimic each other's foot positions, and will move their feet to point at the person on whom are focused. According to Navarro (2008) and Vrij (2009), feet are the most honest part of our body, as they reflect the true intentions and emotions being felt. Feet will freeze, move forward, or withdraw according to our immediate emotional experiences (Givens, 2002). Foot movements will now be discussed according to how the BAP coding systems describes the different movements relevant to this study.

Any movement of the legs including legs shaking, bouncing, or rocking movements of the legs. Furthermore, feet moving forward, when stretched out in a resting position in front of the body, or feet observed in a neutral resting position. This is when the feet are kept in a natural middle position, relative to the anatomical standard position. It was further of interest when the feet were placed in a backwards position under the chair and pulled back. The last foot position monitored were the feet moving into a toe-to-toe position, described as one foot pointing towards the other foot. The complete coding list of the feet can be viewed in Appendix E. The next section will introduce the role of the polygraph related to data collection in this study.

The Results Collected from the Polygraph Test.

The previous section dealt with the description related to nonverbal behaviour. This section will describe the polygraph's role linked to the pre-interview, and generating the polygraph results.

Data collection related to the polygraph test included two stages. The first was from data captured from the pre-interview. This was before the polygraph machine was attached to the participant and was done through observations of their nonverbal movements. The second was the retrieval of the results on completion of the polygraph test. The polygraph results

indicated either a result that the participant failed the polygraph test, the deceptive indicator (DI), or the result of a pass, the non-deceptive indicator (NDI) (Krapohl et al., 2012).

The Pre-Interview.

This section will describe the pre-interview related to the collection of the data. During the pre-interview no sound recordings were done concerning the specific cases presented, only movements for each participant were recorded and analysed as prescribed by the ethics committee. All of the pre-interviews were video recorded, and they were all specific event-orientated interviews, which presented this study with a degree of consistency (Matsumoto, 2011; Matsumoto, Ekman & Fridlund, 1991). The recorded video footage included data from participants, these video recordings varied in length. This was due to the nature and differences in merits of each case investigated by the polygraph examiner. This presented the researcher with more depth of information, due to the uniqueness and length differences of each interview (Matsumoto, 2011; Matsumoto, Ekman & Fridland, 1991).

The pre-interviews made up the core of the data collection process for this study, as this was the context in which all the nonverbal behavioural data were collected.

The Procedure During the Pre-Interview.

The polygraph examiner started the polygraph test session with the pre-interview. The pre-interview prepares the examinee regarding the questions, which one asked during the actual polygraph test, and aims to retrieve and discover important information concerning the events, context, and involvement of the examinee (Galianos, 2012). During the pre-interview, the examinee was provided with the service provider's consent form, and the process of the testing was then explained in detail by the polygraph examiner. During this time, the polygraph examiner reviewed the incident details with the examinee, to ensure complete

understanding of the situation, and to determine that the correct set of questions were formulated, to guarantee an accurate outcome of the polygraph test (Galianos, 2012).

The pre-interview of the polygraph tests was presented in a question format, whereby questions were adapted to fit each specific investigating scenario. This question format refers to the specific questions put to each participant, due the differences of each real life case presented for polygraph investigation. According to Matsumoto et al. (1991) an unstructured interview, referred to as the adaptive question format explained above, possesses the advantage of being more flexible compared to a structured interview. The unstructured interview varies in length, in which the participants present behavioural cues, which may be studied for a longer period of time, but also with more depth (Matsumoto, 2011). Matsumoto et al. (1991) are of the opinion that a structured interview will cause the interview to be more rigged, and therefore inhibits the participant's expressions and movements, due to the restrictive conditions. During the present study, the participants were free to move and express themselves during the pre-interview, which was recorded for the purpose of analysis of the nonverbal behavioural signals.

The Conduct of the Polygraph Examiner During the Pre-Interview. The polygraph examiner uses the pre-test procedure to obtain a signed consent form, to establish the mental and physical state of the examinee, and to explain the instrument and examination procedures to the examinee (Galianos, 2012; Krapohl et al., 2012). It is the responsibility of the polygraph examiner to validate the testing technique, to state the technique being used to the examinee, to ensure that the correct sequence of questions will be followed, as well as to ensure the correct number and balance of relevant and control questions to be used (Galianos, 2012).

The polygraph examiner prepares the examinee by asking the exact questions set to be asked during the in-test polygraph examination. To ensure the examinee correctly

understands the questions, time is allowed to ask questions to clarify misconceptions (Galianos, 2012; Krapohl et al., 2012). This is done to minimise a surprise reaction and unwarranted physiological responses (Clifton, 1991). Once the examiner had concluded the pre-interview process, the polygraph test procedure followed directly afterwards.

The Polygraph Results in Data Collection. Once the polygraph test was completed, the polygraph examiner analysed the test charts and calculated the results. Each participant's results were provided to the researcher by the polygraph examiner and recorded on the researchers' data collection spreadsheet. The results retrieved from the polygraph examiner, who will be referred to as the service provider, divided the participants into two groups, namely the DI and the NDI group, according to their polygraph results.

Measures

Each of the analysis that were used are referred to in this section of the study. These include the nonverbal behavioural coding system and the data recorder utilised in counting the nonverbal movements of the participants' video recordings.

The Nonverbal Behavioural Coding System.

A nonverbal behavioural coding system, called the Body Action and Posture Coding System (BAP), was used in measuring nonverbal behaviour (Deal et al., 2012; Kipp, 2001). The BAP coding system provided a standardised protocol for describing non-verbal behaviour, minimises observer inference, and provides a detailed account of body movement (Kipp, 2001, 2012). The coding system is a fixed system with specified codes for every nonverbal movement and not influenced by subjective observational judgments by the observer, and provides a detailed and highly reliable description of body movement, action, parts, and posture, of the specific movements (Deal et al., 2012; Kipp, 2001). The complete BAP

coding system was described in the section above under the heading Data Collection, and the BAP codes can be viewed in the attached appendices (see Appendices B, C, D, E).

The Body Action Posture Coding System's Reliability and Validity.

The BAP coding system is based on human anatomy, and descriptions are directly linked to movements produced by the body (Deal et al., 2012). The BAP coding system was applied in the current study during the data- recording and collection phase. This was done by manually observing the footage recorded of the participants, and ascribing the different movement description codes to each movement made by the head, shoulders, hands, fingers, feet and legs.

The Data Recorder. A data recording system (referred to as the data recorder) was developed specifically for this study to count nonverbal behavioural movements of the participants (see Figure 7 below). This data recorder enabled the researcher to accurately count and record the data that was collected. To reduce mistakes in data measuring, and to ensure high accuracy, this data recording system was specifically designed for this study by Nicholas Blom, a 4th year Software Development student at Nelson Mandela University, on request of the researcher. The data recorder system was designed through the applications within the Microsoft tool set referred to as the System.Windows.Interop Namespace, which is part of Microsoft Visual Studio 2015 (Microsoft, 2017).

The data recorder system (see Figure 7) consisted of two frames, one frame provided place for the video recording of the participant to be loaded into the application and viewed, and the other frame, to the right of this, contained the radio buttons that allowed the researcher to press and indicate the various body movements noticed in the video (CodeProject, 2017). This was done through drop-down lists and radio buttons in the application, which allowed the researcher to indicated the different movements, by pressing the applicable keys according to the BAP coding system, with detailed reference to the names

and codes of the behaviour being observed (CodeProject, 2017). The researcher did observations of the participant's behaviour manually.

This Microsoft tool provided support and a connection between the Microsoft Office Word packages and the data recorder, for utilization on the researcher's personal computer (Microsoft, 2017). It created the system that allowed communication between the data recorder and Microsoft Word document-recording table (CodeProject, 2017). It also allowed for direct interaction between its keyboard functions and the word document, in which the data was recorded and saved (CodeProject, 2017).

The data recorder is illustrated in Figure 7 below. It consists of two components; the frame on the left, which is the designed video viewer and this, is interlinked with the frame on the right, which houses the keyboard section with the radio buttons of the data recorder, which is linked to the BAP coding system.

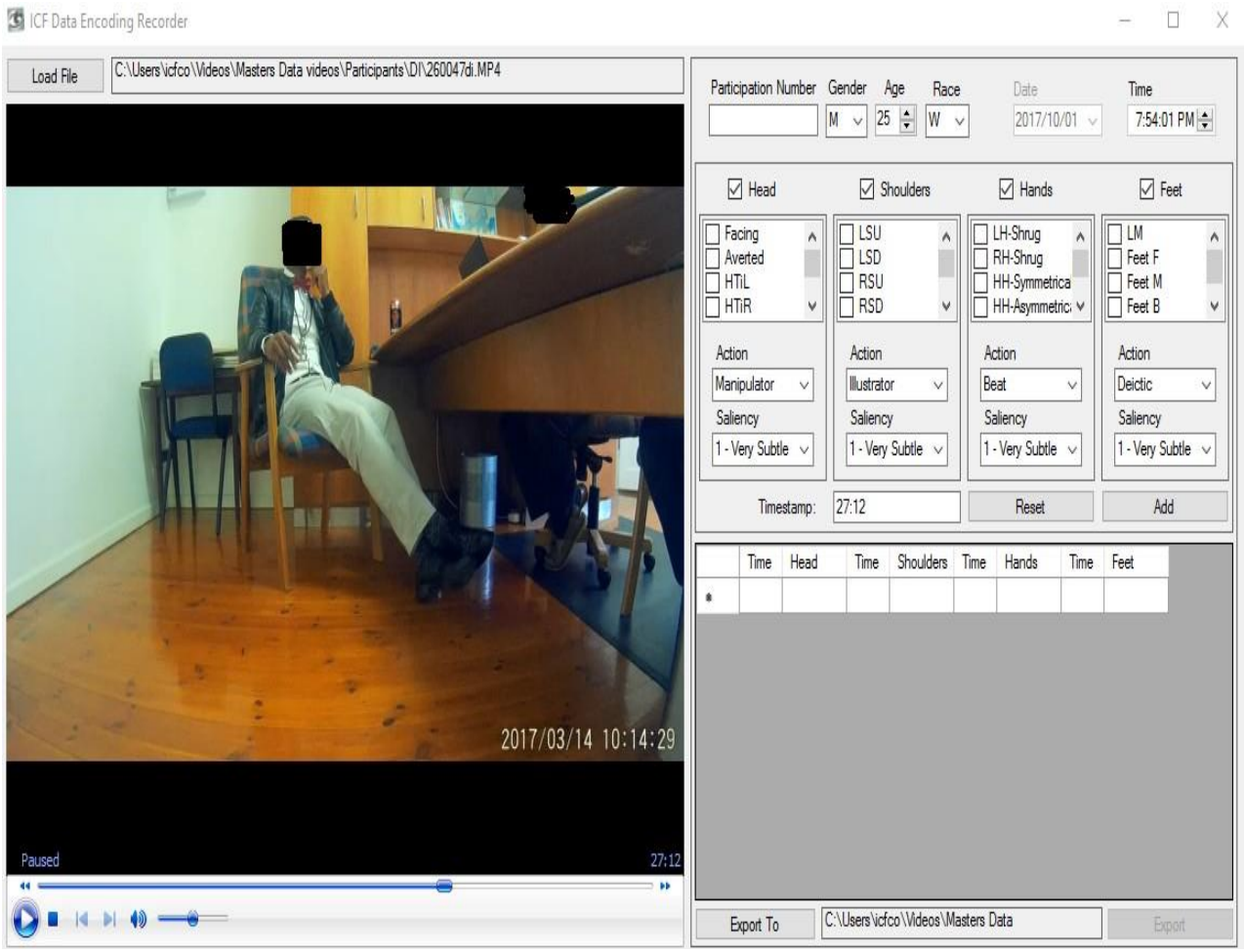

Figure 7. Data Recorder (CodeProject, 2017).

Once the particular coding was completed for a participant, all the relevant data was noted in a table, which was automatically created by the data controller. This is shown in Figure 8, which depicts one example of data that was collected from one participant and how it was coded. This shows the case identification number, the polygraph test result, time of day, duration of the footage, cultural group, gender, age, and the four body parts observed, including the indication of their movements.

The Microsoft Visual Studio 2015 data recorder described in the previous section (CodeProject, 2017), allowed the researcher to view the recording in slow speed, for accurate coding and specific observation purposes. The manual coding system does not explore movement quality descriptions, but identifies existing nonverbal movement of certain body parts (Ekman & Friesen, 1972; Mehrabian, 1972; Wallbott, 1998). It is a single system in which behaviour is categorised in terms of action, posture, and levels of anatomical form and function (Dael et al., 2012). The BAP developers provide evidence of coding, reliability of occurrence, precision and segmentation, and stipulate that reliability results are very promising (Dael et al., 2012). Dael et al. (2012) argue that the BAP codes are based on specific operational definitions, and as a result are not influenced by subjective behavioural judgments. The BAP coding system provides the observer with detailed descriptions and defined accounts of body movements, which minimises observer inference and argumentatively presents the coding systems as highly reliable (Dael et al., 2012). The movement characteristics expressed by the participant can therefore be verified and reproduced by another coder (Dael et al., 2012).

The BAP codes describe the head, shoulders, arms, hands, fingers, feet and legs, which are formalised on anatomical articulation, and well established kinesiological standards (Dael et al., 2012). The BAP codes refer to the form of body movement, as well as movement direction, in relation to the three orthogonal axes of the body, the sagittal, vertical

and transverse axis (Dael et al., 2012). Dael et al. (2012) states that only coding the type of movements and excluding coding subtle or ambiguous movements, improves the reliability of the BAP coding results. This study kept specifically to coding only the type of movements expressed by the participants, in order to keep to a high standard of reliability in results produced (Dael et al., 2012). The next section will discuss the procedures of the data capturing and analysis stages of the study.

Case Identification No.			**Male**	**Female**	**Age**	**Race**	**Time of day**
016di			M		49	C	12:12:00 PM
Time	**Head**	**Time**	**Shoulders**	**Time**	**Hands**	**Time**	**Feet**
01:23	Emblem FacingHVU 1	01:23	Emblem BSS 1	01:23	Emblem HH-SymmetricalTD 1	01:23	Emblem Feet M 1
01:26	Emblem Facing 1	x	x	01:50	Manipulator RFTouch 3	02:42	Beat LM 1
01:50	Illustrator HVD 1	x	x	01:53	Manipulator HH-Symmetrical 2	03:03	Beat LM 1
01:53	Illustrator HVD 2	x	x	01:58	Emblem TD 1	03:41	Beat LM 1
01:58	Illustrator FacingHVU 1	x	x	02:20	Manipulator HH-AsymmetricalTouch 2	04:00	Beat LM 1

Figure 8. . Illustration of Data Recorder Information (CodeProject, 2017).

Data Analysis

Data analysis of the nonverbal behaviour refers to systematic observations conducted through 68 files of video footage, and reducing these to manageable data by applying the BAP coding. Data analysis included the recording of the participants, the coding of the nonverbal behaviour, polygraph test result, the participants were placed into the deceptive indictor (DI) or non-deceptive indicator (NDI) groups based on their polygraph test results. and analysis of the data. The data was transformed into findings by identifying patterns and developing a framework in order to report the findings (De Vos et al., 2011).

These results were then correlated to discover if the nonverbal behaviour was significantly different between participants in the NDI and DI groups. In addition, a Cohen's d test was applied as a statistical method to establish the practical application of significant differences in the behaviour observed (Gravette & Wallnau, 2009). Correlation statistics of the nonverbal recorded data were done through the bivariate method, which compares two variables with each other (De Vos et al., 2011). For example, the behavioural observations of the DI and NDI groups were compared. This formed the core data of the current study.

Ethical Considerations

Ethical guidelines provide a boundary, and serve as a basis for the researcher to evaluate their code of conduct, ethical level of professionalism and accountability (De Vos et al., 2011). To attain this standard of professionalism, the researcher followed a number of guidelines to ensure an ethical approach was adhered to in this research study. Ethical guidelines set out by the REC-H, need to be followed in a strict manner to ensure the protection of participants in a study of this nature (Strydom, 1998).

Participants were informed of the aims and procedure of the study, their right to informed consent, to voluntary participation, and that they may withdraw from the study at any time (see Appendix G). During the informed consent process, the participants were informed in detail about the issues of confidentiality and anonymity. The researcher maintained a high level of respect and courtesy towards the participants, and they were treated with dignity throughout the study (De Vos et al., 2005). The professional relationship the researcher had with the participants was maintained by making the results of the study available to any who had requested this during the informed consent process. This was done in the form of general feedback email correspondence.

The Researcher is competent and adequately skilled to conduct the proposed research. The researcher is a former police detective of 12 years and was trained by the SA Police Service during a formal Detective Course and a Narcotic Detective Course. During these courses, crime scene and everyday life observation skills were taught, including observation work regarding nonverbal behaviour (see Appendix H). He also received a certificate for faithful services for his time in the South African Police Force (see Appendix I). In addition, the researcher completed the micro-facial expression training course, which enables an individual to recognise the seven universal emotions during facial expressions, and was awarded an Expert Level Certificate from the Paul Ekman group (see Appendix J). Joe Navarro guided the researcher's list of literature dealing with nonverbal behaviour and method of interpretation via online discussions, and presented the researcher with a personal quote (see Appendix K)

The researcher obtained formal permission (see Appendix L) from the polygraph service provider to approach participants and for the data collection process at the service provider's venue. A formal detailed written agreement was established between the researcher and the service provider (see Appendix L).

Throughout the duration of the research study the researcher applied the ethical standards mentioned above, and the guidelines according to the informed consent form.

Conclusion

This chapter discussed the primary aim of the study, the research hypothesis, research design and methodology, participants and sampling data collection methods, the coding conducted with the data recorder system. In addition, explanations concerning the coding system referred to as the Body Action and Posture coding system (BAP), the reliability and validity issues regarding the BAP measuring tool, the pre-interview procedures, the data

collection procedures, and the ethical standards that were taken in consideration throughout the procedure, were provided.

The research methodology and design were based on the aims and purposes of the study. The data were gathered by approaching potential participants who were referred for an event-specific polygraph test. The data collection followed two major paths, the nonverbal behavioural observation recordings (during the pre-interviews) and the results of the polygraph testing. These two paths formed the basis of this correlational study.

The next chapter presents the results and discussion of the study obtained in the correlation between the nonverbal behaviour of the Non-Deception Indicator (NDI) group and the Deception Indicator (DI) group.

Chapter 5

Results and Discussion

Introduction

In the current chapter the results of the study are presented and discussed in relation to the aim, objectives, and the literature review. The primary aim of this study was to explore and describe the relationship between the observational nonverbal data collected from participants during a polygraph pre-interview, and their polygraph test results. The objectives were to discover if a statistically significant relationship exists between specified nonverbal behaviours and deceptive indictor (DI) and non-deceptive indicator (NDI) polygraph results, related to deception. In polygraph terminology, the results of those who pass the polygraph test are referred to as Non-Deceptive Indicators (NDI), and a fail as Deceptive Indicators (DI).

In order to achieve the primary aim, the data were analysed according to the following four research objectives:

Objective 1: To explore and describe the head movements between the DI and NDI groups as follows: head facing, head averted, lateral head tilt towards a right position, lateral head tilt towards a left position, vertical head tilt towards an upward position, and vertical head tilt towards a downward position (see Appendix B)

Objective 2: To explore and describe the shoulder movements between the DI and NDI groups as follows: left shoulder up, left shoulder down, right shoulder up, right shoulder down, both shoulders static, both shoulders up (see Appendix C).

Objective 3: To explore and describe the hand, arm and finger movements between the DI and the NDI groups as follow: left and right hand shrug, hand hold symmetrical and asymmetrical, the left or right held still while the other is performing

an action, left and right hand/fingers movements, thumbs moving upward and downward, and touching behaviour (see Appendix D).

Objective 4: To explore and describe the feet and leg movements between the DI and the NDI group as follows: leg movement, feet remaining static, feet pulled in under the chair, feet in middle resting position and feet pushed out to the front (see Appendix E)

In analysing the results, the Visual Basic for Applications (VBA) was used which was developed on a Microsoft Excel platform by the statistics consultant, Dr D. Venter (Investopedia, 2017). The Visual Basic for Applications (VBA) is a programming language that allows the user to create automatic calculations within a specific computer process, as was referred to in Chapter 4 (Investopedia, 2017).

The results of the body movements of the statistically significant differences will be described. A demographic description of the participants and the duration of the observed video clips pertaining to the group as a whole, as well as the differences between the DI and NDI groups', head, shoulders, hands, and foot actions, will be presented and discussed below.

Demographic Description of the Sample

The demographic dependent variables of age, gender, ethnicity and time of day the polygraph test was undertook, related to the results in the DI and the NDI group.

Demographic variables will be discussed in relation to the two groups. Firstly, the demographics will be reviewed within the DI group and thereafter in the NDI group.

Deceptive Indicator (DI) Group. When compared to the whole sample (N = 68), 53% (n = 36) failed the polygraph test, and were referred to at the DI group. Of this 57% were males and 36% were females. The ages of those in this group were divided into three

categories. The middle category, which ranged from 30 – 39 years, had the highest percentage of fails at 62%, this was followed by the 40 – 59 group (48%), and then the 20 -29 age group (47%). The total mean age for the DI group was 36,75 years, compared to the total mean age of the entire samples which was 37,15, with an S.D. of 9,66. The DI group had 62% black, 55% coloured, and 0% white participants. The results, that calculated the time of day the tests were undertaken, showed interesting findings, with participants failing the test in the morning, amounting to 63%, and to 48% in the afternoon.

Non-deceptive Indicator (NDI) Group. In the NDI group (N = 32, 47 %), more females (64%) than males (43%) were found to pass the polygraph test. The age categories were divided into the same three age category groups as the DI group. A total of 53% of the participants in the 20-29 age group passed their polygraph test. The 40-59 group (47%), and then the 30-39 age group (38%) followed this. The NDI group had a total mean age of 37,59. The NDI group had 100% of the white, 38% of the black and 45% of the coloured participants, who all passed. It was found that 38% of participants passed their test in the morning, compared to 52% who passed it in the afternoon.

The demographic dependent variables had no significance influence on the overall results of the study, but revealed interesting information relating to the polygraph. It was found that more participants failed their polygraph test when taken in the morning, overall a higher number of males failed the polygraph test, and participants in the age category of 30-39 had the highest fails, totalling 62%. The mean age of those that failed the polygraph was 37,15 years old, and more black participants, compared to coloured and white, failed the polygraph test.

Gender. As is depicted in Table 1 there were more males than females participants in the study. This study however did not focus on the gender differences between participants. A total of 68 participants took part in the study, of which 53% had deceptive and 47% had non-deceptive indicator results, with 57% of the male, and 36% of the female participants, receiving results indicating deceptive indicators (DI).

Table 1. Distribution of Gender Per Deception Group

	DI		NDI		Total	
Gender	**n**	**%**	**n**	**%**	**n**	**%**
Male	31	57%	23	43%	54	100%
Female	5	36%	9	64%	14	100%
Total	36	53%	32	47%	68	100%

Age. Table 2 depicts the age categories of the participants, which are displayed according to the DI and NDI groups, but the highest incidence of deceptive indicators was in the 30 – 39 age group, were 62% failed. The majority of participants in this sample fell into the 40-59 age category.

Table 2. Distribution of DI and NDI Group Age Categories

	Group DI		*Group NDI*		*Total*	
Age Category	**n**	**%**	**n**	**%**	**n**	**%**
20 -29	7	47%	8	53%	15	100%
30 -39	16	62%	10	38%	26	100%
40 -59	13	48%	14	52%	27	100%
Total	36	53%	32	47%	68	100%

Ethnicity. Table 3 presents the distribution of ethnicity of the total sample in the present study. In both the DI and NDI groups, the majority of participants were Black with 100% of White in the NDI and 62% of Black in the DI.

Table 3. Distribution of Ethnicity in the DI and NDI Group Categories

	DI		NDI		Total	
Ethnicity	**n**	**%**	**n**	**%**	**n**	**%**
White	0	0%	7	100%	7	100%
Black	24	62%	15	38%	39	100%
Coloured	12	55%	10	45%	22	100%
Total	36	53%	32	47%	68	100%

Duration of the Pre-Interview Video Footage Observed. The length of each video recording plays an important role during the measuring of data. If one participant's recording is much longer in length compared to another participant's, more body movements would be counted in the lengthier recordings. However, in the current study, the duration of the video recordings of the participants showed to have a fairly consistent distribution with a value of 1,31 difference between the S.D. The DI group had a S.D. of 2,70 and the NDI group that had a S.D. of 3,42. The p-value was calculated to be 0,84, which reflects no Significant Difference, therefore the duration of the video recordings of both groups, NDI and DI, was similar in duration.

The Analysis and Correlation of the Movements and Actions of Participants Between the DI and the NDI Groups. This part of the data analysis was divided into four focal points, namely, the head, shoulders, hands, and feet. The central tendency and dispersion of the nonverbal behaviour and movement are presented here according to the two groups DI and NDI are displayed in Table 4 (DI group) and Table 5 (NDI group).

Table 4. Central tendency and Dispersion - Head, Shoulders, Hands and Feet (DI Group)

	Mean	S.D.	Minimum	Quartile 1	Median	Quartile 3	Maximum
He_Facing	20,97	13,96	3,00	10,75	15,50	33,50	62,00
He_Averted	4,81	3,96	0,00	1,75	4,00	7,25	14,00
He_HTiL	7,28	6,82	0,00	2,00	5,00	10,25	24,00
He_HTiR	6,97	6,13	0,00	3,00	5,00	9,00	23,00
He_HVU	4,56	4,50	0,00	1,00	3,00	6,25	17,00
He_HVD	4,36	3,99	0,00	2,00	3,00	6,00	17,00
Sh_LSU	1,08	1,18	0,00	0,00	1,00	2,00	3,00
Sh_LSD	0,11	0,52	0,00	0,00	0,00	0,00	3,00
Sh_RSU	1,33	1,64	0,00	0,00	1,00	2,00	7,00
Sh_RSD	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sh_BSU	1,61	1,98	0,00	0,00	1,00	2,00	7,00
Sh_BSS	2,03	1,89	1,00	1,00	2,00	2,00	12,00
Ha_LH-Shrug	8,14	7,65	0,00	3,00	7,00	9,25	29,00
Ha_RH-Shrug	8,33	9,28	0,00	2,00	5,00	10,50	39,00
Ha_HH-Sym	11,64	11,07	0,00	3,00	9,00	16,25	48,00
Ha_HH-Asym	6,47	6,24	0,00	2,00	4,00	10,00	23,00
Ha_LA	5,14	4,80	0,00	2,00	4,00	6,25	19,00
Ha_RA	5,64	5,64	0,00	1,00	4,50	7,25	21,00
Ha_LF	30,69	22,10	2,00	10,50	27,00	43,25	97,00
Ha_RF	36,28	25,41	5,00	16,00	28,00	54,00	88,00
Ha_Touch	30,17	21,73	1,00	13,75	24,50	42,00	102,00
Ha_TU	3,39	4,15	0,00	0,00	2,00	4,50	19,00
Ha_TD	2,19	3,20	0,00	0,00	1,00	3,00	15,00
Fo_LM	25,42	16,07	5,00	14,00	21,50	33,25	83,00
Fo_F	5,42	7,16	0,00	1,75	4,50	7,00	43,00
Fo_M	2,11	2,98	0,00	0,00	1,00	3,00	15,00
Fo_B	4,78	6,47	0,00	1,00	3,00	6,00	37,00
Fo_Toe to Toe	0,22	0,64	0,00	0,00	0,00	0,00	3,00

Table 5. Central Tendency and Dispersion - Head, Shoulders, Hands and Feet (NDI Group)

	Mean	S.D.	Minimum	Quartile 1	Median	Quartile 3	Maximum
He_Facing	21,06	14,21	3,00	12,00	18,50	26,25	58,00
He_Averted	6,50	7,02	0,00	1,75	4,00	9,25	31,00
He_HTiL	8,16	8,67	0,00	3,00	6,00	9,00	44,00
He_HTiR	7,03	7,22	0,00	2,00	5,00	9,50	36,00
He_HVU	5,44	5,27	0,00	1,00	4,00	8,00	23,00
He_HVD	5,97	5,15	0,00	2,00	4,50	9,00	20,00
Sh_LSU	1,41	1,68	0,00	0,00	1,00	2,00	5,00
Sh_LSD	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sh_RSU	1,22	2,46	0,00	0,00	0,00	1,25	10,00
Sh_RSD	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sh_BSU	2,13	3,70	0,00	0,00	1,00	3,00	17,00
Sh_BSS	1,75	1,24	0,00	1,00	1,00	2,25	5,00
Ha_LH-Shrug	6,91	9,62	0,00	0,00	3,00	11,25	35,00
Ha_RH-Shrug	8,94	11,73	0,00	1,00	4,00	12,25	42,00
Ha_HH-Sym	4,59	5,88	0,00	0,00	1,50	8,25	19,00
Ha_HH-Asym	7,13	8,89	0,00	0,75	3,50	8,00	30,00
Ha_LA	3,38	3,21	0,00	1,00	2,00	5,00	12,00
Ha_RA	2,59	2,38	0,00	0,75	2,00	4,00	8,00
Ha_LF	18,78	13,68	1,00	9,75	16,00	24,25	54,00
Ha_RF	28,41	21,74	2,00	15,50	24,00	37,00	86,00
Ha_Touch	20,91	14,53	0,00	11,00	18,50	28,00	57,00
Ha_TU	1,09	1,73	0,00	0,00	0,00	1,25	6,00
Ha_TD	0,78	2,46	0,00	0,00	0,00	0,00	12,00
Fo_LM	21,75	18,54	0,00	7,75	18,00	29,00	79,00
Fo_F	3,09	3,10	0,00	1,00	2,50	4,00	13,00
Fo_M	1,34	1,75	0,00	0,00	1,00	2,00	6,00
Fo_B	2,69	2,71	0,00	1,00	2,00	4,00	12,00
Fo_Toe to Toe	0,19	0,54	0,00	0,00	0,00	0,00	2,00

Only statistically significant differences between these groups will be discussed below.

The Correlation Between Nonverbal Behaviour in the DI and NDI Groups

In order to explore and describe the differences in movements between the two groups, t-Tests were computed to determine whether significant statistical differences existed. To add to the practical use for real life application concerning the movements observed, the Cohen's d test was applied.

Table6. Cohen's d Interpretation Intervals

<0.20	**<0.21**
0.20 - 0.49	Small
0.50 - 0.79	Medium
0.80+	Large

The Head Movements. To explore and describe the head movements between the DI and NDI groups, and to see whether statistically significant differences exist in head actions during the pre-interview of the participants, a t-Test was computed. The relationships between the following movements in both groups (DI and NDI) included: head facing, head averted, lateral head tilt towards a right position, lateral head tilt towards a left position, vertical head tilt towards an upward position, and vertical head tilt towards a downward position.

No significant difference was found between the DI and the NDI group with regards to the head actions observed. The Cohen's d test also showed no significant practical implications for the head movements.

The Shoulder Movements. To explore and describe the shoulder movements observed between the DI and NDI groups.

The t-Test, p-values and Cohen's d reflected no significant differences between the DI and the NDI group with regards to the shoulder movements observed.

Hands, Arms and Finger Movements. This section will describe the significant differences found in the movements of the hands, arms and fingers.

Table7. DI and NDI Differences Between Hands, Arms and Finger Action Movement

Variable	Group	n	Mean	S.D	Difference	t	p(d.f.=66)	Cohen's d
Ha_LH-Shrug	DI	36	8,14	7,65	1,23	0,59	,559	n/a
	NDI	32	6,91	9,62				
Ha_RH-Shrug	DI	36	8,33	9,28	-0,60	-0,24	,814	n/a
	NDI	32	8,94	11,73				
Ha_HH-Sym	DI	36	11,64	11,07	7,05	3,22	**,002**	**0,78**
	NDI	32	4,59	5,88				**Medium**
Ha_HH-Asym	DI	36	6,47	6,24	-0,65	-0,35	,725	n/a
	NDI	32	7,13	8,89				
Ha_LA	DI	36	5,14	4,80	1,76	1,76	,083	n/a
	NDI	32	3,38	3,21				
Ha_RA	DI	36	5,64	5,64	3,05	2,84	**,006**	**0,69**
	NDI	32	2,59	2,38				**Medium**
Ha_LF	DI	36	30,69	22,10	11,91	2,63	**,011**	**0,64**
	NDI	32	18,78	13,68				**Medium**
Ha_RF	DI	36	36,28	25,41	7,87	1,36	,177	n/a
	NDI	32	28,41	21,74				
Ha_Touch	DI	36	30,17	21,73	9,26	2,04	**,046**	**0,50**
	NDI	32	20,91	14,53				**Medium**
Ha_TU	DI	36	3,39	4,15	2,30	2,91	**,005**	**0,71**
	NDI	32	1,09	1,73				**Medium**
Ha_TD	DI	36	2,19	3,20	1,41	2,02	**,047**	**0,49**
	NDI	32	0,78	2,46				**Small**

The significant statistical differences include, a *hands hold symmetrical* indicated in the table 7 as code Ha HH-Symmetrical, *hands right arm still* indicated as Ha RA, *hands left finger/hand* as Ha LF, *hands touch* indicated as Ha Touch, *hands thumbs upwards* as Ha TU, *hands thumbs downwards,* as TD.

Figure 9 below, is a scatterplot depicts the hands/arms and finger movements of the DI and NDI groups. These differences will be discussed in the section below in systematically integrated manner.

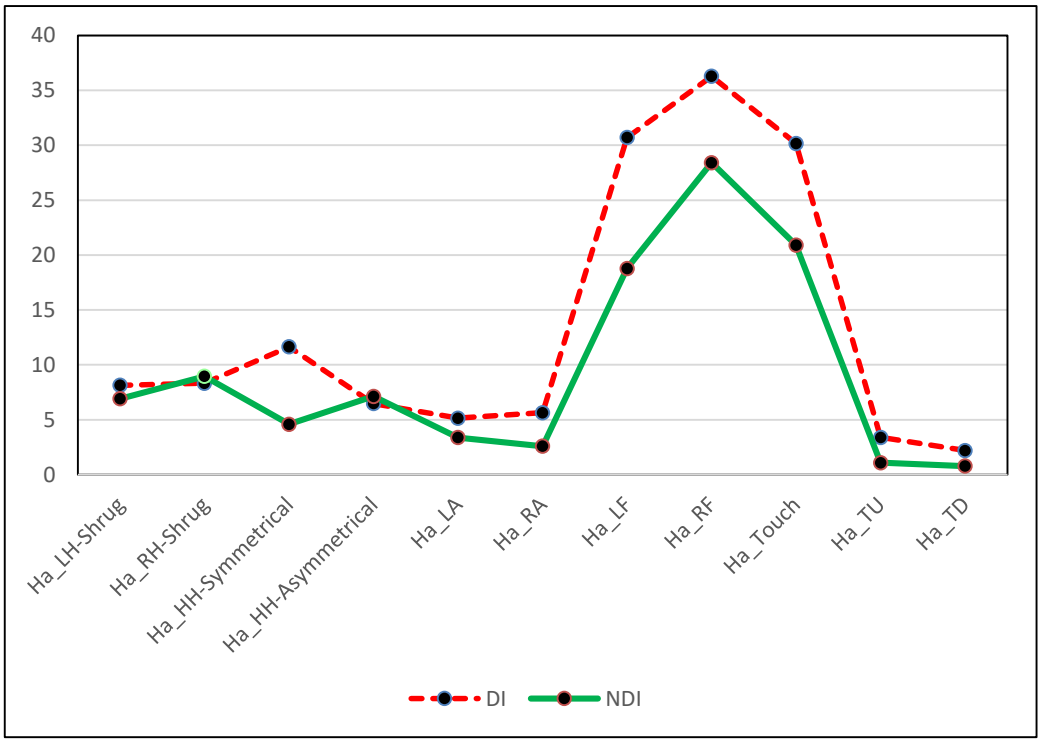

Figure 9. Hands/Arms and Finger Display (DI and NDI Groups)

This section describes the different movements, noted in Table 7, that were identified as statistically significant. Pertinent theoretical concepts relating to the study's findings are the deception detection theories, more specifically, the Multi-Factor Model, the Self-Presentational Perspective and the Interpersonal Deception Theory. The theoretical concepts integrated with the published research results and dependent variables will now be discussed.

The Multi-Factor Model. According to the Multi-Factor Model the participants could show an increase in hand movement due to emotional experiences caused by feelings of anxiety, brought on by the testing conditions of the polygraph (Vrij, 2008). Conversely, the theory states that a participant may experiences an overload in their thought process, due to

actual involvement in alleged criminal event that they are being tested for, and may therefore express a decrease in the hand action (Vrij, 2008). This study had confirmed an increase in touching behaviour and correlates with this theory that an increase in hand movement may occur due to feelings of anxiety. A deduction may be made, according to the results and the application to the multi-factor theory, that the participants in the DI group may have been more anxious compared to the NDI group due to the increased hand movements, hand held symmetrical, self-touch, thumbs upwards and thumbs downward calculated in this research. The results also show the presence of a certain amount of control in the event of a person experiencing cognitive overload. Cognitive overload may either increase or decrease movement according to this theory. The results reflected both these scenarios in relation to an increase in touching behaviour yet a factor of control was present that may indicate the presence of cognitive overload in the result of the right arm that was held static in the DI group compared to lesser thereof in the NDI group, which could indicate, in relation to this theory, that a cognitive overload may decrease movement. The term cognitive overload can be described as follow; when one is deceptive the brain experiences a flood of thoughts that attempts to manage the thought pattern of deception while the person simultaneously struggles with inner thoughts of the truth. During cognitive overload, the person being deceptive according to this theory controls aspects of their nonverbal movement, for example as found in this study, where the right arm was held static while the left arm was moving. In this study the right hand movement was significantly static while the left hand was involved in movements.

The Self-Presentational Perspective. The Self-Presentational Perspective states that participants in the DI and the NDI groups may show exactly the same nonverbal behaviour. Guilty and innocent participants may be afraid of not being believed, and may display the same non-verbal cues according to this perspective (Vrij, 2008). In contrast to this theory, the

results of this study showed that there was a significant difference in the hand actions between the DI and NDI group.

The results were as follow: (see Table 7)

Hands Held Symmetrical was higher in the DI compared to the NDI group.

Hand Right Arm held static showed an increase in the DI group compared to that of the NDI group.

The left hand and fingers moved more in the participants of the DI compared to those in the NDI group

Touching increased in the DI group and presented a significant difference compared to the NDI group.

Thumbs moved more up and down in the DI group than what was observed in the NDI group.

The Interpersonal Deception Theory. The Interpersonal Deception Theory states that participants will experience numerous simultaneous communication tasks during a conversation with a partner. During this time, they must be able to maintain credible nonverbal behaviours in various modes. For example, managing their emotions, maintaining a dialogue, and responding appropriately. This may cause the participant to mirror the interviewer's nonverbal behaviour. According to this theory the participants should present the same behaviour as the examiner, in the hope that they will appear the same as the interviewer, and will therefore be seen as being truthful (Vrij, 2008). This will often occur when the examinee is of timid personality and is faced with an aggressive interviewer. The results of this study shows significant differences in results between the two groups, in relations to the hand actions of the participants, therefore cancel the relevance of the theory to this particular study. Should this theory be applicable to this study then one would have seen very similar results in the participants and not significant differences as was the case.

The Neurobiological Systems. The limbic system is strongly linked to involuntary nonverbal signals and the hypothalamus signals the primary emotional responses automatically. In contrast, the secondary emotions are not automatically expressed and require cognitive processing to control them, this process requires higher cortical processing (Zillmer et al., 2008). Primary emotional responses by the participants may be automatically shown through involuntary movements that could lead to increased movements as shown in this study compared to the DI and NDI group. The secondary emotional reactions are controlled according to studies of the hypothalamus and secondary emotional expression becomes a cognitive process, after the primary emotion is experienced, and the initial emotional feeling is expressed. The initial emotional feelings will be expressed automatically. Zillmer et al. (2008) find that nonverbal actions serve as protection against a threat and are an automatic reaction. This research result shows a higher hand action in the DI group compared to the NDI group.

Freeze, Flight and Fight. The Sympathetic Nervous System is responsible for the body's reactions and ensures that the body functions when a perceived threat is experienced. This occurs through the release of adrenalin during a stressful situation. This causes the body to respond with behaviour that is categorised as freeze, flight and fight. During a freeze response the body's action will be still and static (Givens, 2002). This behaviour was seen in the current study with the right arm being static during the pre-interview. According to the results of this study the right arm was kept significantly static for the participants in the DI group when compared to the NDI group. The freezing of the right hand during the pre-interview indicate a Sympathetic Nervous System response that keeps the body out of danger by going into involuntary freeze, when anxiety and danger is present (Ekman 1992; Navarro, 2008; Vrij, 2008). As this primary emotional response is automatic, the initial freeze movement or expression will be automatic (Zillmer et al., 2008). The static and motionless

right arm and hand action presented by the participants in the DI group of this study, is referred to as a freeze action, as described above, and confirmed by research done through Givens (2002), Navarro (2008), Vrij (2008) and Zillmer et al. (2008). The freezing action is expressed when an individual want to escape danger (Vrij, 2008).

Givens (2002) and Navarro (2008), established that hands withdrawing, pulling hands back from their resting position, self-touch or touching other parts on the body, during a stress event, are linked to the flight response. The results indicated that a significant increase in hand touch behaviour was present with participants in the DI group, in comparison to the NDI group. Touch behaviour will be further explained in the next section.

Pacifying Behaviour. Touch and self-touch behaviour are identified as a pacifying behaviour (Navarro, 2008). The current study's results indicated that there was a statistically significant difference in the touch behaviour between the participants in the DI and NDI groups. The results showed an increase in touch by the participants in the DI group compared to those in the NDI group. Touch behaviour can be explained by exploring the functioning of the parasympathetic nervous system (PNS). Research shows that PNS restores the body's resources, and frees the body from distress, ensuring the body remains in a state of homeostasis. This correlates with the results of this study, which found an increase in touch behaviour within the DI group when compared to the NDI group, who were found to touch themselves less. Therefore, in the current study, the researcher observed that participants in the DI group touched their faces, or stroked their necks subconsciously, thereby pacifying the heart via stimulation of the vagus nerve.

The Hands Held in a Symmetrical Position. The participants in the DI group showed significant differences in the hands held in a symmetrical manner, compared to the participants in the NDI group. This action occurs in front of the body, and acts as a protection shield, keeping one safe from a threat of perceived danger and was noticed in participants

behaviour, who obtained a DI result in their polygraph test (Morris, 2002). The mean score for this hand action in the DI group was 11,64, compared to the mean score in the NDI group which was 4,59. The results showed that participants, who failed their polygraph test, in this case the DI group, held their hands symmetrically more than the participants in the NDI group. The Cohen's d test showed a value of 0,78, which indicated a medium practical implication, as it fell within the 0,50 and 0,79 value of the Cohen's d interpretation intervals scale (Gravetter & Wallnau, 2009).

According to research done by Navarro (2008) and Vrij (2008), if individuals hold their hands symmetrically in front of them, with interlocked fingers, it is not necessarily a signal of blocking out the world outside our personal perimeter, it can also be a signal of comfort, if the hand hold represents a type of body hug, which can be interpreted as a self-comfort signal, which is demonstrated when feelings of insecurity are present (Navarro, 2008; Morris 2002; Vrij, 2008). Conversely, interlocking of the fingers in a symmetrical handhold with interlaced fingers, is seen as a discomfort signal in high-stake situations (Givens, 2002; Morris, 2002; & Navarro, 2008).

Hand Right Arm Static. The participants in the DI group showed a significant difference in their right arms and hands, which were kept static during the pre-interview of the polygraph test, in comparison to the NDI group, who tended to exhibit more hand and arm movements. The mean score for the static right arm action in the DI group was 5,64, compared to the mean score in the NDI group, which was 2,59. This difference reflected a significant result in the movement regarding the p (d.f. = 66), and was calculated as .006 indicating the value for $p<0.05$. The Cohen's d test showed a value of 0,69, a medium practical implication. (Gravetter & Wallnau, 2009). The Cohen's d test results indicate the level of practical use of the data in real life application, and can be further described as the

practical application and implementation of this information in a real life observation environment (Gravetter & Wallnau, 2009).

Left Hand and Finger Movements: (Ha LF.) The left hand and finger actions presented significant statistical differences in the movement of the participants in the DI group, compared to the NDI group. The DI groups' left hand and fingers pointed, illustrated, and presented with more beat and manipulating movements, compared to the NDI group.

The mean score for the left hand and fingers movement in the DI group was 30,69 compared to the mean in the NDI group that was 18,78. This difference reflected a significant result in the movement regarding the p (d.f. =66) and was calculated as .011 indicating the value for $p<0.05$. The Cohen's d test showed a value of 0,64 medium practical implications. (Gravetter & Wallnau, 2009).

Touch Behaviour: (Ha Touch.) Touching behaviour presented by participants in the pre-interview were: self-touching, face touching, neck touching, touching the other hand, and scratching actions. Touching behaviour in participants in the DI group were more elevated compared to the NDI group's participants.

The mean score for touch actions in the DI group was 30,17, compared to the mean score in the NDI group that was 20,91. This difference reflected a significant result in the movement regarding the p(d.f.=66), and was calculated as .046, indicating the value for $p<0.05$. The Cohen's d test showed a value of 0,50 medium practical implications. (Gravetter & Wallnau, 2009). Therefore, the increase of touching behaviour holds practical value when observation for deceptive behaviour is conducted in a real life situation. It has been found that self-touching actions reflect arousal levels of the sympathetic nervous system's responses of flight (Vrij, 2008; Zillmer et al., 2008). We touch our bodies to calm ourselves when emotions run high. According to Givens (2002), self-touch, massaging a hand, scratching, rubbing increases when stress factors are present, and may signal deception,

disagreement, fear or uncertainty. This behaviour may also be described as displacement activity caused by ‘nervous energy’ (Givens, 2002).

Humans build up energy levels, resulting in the need to release this energy. This is displayed by movements of releasing the tension retained by the body (Givens, 2002). This study confirms, in the increase in hand and touch movements, what Givens (2002) and Morris (2002) describe, that the nervous energy referred to above, results in individuals displaying displacement activities, such as an increase in scratching, touching, adjusting clothes, and tapping behaviour. These will all be observed when anxiety increases and levels of energy are heightened. Furthermore, arm rubbing, neck touching, face touching, earlobe pulling and scratching behaviour are all identified as pacifying behaviour, controlled by the parasympathetic nervous system, to keep the body free from stress during high anxiety (Navarro, 2008). Touching behaviour can safely be identified as a gesture of discomfort, which was significant according to this study in participants of the DI group.

Hands Thumbs Upwards: (Ha TU.) Thumbs moving up, were presented during the symmetrical hand hold, when fingers were interlocked, and the thumbs rested on the top part of the hand and index fingers. Thumbs moving into an upwards position from their original resting position was counted as a thumbs upward action. Participants in the DI group presented significant statistical differences, and increased thumbs upwards movement, compared to the NDI group.

The mean score for thumbs upward actions in the DI group was 3,39, compared to the mean score in the NDI group that was 1,09. This difference reflected a significant result in the movement regarding the p(d.f.=66), and was calculated as .005 indicating the value for $p<0.05$. The Cohen’s d test showed a value of 0,71 medium practical implication falling within the 0,50 and 0,79 value of the Cohen’s d interpretation intervals scale (Gravetter & Wallnau, 2009). The Cohen’s d results indicate that there is practical value in real life

applications in thumbs upward movements, when hands are held asymmetrical. When hands are held in a symmetrical position while the thumbs are held in an upward position, it reflects high confidence, according to research done by Ekman (2008), Givens (2002), Navarro (2008) and Vrij (2008). This movement was higher in participants in the DI group.

The thumbs upward action cannot be viewed without observing it in relation with thumbs moving downwards. The next section will discuss the downwards moving of the thumbs.

Hands Thumbs Downwards: (Ha TD.) Thumbs moving downwards occurred when the participant held their hands in a symmetrical handhold, when fingers interlocked, and the thumbs moved from their resting position downwards, disappearing into the palms of the hands. This occurred more in the DI group compared to participants in the NDI group. Results from the DI group presented significant statistical differences and increased thumbs downwards movements. The mean score for thumbs downward actions in the DI group was 2,19, compared to the mean score in the NDI group, which was 0,78. This difference reflected a significant result in the movement regarding the p(d.f.=66), and was calculated as .047 indicating the value for $p<0.05$. The Cohen's d test showed a value of 0,49, small practical implication. (Gravetter & Wallnau, 2009). Research shows that thumbs moving downwards indicate low confidence (Givens, 2002; Navarro, 2008). This could possibly mean that the DI group in the current study were less confident than the NDI group.

Conclusion

In this chapter the results of the present study in relation to the aim and the four objectives of the research, and literature reviewed were presented and discussed. Added to this discussion was a detailed description of the sample. The results were linked to previous research findings, and to the relevant theoretical literature that was reviewed. Included in this

chapter was an overview of the pre-interview video footage observed, the analysis and correlation of the movements and actions of the participants in the DI and the NDI group. The correlation between the nonverbal behaviour in the DI and the NDI groups where discussed according to the significant differences showed in the results of the hand movements. The nonverbal behaviour related to the research results was discussed, and included a description of the hand hold symmetrical action, the right arm/hand still, the left hand/finger actions, touch behaviour and the thumbs up and downwards movements. The following chapter focuses on the conclusions, limitations, and recommendations of the study.

Chapter 6

Limitations, Conclusions and Recommendations

Chapter Overview

This final chapter concludes the dissertation. The chapter briefly discusses the conclusions and limitations of the study, and offers recommendations for future research in this field.

Conclusions of the Study

The study explored and described the relationship between nonverbal behaviour exhibited by participants who failed their polygraph test (the Deceptive Indicator [DI] group), and participants who passed their polygraph test (the Non-Deceptive Indictor [NDI] group). The research hypothesis indicated that there would be significant differences between specified nonverbal behaviour of the DI and the NDI group. Significant statistical differences between movements of the hands, arms and fingers exhibited by two groups were identified by t-Tests and Cohen's d test. Certain movements of the hands/arms and fingers proved to hold practical significance related to the result, when participants failed the polygraph test (DI group) according to the Cohen's d results. The arm and hand movements that held practical and real life implicational value were: the hands held symmetrical, the right arm and hand been kept in a static position while the other hand executes an action, the left finger and hand in actions of pointing direction, and indicating illustrations to fit in with verbal communication. Hand touch behaviour, where the hand touches the face, neck and arms, and lastly the thumbs moving upwards or downwards expressing high and low confidence, low confidence when the thumbs are in a downward position, and high confidence when the thumbs are in an upward position.

The practical implications of these results lie in noticing these movements during real life interviews. This may hold a significant meaning, if the observer can manage to establish a nonverbal baseline (see Chapter 3) for the individual, and be able to notice changes in nonverbal behaviour of the hands, by applying the findings and results of this study. The research hypothesis was therefore accepted for the movements of the hands, arms and fingers in this study, between the DI and the NDI groups.

Limitations

All investigations have limitations, and it is very difficult to exclude all research problems to ensure a perfect investigation (Drew, Hardman & Hart, 1996). According to De Vos, Strydom, Fouche and Delport (2011) even the most carefully planned study holds the potential for limitations. Limitations in the current study concern methods and decisions about how the study was designed, and limitations originating in execution of the study in itself (Cone & Foster, 2006).

Limitations in Designing the Study. The data collection of this study took one year, due the nature of this real life study. A larger number of participants could possibly have provided additional statistically significant results. As the study was conducted in a real life setting, the researcher could not predict nor controlled who would participate in the study. A further limitation was that no sound was recorded during the pre-interview, and only the movements of the participants were observed. This restricted the researcher in making broader correlations of the nonverbal behaviour.

Limitations Originating During the Execution of the Study. This study focused on the non-verbal behavioural differences in the movements of the head, shoulders, hands/arms/fingers, and the feet of the two groups of participants. Other areas of behaviour

such as verbal behavioural indicators, could hold significant meaning in the detection of deception.

Recommendations

As mentioned above, the current study only focused on non-verbal movements. It is therefore recommended that knowledge in this field could be advanced further if non-movement and verbal behaviour during the pre-interview of the polygraph testing process are included in further studies. This would ensure a broader and more holistic understanding of the behaviour of individuals regarding possible deception during the pre-interview.

It is further recommended that future studies could include the use of an infra-red scanner in the form of a thermal camera, measuring the temperature changes of the participant's face, to discover if temperature changes are visible during deception. According to Vrij (2008), blood flow patterns change when deception is present by an individual, and can be recorded and measured through thermal photography. Thermal photography is an unobtrusive manner with the potential of replacing the polygraph, should studies find that it can measure deception accurately, by monitoring specific and increased temperatures or changes in temperature when deception is present.

Conclusion

This study explored and described the relationship between the specified non-verbal behaviour of participants who failed their polygraph test, the Deceptive Indicator (DI) group, and the participants who passed their polygraph test and made up the Non-Deceptive Indictor (NDI) group.

Only the results in the hand movements indicated a significant statistical difference between NDI and the DI group.

It is anticipated that the results in this study may contribute to increased observation ability of polygraph practitioners regarding their nonverbal behavioural observations during the pre-interview. The specific hand movements identified and described in table 6 and further elaborated on through this research will provide the polygraph examiner with a key and starting point in establishing baseline behaviour, in order to clearly notice nonverbal behavioural changes. Once a polygraph examiner knows what to look for, they can then notice changes in nonverbal behaviour from the baseline behaviour of the examinee. These changes alert the examiner that the person in front of them is undergoing an emotional or cognitive change (Vrij, 2008). These nonverbal behavioural changes of table 6, can then be explored further, by asking questions directly linked at to the observed non-verbal changes, to uncover deception or truthfulness (Navarro, 2008 & Vrij, 2008).

The analysis of nonverbal behaviour is in its infancy in South Africa, and the current study was one of the only studies conducted in South Africa, related to non-verbal behaviour and the pre-interview of the polygraph. It is hoped that research interest in this field of psychology will increase in South Africa, as deception, in several forms such as corruption, are rife in South Africa. The potential of forensic investigation to contribute to psychology and several other relevant disciplines is still unexplored, and holds vast potential for meaningful future research and practice.

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Appendix A Data Spreadsheet Example

Participant number	Group	Age	Age Category 20-29=1 30-39=2 40-59=3	Race 1 =w,2 =b and 3=c	Time of day start	Time of day A.M or P.M	Duration of video clip	Head actions	Shoulder actions	Hand actions	Feet actions
DI.001	1	28	1	2	08:49:42	AM	16,48	6	9	4	5
NDI.001	2	45	3	3	12:47:12	PM	17,02	4	3	6	9

The table above is an example of the contents included in the data spreadsheet which contained the following headings: Participant number and division indicated by DI or NDI results; Group column classified the DI and the NDI with a number 1 or 2; Age presenting the age of the participant; The age category indicating the ages between 20-29, 30-39, 40-59; Time of day the test was conducted; Time of day indicating A.M or P.M, showing if the test was taken in the morning or the afternoon; The duration (minutes and seconds) of the video clip of the recording taken during the pre-interview; The columns following presented the head, shoulders, hands and feet actions reflecting the number of times each of the specified body parts moved according to the coding indicated in appendices 7,8,9 and 10.

Appendix B Body Action and Posture Coding System (BAP) Head Movements

BAP Code	Head: Behaviour Variable	Short Description
Facing	Facing	The face is oriented towards the interlocutor
Averted	Averted	The face is oriented away from the interlocutor
HTil: Head tilt left	Lateral head tilt towards a left position	A rotation of the head around the sagittal axis that results in the head tilted laterally towards the left shoulder
HTiR: Head tilt right	Lateral head tilt towards a right position	A rotation of the head around the sagittal axis that result in the head tilted laterally towards the right shoulder
HVU: Head vertical Up	Vertical head tilt towards an upward position	A rotation of the head around the transversal axis that results in the head lifted up relative to the anatomical standard position
HVD: Head vertical down	Vertical head tilt towards a downward position	A rotation of the head around the transversal axis that results in the head dropped down relative to the anatomical standard position

Appendix C Body Action and Posture Coding System (BAP) Shoulder Movements

BAP Code	**Shoulder: Behaviour Variable**	**Short Description**
LSU	Left shoulder up	The left shoulder is lifted up relative to the anatomical standard position
LSD	Left shoulder down	The left shoulder is dropped down, lowered to the ground relative to the anatomical standard position
RSU	Right shoulder up	The right shoulder is lifted up relative to the anatomical standard position
RSD	Right shoulder down	The right shoulder is dropped down, lowered to the ground relative to the anatomical standard position
BSU	Both shoulders drawn upward	Both shoulders drawn upward from their resting position
BSS	Both shoulders static	Both shoulders in a static position and not moving

Appendix D Body Action and Posture Coding System (BAP) Hand Movements

BAP Code	Hand: Behaviour Variable	Short Description
LH-Shrug	Left hand wrist articulation	Action articulation of the left wrist resulting in movement of the whole hand
RH-Shrug	Right hand wrist articulation	Action articulation of the right wrist resulting in movement of the whole hand.
Hand hold Symmetrical	Both arms/hands held in front	Both hands/arms hold each other in front of the body
Hand hold another Asymmetrical	One arm holds the other in front	One arm rests on the other or is held by the other in front of the body
Left Arm Still	Left arm action hold	The left arm is held static while performing an action
Right Arm Still	Right arm action hold	The right arm is held static while performing an action
Left Fingers	Left finger(s) articulation	Action articulation of one or more fingers of the left hand
Right Fingers	Right fingers(s) articulation	Action articulation of one or more fingers of the right hand
Touch	Touch	One body part touches another

		body part or an object as part of an action
Thumbs upward	Hands in symmetrical position Thumbs held in upward position	Thumbs touching each other and held in a vertical position when hands are held in a symmetrical position
Thumbs Downward	Hands in symmetrical position Thumbs held in downward position	Thumbs held in a downward position when hands are held in a symmetrical position

Appendix E Body Action and Posture Coding System (BAP) Feet Movements

BAP Code	**Feet: Behaviour Variable**	**Short Description**
Leg movement	Leg movement	Any movement of the lower limbs
Feet – F	Feet moving forward – stretched out in front	Feet in a stretched-out position in front – in a resting position
Feet – M	Feet kept in neutral position	Feet in middle relative to the anatomical standard position
Feet - B	Feet under chair	Feet positioned under the chair, pulled back
Feet toe to toe	Feet pointing towards the other	Feet positioned by one foot pointing towards the other foot

Appendix F Informed Consent Form

Nelson Mandela Metropolitan University
for tomorrow

RESEARCHER'S DETAILS	
Title of the research project	**The correlation between polygraph results and non-verbal behaviour.**
Reference number	**H15-HEA-PSY-028**
Principal investigator	**Mr. Ian Carl Ferreira**
Address	**Psychology Department , NMU, Port Elizabeth**
Postal Code	**6045**
Contact telephone number (private numbers not advisable)	

A. DECLARATION BY PARTICIPANT	Initial

I, the participant and the undersigned		
ID number		
Address (of participant)		

A.1 HEREBY CONFIRM AS FOLLOWS:		**Initial**
I, the participant, was invited to participate in the above-mentioned research project		
that is being undertaken by	Mr. Ian C Ferreira	
from	The Psychology Department	
of the Nelson Mandela Metropolitan University.		

THE FOLLOWING ASPECTS HAVE BEEN EXPLAINED TO ME, THE PARTICIPANT:			**Initial**
2.1	**Aim:**	The researcher aims to explore, describe and understand the link between specific body movements and polygraph results.	
2.2	**Procedures:**	I understand that my body movements will be looked at during the time I am in the pre-interview, before I take the polygraph test. My body movements will be looked at via a video recording, only my body movements will be	

		recorded and not what I will say. No sound will be recorded.			
2.3	**Risks:**	There are no physical risks involved in taking part in this study, but I might feel slightly uncomfortable during the video recording and polygraph test as such procedures might be unfamiliar to me.			
2.4	**Possible benefits:**	By taking part in this study I will help the researcher to understand the link between body movement and polygraph results.			
2.5	**Confidentiality:**	My identity will not be made known in any discussion, description or scientific publications by the researcher. My personal details will not be linked with my body movement recordings or with the results of my pre-interview or polygraph test results.			
2.6	**Access to findings:**	The findings of the study will be included in a report which will be available in the university library. If you want to know about the results of the study and ask me about it, I will share it with you. I request individual feedback	YES	NO	
2.7	**Voluntary participation / refusal / discontinuation:**	My participation is voluntary	YES	NO	
		My decision whether or not to take part will in no way affect my present or future care / employment	TRUE	FALSE	

		/ lifestyle				

3. THE INFORMATION ABOVE WAS EXPLAINED TO ME/THE PARTICIPANT BY:									**Initial**
Ian Ferreira									
in	**Afrikaans**		**English**		**Xhosa**		**Other**		
and I can understand this language.									
I was given the opportunity to ask questions and all these questions were answered satisfactorily.									

4.	I was not forced to give consent to take part and I understand that I may withdraw at any stage without being punished for it.	

5.	Taking part in this study will not result in any additional cost to myself.	

A.2 I HEREBY VOLUNTARILY CONSENT TO PARTICIPATE IN THE ABOVE-MENTIONED PROJECT:	
Signed/confirmed at	on 20
	Signature of witness:

Signature of participant	Full name of witness:

STATEMENT BY INVESTIGATOR									
I,	Ian Carl Ferreira							declare that:	
1.	I have explained the information given in this document to								
2.	He / she was encouraged and given ample time to ask me any questions;								
3.	This conversation was conducted in	**Afrikaans**		**English**		**Xhosa**		**Other**	
	And no translator was used								
		by							
4.	I have detached Section D and handed it to the participant							**YES**	**NO**
Signed/confirmed at				on				20	

Signature of interviewer	Signature of witness:
	Full name of witness:

B. IMPORTANT MESSAGE TO PARTICIPANT	
Dear participant Thank you for taking part in this study. Should, at any time during the study: - an emergency a rise as a result of the research, or - you have any concerns or require any further information with regard to the study	
Kindly contact	Mr. Ian Ferreira
at telephone number	041 504 2330

Appendix G Letter to Participants

Department of Psychology

NMMU

Tel: +27 (0)41 504 2330

Date 30/03/2016

Ref: H15-HEA-PSY-028

Contact person: Ian C Ferreira

Dear participant

You are being asked to take part in a research study. I will give you information about the study, help you to understand and explain what part you will play in the research study. The information I will give you will include information about what is expected of you, the risks, benefits, and your rights as a study participant. Please feel free to ask me, the researcher, to explain anything that is not clear to you.

Before you take part, it will be necessary of you to give written permission that will include your signature, date and initials to make sure that you understand and agree to the study conditions. As the researcher I am aiming to explore and describe the relationship between body movements and polygraph results. I will observe the movements you make during your pre-interview, before you take the polygraph test. I will compare observations taken from your pre-interview to your polygraph result.

At no stage will your identity and personal information be known to anyone besides me as the researcher. Your identity will also not be made know in any written publications or discussions. No recording will be made of anything you say during the pre-interview. Only your body movements will be recorded by means a camera. The camera will be visible to you and will focus on your upper body area and on your feet. I will be the only person that will see the video footage.

Your participation in this study will help me to understand the link between body movement and polygraph results.

There are no physical risks involved in taking part in this study, but you might feel slightly uncomfortable during the video recording and polygraph test as such procedures might be unfamiliar to you.

You have the right to ask questions about the study at any time. Immediately report any new problems during the study, to me, the researcher by calling me on (xxxxxxxxxx). Please feel free to call this number. You may also speak to me afterwards should you have any concerns.

Furthermore, it is important that you are aware of the fact that the ethical truthfulness of the study has been approved by the Research Ethics Committee (Human)(REC-H) of the

university. The REC-H consists of a group of independent experts that has the responsibility to ensure that the rights and welfare of participants in research are protected and that studies are conducted in an ethical manner. Studies cannot be conducted without REC-H's approval. Queries with regard to your rights as a research participant can be directed to the Research Ethics Committee (Human), Department of Research Capacity Development, PO Box 77000, Nelson Mandela Metropolitan University, Port Elizabeth, 6031.

If no one can assist you, you may write to: The Chairperson of the Research, Technology and Innovation Committee, PO Box 77000, Nelson Mandela Metropolitan University, Port Elizabeth, 6031.

Taking part in research is completely voluntary. You are not obliged to take part in any research. If you choose not to participate in research, your present or future life situation will not be affected in any way and you will incur no penalty and/or loss of benefits to which you may otherwise be entitled.

If you do participate, you have the right to withdraw at any given time, during the study without penalty. However, if you do withdraw from the study, you should return for a final discussion in order to terminate the research in an orderly manner.

If you fail to follow instructions, or if your situation changes in such a way that the researcher believes that it is not in your best interest to continue in this study, or for administrative reasons, your participation may be discontinued. The study may be terminated at any time by the researcher or the Research Ethics Committee (Human).

Although your identity will at all times remain confidential, the results of the research study may be presented at scientific conferences or in specialist publications.

This informed consent statement has been prepared in compliance with current statutory guidelines.

Yours sincerely

Ian Carl Ferreira

RESEARCHER

Appendix H

SAP Confirmation of Duties

Amapolisa Omzantsi Africa

South African Police Service — Suid-Afrikaanse Polisiediens

Private Bag X 6077 PORT ELIZABETH — Fax NO (041) 394 6598

My Reference:	26/1/1
Enquiries:	Brigadier Louw
Contact Details:	0827797113

THE SECTION HEAD
CRIME INTELLIGENCE
CLUSTER CO-ORDINATION AND
OVERT OPERATIONS
EASTERN CAPE

2017/11/17

TO WHOM IT MAY CONCERN

CONFIRMATION OF DUTIES AT SOUTH AFRICAN POLICE SERVICE: FORMER MEMBER: IAN CARL FERREIRA: 0410975-9

1. Herewith confirmation that Ian Carl Ferreira is a former member of the South African Police Service performing duties from 1985/01/11 to 1997/12/31 which totals a number of 13 years. At the time of his resignation he held the rank of Captain with Persal Number 0410975-9.

2. The service history and duties performed by the former member as follow:

- 1985 Training at South African Police Service College, Pretoria
- 1985-1986 Special Guard Unit Cape Town.
- 1987 Uniform Branch Port Elizabeth.
- 1987 -1992 Detective Branch, SANAB, Grahamstown (Specialist Unit)
- 1992 Division Crime Intelligence, Grahamstown (Specialist Unit)
- 1993-1997 Division Crime Intelligence, Port Elizabeth (Specialist Unit)

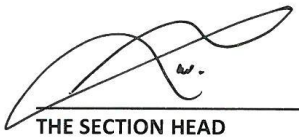
3. The former member received training in the following specialized fields while in duty of the South African Police Service:

- 1985 VIP Protection Special Course, South African Police College Pretoria
- 1988 SA Narcotic (SANAB) Detective Course, Pretoria
- 1989 Detective Course, Port Elizabeth

- 1991 Internal Security Training Course, Maleoskop, Eastern Transvaal
- 1992 Tactical Combat Survival Training, Slagboom, Eastern Cape
- 1992 Special Negotiation Course, Pretoria

Outcomes of the detective courses include observation techniques of persons, situations and crime scenes.

Kind Regards



BRIGADIER
THE SECTION HEAD
CRIME INTELLIGENCE
CLUSTER CO-ORDINATION AND OVERT OPERATIONS
EASTERN CAPE
(A.M. LOUW)

Appendix I

SAPS Certificate for Faithful Service

Appendix J

Certificate of Training with Paul Ekman Group

Certificate of Training

This is to certify that

Ian Ferreira

has successfully completed the training course

METT Advanced

Expert Level

Issued this 15th day of January, 2012

PAUL EKMAN GROUP

Paul Ekman

Paul Ekman, Ph.D

Appendix K

Personal Quote by Joe Navarro

Joe Navarro is a former FBI behavioural analysis unit commander presented to Ian Ferreira

"It is said that the only way to differentiate ourselves anymore is through knowledge and skill.

Ian Ferreira can provide you with the kind of information that will make you see the world differently and will transform how you are perceived."

BY: Joe Navarro author of the International best-seller "What everybody is saying."

Appendix L

Letter of Agreement Between Researcher and Polygraph Company

Department of Psychology

NMMU

Tel: +27 (0)41 504 2330

Date 30/03/2016

It is understood and agreed that the owner of Polygraph Truth Verification Services Mr Kobus Van Heerden who is also the polygraphist, consents to the use of his company, premises, access to clients on his premises by the researcher Mr I Ferreira.

Mr Kobus Van Heerden is the sole owner and polygraphist and the only person who can provide permission for the use of the premises and access to clients there.

The researcher and Mr K Van Heerden would exchange certain information that may be considered confidential. To ensure the protection of such information and in consideration of the agreement to exchange said information, the parties agree as follows:

1. The confidential information to be disclosed by both parties under this Agreement can be described as and includes:

Polygraph test results relating to participants who had agreed to take part in the study and who had signed the informed consent form. Participants are the clients visiting the Polygraph Truth Verification Services, at 129 Prospect Road Walmer, Port Elizabeth.

In addition to the above, confidential information shall also include, the researcher and Mr Kobus Van Heerden shall have a duty to protect, other confidential and/or sensitive information pertaining to the pre-interview and observational recordings done.

2. That Mr K Van Heerden and the researcher shall not use the Confidential Information for any purpose of business and/or in business relationships. The researcher has no business interest or share any business responsibilities at the Polygraph Truth Verification Services.

3. Mr K Van Heerden shall limit disclosure of confidential information within its own organization to its directors, partners, members and employees having a need to know and shall not disclose confidential information to any third party, whether an individual, corporation, or other entity.

4. This Agreement states further that Mr Kobus Van Heerden consents to the use of his property, business and access to his clients at the Polygraph Truth Verification Services at 129 Prospect Road Walmer, Port Elizabeth by Mr Ian Ferreira the researcher for the purposes and collection of data in the form of observing the pre-interview via remote camera, during the duration of his studies and until it is completed.

5. This agreement further states that Mr Kobus Van Heerden is the owner and also the polygraphist who will conduct the polygraph testing and will be conducting the pre-interviews in each polygraph test. These duties form part of Mr Kobus Van Heerden's everyday tasks, and the researcher will solely observe the procedure and client being interviewed in the pre-interview conducted by Mr K Van Heerden.

The parties acknowledge that they have read and understand this agreement and voluntarily accept the duties and obligations set forth herein.

Recipient of Confidential Information: Researcher

Name: IC Ferreira

Purpose: MA Psychology Research

Title: Mr

Address: Psychology Department, NMU Port Elizabeth

Signature:

Date:30/03/2016

Discloser of Confidential Information: Polygraph Truth Verification Services

Name: Kobus Van Heerden

Company: Polygraph Truth Verification Services

Title: Mr

Address: 129 Prospect Rd, Walmer, Port Elizabeth

Signature:

Date: 30/03/2016