The role of perceptual learning in accounting for the own-race bias, the inversion effect, and the distinctiveness effect in recognition memory for faces from a developmental perspective

by

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Abstract

The rated distinctiveness of a face, the orientation in which a face is seen and the race of the face, are all factors that are known to affect subsequent recognition of faces. These three factors are known as the distinctiveness effect, the orientation effect and the own-race bias. The main objective of this study was to track the extent to which these three effects develop across the lifespan. The study consisted of three experiments. The first experiment was designed to gather distinctiveness ratings for a large set of black and white faces and to establish whether there was a significant correlation between the distinctiveness ratings provided by black and white participants on both black and white faces. The correlation coefficient between ratings of white faces from both the black and white subjects was significant $r(23) = 0.64$ ($p<0.01$). From the ratings obtained during this experiment, equal numbers of distinctive and typical faces of each race were selected for use in experiment 2. The second experiment was designed to determine whether the distinctiveness effect, the inversion effect and the cross-race effect would emerge using stimuli selected as part of experiment 1. The results showed significant main effects of distinctiveness ($F(1, 46) = 13.623$, $p<0.05$) and of face orientation ($F(1, 46) = 75.204$, $p<0.05$). Furthermore, there was a significant interaction between race of face and race of subject ($F(1,46)= 18.744$, $p<0.05$). The third experiment sought to determine the progression of the distinctiveness effect, the inversion effect and the cross-race effect from early childhood (i.e. 6 years) to early adulthood (i.e. 23 years), using both recognition accuracy and response latency as dependent variables. As predicted, the results showed a significant main effect of face distinctiveness ($F(6, 154) = 40.229$, $p<0.05$), orientation of the face ($F(6, 154) = 175.132$), age of subjects ($F(6, 154) = 28.892$, $p<0.05$) However, these effects were accompanied by unpredicted main effects of race of face ($F(6, 154) = 24.184$, $p<0.05$) and race of subjects ($F(1, 154) = 8.957$, $p<0.05$). Also, the following interactions were significant: distinctiveness X orientation X race of face X race of subject and age of subject ($F(6, 154) = 3.461$, $p<0.05$); race of face and race of subject ($F(6, 154) = 2.081$, $p<0.05$); race of face X race of subject X age of subject ($F(13,154) = 2.246$, $p<0.05$); age of subject X orientation of the face ($F(6, 154) = 2.886$, $p<0.05$); age of subject X race of face X orientation of the face ($F(6, 154) = 2.284$, $p<0.05$).

Overall, the distinctiveness effect, inversion effect and own-race bias was evident among participants who were older than 8 years. Six-year-olds did not show a bias towards recognising distinctive, upright or own-race faces. Also, the own-race bias continued to affect the white subject's ability to recognise faces as they became older but this was not the case for black subjects.

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Chapter 1

Introduction and Literature Review

1.1 Introduction and motivation for study

People's ability to recognise faces has been of interest to psychologists for several decades. However, the past 40 or so years has witnessed a heightened interest in empirical research in the field of face recognition. Face recognition research has attracted a wide spectrum of researchers including: forensic psychologists, cognitive psychologists, developmental psychologists, neuropsychologists, neuroscientists, lawyers and policy makers, to name a few. Furthermore, models which help to explain the brain's functioning when recognising people's faces have been developed. This field of research has contributed towards reforms in the criminal justice system's handling of eyewitness identification evidence in many countries around the world. More recently, IT specialists have been and continue to develop programs based on face recognition research that are used at security check points in order to help law enforcement in identifying suspects on security cameras.

This thesis adds to the existing body of research by exploring the role of perceptual learning in accounting for the own-race bias effect, the inversion effect, and the distinctiveness effect in recognition memory for faces from a developmental perspective. Previous research has demonstrated that: (i) faces rated as being distinctive are recognised faster and more accurately than faces rated as typical (e.g. Busey, 1999; Newell, Chiroro & Valentine, 1999; Stevenage, 1995), (ii) faces that are presented upside down are considerably more difficult to recognise than faces that are presented in an upright orientation (Leder & Bruce, 2000; Yin, 1969), (iii) people recognise own-race faces faster and more accurately than other-race faces (Chiroro & Valentine, 1995; Slone, Brigham & Meissner, 2000; Wright, Boyd & Tredoux, 2001). These findings constitute what has become known as the “distinctiveness effect”, “the inversion effect” and the “cross-race effect” respectively. These effects have been demonstrated using a variety of experimental techniques, including, sorting tasks, similarity judgement tasks, categorisation tasks, face-matching tasks and recognition memory tasks in which either the ‘yes-no’ or the ‘forced-choice’ recognition test procedures were used (e.g. Metzger & Brigdes, 2004; Newell, Chiroro & Valentine, 1999, Sangrigoli & de Schonen, 2004; Valentine, 1991). However, the theoretical bases for these effects have remained controversial.

Theoretical accounts for the distinctiveness effect include: the exemplar-based model (Valentine, 1991), the norm-based model (Valentine, 1991), the face-space-R model (Lewis, 2004), the absolute coding face-space model (Byatt & Rhodes, 1998) and the Voronoi face-space model (Johnston & Lewis, 1998; Lewis, 2004). The inversion effect has been accounted for by the configural hypothesis (Leder & Bruce, 2000; Macrae & Lewis, 2002; Mondloch, Le Grand & Maurer, 2002). The own-race bias effect has been accounted for by the contact hypothesis (Chiroro & Valentine, 1995; Meissner, 2001; Wright, Boyd & Tredoux, 2003), the norm-based model (Byatt & Rhodes, 1998; Valentine, 1991) and the absolute coding face-space model (Byatt & Rhodes, 1998).

All the above models assume that some form of perceptual learning occurs during the course of exposure to faces from childhood to adulthood (Busey, 1999; Lewis, 2004; Meissner, 2001; Valentine, 1991; Valentine & Endo, 1992). However, little research has been done to investigate directly the extent to which all three effects interact with each other among children of different age groups and adults. Such a developmental study would provide an opportunity for a direct exploration of the role of perceptual learning in accounting for these effects.

The purpose of this study was to investigate the extent of the interaction between the distinctiveness effect, the inversion effect and the cross-race effect in face recognition, from the age of 5 years to young adulthood. Because previous studies have investigated these effects separately, the extent to which they interact with one another at various age groups has received less attention. It is assumed that the distinctiveness effect, the inversion effect and the cross-race effect are all products of the underlying cognitive mechanisms involved in learning to encode, store and recognise faces. The role of such perceptual learning processes in understanding how faces are recognised could shed more light on differences between how children and adults process faces as well as contribute significantly to the on-going theoretical debates in the face recognition literature.

1.2 Literature Review

The rated distinctiveness of a face, the orientation in which the face is seen and the race of the face are all factors that are known to affect the ability of an observer to recognise the face later on. These three effects are central components to the hypotheses investigated in this study. These three factors are also known to vary amongst different age groups. In this section, key studies on the distinctiveness effect, the inversion effect, the cross-race effect, research on developmental studies on face recognition and theoretical viewpoints are reviewed.

1.2.1 The Distinctiveness effect

The notion of the distinctiveness of a face is associated with the ease with which a face can be recognised in the context of other faces drawn from the same population. Most of the research done to date has shown that distinctive faces are more quickly and more accurately recognised than typical faces (e.g. Busey, 1999; Metzger & Bridges, 2004; Newell, Chiroro & Valentine, 1999; Stevenage, 1995).

Distinctiveness ratings are often obtained by presenting a group of participants with a series of faces, one face at a time. The participants are simply asked to rate each face on the likelihood of recognising it in a crowd. The faces that are rated by participants to be easier to recognise in a crowd would be categorised as distinctive. The faces that are rated by participants to be difficult to recognise in a crowd would be categorised as typical. The distinctive faces and typical faces are used subsequently in a recognition memory task to determine whether there are differences in recognition performance.

The recognition memory task often begins with by having an equal number of both types of faces being individually presented to participants. A break is taken and then participants are presented with the same faces presented previously, together with “new” faces. Participants are required to respond to each face by indicating whether or not they had seen the face in the initial list of faces. The complexity of the recognition memory task for each individual is measured by the time taken from when the image is presented to when a response is made. In such a simple recognition tasks, participants would be more likely to recognise the face shown in figure 1(a) more quickly and more accurately the face shown in figure 1(b). Similarly, Figure 1(c) would be more likely to be recognised more quickly and more accurately than Figure 1(d).

Figure 1(a): A distinctive black face[*]

Figure 1(b): A typical black face[*]

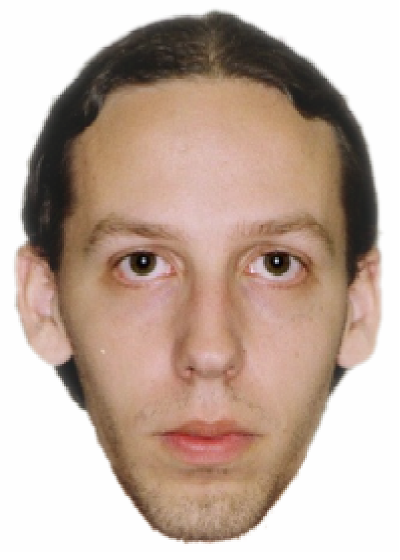

Figure 1(c): A distinctive white face[*]

Figure 1(d): A typical white face[*]

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[*] Distinctiveness of the faces was determined in Experiment 1

Research on the distinctiveness effect on face recognition is vast. Valentine and Endo (1992) conducted a recognition memory experiment using Japanese and white British participants. The stimuli consisted of slides of white British male faces and male Japanese faces. The faces that were in this experiment were photographed in a full-face view with neutral expressions. Participants rated their own-race and other-race faces for distinctiveness on a 7-point Likert scale. The participants rated the faces based on how easy the face would be to pick out in a crowd. The distinctiveness of the face was only obtained from those faces rated by the same-race group as that of the face. The ratings on the own- and other-race faces were used for comparative purposes. The relationship between distinctiveness ratings of own- and other-race subjects for Japanese faces was not as significant as that found for the British faces. However, even though participants had differing degrees of experience to either race group, the correlations between distinctiveness ratings from the participants of the two race groups were found to be consistent with each other.

From the rated faces, Valentine and Endo (1992) selected were 8 distinctive distractors, 8 distinctive targets, 8 typical distractors and 8 typical targets for each race group. Depending on the experimental conditions, subjects were shown either the typical set or the distinctive set of faces first, then followed by the other set. Participants were instructed to remember each face that was projected onto a white screen for 5 seconds followed by a 2 second interstimulus interval between slides. Immediately after the initial presentation, the recognition test took place where participants were instructed to respond as quickly and accurately as possible by pressing the “yes” or the “no” button on the response box. The results showed that distinctive faces were recognised more accurately and more quickly than typical faces regardless of whether the faces were own-race or other-race faces (Valentine & Endo, 1992).

In another study, Newell, Chiroro and Valentine (1999) used male faces that were unfamiliar to the subjects. Both male and female participants were used in each task but no participant participated in more than one task. In the first experiment, distinctiveness ratings were gathered by having participants rank the faces from the easiest to pick out in a crowd to the most difficult to pick out in a crowd. A median split was done on the distinctiveness ratings to determine the distinctiveness of the face. Newell, Chiroro and Valentine (1999) followed the distinctiveness ranking order by carrying out a face-matching task with an equal number of male and female participants. Each trial in the face-matching task consisted of a face in full-face view shown for 1 second and then followed by another face presented in one of the five different facial views. The faces were separated by a 500ms interstimulus interval. It was found that the distinctive faces were matched more accurately and quicker than typical faces. The mismatching of different views of the faces was mainly evident with the typical faces.

In a second experiment, faces were ranked for distinctiveness and then a recognition memory test followed. During the face recognition task, participants were initially shown a set of target faces to learn. Each target face was shown on a computer screen for 3 seconds. This was followed by a test session where each target face was paired with an appropriate distractor. Typical faces were found to be less accurately recognised than distinctive faces. However, there was no distinctiveness effect when taking the reaction time into consideration (Newell, Chiroro & Valentine, 1999). This latter finding can be as a result of a possible ceiling effect because the test set size was small and thus made it perhaps easier to remember the targets.

Stevenage (1995) conducted a study to find out whether the use of caricatures could be another effective measure in determining the distinctiveness effect. Caricatured faces are images where the faces are an exaggeration of the distinctive features. Four separate experiments were carried out and they varied from examining the effect of distinctiveness enhancement on the performance on a face recognition task, face classification task and a learned identification task on unfamiliar faces (see Stevenage, 1995). Each of these experiments used both veridical line drawing and caricatured faces in the procedures. Caricatured faces were better recognised than veridical line drawings of faces. It was concluded that the exaggeration of the distinctive feature among caricatured faces resulted in participants being better able to recognise these caricatured faces than the veridical faces.

In one of the experiments, it was found that not only familiar faces had a recognition-caricature advantage but unfamiliar faces had the same advantage as well. In the fourth experiment, training was done with participants to determine whether caricatured faces had a recognition advantage on veridical faces when recognising these faces from real photographed faces. Caricatured faces were found to be more recognisable from the real photographed faces than the veridical faces (Stevenage, 1995). This would suggest that distinctive features are made more obvious in the caricatured faces and thus making it easier for the participants to recognise the faces. Therefore, the conclusion that can be drawn from this study is that caricatures may be useful when examining the distinctiveness effect and determining the distinctiveness within a face.

It should be noted that confounding variables such as attractiveness, familiarity and age of the face could result in interference when comparing distinctive faces with typical faces. This could be rectified by creating a caricatured image, which is an exaggeration of the face to the extreme, so that it will be recognised as distinctive. This has been known to be an effective controlling measure (Byatt & Rhodes, 1998; Stevenage, 1995).

Recognition of typical faces tends to have a higher false alarm rate than distinctive faces. This high false alarm rate for typical faces can be attributed to the familiarity of the face because the face seems to the participants as if they had seen it before but have not (Busey, 1999). In another study by Davidenko & Ramscar (2005), it was proposed that the distinctiveness effect could be reversed if the distractors were controlled.

1.2.2 Inversion effect

Inverting a face during a face recognition task affects the way in which an individual would normally discriminate or recognise the face. Therefore, faces presented in an upright orientation are recognised more quickly and accurately than faces presented in an upside-down orientation (e.g. Leder & Bruce, 2000; Yin, 1969). The inversion effect is usually found by carrying out a face recognition task. Faces are initially presented in an upright orientation. This is followed by a set of faces that are presented in both an upright [as seen in Figure 2(a)] and an inverted orientation [as seen in Figure 2(b)]. The participants usually have to respond to the subsequent set of faces by saying “yes” to faces seen in the initial set or “no” to novel faces.

Figure 2(a): Faces presented in an upright position

Figure 2(b): The same faces as in figure 2(a) but in an upside-down orientation

In a classical study, Yin (1969) carried out three experiments where images were presented either in an upright or in an inverted orientation and tested in either the same or opposite orientation. The procedures in two experiments were based on presenting 40 images in the study phase followed by 24 pairs. These 24 pairs consisted of images previously presented in the study phase together with a new image. This would mean that 16 images were left out during the test phase. The images used were faces, houses, airplanes and men in motion. The findings for all the images were that it was more difficult to recognise them when they were presented in an upside down orientation. It was further found that recognition for inverted faces was profoundly more complex than having to recognise other objects inverted. This was called the face-inversion effect. To further understand this phenomenon, Yin (1969) used line drawings of faces and faceless figures dressed in various costumes. It was found again that inverted faces tended to be a harder set to recognise. Furthermore, the inversion effect was found when line drawings were used (Yin, 1969). Yin noted that there was a special factor involved in making inverted faces more difficult to recognise than other inverted images. In particular, Yin noted that faces were processed into memory by holistically focusing on distinguishable features in the faces.

Inverting a face has been known to affect adults' discrimination (Freire, Lee & Symons, 2000; Mondloch, Le Grand & Maurer, 2002) and recognition (Leder & Bruce, 2000) of faces that differed mostly in the spacing of facial features than the shape of individual features. Therefore, the inversion effect occurs mainly when people use the configuration of a face for face recognition purposes (Freire, Lee & Symons, 2000; Leder & Bruce, 2000; Macrae & Lewis, 2002; Mondloch, Geldart, Maurer & Le Grand, 2003; Mondloch, Le Grand & Maurer, 2002). Diamond and Carey (1986) suggested two different types of configural information. Firstly, first-order relational information is understood to be information about the relationship between the constituent parts of an object. Therefore, it is the make-up of these relational constituent parts, which constitutes part of the information derived from a face (e.g. nose above the mouth, eyes on both sides of the nose, chin below the mouth, etc.). Secondly, the second-order relational information is understood to be the relative distance between these spatial relations. Therefore, faces differ from each other based on the second-order relational information. The processing of a face is sensitive to the relational information and this is thought to disrupt the recognition of the inverted faces (Leder & Bruce, 2000; Macrae & Lewis, 2002; Mondloch *et al.*, 2003).

Leder and Bruce (2000) proposed that the inversion effect occurs because people use relational information of a face when processing an upright face. Even though local or separate features of a face (like the nose or the eyes) may help in recognising upright faces, this is not the case for inverted faces. In various experiments, Leder and Bruce (2000) used two sets of faces where either featural information differed (e.g. hair colour) or spatial relational information differed on the faces (e.g. distance between eye-brow and eye). All faces used in this study were greyscale. The various experiments differed by having the study and test sets separated, combined or having the brightness of featural information differ. When the sets were separated, the order of each set of faces was counterbalanced across participants. During the study phase, six faces were used and names were attached. These names were used for identification purposes during the test phase. During the test phase, each face had been shown in both the upright orientation and in the inverted orientation. The inversion effect was only found in those faces with spatial relational differences.

Therefore, the recognition of processed relational information from up-right faces is disrupted when those same faces are inverted. This explains the difficulty respondents had when having to recognise the inverted face (Leder & Bruce, 2000). However, these experiments could not explain fully how relational features were processed. Therefore, Leder and Bruce (2000) conducted another experiment to determine whether relational information is already represented in memory. By using isolated relational information only in the faces or isolated relational information in a highly redundant context or only one facial feature that was involved in the critical relational information; it was found that spatial relationships from the face were represented in memory (Leder & Bruce, 2000).

Itier and Taylor (2004), Leder and Bruce (2000), and Macrae and Lewis (2002) have found that face recognition is affected by the orientation of the face because an individual relies on the configural and featural information during encoding of the face. The perceptual representation of the face in memory relies on the orientation in which it was processed. A face can give a lot of information to the perceiver and part of this information is recognising the individual. However, when the face is presented upside-down, information required for face recognition is less evident, thus making recognition of the face more difficult (Leder & Bruce, 2000). Face recognition improves when faces are processed in a holistic and configural manner. However, the processing of a face into memory is hindered by featural processing (Macrae & Lewis, 2002). Itier and Taylor (2004) used upright, inverted and contrast-reversed unfamiliar faces and only a few of the faces were repeated directly after or after an interceding face. Participants were required to respond to the repeated faces and the event-related potentials (ERP) were recorded. It was found that the encoding of the faces was only affected by configural changes (Itier & Taylor, 2004).

1.2.3 Cross-race effect

The cross-race effect in face recognition is the tendency to recognise faces from one's own race more easily and more accurately than faces from another race (e.g. Chiroro & Valentine, 1995; Slone, Brigham & Meissner, 2000; Wright, Boyd & Tredoux, 2001). This is known as the own-race bias in face recognition. This effect has been demonstrated using participants drawn from among the white, black, Hispanic, Japanese and Asian populations. In a typical study, participants from separate race groups are used in the experiment. Then, sets of faces representing the participant's race are used in a typical experiment. In a recognition memory task, participants are first shown sets of faces from all race groups being represented in the experiment. The participants are required to remember as many faces as possible from this initial set of faces. Then, participants are given a break before they are shown another set of faces comprised of the various race groups. This second set of faces is further comprised of an equal number of "new" faces and faces used which were used in the first set. From this second set of faces, the participants are required to indicate whether they had seen the face from the initial batch or not.

A lot of research has contributed to an understanding of the phenomenon of own-race bias in face recognition. Furthermore, many models have been developed to explain the cross-race effect (for review, see Sporer, 2001). The own-race bias is characterised by the impairment in accurately recognising other-race faces (Ferguson *et al.*, 2001; Sangrigoli & de Schonen, 2004). Research has found that false alarm rates for own-race face recognition are consistently lower in comparison to recognition for other-race faces (Meissner, 2001; Slone, Brigham & Meissner, 2000). Meissner (2001) found that racial attitudes did not affect the own-race bias in face recognition significantly but this changed as inter-racial contact became a factor. Ferguson *et al.* (2001) investigated whether prejudice would affect the recognition of other-race faces by comparing the results of high prejudice and low prejudice participants, as determined by a self-report scale. The study could not find any relation between prejudice and the cross-race effect. However, what was found from this study was that prejudice (e.g. “they all look the same”) “helped” improve recognition performance for own-race faces (Ferguson *et al.*, 2001). Positive emotions were found to reduce the own-race bias. However, this finding could be attributed to positive emotions leading to holistic perceptual processes or where less memory distortions occur for other-race faces (Johnson and Fredrickson, in press).

Meissner (2001) reported three characteristics from which the own-race bias is based. These include (i) the conceptual knowledge of the configurations; (ii) a skilled representational system; and (iii) the cognitive efficiency (Meissner, 2001). Even though experience may help with the efficiency and accuracy of encoding own-race faces, this is not the case for other-race faces. Other-race faces tend to be encoded with greater difficultly and less efficiency because these faces are stored by using fewer and often incorrect cues. Therefore, the criterion used to recognise own-race faces may interfere with the recognition of other-race faces (Meissner, 2001). Thus, Meissner (2001) suggested that the own-race bias is the result of having conceptual knowledge of the appropriate features of the face as well as having the conceptual knowledge of the configural relations of own-race faces but not for other-race faces.

Wright, Boyd & Tredoux (2001) conducted a study where participants had to recognise the person's face in a sequential line-up. This study found that other-race faces were less accurately recognised than own-race faces. The results from this study were explained by the **optimality hypothesis**. This hypothesis suggests that information is encoded optimally when information is associated with confidence and accuracy. Therefore, more attention would have been given to the confederate if they were from the same race (Wright, Boyd & Tredoux, 2001).

One of the most commonly used explanations for the occurrence of the own-race bias in face recognition is the contact hypothesis. This hypothesis suggests that practice and exposure to a specific type of face, allows people to recognise those faces better than other types of faces. Being exposed to one's own-race faces often enough and having an own-race bias in face recognition, could be explained by this hypothesis. Most studies have shown a positive correlation between contact with other-race faces and identification accuracy (Slone, Brigham & Meissner, 2000; Wright, Boyd & Tredoux, 2001; Wright, Boyd & Tredoux, 2003). However, Wright, Boyd and Tredoux (2001) could not find a positive correlation between contact with other-race faces and identification accuracy but the assumption was made that English subjects should have had more inter-racial contact than South African subjects.

Wright, Boyd and Tredoux (2003) found that black participants in South Africa with some inter-racial contact recognised other-race faces better than white participants in South Africa with some inter-racial contact. The results are possibly due to white people in South Africa being more prevalent in universities and higher positions in the workplace even though they only make up a small section of the population (Wright, Boyd & Tredoux, 2003).

Chiroro & Valentine (1995) explored the contact hypothesis by investigating the presence of an own-race bias depending on the amount of contact one race has had with another. They used groups of black and white participants who had little or no exposure of the other-race. The procedure consisted of a recognition memory task where white typical and distinctive faces and black typical and distinctive faces were used. The dependent variable was recognition accuracy. According to the exemplar-based model, it had been suggested that typical own-race faces should have a larger exemplar density in the central tendency than distinctive own-race faces. Chiroro and Valentine (1995) suggested that the central tendencies of the other-race faces may be located separately on a multidimensional space than the own-race faces. Again, this study found support for the own-race bias because recognition accuracy was higher than that for other-race faces. Only black participants who had high contact with the other-race group were found to have a lower performance in own-race recognition. Therefore, this study supported the contact hypothesis only for black participants but not for white participants (Chiroro & Valentine, 1995).

The contact hypothesis has been criticised because of the lack of conclusive empirical evidence to support the hypothesis (e.g. Meissner & Brigham, 2001). The lack of support for the contact hypothesis can also be attributed to the concept of “contact”, which is too broad and difficult to measure empirically. There has been an attempt to find alternative explanations for the own-race bias. One premise of research that has emerged is research regarding the perceptual encoding of faces.

Meissner (2001) conducted a study where participants were required to sort faces in certain groups and in another experiment; participants' eye-fixation behaviour was tested. From the sorting task, it was found that the own-race bias was only really evident for featural differences between black vs. white faces. The own-race bias was not evident in the type of features reported in the grouping descriptions. It was assumed, however, that these differences in the sorted groups of faces may have been subtle and could only be determined by an analysis of the statistical structure of the participants' sorting. It was further found that the sorting consistency of the participants was greater for own-race faces. However, the existence of such a "differential feature recruitment" process when viewing different race groups' faces is doubtful (Meissner, 2001).

Walker and Tanaka (2003) used the 'same-different' sequential matching task to investigate whether own-race faces are perceived as more differentiated than other-race faces. The results showed that Caucasian participants were more accurate at detecting differences between Caucasian faces than between Asian faces, while Asian participants were more accurate at detecting differences between Asian faces than between Caucasian faces. Walker and Tanaka (2003) came up with the conclusion that an own-race bias occurs not only at a recognition level but perhaps also at a perceptual encoding level. This suggests that own-race and other-race faces may be encoded differently and therefore the own-race bias may occur because of such perceptual encoding differences. However, what is not clear, is what accounts for the perceptual encoding differences?

Other studies have focused on the role of perceptual expertise in accounting for the own-race bias. The basis of this view is that the configural information in other-race faces is more difficult to derive, process and store than own-race faces (for review, see Turk, Handy & Gazzinga, 2005). Turk, Handy and Gazzinga (2005) conducted a study in which they investigated the extent to which a split-brain patient could encode own-race and other-race faces by using a delayed match-to-sample task. The cerebral hemisphere in this study was manipulated during the performance of the task. It was found that the right hemisphere demonstrated a significant performance advantage for own-race faces, whilst in the left hemisphere, there was no effect of race on performance. Perceptual expertise can be described as a shift in processing strategy from a feature-based encoding, which occurs in the left hemisphere, to configural encoding by the right hemisphere (Rossin *et al.*, 2000). Therefore, this study by Turk, Handy and Gazzinga (2005) provides direct evidence for the role of expertise in accounting for an own-race bias.

It has also been found that racial categorisation of faces may even be a factor that could account for the own-race bias. According to the racial categorisation hypothesis, an own-race bias occurs as a result of the differences in which own-race and other-race faces are perceived and encoded at the point of initial encounter. MacLin and Malpass (2003) conducted a study where identical same-race and other-race faces were used with regard to facial features and facial configurations. When key featural characteristics were used as racial markers, participants perceived the face as belonging to the race consistent with the racial marker. MacLin and Malpass (2003) concluded that the categorisation process of featural information of the face into other-race faces becomes biased. Thereafter, recognition of the face is affected by the mere categorisation of that face at the point of encounter because the categorised facial feature becomes a hindrance to differentiating the faces from the other-race.

1.2.4 Development of perceptual learning for face recognition

Meissner (2001, p.7) defined perceptual learning as "…the acquisition of conceptual knowledge regarding both invariant features and relationships between the features of stimuli within a given domain". An important aspect regarding perceptual learning includes the ability to ignore irrelevant characteristics and attend to the relevant characteristics. Thus, an individual is flexible enough to store and retrieve "domain relevant stimuli" from this complex structural system. Another characteristic of perceptual learning is the ability to gain access to domain specific information in order to separate distinguishable stimuli. Meissner (2001) suggested that as people gain experience about recognition of objects, they put certain weights on features that people regard as discriminating factors of that object. Therefore, perceptual learning takes place during the course of an individual's life.

The first aspect of perceptual learning that will be discussed is the development of the inversion effect. Sangrigoli and de Schonen (2004) conducted a number of developmental studies on the processes involved in learning to recognise faces. Their research has showed that 6-month-old infants were able to categorise faces and 10-month-old infants were able to create proto-types of faces. Other studies have shown configural processing already occurring in one-year-olds. Sangrigoli and de Schonen (2004) used a forced-choice task to conduct the research with children aged between 3 to 6 years. A forced-choice task involves the process of first presenting a face and then following this with a recognition task, where both a novel face (i.e. a never seen before face) and a familiar (i.e. previously shown face) face are shown. The study found that recognition processing skills improve dramatically from the age of 3-years to the age of 5-years. The results also showed that upright faces were better recognised than inverted faces and own-race faces were better recognised than other-race faces. There was also an increase in accurately recognising the faces with regard to age (Sangrigoli & de Schonen, 2004). Sangrigoli and de Schonen (2004) supported previous research in this field where it was also found that the inversion effect was as a result of configural processing.

The research explained in Itier and Taylor (2004) and Sangrigoli and de Schonen (2004) regarding the development of the inversion effect has produced different results regarding the age of onset of the inversion effect. Itier and Taylor (2004) used event-related potentials to measure the brain’s response to the stimuli. Recognition for upright faces was better and quicker than that for inverted faces as the individual got older. This inversion effect was evident at 8-years-old (Itier & Taylor, 2004). However, Itier and Taylor (2004) did discuss other research that found support for the inversion effect among children as young as 5-years. One of the studies done by Pascalis *et al.* (2001) found that the error rate for recognising inverted faces lowered from the age of 5 years to the age of 8 years. The orientation of the face did not influence how faces were processed by 6-month-old infants (de Haan, Pascalis &

Johnson, 2002). Therefore, these results indicate that the inversion effect may begin to develop later on in life between the ages of 5 years to 7 years.

In a study where children aged between 5 and 6 years participated in a forced choice task. The children were required to identify the faces based on second-order relational features, like facial expression, sounds being mouthed or direction of gaze. The children had a ceiling effect on their performance. It was argued that children's ceiling performance could be attributed to the children identifying the faces based on the isolated features (e.g. shape of mouth) than focusing on the spatial relations amongst facial features (Bruce *et al.*, 2000).

Perceptual learning also involves the cross-race effect. However, what remains controversial is, when does the own-race bias become a specific hindrance to recognising faces? Sangrigoli and de Schonen (2004) have found that 3 to 5--year-old children had significantly better recognition accuracy for own-race upright faces than for other-race upright faces. This research has led some researchers to speculate that the cross-race effect is present in children aged between 3 to 6-years-old (Sangrigoli & de Schonen, 2004). Therefore, it was suggested from the results of Sangrigoli and de Schonen (2004) that by the age of 3 years, the human face prototype would be natively specific.

In another study, Sangrigoli and de Schonen (2004) were interested in finding out whether the own-race bias could develop as early as infancy. Therefore, their study investigated whether 3-month-old infants had enough experience to show an own-race bias. Sangrigoli and de Schonen (2004) found that infants looked longer at the novel faces than at the habitual faces. Following this, the infants were shown other-race faces and own-race faces. The infants stared longer at the other-race faces than at the own-race faces. The unfamiliarity of the other-race face caused the infant to stare longer but when shown the own-race face, the infant became bored and turned their head away. Thus, infants as young as 3 months had shown a possible own-race bias. In another experiment, it was found that early exposure to another-race group's face could help in recognition of that race group's face later on in life. Therefore, face recognition appeared to have been dependent on the amount of exposure to faces of another race (Sangrigoli & de Schonen, 2004).

Sangrigoli *et al.* (2005) carried out a face recognition study on three groups of individuals. These groups consisted of French born Caucasian subjects (as a control group); Korean subjects born in Korea but then lived as adults in France (as a control group); and adopted Korean subjects who grew up with European Caucasian families from the age of 3 years. The procedure consisted of a face recognition task, which used Asian and Caucasian faces. Both the adoptees and the Caucasian control group were more likely to correctly recognise Caucasian faces more accurately than Asian faces. However, the Korean control group performed better with the Asian faces than with the Caucasian faces. It had been suggested that previous experience of a particular race group's face at a younger age may be erased from memory because of the exposure to the new race group's face. This meant that the recognition of the new race group's faces would be better than other groups' or even one's own-race group's faces. This finding offers support for the view that the other-race effect can be reversed in late childhood (Sangrigoli *et al.*, 2005). The results of Sangrigoli *et al.* (2005) suggest that the early exposure to other-race faces can still have an impact on face processing in memory, even at the age of 9 years. This is similar to the findings that suggest that facial recognition improves up to the age of 12 to 14 years before it slows down (e.g. Bruce *et al.*, 2000; Carey, Diamond & Woods, 1980; Mondloch, Le Grand & Maurer, 2002).

The studies reviewed in this section thus far have only focused on small age group ranges (i.e. either children aged 5 to 7 years or only adults). However, what happens once you broaden the age variable in order to get a clearer understanding of the developmental trend over several years? The reason for such a question at this point is based on the differences children may have during the face recognition task in comparison to adults.

Mondloch, Le Grand & Maurer (2002) conducted a study in which measured face-processing skills (i.e. featural, configural and contour processing) in children aged 6, 8 and 10 years and adults was measured. The stimuli for the experiment consisted of upright and inverted faces. Recognition of the faces was tested by first presenting a model of faces and after an interstimulus interval, the test face was presented. It was found that face processing skills improved from the age of 6-years to 10-years but at the age of 10-years, it was not yet adult-like. It was also found that children as young as six years were still more likely to focus on featural processing and processing based on external contour, more than configural processing. It was further found that adults and 10-year-olds revealed a greater inversion effect on the configural set of faces than they did on the featural and external contour sets. The inversion effect was less evident in children aged 6- and 8-years, as performance was similar on the configural set regardless of orientation of the face. There were no significant differences in memorising external contours of faces between the ages of 6-years and adulthood (Mondloch, Le Grand & Maurer, 2002). Mondloch, Le Grand and Maurer (2002) concluded that the poor performance in identifying faces amongst children is due to poor configural processing skills. Furthermore, configural processing develops more slowly than featural processing and external contour processing.

Pellicano, Rhodes and Peters (2006) conducted a study on children and adult's abilities to recognise faces, in upright and inverted positions, with differing configural information. The researchers used a two-alternative forced-choice task to determine whether children (aged 4 to 5 years) are less able to encode slight configural changes in the face than adults. Participants were shown a face followed by a pair of faces. The pair of faces consisted of the face that had been shown to the participant previously (i.e. target) and a face that differed slightly in the configural make up of the face (e.g. space between eyes). Both children and adults performed better on faces that had the same configuration than on faces where the spatial configuration differed. There was also no developmental trend that suggested an increase in performance between children and adults.

Mondloch *et al.* (2003) conducted another study in which the aim was to test the findings by Bruce *et al.* (2000). Both adults and children were used in the study using the same 5 tasks (i.e. identity/changed facial expression; identity/changed head orientation; facial expression; lip reading; and direction of gaze) to measure the effect of second-order relational processing. Adults were split into two groups, namely, those shown the faces in an upright orientation and those shown in an inverted orientation (Mondloch *et al.*, 2003). As previous studies had suggested that recognition of inverted faces is affected by the configural make-up of the face more than it would for the shape of individual features (Freire, Lee & Symons, 2000; Leder & Bruce, 2000; Mondloch, Le Grand & Maurer, 2002).

Mondloch *et al.* (2003) found that inversion of the face affected the ability to recognise the face's identity. This suggested that inversion of the face was most likely to affect recognition of second-order relations, as the performance on that task was most dependent on sensitivity to second-order relations (Mondloch *et al.*, 2003). Children performed differently in various face-processing tasks. Children aged around 6 years were less accurate than adults on the 5 tasks. There was a developmental increase in performance when 8 and 10 -year-olds were nearly as accurate as adults in the matching facial expression and lip reading tasks. This study also found that sensitivity to second-order relations had a developmental trend mostly in the ability to match facial identity through changes in orientation because 10-year-olds were significantly less accurate than adults. Therefore, this supports previous research where second-order relational processing in face recognition is thought to develop slowly in children (Mondloch *et al.*, 2003).

Newell (2005) conducted research on the development of the cross-race effect in children aged 5- to 11-years and adults. The faces used in the experiment varied in distinctiveness (i.e. typical faces and distinctive faces). This was done to explore the role of distinctiveness in the cross-race effect. The faces were female Caucasian and female Asian faces. Distinctiveness ratings of the faces were obtained by the subject rating their own-race group's faces. Participants were split into two groups for every age group. One group was in the “incidental learning condition”, where they were required to remember the story, and the other group was in the “intentional learning condition”, where they were required to remember the faces from the story. The study involved the use of a story that was age appropriate. The story began by showing participants the faces of the characters in the story. This was followed by a delay task, where participants would only hear the story. Finally the test period took place where the participants were required to identify the faces from the story. It was found that face recognition skills increased with age. There was a significant difference between adults and 5-year-olds. All age groups were found to recognise distinctive faces better than typical faces. This study also found that the distinctiveness effect was apparent at the age of 5-years (Newell, 2005). This was different to other research which had shown that the distinctiveness effect only develops after the age of 7-years (e.g. Gilchrist & McKone, 2003; Johnston & Ellis, 1995).

Recognition of distinctive Asian faces (other-race faces) was better than that for distinctive Caucasian faces (own-race faces). There was no significant difference for typical faces (Newell, 2005). Newell’s (2005) study found similar findings to Valentine and Endo (1992) for the distinctiveness effect occurring regardless of the race of face. However, Valentine and Endo (1992) still found an own-race bias. From this finding by Newell (2005), it had been proposed that when extremely typical and extremely distinctive faces of each race are compared in a face recognition task, the cross-race effect may become more complex.

1.2.5 Development of the Face-Space Models

Many face-space models have been developed which have sought to provide a parsimonious explanation for the distinctiveness effect, the own-race bias and the inversion effect. One of these most acknowledged models is the exemplar-based model. Valentine and Endo (1992, p.675) defined the exemplar-based model as involving “the assumption that the psychological similarity between two faces is determined by a monotonic function of the distance separating the points in the multidimensional space by which the faces are encoded.” This model suggests that faces are encoded as points in a multidimensional face space. The space is a metaphor for the mental representation of the encoded faces. Depending on the density of points in the space, the face should either be typical or distinctive (Valentine, 1991). Typical faces are more common and are located near the central tendency of the space. Therefore, typical faces will be less recognisable than distinctive faces because there is more interference during the recognition of typical faces than distinctive faces (Valentine, 1991). The norm-based model is based on the notion that a single proto-type exists and faces are encoded as deviations from this proto-type (Valentine, 1991). The absolute coding face-space (ABC) model is a modified version of the exemplar-based model. Byatt & Rhodes (1998) ABC model explains that faces are encoded as absolute values on a set of shared dimensions where the norm has no significant role in face recognition. Caricatures of the face play a significant role by making the exemplar density less and more distinctive only for own-race faces (Byatt & Rhodes, 1998). The Voronoi face-space model is based on the view that faces are encoded as points on the face-space. However, faces are separated into identity regions. There is a central caricature to each region (Johnston & Lewis, 1998; Lewis, 2004). The face-space-R model incorporates some of the aspects of the previously mentioned models (Lewis, 2004). The various face-space models can also help researchers understand why the recognition of typical faces tends to have a higher false alarm rate than distinctive faces.

A multidimensional space framework was proposed by Valentine (1991), which included some aspects of both the norm-based model and the exemplar-based model. According to the norm-based model, it is assumed that faces are encoded in relation to a proto-type. According to the exemplar-based model, it is assumed that only category exemplars are stored (Valentine, 1991). Valentine (1991) suggested that faces are encoded as points or vectors on a multidimensional space. The multidimensional space framework explains how faces are distinguishable from each other. Furthermore, this framework offers a reasonable account for face recognition by offering a combined explanation for the distinctiveness effect, the inversion effect and the cross-race effect (Meissner, 2001; Valentine, 1991).

Johnston *et al.* (1997) provided empirical support for the multidimensional space framework proposed by Valentine (1991). However, what made their research unique was that their study used similarity judgements to rate the pairs of faces. Johnston *et al.* (1997) used adult male faces to determine similarity judgements based on faces rated for distinctiveness. The faces that were used in this experiment were initially rated on a 7-point Likert scale. Participants rated each face’s distinctiveness based on how easy the face would be to remember in a crowd at a railway station. The similarity judgement task involved having each face appear on the screen for 1 second. This was followed by a 500ms interstimulus interval. Then the same face would appear on the screen again for another second. Participants were required to rate the paired faces on how similar the faces appear to each other on a 7-point Likert scale. In order to create a face space model, multidimensional scaling was used. The research gave an adequate account for the distinctiveness effect because distinctive faces were located on the outer regions of the multidimensional space, whilst typical faces were located towards the centre on the multidimensional space (Johnston *et al.*, 1997).

Valentine & Endo (1992) found that their results supported the exemplar-based model more than the norm-based model. Valentine and Endo (1992) also found that the other-race faces' distinctive ratings are more densely clustered compared to own-race faces' distinctive ratings suggesting that this model also offers an explanation for the impact of race on the distinctiveness of the face (see also Lewis, 2004). Valentine (1991) suggested that recognition of distinctive faces would be less affected than typical faces if the faces were inverted because distinctive faces are encoded in terms of separate features. Upright faces were more recognisable when distinctive relational features were included in the study than when those distinctive features did not exist (Leder & Bruce, 2000).

Valentine (1991) and Lewis (2004) both suggested that the norm-based model is based purely on a prototypical norm face being stored. However, the norm-based approach will not be elaborated on because most research has found that the recognition advantage only occurs with small exaggerations below 16% on the faces (Lewis, 2004).

As is obvious from the various models developed to explain the own-race bias, there has not really been a complete theoretical framework to account for the various findings (Meissner, 2001). Byatt and Rhodes (1998) suggested that the physiognomic variance between all race groups is very similar. Since no racial group's face is particularly difficult to recognise, difficulty in recognition of other-race faces can best be explained by the way in which faces are encoded into memory. According to the norm-based model, the difficulty in recognising other-race faces accurately could be accounted for by the use of a representation of an average of most faces perceived by an individual. Byatt and Rhodes (1998) defined the absolute coding model as: "…the suggestion that faces are represented simply as discrete points in the space, with the location of each face determined by the absolute value of each facial feature" (p.2456). Therefore, according to the absolute coding model, the feature dimensions on the face space are more appropriate for own-race faces because experience allows for own-race faces to appear for people as being more distinctive than other-race faces. Therefore, as a person gets more experience with other-race faces, that person will be able to use those dimensions necessary to recognise the group of faces (Byatt & Rhodes, 1998). Byatt and Rhodes (1998) were able to find results from their research that supported the absolute coding model.

Meissner's (2001) study also empirically supported Valentine's (1991) proposed exemplar-based model and Byatt and Rhode's (1998) absolute-coding model, where own-race faces could be represented with greater complexity than other-race faces and where participants focused more on configural information of the own-race faces more so than other-race faces.

The models discussed so far do not give an adequate explanation for some faces that are only encoded into memory with less importance. Lewis (2004) suggested a revision to the face-space model and called it the face-space-R model, because it now includes all possible exemplars that may be recognised. As with most "face-space" models described thus far, the model explains the mechanism that creates an internal representation of the perceived face. The face-space-R model suggests that the distinctiveness of the face is determined by the distance between the exemplar and the average. This means that the distinctiveness of the face is determined by the distance between the representation of the face and the average face. Therefore, distinctive faces should be more recognisable than typical faces because distinctive faces are located further away from the average face. It has also been argued that when faces are rated, an individual cannot make full use of all dimensions of a face but uses the average face to determine whether the face is typical or distinctive (Lewis, 2004).

1.2.6 Objectives of this Study

Research in the field of face recognition that has been discussed in this section provides an understanding about the three factors that affect a person's ability in recognising faces. However, there has been a lack of research in understanding the distinctiveness effect, inversion effect and own-race bias across the life span of an individual. Therefore, the primary objective of this study was to examine the extent to which the distinctiveness effect, inversion effect and own-race bias are present in participants drawn from among individuals aged 6 – 23 years. The broader empirical question in this investigation has to do with the role of learning in perceptual processing of faces and the underlying cognitive mechanisms.

Chapter 2

Methodology

2.1 Introduction

Consistent with most research conducted in the chosen field of investigation, the proposed study will utilise experimental procedures. In each experiment, independent variables were identified, manipulated and the effect of such manipulation measured on pre-identified dependent variables. It was important to understand the procedures that have been used in previous studies on recognition memory in order to select the most appropriate procedure for the present study. Therefore, in this chapter, a detailed description of each procedure is given. The three most commonly used experimental procedures for testing subjects' face recognition memory performance are reviewed, namely, the 'yes-no' recognition procedure, the 'simple forced-choice' procedure and the 'delayed-matching forced-choice' procedure. The reasons for the specific method used in the present study are explained.

2.2 "Yes-No" study-test procedure

In a typical 'yes-no' recognition experiment, an initial set of faces (called the "study list") is shown to the participant who is often asked to study each face carefully. Once all the faces have been shown to the participant, the test list is presented. The participant is required to respond with a "yes" if they think that the face was part of the initial set of faces or say "no" if they think that the face was not part of the faces seen during the study phase. This method allows for the calculation of highly sensitive signal detection measures of recognition accuracy.

2.2.1 Signal-Detection Theory

The signal-detection theory is important in explaining research in recognition memory thoroughly (Murdock, 1982). This section explains the various components of the signal detection theory as well as how this theory is used in the analysis of data obtained during a “yes-no” study-test procedure. The signal-detection theory was developed in the 1950’s in the working fields of mathematical statistics and electronic communications and proposed by Tanner and Swets (1954) as an alternative to previous psychophysical methodologies.

Schiffman (2003) explained that humans make decisions from conditions that are ambiguous from a sensory point of view. Therefore, the signal detection theory was developed to determine whether a subject could detect a signal along the same sensory continuum. The classical example includes participants being exposed to a signal (in this case a faint sound) and a noise. Neural activity in the brain continues to detect the signal regardless of whether an external stimulus was present at all. The spontaneous-neural activity is due in part to random firing of the neurons in the brain. Therefore, in a typical signal detection experiment, the subject has to decide whether the noise was detected alone (*Noise*) or it was due to a signal present with the background noise (*Signal*+*Noise*).

The distribution of the sensory effects can be plotted on a graph and it would be represented as a bell-shape. The representation of the noise alone on the graph can been seen in figure 3(a) where the *χ*-axis is based on the level of sensory activity; and the *У*-axis plots the frequency of the different levels of the sensory activity. The representation of the noise and signal is plotted on the graph in figure 3(b). The two distributions of *noise* alone and *signal+noise* will differ when combined on a single graph as seen in figure 3(c). The plotted distribution shows that the average for *signal+noise* is higher than the average for the *noise* alone.

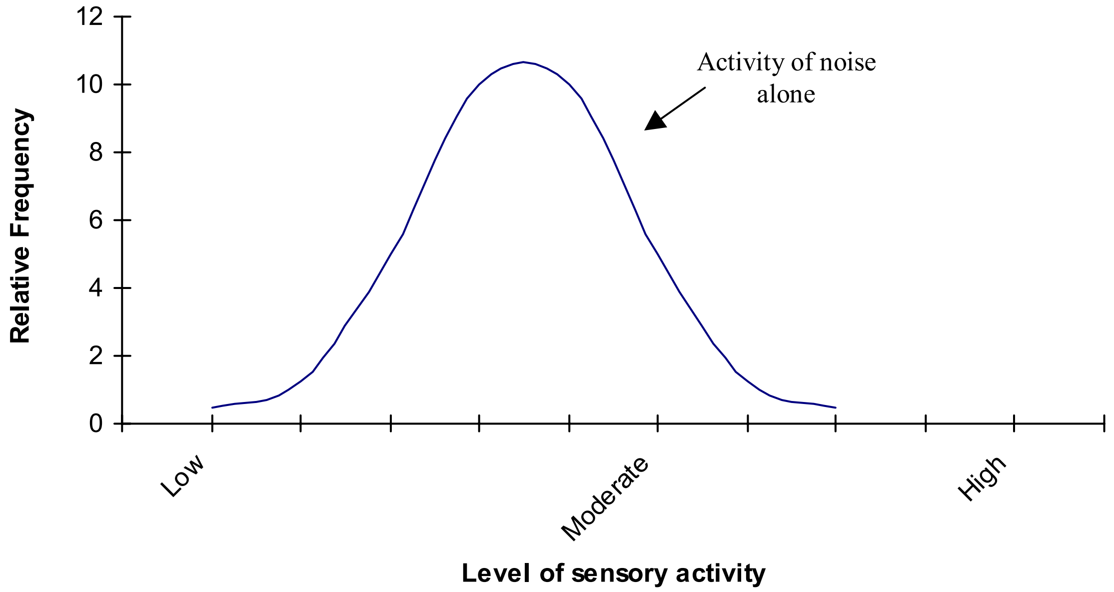


Figure 3(a) Frequency of varying levels of sensory activity produced by *N*(noise)

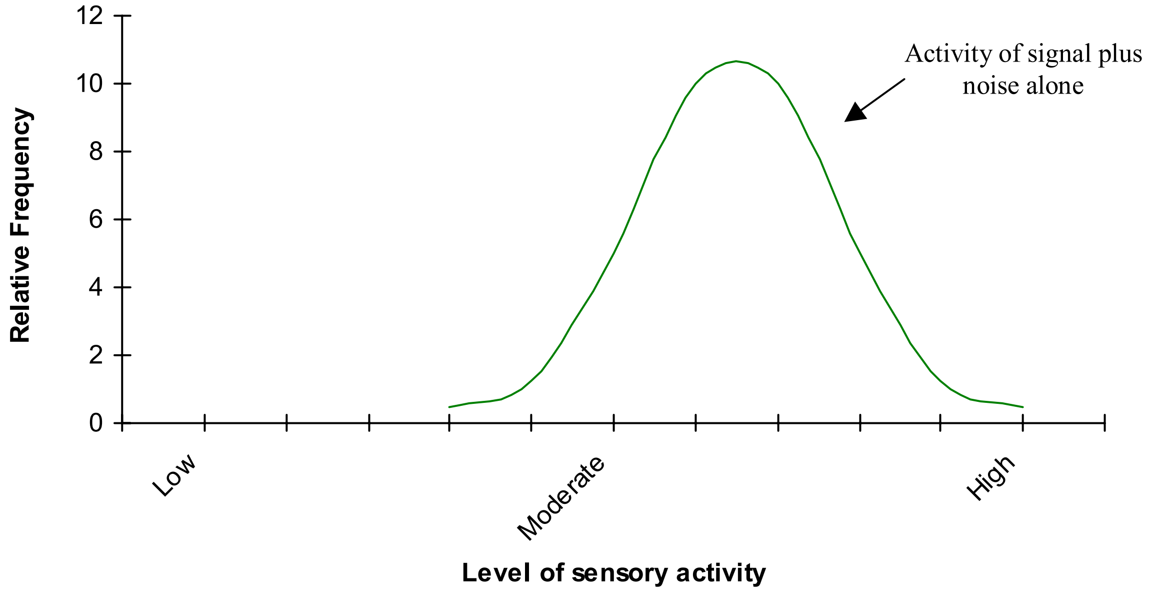


Figure 3(b) Frequency of varying levels of sensory activity produced by *S+N* (signal plus noise)

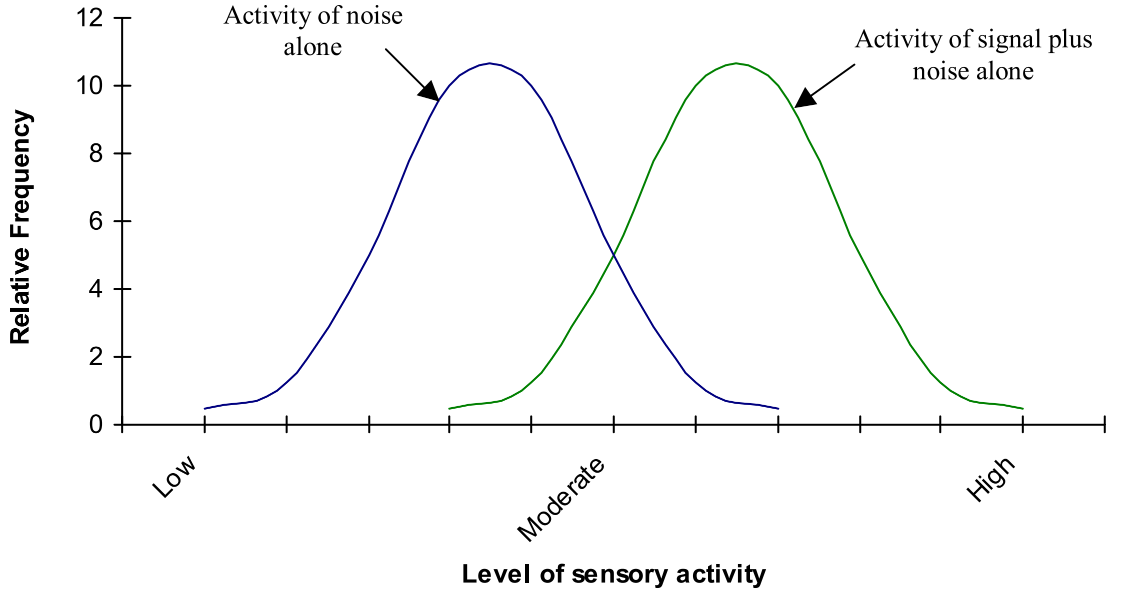


Figure 3(c) Frequency of varying levels of sensory activity produced by distributions of *N* (noise) and *S+N* (signal plus noise)

The distribution in figure 3(c) can be further defined by the role of a criterion. The subject will respond with a “yes” or “no” response based on the certainty of the signal being present or not. This is known as the criterion. The criterion response is measured on the sensory continuum as seen in figure 3(d). Therefore, the subjects will give a “yes” response when their certainty on the level of the sensory continuum is greater than criterion and a “no” response when their certainty on the level of the sensory continuum is less than the criterion. This could mean that a subject would respond affirmatively to the condition being present when it was not present. This would mean the respondent experienced a false alarm.

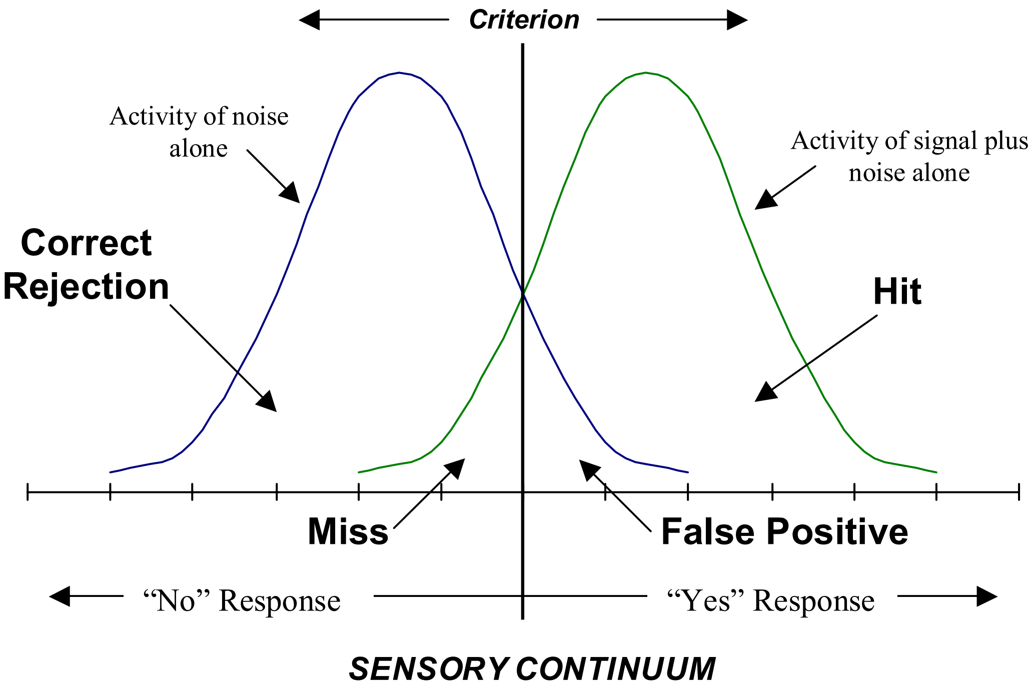


Figure 3(d) Frequency of sensory effects produced by distributions of N(noise) and S+N(signal plus noise) related to the respondent’s criterion value.

In order to determine the overall performance of the subject’s responses, a single score should be obtained that incorporates the information from the two distributions. There are four possible kinds of responses. If the subject responded with a “yes” response and the signal plus noise (*S*+*N*) was present, this would make it a “Hit”. If the subject responded with a “yes” response and the signal plus noise (*S*+*N*) was NOT present, this would make it a “False Positive”. If the subject responded with a “no” response and the noise (*N*) was only present, this would make it a “Correct

Rejection”. If the subject responded with a “no” response and the signal plus noise (*S*+*N*) was present, this would make it a “Miss”. The noise (*N*) only distribution is also known as the “Distractor” or “New Item”. The signal plus noise (*S*+*N*) distribution is also known as the “Target” or “Old Item”. These responses have been placed in a matrix as shown in figure 3(e). The most important collected responses in the signal detection theory are hits and false positives.

	Target	**Distractor**
Yes Response	**HIT**	**FALSE POSITIVE**
No Response	**MISS**	**CORRECT REJECTION**

Figure 3(e) Stimulus response matrix for subjects yes-no responses

The signal detection theory is used in face recognition studies to determine statistically the accuracy in detecting old and new items. The signal detection theory can therefore be applied to the typical yes-no and forced-choice face recognition tasks. Stanislaw and Todorov (1999) mentioned that the sensitivity in a forced-choice task can be determined by dividing the number of correct responses by the number of trials. This would constitute a percentage of correctness.

In order to eliminate response bias that may cause the results to be skewed, a non-parametric measure was developed by Pollack and Norman (1964). This measure is known as an *A*-prime score (*A’*). Stanislaw and Todorov (1999) mentioned various ways of calculating A’ from different authors, however, one single formula can be used:

$$A' = 0.5 + \left[\operatorname{sign}(H - F) \; \frac{(H - F)^2 + |H - F|}{4\max(H,F) - 4HF} \right]$$

*H is the total number of hits by a participant in each condition. F is the total number of false positives by a participant in each condition. Where $\operatorname{sign}(H - F)$ equals +1 if $H - F > 0$ (i.e. if $H > F$); equals 0 if $H = F$; and equals –1 otherwise. Where $\max(H,F)$ equals either H or F, whichever is higher.

However, when the hits or false positive rates equal to 1 or 0; problems would arise. Therefore, when $F = 0$, this would give a score equal to +1.0 because this would mean perfect accuracy. When $H = 0$, this would give a score equal to 0 because this would mean perfect inaccuracy.

Grier (1971) introduced an updated version of the non-parametric measure of bias by Hodos (1970). However, the updated formula by Grier (1971) did not take into account the problem of signage when $H < F$. Therefore, Stanislaw and Todorov (1999) introduced a more introduced a more inclusive and updated formula for B'':

$$B'' = \operatorname{sign}(H - F) \; \frac{H(1 - H) - F(1 - F)}{H(1 - H) + F(1 - F)}$$

*H is the total number of hits by a participant in each condition. F is the total number of false positives by a participant in each condition. Where $\operatorname{sign}(H - F)$ equals +1 if $H - F > 0$ (i.e. if $H > F$); equals 0 if $H = F$; and equals –1 otherwise.

In order for an ANOVA to be done with A', all the A' scores must first be converted into $\sin^{-1}\sqrt{A'}$ (McNicol, 1972).

The signal-detection theory assumes that anyone, regardless of their age, uses a criterion to determine their response. It is not known whether children have developed this criterion and for this reason. Therefore the “yes-no” study-test procedure was not used in the present study because young children do not have the same abilities as adults when memorising large quantities of faces. Young children would have performed poorly in the task and this would have resulted in a floor effect. Instead, a forced-choice procedure, which uses some of the proponents from the signal detection theory, was proposed and used in this study.

2.3 Forced-choice study-test procedure

In a simple forced-choice procedure, a target face is presented to the participant. This is followed directly by the presentation of two faces next to each other. The participant is required to indicate which of the two faces they think was presented to them earlier. This continues for a number of trials. The order of faces is randomised across subjects. The advantage in this procedure is that young children do not perform poorly as a result of their low memory span. The disadvantage for this procedure is that the amount of exposure time to the “study” faces is so short that in a realistic situation, no one ever sees a face for less than a second.

In a delayed-matching forced-choice task, the procedures are very similar to a simple forced-choice task. The only difference between the two tasks is that the delayed-matching forced-choice task involves having a number of study faces presented before the test faces. Once the study list is completed, the participants receive a forced-choice procedure where faces are shown in pairs. One face is a distractor and the other face in the pair was shown to participants in the study list (i.e. target face).

Participants are required to indicate which of the two faces was shown in the study list. The advantage to this procedure is that young children and adults are not affected by task complexity. The disadvantage is that adults may still find this procedure easier than younger children. However, Yin (1969) made use of this procedure and still was able to find an inversion effect. The reason for the use of this procedure in this study was to include advantageous aspects of the simple forced-choice task and the “yes-no” recognition task.

The exposure time for faces shown during the study phases was determined by previous studies mentioned earlier as well as a study done by Nega (2005). Nega (2005) used three different times for the study phase (i.e. 300-700ms; 1second; & 5seconds). It was found that the perceptual fluency for faces increased as the duration for studying each face got longer. Therefore, Nega’s (2005) study found that remembering a face was significantly better for the longest time in comparison to the other two shorter times.

2.4 Reaction Time/Response Latency

Reaction time (also known as response latency) is the time taken from when the face first appears to the subjects until a response has been given by that respondent. Reaction time has been known to be influenced by conditions in face recognition studies and can give a more holistic understanding of respondents’ results. Weber and Brewer (2006) investigated the relationship between response latency and response accuracy in a face recognition paradigm. There was a stronger relationship between response latency and response accuracy when faces were positively identified than when they were not. This means that during the test phase; faces that were correctly identified resulted in a stronger response latency-accuracy relationship than when faces were incorrectly recognised. Therefore, the reaction time for hits will be calculated in experiment 3 because this will show a more accurate picture of whether subjects responded by chance or whether there was a significant difference between the conditions in study. The reaction time will be calculated according to an average time that will be worked out for hits only based on each condition. Since this study is a forced choice task, no reaction times can be gathered for correct rejections.

2.5 Ethical Considerations

The participants' identities were kept confidential and no names were needed for participation in the experiment. The Dean of the university and the governing bodies of the school used in the study gave their permission for the researcher to carry out the study at their respective schools (see in Appendix B). When recruiting participants under the age of 18, permission from the parents or the guardians was needed. The permission included their consent to allow their child's participation in the study (see Appendix C). All participants, regardless of age, had to sign an informed consent form before they could take part in the study. An example of the consent form is given in Appendix D. The informed consent form allowed the researcher to use their results for the purpose of this experiment only. All participants under the age of 17 years were asked to sign an assent form. Any individual could refuse to participate in the experiment even though there was an informed consent from the parents or guardian. The participant also had the right to leave at any time when they did not feel comfortable during the proceedings of the experiment. The school also had the right to stop and disallow the experiment from running at their school at any time.

Chapter 3

Experimental Work

Only male participants were used in all three experiments. This was done to control for gender differences that may exist if only male faces are to be presented and rated (e.g. Rehnman & Herlitz, 2006; Wright & Sladden, 2003). Individuals who have had high contact with another race in schools and/or at university (i.e. black participants who have high contact with the white population in South Africa and white participants who have high contact with the black population in South Africa) were used for the three experiments. The reason for this is that the amount of contact an individual has had with the other race is controlled for experimental conditions. Studies have shown that the amount of contact an individual has had with another race group, could affect the participant in a face recognition task (e.g. Chiroro & Valentine, 1995; Meissner, 2001; Wright, Boyd and Tredoux, 2001; Wright, Boyd and Tredoux, 2003).

3.1 <u>Experiment 1</u>

3.1.1 Aim

The aim in this experiment was to gather distinctiveness ratings for the two sets of black and white faces, from which the stimuli were selected. The ratings were used to categorise the faces as either “distinctive” or “typical”. The distinctive and typical faces that were selected were used in all subsequent experiments. This experiment also sought to establish whether there was a significant correlation between the distinctiveness ratings provided by white participants on black faces and that provided by black participants on the same black faces. Similarly, the magnitude of the correlation between distinctiveness ratings provided by white participants to white faces and the distinctiveness ratings provided by black participants to white faces was investigated. It has been suggested in the literature that one of the reasons why people find other-race faces difficult to recognise is that they employ strategies for encoding own-race faces when looking at other-race faces. Information for encoding own-race faces may be inappropriate for encoding other-race faces. Thus, it could be assumed that when asked to say how easy or difficult a person would find it to recognise a particular face in a crowded shopping mall, and an own-race face is presented, the appropriate configural and featural information can be attended to so that an accurate rating of the faces is given. However, when presented with other-race faces, the use of cues learned when looking at and remembering own-race faces may lead to failure to attend to discriminating information among other-race faces. Thus, the hypothesis for the second component of this experiment was that the distinctiveness ratings given to each set of faces by participants from the two different racial groups will not correlate significantly with each other.

3.1.2 Research Design

Black and white participants were presented with both black and white male faces. Subjects were asked to rate each face on "how easy they think it will be to recognise the face in a crowded shopping mall in South Africa" on a scale of 1 – 6: (1 = extremely difficult; 2 = very difficult; 3 = difficult; 4 = easy; 5 = very easy; 6 = extremely easy). In order to control for order effects, participants were shown both sets of faces in alternating orders. A 2-minute break was introduced between the two rating tasks. However, participants were shown all the faces in the same order. A pilot study was also conducted to assess the feasibility of experiment.

3.1.3 Participants

The number of participants used for this experiment was 24. Undergraduate male students at a large university in South Africa were approached individually and asked to voluntarily participate in the study. There were 12 white participants (mean age=19.25 years old) and 12 black participants (mean age=19.83 years old).

3.1.4 Apparatus and stimuli

Colour photographs of faces were used from two race groups, namely black South Africans and white South Africans. Each participant was shown a total of 138 photographs of faces. Of these, 70 were photographs of black South Africans and 68 were photographs of white South Africans. These photographs were taken 4-5 years previously at a different university in South Africa and scanned onto a computer. Using a computer software programme called RealDraw Pro 3.1 ^{c}, the pictures were adjusted by removing the background. This was done by a process called "Magic Brushing". Only the faces were left and all additional features like background and neckline were eliminated. The reason for the elimination of these additional features was to prevent background information from interfering with the memorability and the distinctiveness of the faces. Sample of the original and "cleaned" photographs are shown in figures 4(a), 4(b), 4(c) and 4(d) below:

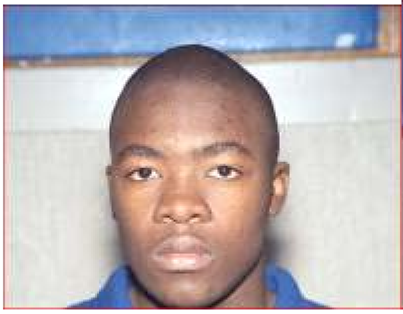


Figure 4(a): Original photographs of Black South African faces

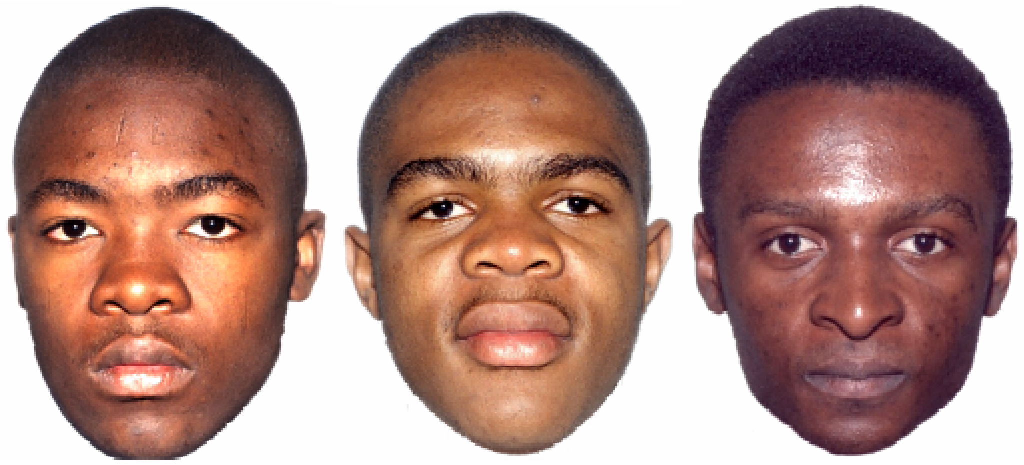


Figure 4(b): "Cleaned" photographs of Black South African faces

Figure 4(c): Original photographs of White South African faces

Figure 4(d): "Cleaned" photographs of White South African faces

The faces were also processed for "light contrasting" to equate the lighting conditions across all faces. The reality exists that all the faces used in the study did not have the same complexion. Therefore by changing the contrast and lighting of the image, the complexion of the faces were not affected. This change could also eliminate unnecessary memorability and distinctiveness effects that may have occurred if it had not been done. This process was done by using a computer programme called GIMP 2.0[c].

All faces showed a full-frontal pose and the facial expressions were kept neutral. The stimuli presentation was controlled by a programme called SuperLab Pro, running on a computer with a Pentium 4 processor. The faces were presented on a 15-inch monitor computer screen and the height of each face presented on the screen was standardised at 19.5cm. The pixel setting was set to 1024x768 with a colour resolution of 24-bits. A Cedrus RB560 response box was used during the rating task to move on from one face to the next.

3.1.5 Procedure

Participants were required to agree to the consent form before commencing with the experiment and they were reminded that their identity would not be disclosed to anyone else. Each participant was given a set of instructions before they could commence with the rating task. Once the participants fully understood the instructions, they then began to rate the faces one by one.

Participants were shown two sets of faces in alternating sequences (e.g. Participant 1 was shown black SA faces then followed by white SA faces; participant 2 was shown white SA faces then followed by black SA faces; and so on…). A break of 2-minutes was taken to reduce fatigue effects. After the 2-minute interval, the participants were shown another set of instructions. Each face was presented on the monitor and once the face was rated on the Likert scale, the participant pressed the appropriate button on the response box to continue. Each consecutive face had an alternative button on the response box. This was done to ensure that no faces were skipped accidentally.

A 6-point Likert scale was used. The Likert scale was based on how easy or difficult the participant thought each face would have been to recognise in a crowded shopping mall in South Africa. The scale ranged from “extremely difficult” (i.e.1) to “extremely easy” (i.e.6). There was a scale for each face and the scale was presented on response sheets produced by the experimenter. Each scale had its own heading with a number corresponding to a particular face. The faces were also numbered in the top right hand corner. The numbers on each face had been in a black Arial bold font of 20. This was done to ensure that the right faces were rated on the Likert scale. Once the participant had completed the rating task, he/she had was thanked and compensated for their participation. A R10 token of appreciation was given.

3.1.6 Results

The aim of this experiment was to gather distinctiveness ratings for black and white faces for use in subsequent experiments. Even though the distinctiveness ratings were gathered from both race groups, only ratings from the subjects of same race as the face were used to determine the distinctiveness of each face. A median split was done to determine the faces which were rated overall as distinctive or typical. The mean distinctiveness rating of black distinctive faces was 4.325 and for the black typical faces 3.333. The black typical faces were chosen in the range of 2.83 to 3.58 whilst the black distinctive faces were chosen in the range of 4.00 to 5.42. The mean distinctiveness rating of white distinctive faces was 4.378 and for the white typical faces 3.498. The white typical faces were chosen in the range of 3.00 to 3.67 whilst the white distinctive faces were chosen in the range of 3.92 to 5.08.

The ranges of the typical and distinctive faces for black and white faces did not overlap. Indeed the t-test for related samples showed that for typical and distinctive faces, there was a significant difference in distinctiveness ratings for black faces ($t(23) = 13.533$, $p<0.005$) and for white faces ($t(23) = 11.714$, $p<0.005$).

Since both race groups had rated both the black South African and white South African sets of faces, a relationship between black and white subjects based on race of face was calculated from the mean distinctiveness ratings. The correlation coefficient between ratings of white faces from both the black and white subjects was significant *r*(23) = 0.64 (p<0.01). In figure 5(a), the scatterplot gives an indication of the how the white faces were rated by the black and white subjects. There is a positive correlation for the distinctiveness ratings of white faces between black and white subjects.

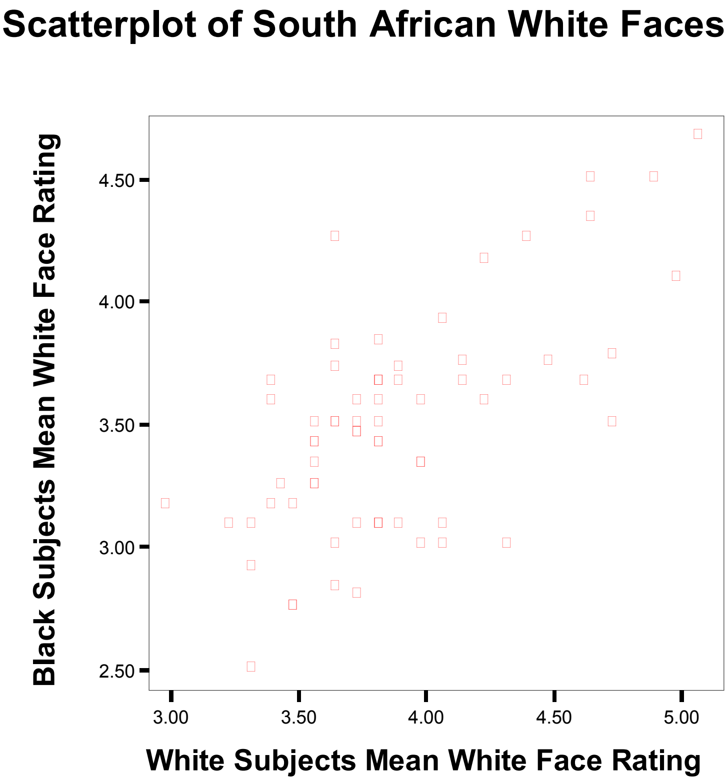


Figure 5(a) A scatterplot for distinctiveness of white faces obtained from black subjects plotted against ratings obtained from white subjects

The correlation coefficient between ratings of black faces from both the black and white subjects was lower but also statistically significant *r*(23) = 0.44 (p<0.01). In figure 5(b), the scatterplot gives an indication of the how the black faces were rated by the black and white subjects. There is a positive correlation for the distinctiveness ratings of black faces between black and white subjects.

Scatterplot of South African Black Faces

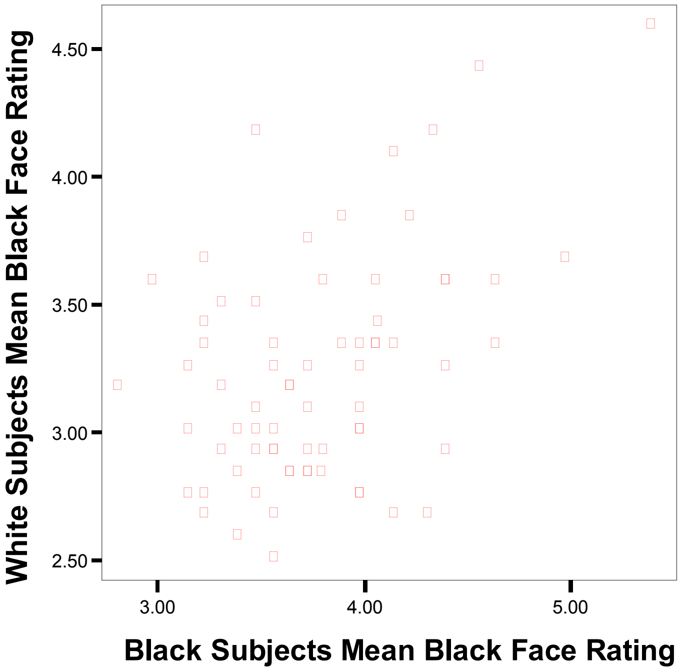


Figure 5(b) A scatterplot for distinctiveness of black faces obtained from white subjects plotted against ratings obtained from black subjects

3.1.7 Discussion

The correlations between the distinctiveness ratings from subjects of different races suggest that people may still be able to rate faces from other race groups for distinctiveness and get a similar rating as that done by people rating distinctiveness for their own race group's faces. These findings are consistent with a study done by Valentine and Endo (1992). The correlation data does not provide any indication of the range of distinctiveness perceived in own- and other-race faces. These findings are also relevant for the experiments that will follow because the distinctiveness of the face is perceived similarly by both race groups. The subsequent experiments investigated the effects of distinctiveness by using the ratings gathered from this experiment. The second experiment will confirm whether the faces rated distinctive and typical do result in a distinctiveness effect. The next two experiments also investigated the inversion effect and the cross-race effect using only the faces rated distinctive and typical.

3.2 Experiment 2

3.2.1 Aim

The aim in this experiment was to examine whether the distinctiveness effect, the inversion effect and the cross-race effect would emerge using stimuli selected as part of experiment 1.

3.2.2 Hypotheses

From previous research, it was hypothesised that:

(1) The recognition of own-race faces will be better than the recognition of other-race faces.

(2) The recognition of distinctive faces will be better than the recognition of typical faces.

(3) The recognition of upright faces will be better than the recognition of inverted faces.

Since little research has been done on the interaction between the distinctiveness effect, the inversion effect and the own-race bias effect, not all predictions regarding the interaction of these effects can be produced.

3.2.3 Research Design

A mixed factorial design was used. This design examined the within subject factors of race of face (i.e. black vs. white), distinctiveness (i.e. typical vs. distinctive) and orientation (i.e. upright vs. inverted). This design also examined the between subject factor of race of participant (i.e. black vs. white) during the recognition task. The dependent variable in this experiment was the recognition accuracy. The recognition accuracy for the face was measured in terms of percentage correct scores.

3.2.4 Participants

The number of participants used in this study was 48. Purposive sampling was done to recruit participants from the undergraduate classes at a large university in south Africa to take part in the experiment. There were 24 white participants (*M*= 19.3 years) and 24 black participants (*M*= 19.8 years).

3.2.5 Apparatus and stimuli

This experiment used 96 faces that were rated as either distinctive or typical from the preceding experiment. From the 96 faces, 48 were South African black faces and 48 were South African white faces. In each of the two conditions, there were 24 distinctive faces and 24 typical faces. In each of the four conditions, there were 12 inverted faces and 12 upright faces. In each of those eight conditions, 6 faces would serve as targets and the other 6 faces would serve as distractors. All the faces were randomly assigned to their conditions. This is illustrated in Figure 6 below.

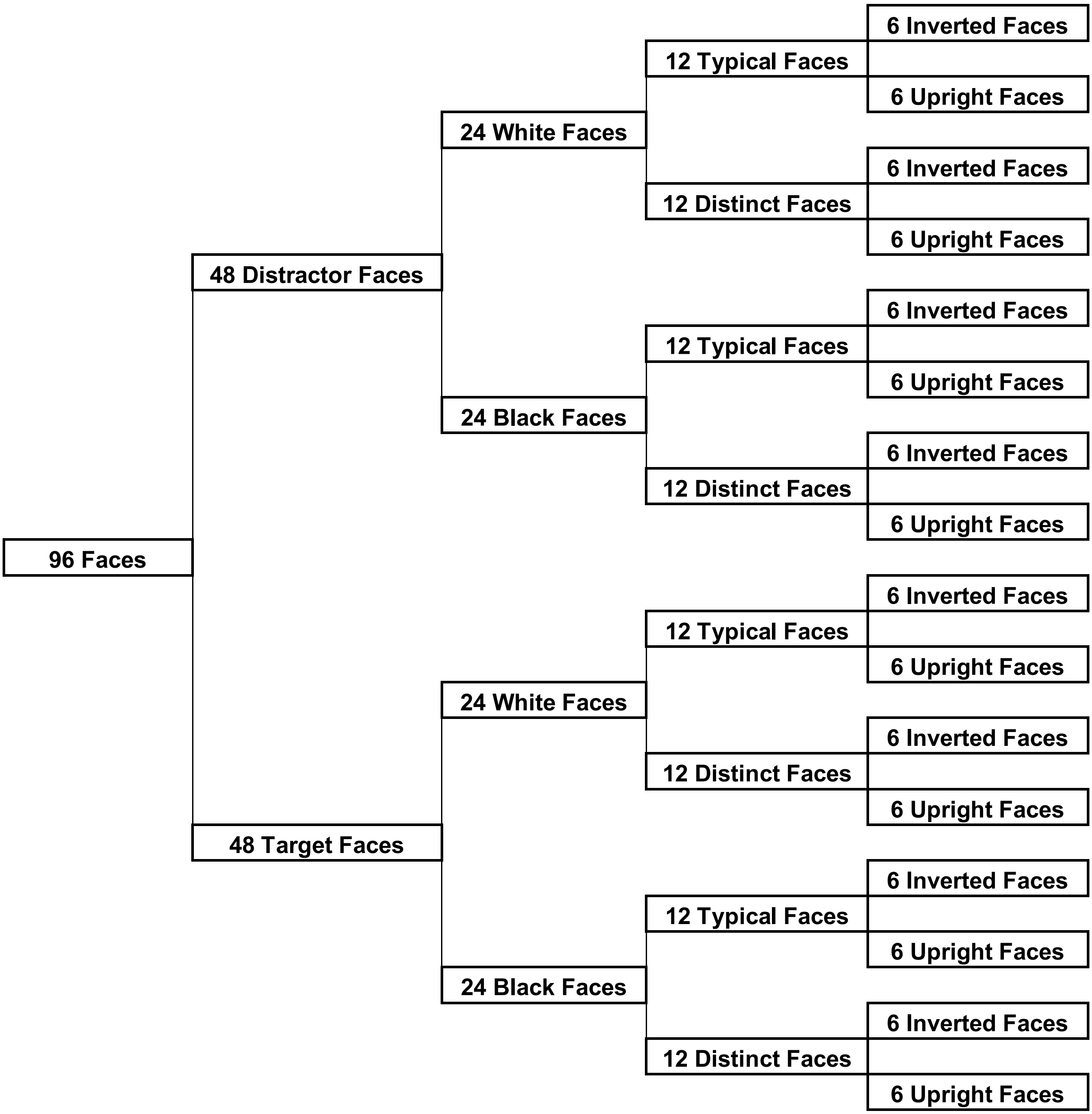


Figure 6: The number of faces used for each condition.

The faces were presented using the SuperLab Pro programme and operated on a Pentium 4 computer. The faces were presented on a 15-inch monitor computer screen and the height of each face presented was standardised at 19.5cm. The pixel setting was set to 1024x768 with a colour resolution of 24-bits. By using the Cedrus RB560 response box, the results from whether the faces were seen before or not, were recorded.

3.2.7 Procedure

The participants in this experiment were given informed consent forms to sign. Participants were also given a set of instructions which clearly outlined what they needed to do during the experiment. Once the participant fully understood what they needed to do, they commenced with the experiment.

The participants were shown a set of 24 target faces in the study phase followed by 24 pairs of faces in the test phase. Each participant either had one study and one test set of white faces followed by a set of black faces or they had one study and one test set of black faces followed by a test set of white faces. The black and white face sets were shown to participants alternately. In the study phase, participants were asked to study each of the 24 faces carefully and they were told explicitly that their ability to recognise each of the faces would be tested later. Out of these 24 faces shown as the study set, 12 were typical and 12 were distinctive. Each face was shown for 5 seconds with an interstimulus-interval of 1 second between faces. After the participants had been shown all 24 faces, there was a break where they were given another set of instructions to carry on with the test phase. After the instructions were properly understood by the participant, they were required to recognise the faces shown previously (i.e. targets) from 24 pairs of faces. During the test phase, from the 24 pairs of faces shown to participants, 12 pairs were typical faces and 12 pairs were distinctive faces. Furthermore, half of the typical face pairs and half of the distinctive face pairs were inverted. The remaining faces were left upright. The typical and distinctive faces were also randomly assigned to each condition. Each pair of faces consisted of one target face (i.e. shown before) and one distractor (i.e. never seen before face). The faces were counter-balanced in all conditions for all the participants. During the test phase, each face remained on the screen until the participant responded on the response box. Participants responded by pressing the left or right buttons on the response box. The left button was pressed if the participant thought that the target face was on the left and pressed the right button if the participant thought that the target face was on the right. The reaction time was also collected. Once they had completed the delayed-matching forced-choice task, the participants were thanked and compensated for their participation. A R10 token of appreciation was given to each participant.

3.2.8 Results

Hit and false positive rates were calculated for each participant in each condition and then percent correct scores were derived. The maximum number of hits or false positives that could be attained in each condition for each participant was 6. The data was statistically analysed.

The data was subjected to an ANOVA where the within-subject factors were the distinctiveness of the face, the race of the face and the orientation of the face. The between-subject factor was race of subject. The results for each measure are only discussed below as percent correct scores.

Determining the percent correct score is necessary for determining the sensitivity of a response bias in a forced-choice task (Stanislaw & Todorov, 1999). To examine the between-subject effects, the total percentage correct was analysed for race of subject (black and white South Africans) using an ANOVA. There was a significant main effect of race of subjects (*F*(1, 46) = 6.218, p<0.05). A comparison of mean scores showed that white subjects performed better (*M*=83.767, *SD*=1.797) than black subjects (*M*=77.431, *SD*=1.797) on the face recognition task.

The percent correct scores for race of subject (black vs. white), distinctiveness of face (distinctive vs. typical), orientation of face (inverted vs. upright) and race of face (black vs. white) were subjected to multivariate analysis of variance (MANOVA). There was a significant main effect for distinctiveness of the face (*F*(1, 46) = 13.623, p<0.05). Distinctive faces were better recognised (*M*=83.507, *SD*=1.485) than typical faces (*M*=77.691, *SD*=1.505). There was also a significant main effect for the orientation of the face (*F*(1, 46) = 75.204, p<0.05). Upright faces were better recognised (*M*=87.934, *SD*=1.315) than inverted faces (*M*=73.264, *SD*=1.712). There was no main effect for race of face and there were no further significant interactions between various factors.

As predicted there was a significant interaction with the race of face and race of subject (*F*(1, 46) = 18.744, p<0.05). Black subjects recognised black faces significantly better (*M*=80.035, *SD*=1.910) than white faces (*M*=74.826, *SD*=2.226). White subjects recognised the white faces significantly better (*M*=87.500, *SD*=2.226) than the black faces (*M*=80.035, *SD*=1.910). This is illustrated in figure 7(a).

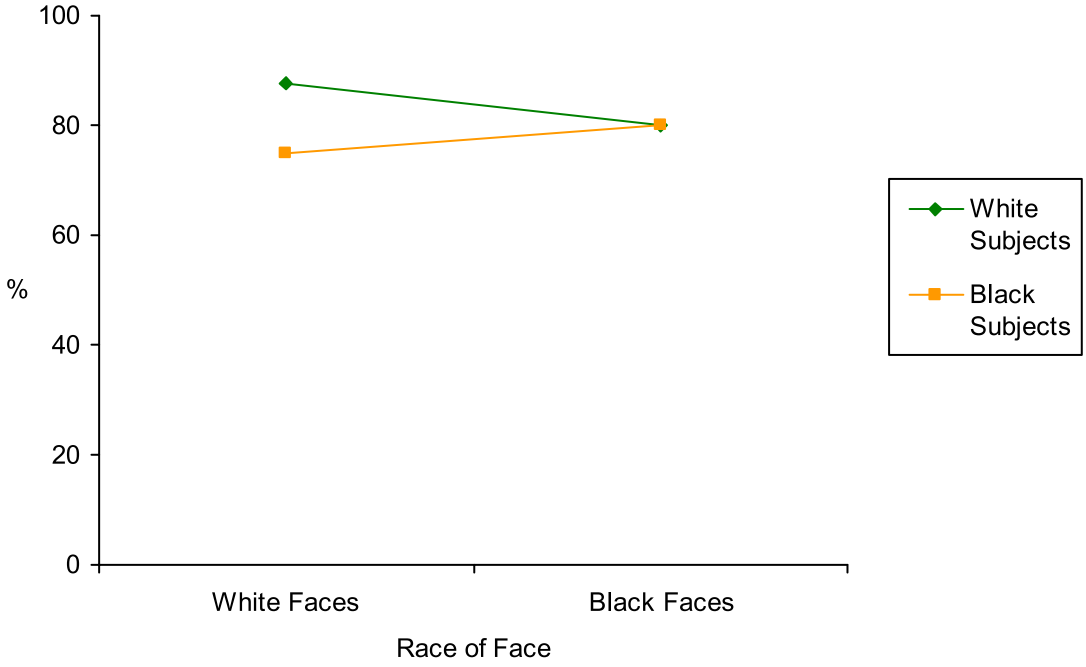


Figure 7(a): The interaction for race of face on race of subject

3.2.9 Discussion

This study supported the hypotheses for the distinctiveness effect, the inversion effect and the cross-race effect would be present. Distinctive faces were recognised more accurately than typical faces. Furthermore, the inverted faces were not recognised as well as the upright faces. Own-race faces were significantly better recognised than other-race faces. This would suggest that an own-race bias was present amongst subjects during the test procedures. These faces can be used for the follow-up experiment because all three effects were present among adults. This would indicate that if one of the effects is not present before a certain age; individuals from that age group would not have developed a bias towards recognising certain conditions of faces.

There was a main effect regarding the race of the subject during the experiment. This has been found in various studies where black subjects do not perform as well as white subjects in experimental conditions (e.g. Chiroro & Valentine, 1994; Wright, Boyd & Tredoux, 2003). This situation could be explained by the possible disadvantages the black population would have experienced in South Africa. Not many black South Africans have access to technological devices at home and only when coming to a tertiary institution would they be exposed to such devices. There may be other possible reasons and that is why this area should receive attention in future research. To account for this problem in the next experiment, children from higher socio-economic classes were used. This will help to determine whether race of subject differences are due to people being previously disadvantaged (i.e. lack of exposure to technology whilst growing up) or another phenomenon which could receive further scrutiny.

3.3 Experiment 3

3.3.1 Aim

This experiment sought to determine the progression of the distinctiveness effect, the inversion effect and the cross-race effect from early childhood to early adulthood. Furthermore, this experiment examined the time taken for distinctive faces to be correctly recognised versus the typical faces; inverted faces to be correctly recognised versus the upright faces; and own-race faces to be correctly recognised versus other-race faces across the developmental span of 6-years to 23-years.

3.3.2 Hypotheses

Since little research had been done on the overall interaction between the distinctiveness effect, the inversion effect and the own-race bias effect, no predictions regarding the interaction of all three effects could be produced. Furthermore, some predictions cannot be made regarding the extent to which these effects are present from early childhood to early adulthood, as no previous research had been done on subjects with such a wide age differentiation. According to previous research, it can be predicted that the impact of the inversion effect, the distinctiveness effect and an own-race bias of the face will be less for children than it would be for adults.

However, it is hypothesised that:

(1) The recognition of own-race faces will be quicker and better than the recognition of other-race faces.

(2) The recognition of distinctive faces will be quicker and better than the recognition of typical faces.

(3) The recognition of upright faces will be quicker and better than the recognition of inverted faces.

3.3.3 Research Design

A mixed factorial design was used. The within-subjects factors manipulated in the study were race of face, orientation of the face and distinctiveness of the face. The between-subjects factors were: race of participant (i.e. black vs. white) and age of participant (i.e. 6--year-olds, 8--year-olds, 10--year-olds, 12--year-olds, 14--year-olds, 16--year-olds and 18-23 -year-olds). The delayed-matching forced-choice technique was used in this experiment. The dependent variables in this experiment were the recognition accuracy and the response latency. The recognition accuracy for the faces is measured in terms percent correct scores. The reaction time for hits is the amount of time taken from when the face first appears on the screen to the time taken to respond correctly to the recognised face.

3.3.4 Participants

South Africans from different age groups were used in this study. Children aged 6 years were recruited from a junior preparatory in South Africa. Children aged 8, 10 and 12 years were recruited from a preparatory school in South Africa. Adolescents aged 14 and 16 were recruited from a high school in South Africa. Adults aged between 18-23 years were recruited from the undergraduate classes at a large university in South Africa. A purposive sampling method was used to recruit all participants. A total of 24 participants were recruited from each age group. There were 12 black participants per age group and 12 white participants per age group. This made it a total number of 168 participants.

3.3.5 Apparatus and stimuli

The faces used in experiment 2 were again used in this experiment. The faces were categorised as they were for experiment 2. Faces were randomly assigned to each condition. The delayed-matching forced-choice task was conducted by using the SuperLab Pro programme that was run on a Pentium 4 processor. The faces were presented on a 15-inch monitor computer screen and the height of each face presented was standardised at 19.5cm. The pixel setting was set to 1024x768 with a colour resolution of 24-bits. By using the Cedrus RB560 response box, the results from whether the faces were seen before or not, were recorded. The reaction time was also gathered from the use of this response box.

3.3.6 Procedure

Before the experiment was initiated at the schools and the university, consent was given to carry out the study in both the schools and the university. Thereafter, the sampling procedures took place. The children that were randomly selected for the experiment were required to bring back an informed consent letter from their parents. University students signed their own consent forms. Once consent was given, the experiment was run at the various sections of the school and at the university.

All participants were still required to give their own assent in order for them to partake in the delayed-matching forced-choice task in the study. A set of instructions was given to the participants to begin with. Only once the instructions were understood, did the experiment commence. During the study phase, faces were first presented to the participants in an upright position. There were 24 faces which were presented to the participants during the study phase where each face appeared on the computer screen for 5 seconds. There was an interstimulus interval of 1 second between each face where nothing was presented on the computer screen. Once the study phase was completed, the computer screen remained blank. At this point, participants were given instructions to commence with the test phase. The test phase consisted of faces being presented in pairs where one face appeared on the left-hand side of the computer screen and the other face appeared on the right-hand side of the computer screen. There were 24 pairs of faces, which were presented randomly. The pairs of faces were either inverted or presented upright. There were an equal amount of inverted and upright faces. Half of the inverted faces were typical and the other half were distinctive. This was also the case with upright faces. Out of each pair, one of the faces had been presented during the study phase whilst the other face was a new face that the participant had not seen before. The study and test sets of faces were either only black faces or only white faces. Once the test and study phases of one race group of faces were completed, participants continued onto another set of instructions followed by the study set of faces of another race group. Therefore, if participants were given black faces in the first study-test phase, then they would receive white faces in the second study-test phase and if they received white faces in the first study-test phase, then they would receive black faces in the second study-test phase. The commencing race of faces was alternated for each participant. Participants had to press the left or right button on the response box to indicate which of the two faces they thought corresponded with the face in the study phase. The reaction time was collected from participants based on the time it took for the face to appear on the screen until the participant pressed their choice on the response pad. Once they had completed the task, they were thanked. Only university students received compensation for their participation in the study. The school had agreed not to compensate the children for different personal reasons varying from each section in the school. Those who received compensation were given R10 as a token of appreciation.

3.3.7 Results

Hit and false positive rates were calculated for each participant in each condition and then percent correct scores were calculated. The maximum number of hits or false positive that could be attained in each condition for each participant was 6. The data was statistically analysed.

The data was subjected to an ANOVA where the within-subject factors were the distinctiveness of the face, the race of the face and the orientation of the face. The between-subject factors included race of subject and age of subject. The results are discussed as follows: main effects for percent correct scores and reaction time for hits, and then interactions for percent correct scores and reaction time for hits.

Determining the percent correct score is necessary for determining the sensitivity of a response bias in a forced-choice task (Stanislaw & Todorov, 1999). The percentage correct scores for age of subject (6-year-olds, 8-year-olds, 11-year-olds, 12-year-olds, 14 -year-olds, 16-year-old and adults), race of subject (black and white South Africans), distinctiveness of the face (distinctive vs. typical), orientation of the face (inverted vs. upright) and race of face (black vs. white), and were all subjected to multivariate analysis of variance (MANOVA).

Determining the reaction time for hits will provide a more holistic view of the performance across the various variables. The reaction time for hits was calculated by determining the mean time per condition. The total reaction time for hits was analysed for race of subject (black and white South Africans), age of subject (6-year-olds, 8-year-olds, 11-year-olds, 12-year-olds, 14 -year-olds, 16-year-old and adults), distinctiveness of face (distinctive vs. typical), orientation of face (inverted vs. upright) and race of face (black vs. white) were subjected to multivariate analysis of variance (MANOVA).

3.3.7.1 Main Effects

As predicted in the hypothesis, there was a significant main effect of distinctiveness of the face for the percentage correct scores (*F*(6, 154) = 40.229, p<0.05). Distinctive faces were significantly better recognised (*M*=75.992, *SD*=0.780) than typical faces (*M*=70.188 *SD*=0.804). Furthermore, there was a significant main effect of distinctiveness of the face for the time taken to recognise the faces (*F*(1, 152) = 34.983, p<0.05). Distinctive faces were recognised significantly quicker (*M*=3601.990, *SD*=112.048) than inverted faces (*M*=4181.200, *SD*=139.523).

Regarding the percentage correct scores, there was also a significant main effect for orientation of the face (*F*(6, 154) = 175.132). Upright faces were significantly better recognised (*M*=79.191, *SD*=0.790) than inverted faces (*M*=66.989, *SD*=0.797). To further substantiate this, there was a significant main effect for orientation of the face based on reaction time for hits (*F*(1, 152) = 1.712, p<0.05). Upright faces were recognised significantly quicker (*M*=3434.770, *SD*=107.907) than inverted faces (*M*=4348.420, *SD*=146.930).

There was a significant main effect for age of subjects for the percentage correct scores (*F*(6, 154) = 28.892, p<0.05) but it was not significant for the age of subjects based on reaction time for hits.

A post hoc Tukey HSD test was done to determine the differences in performance of the percent correct scores between the various age groups. It was found that 6-year-olds performed significantly worse (*M*=56.424, *SD*=2.419) than 8-year-olds (*M*=67.274, *SD*=2.419), 11-year-olds (*M*=72.569, *SD*=2.419), 12-year-olds

(*M*=72.396, *SD*=2.419), 14 -year-olds (*M*=78.906, *SD*=2.419), 16-year-olds (*M*=82.726, *SD*=2.419) and adults (*M*=81.337, *SD*=2.419). The post hoc HSD test further revealed that 8-year-olds performed significantly worse (*M*=67.274, *SD*=2.419) than 14 -year-olds (*M*=78.906, *SD*=2.419), 16-year-olds (*M*=82.726, *SD*=2.419) and adults (*M*=81.337, *SD*=2.419) but not for 11-year-olds (*M*=72.569, *SD*=2.419) and 12-year-olds (*M*=72.396, *SD*=2.419). Furthermore, the post hoc Tukey HSD test illustrated that 11-year-olds (*M*=72.569, *SD*=2.419) and 12-year-olds (*M*=72.396, *SD*=2.419) were significantly worse than 16-year-olds (*M*=82.726, *SD*=2.419) and adults (*M*=81.337, *SD*=2.419) but not 14 -year-olds (*M*=78.906, *SD*=2.419).

Tukey HSD

Age of Subject	N	Subset			
		1	2	3	4
6-year-olds	24	56.42361			
8-year-olds	24		67.27431		
12-year-olds	24		72.39583	72.39583	
11-year-old	24		72.56944	72.56944	
14 -year-olds	24			78.90625	78.90625
18-23 -year-olds	24				81.33681
16-year-olds	24				82.72569
Sig.		1.000	.307	.107	.696

Figure 8(a): A Tukey HSD test reveals the different age group subsets that can be created from this forced choice task.

There was a significant main effect for race of face based on the percent correct scores (*F*(6, 154) = 24.184, p<0.05). Overall, black faces were recognised significantly worse (*M*=70.957, *SD*=0.760) than white faces (*M*=75.223, *SD*=0.796). This main effect for race of face has been found in many studies before because there seems to be more contact with one race group's face than the other race group's face in the places where these studies have taken place. However, there was no significant main effect for race of face based on reaction time for hits. This shows that there were differences in the speed of recognising black or white faces.

There was also a significant main effect for race of subjects based on correct percent scores (*F*(1, 154) = 8.957, $p<0.05$). A comparison of mean scores showed that black subjects performed better (*M*=75.025, *SD*=0.914) than white subjects (*M*=71.156, *SD*=0.914) on the face recognition task. There was however a marginal significant main effect for race of subject based on reaction time for hits (*F*(1, 152) = 2.874, $p<0.05$). White subjects tended to be slightly slower (*M*=4089.409, *SD*=165.005) than black subjects (*M*=3693.781, *SD*=165.005). These significant main effect findings for race of subject may suggest that black subjects were more able to recognise the faces because they tended to do the task more quickly and recognise more accurately than white subjects.

3.3.7.2 Interactions

There was a significant interaction between all factors (i.e. distinctiveness *x* orientation *x* race of face *x* race of subject *x* age of subject) for the percent correct scores (*F*(6, 154) = 3.461, $p<0.05$). The mean scores of the interaction between age of subject *x* race of subject *x* race of face *x* distinctiveness of the face *x* orientation of the face can be seen in Appendix A in figure 10(a). However, there was no significant interaction for all factors based on reaction time for hits.

Looking more closely at these interactions, there was a significant interaction between the race of face and race of subject based on the percent correct scores (*F*(6, 154) = 2.081, $p<0.05$). Overall, white subjects recognised white faces better (*M*=74.653, *SD*=1.126) than black faces (*M*=67.659, *SD*=1.075). However, more surprisingly, black subjects recognised white faces better (*M*=75.794, *SD*=1.126) than black faces (*M*=74.256, *SD*=1.075). There was no significant interaction between the race of subject and the race of faces based on reaction time for hits. Even though it may be assumed that black subjects took more caution in the time taken to recognise the faces overall, this did not play any significance for when they had to recognise different race group's faces.

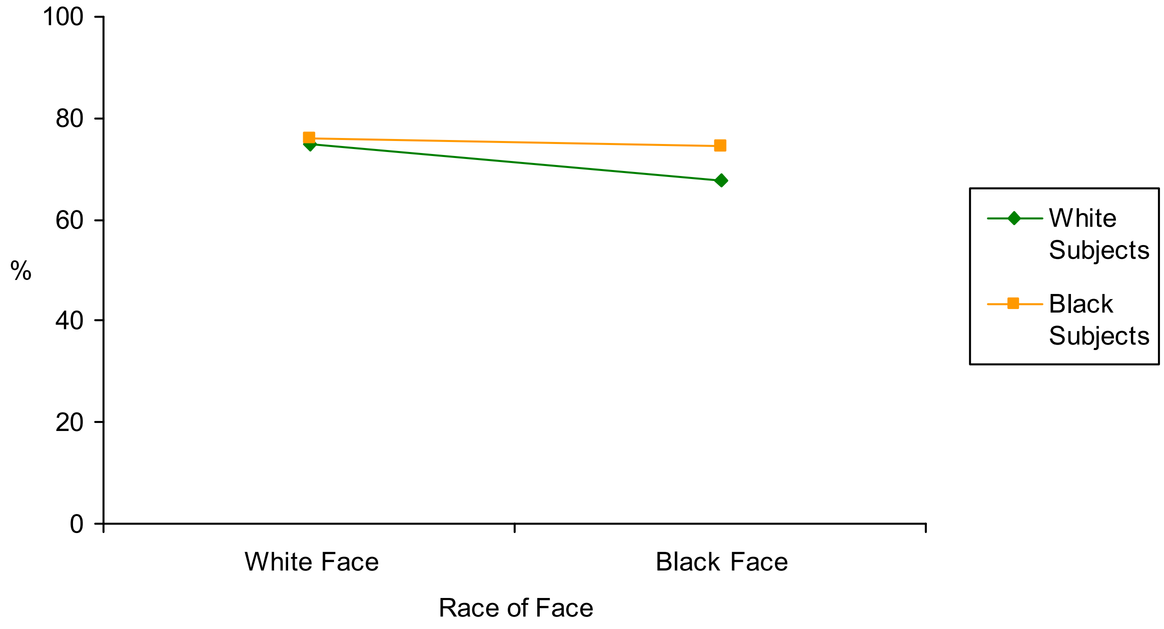


Figure 8(b): The interaction for race of face on race of subject based on percent correct scores.

In regards to those interactions that were found for age of subject, there was a marginally significant interaction between age of subject and race of face based on correct scores (*F*(6,154) = 2.081, p<0.05). Six -year-olds recognised black and white faces equally well. As for those older than 8 years, white faces tended to be better recognised than black faces. This is illustrated in Appendix A, figure 10(b).

Even though there was no significant interaction between age of subject and distinctiveness of the face for both percent correct scores and reaction time for hits;

the recognition of distinctive faces was quicker and better than typical faces for each age group. This is illustrated in Appendix A, figure 10(c) and 10(d). Furthermore, the interaction for percent correct scores between race of face and race of subject across the various age groups is not significant. However, there is an interaction between race of face and race of subject at the age of 12 years and in adulthood. The following interactions are illustrated in Appendix A, figure 10(e). By doing a univariate analysis (UNIANOVA) there was significant interaction between differences on race of face, race of subject and age of subject ($F(13,154) = 2.246$, $p<0.05$). A contrast analysis showed that the significant interaction between race of subject, differences between the race of face and age of subject was only significant for white subjects ($t(154) = 3.356$, $p<0.05$) and not significant for black subjects ($t(154) = 0.04$, $p<0.05$). The linear trend that emerged from the data of white subjects showed that as age increased, so did the difference between recognising white faces over black faces, as tabulated in figure 8(c). This means that there was a developmental trend based on the cross-race effect for white subjects which was not evident among the data from black subjects. This trend showed that an own-race bias became more prominent as white subjects got older.

Race of Subject	Age of Subject	Mean	Std. Error
Black	6 years	-1.736	3.246
	8 years	-3.125	3.246
	11 years	-1.736	3.246
	12 years	2.083	3.246
	14 years	0.000	3.246
	16 years	-6.250	3.246
	18-23 years	0.000	3.246
White	6 years	-1.736	3.246
	8 years	6.944	3.246
	11 years	5.208	3.246
	12 years	5.556	3.246
	14 years	6.597	3.246
	16 years	14.236	3.246
	18-23 years	12.153	3.246

Figure 8(c): Percent correct mean scores for white faces less the black faces (for white subjects) and percent correct mean scores for black faces less the white faces (for black subjects) over the various age groups

There was a significant interaction between age of subject and orientation of the face based on percent correct scores (*F*(6, 154) = 2.886, $p<0.05$). Inverted faces were recognised significantly worse than upright faces for all age groups, as seen in figure 8(d) [table is in figure 9(a) in Appendix A]. There was also a significant interaction between the orientation of the face and age of subject based on reaction time for hits (*F*(6, 152) = 5.601, $p<0.05$). The mean scores for this interaction based on reaction time for hits are tabulated Appendix A in figure 9(b). From the age of 8 years to adulthood, subjects took less time to recognise upright faces than inverted faces. In the 6-year-old group, upright faces took longer to be recognised (*M*=4126.141, *SD*=290.035) than inverted faces (*M*=3628.332, *SD*=394.920). This is illustrated in figure 8(f).

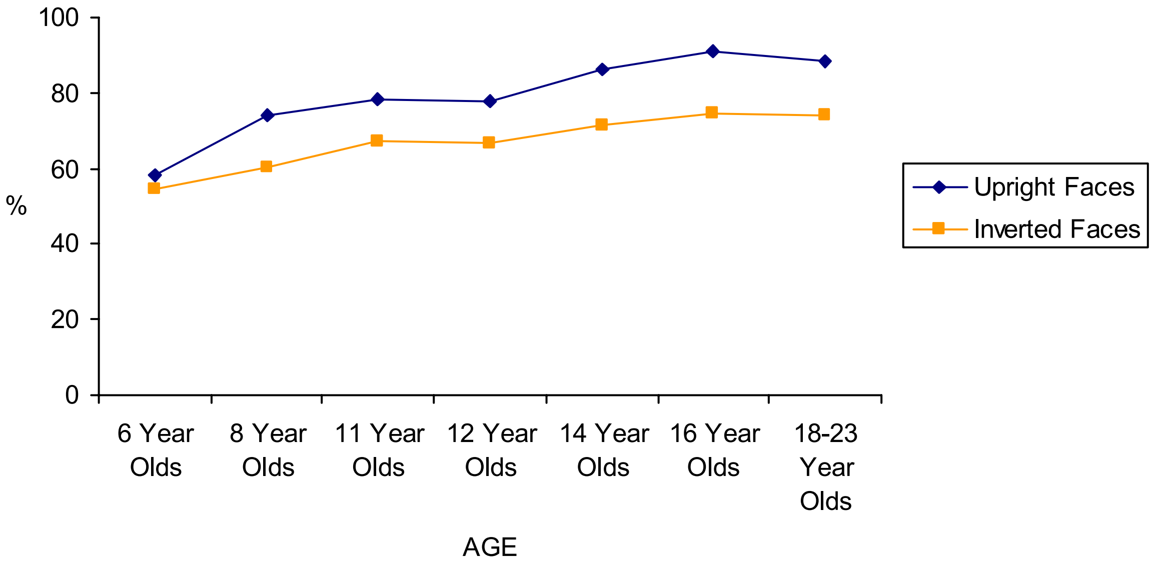


Figure 8(d): A developmental trend showing the interaction between age of subject x orientation of the face based on percent correct scores.

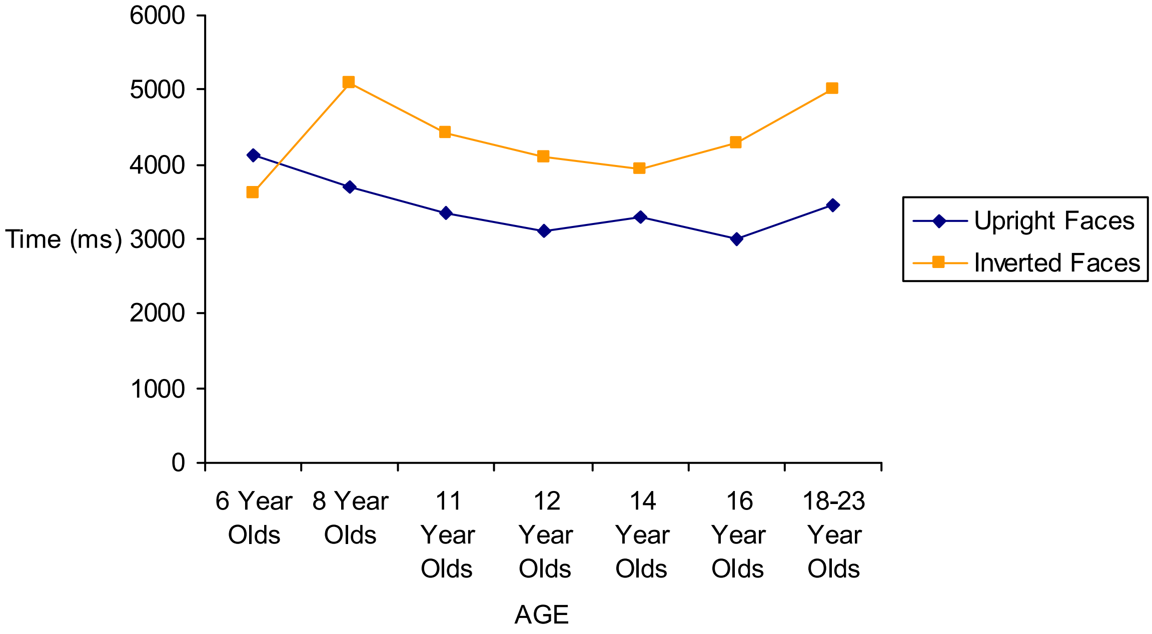


Figure 8(e): A developmental trend chart showing the interaction between age of subject x orientation of the face based on reaction time for hits.

There was a significant interaction between orientation of the face *x* age of the subject *x* race of subject based on reaction time for hits (*F*(6, 152) = 2.898, $p<0.05$).

Upright faces were recognised more quickly than inverted faces by black subjects from the age group of 8 years until adulthood. However, it was the 6-year-old group amongst black subjects that tended to recognise upright faces more slowly (*M*=4817.645, *SD*=401.156) than the inverted faces (*M*=3755.558, *SD*=545.225). White subjects recognised upright faces quicker than inverted faces regardless of the age group. This interaction between orientation of the face *x* age of the subject *x* race of subject based on reaction time for hits has been illustrated in figure 8(f) [table is in figure 9(c) in Appendix A].

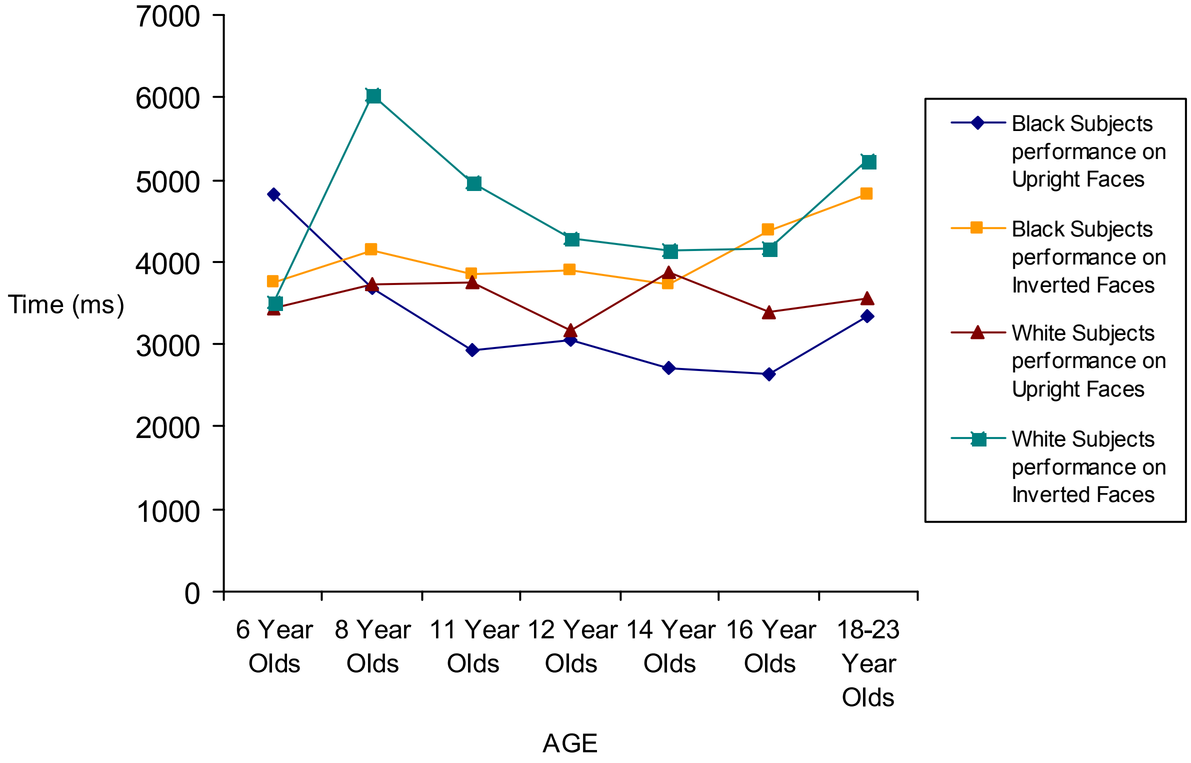


Figure 8(f): A developmental trend chart showing the interaction between age of subject x race of subject x orientation of the face based on reaction time for hits.

There was also a significant interaction between age of subject, race of face and orientation of the face based on the percent correct scores (*F*(6, 154) = 2.284,

$p<0.05$). White inverted faces were recognised significantly worse than white upright faces for all age groups, as well as black inverted faces were recognised significantly worse than black upright faces for all age groups; as seen in figure 8(g) [table is in Appendix A in figure 9(d)]. There was also a significant interaction between race of face, orientation of face and age of subject based on reaction time for hits (*F*(6, 152) = 3.484, $p<0.05$). Black upright faces were recognised more quickly than black inverted faces for all age groups. White upright faces were recognised more quickly than white inverted faces for age groups; 8 years, 11 years, 12 years, 14 years, 16 years and adulthood. However, the 6-year-old group recognised white inverted faces more quickly (*M*=2999.165, *SD*=465.759) than white upright faces (*M*=4429.973, *SD*=346.955). This trend can be found in Appendix A as figure 9(e) and illustrated below in figure 8(h).

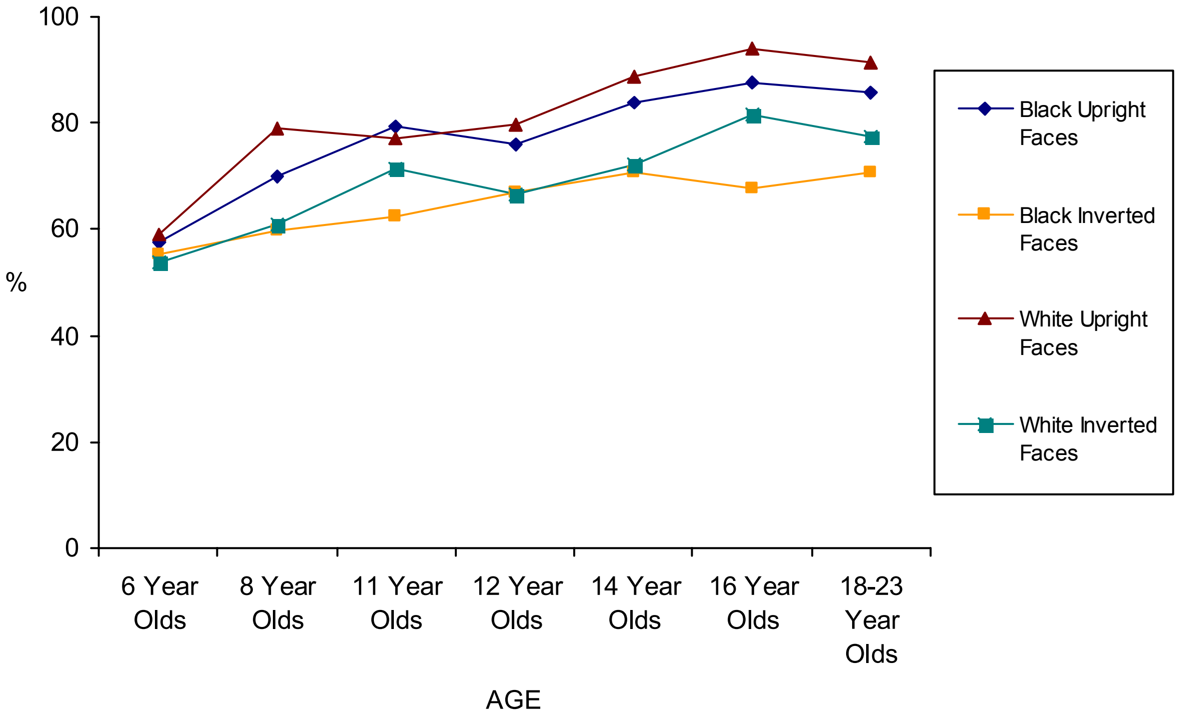


Figure 8(g): A developmental trend chart showing the interaction between age of subject x race of face x orientation of the face for percent correct scores.

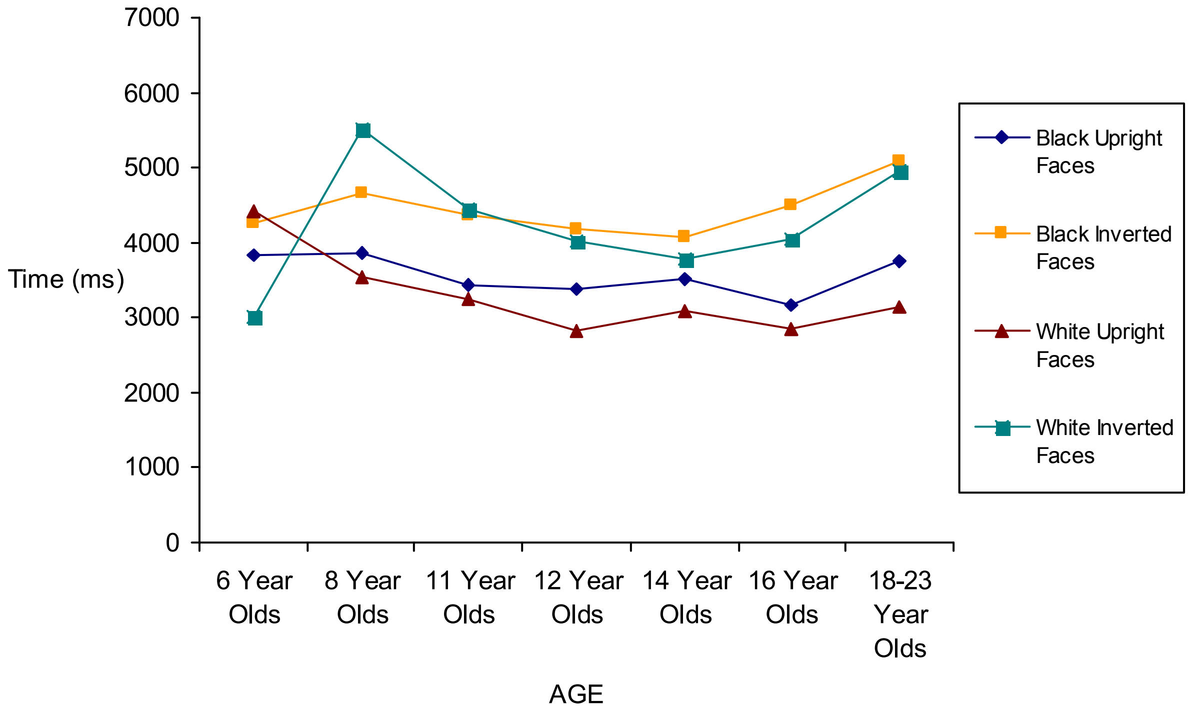


Figure 8(h): A developmental trend of the interaction between age of subject x race of face x orientation of the face based on reaction time for hits.

There was even a significant interaction between race of face, orientation of face and race of subject (*F*(1, 152) = 3.923, $p<0.05$). Black subjects were quicker at recognising black upright faces (*M*=3244.007, *SD*=174.931) than black inverted faces (*M*=4168.905, *SD*=269.786) as were white subjects quicker at recognising black upright faces (*M*=3886.370, *SD*=174.931) than black inverted faces (*M*=4724.023, *SD*=269.786). Furthermore, black subjects were quicker at recognising white upright faces (*M*=3373.287, *SD*=182.553) than white inverted faces (*M*=3988.925, *SD*=245.063) as were white subjects quicker at recognising white upright faces (*M*=3235.416, *SD*=182.553) than white inverted faces (*M*=4511.826, *SD*=245.063). These trends can be found tabulated in figure 8(i) and illustrated in figure 8(j).

	Black Faces		White Faces	
	Upright	**Inverted**	**Upright**	**Inverted**
Black Subjects	3244.007 (174.931)	4168.905 (269.786)	3373.287 (182.553)	3988.925 (245.063)
White Subjects	3886.370 (174.931)	4724.023 (269.786)	3235.416 (182.553)	4511.826 (245.063)

Figure 8(i): The interaction between race of subject x race of face x orientation of the face based on reaction time for hits.

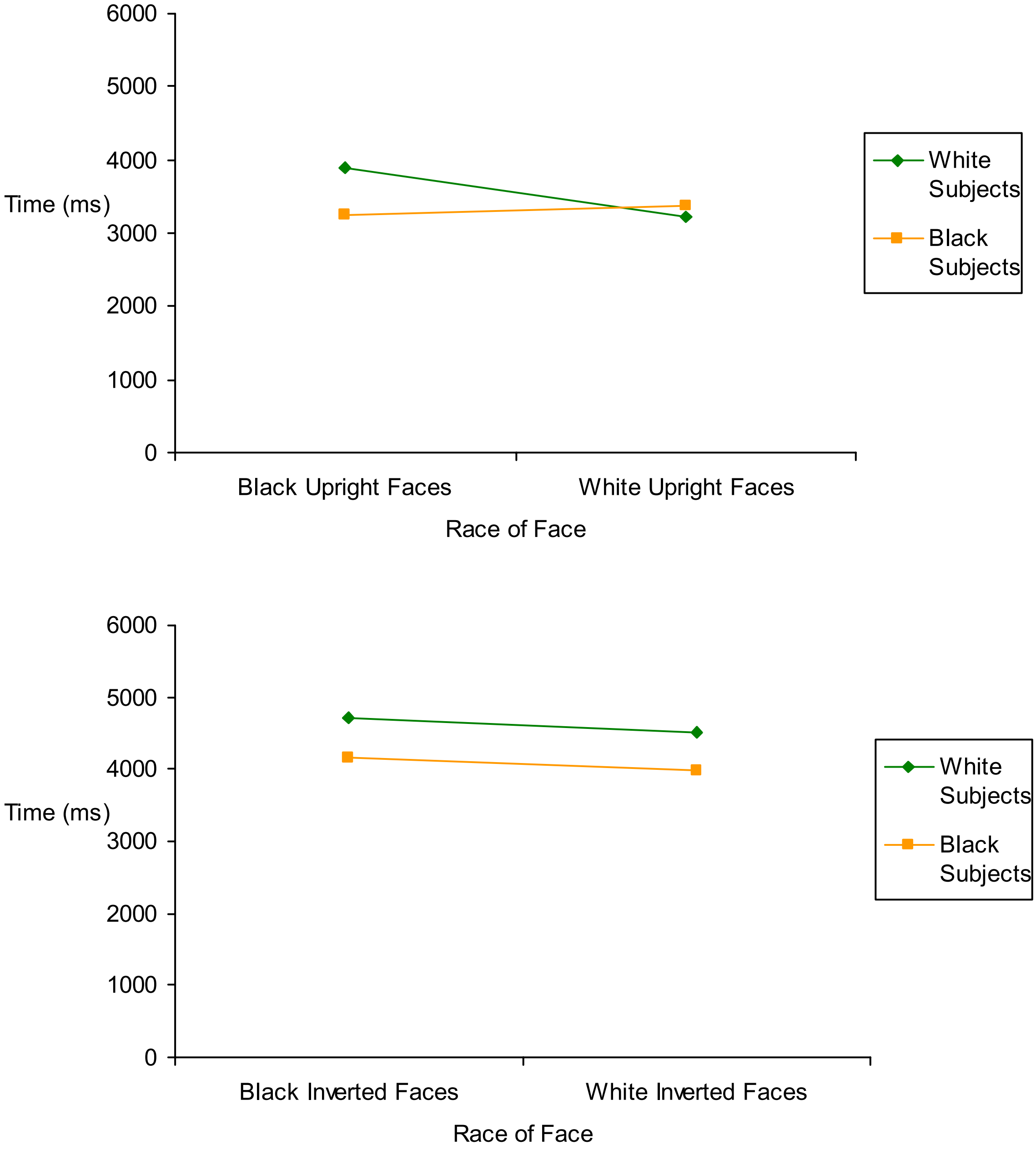
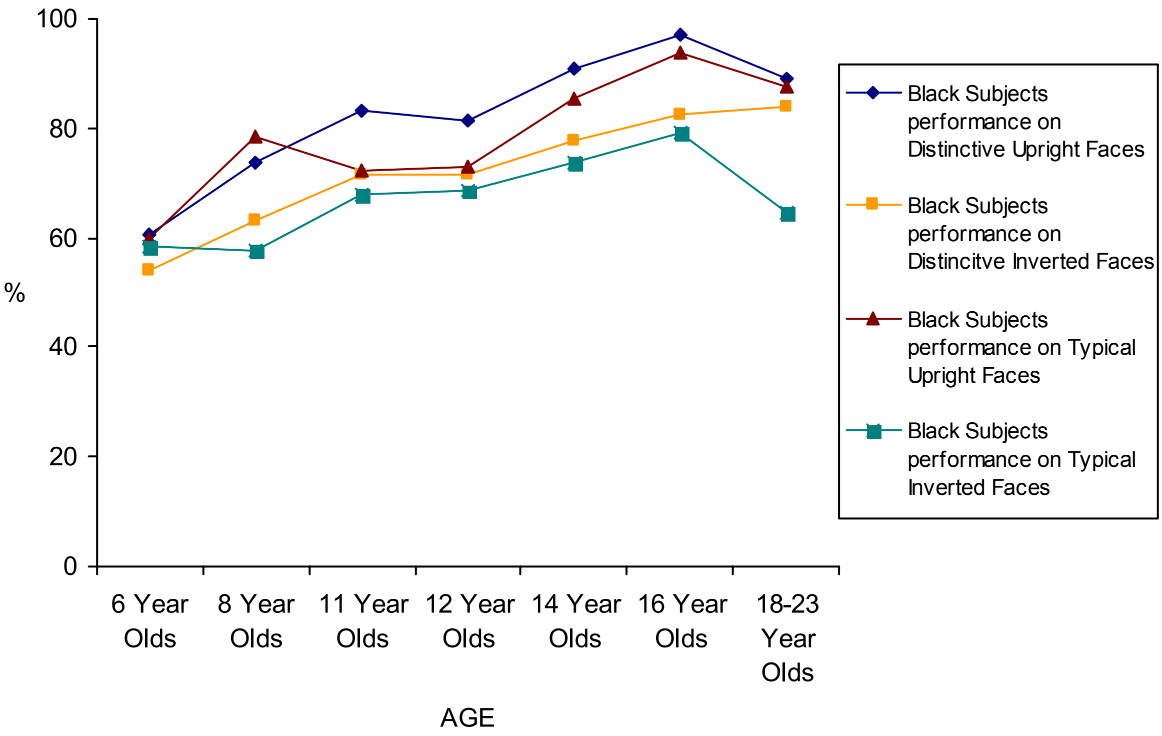
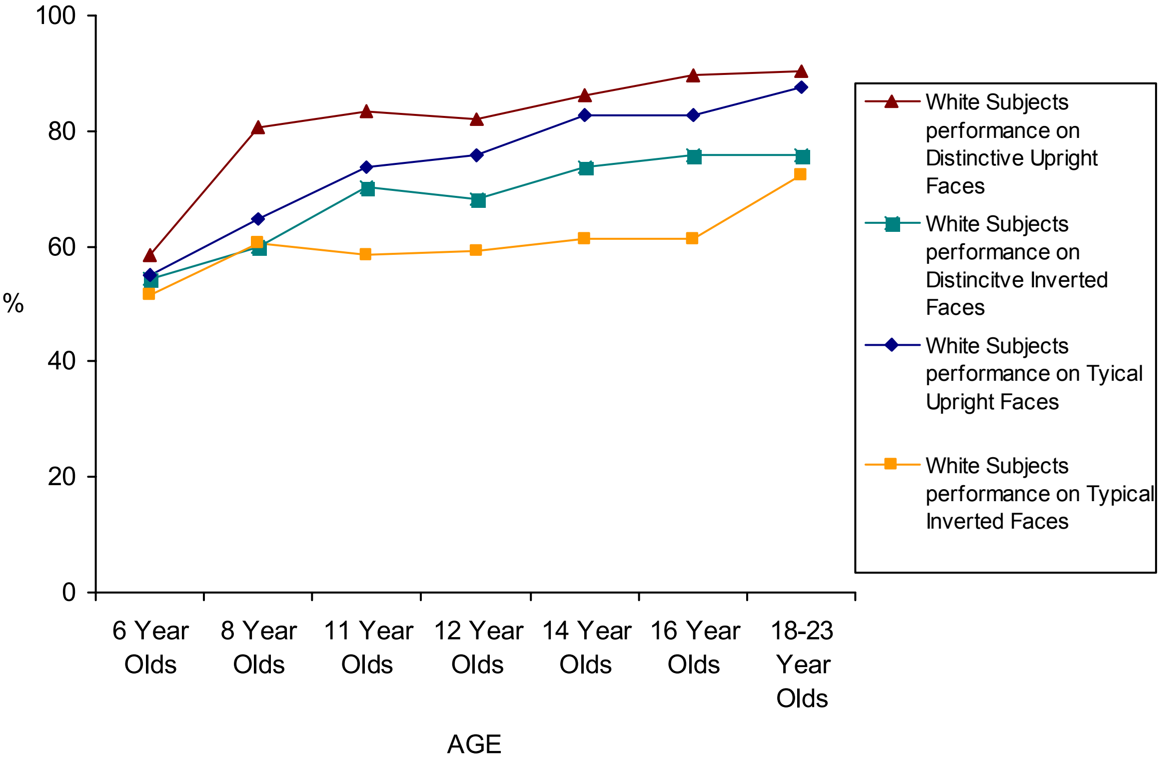


Figure 8(j): The cross-over effect for the interaction between race of subject x race of face x orientation of the face based on reaction time for hits.

Another significant interaction was found for distinctiveness, orientation, race of subject and age of subject based on percent correct scores (*F*(6, 154) = 2.311, $p<0.05$). Distinctive inverted faces were recognised significantly worse than distinctive upright faces for all age and race groups, as well as typical inverted faces being recognised significantly worse than typical upright faces for all age and race groups; as seen in figure 9(f) in Appendix A. There was also a significant interaction between the distinctiveness of the face *x* orientation of the face *x* age of the subject *x* race of the subject based on reaction time for hits (*F*(6, 152) = 3.891, $p<0.05$). The interaction between these factors has been tabulated in Appendix A in figure 9(g) and illustrated below in figure 8(l).




100
80
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40
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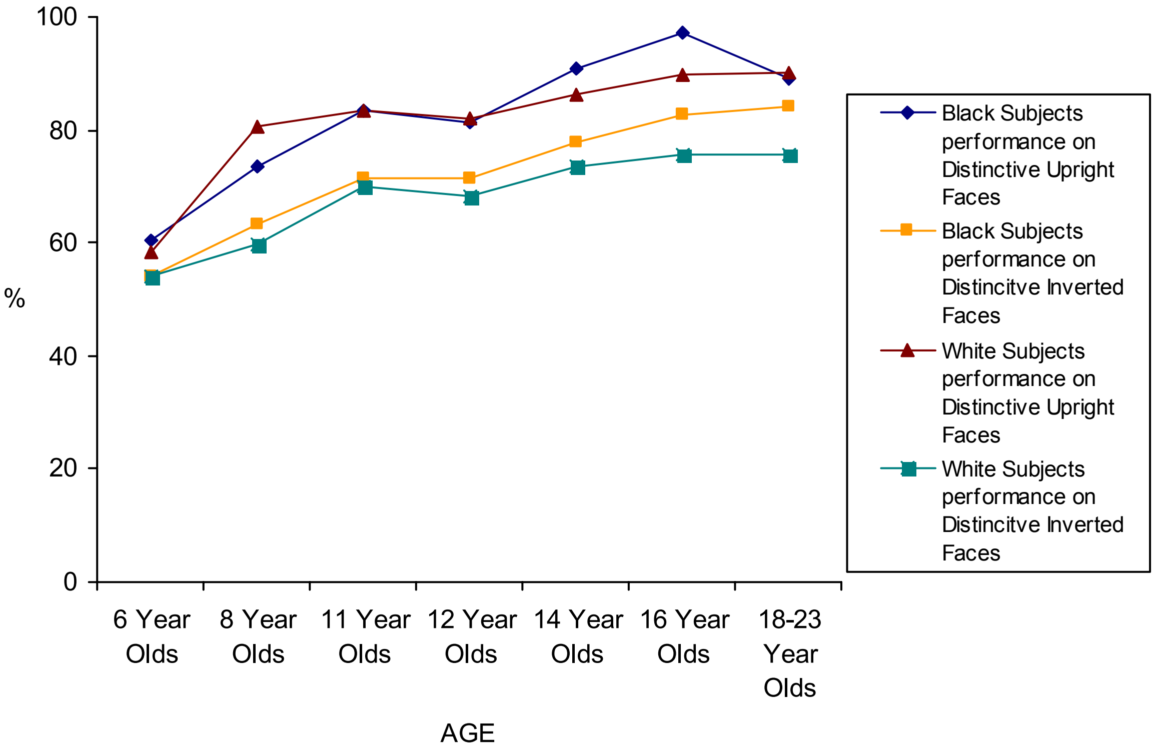
%
6 Year Olds
8 Year Olds
11 Year Olds
12 Year Olds
14 Year Olds
16 Year Olds
18-23 Year Olds
AGE
White Subjects performance on Distinctive Upright Faces
White Subjects performance on Distincitve Inverted Faces
White Subjects performance on Tyical Upright Faces
White Subjects performance on Typical Inverted Faces


100
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6 Year Olds
8 Year Olds
11 Year Olds
12 Year Olds
14 Year Olds
16 Year Olds
18-23 Year Olds
AGE
Black Subjects performance on Distinctive Upright Faces
Black Subjects performance on Distincitve Inverted Faces
White Subjects performance on Distinctive Upright Faces
White Subjects performance on Distincitve Inverted Faces

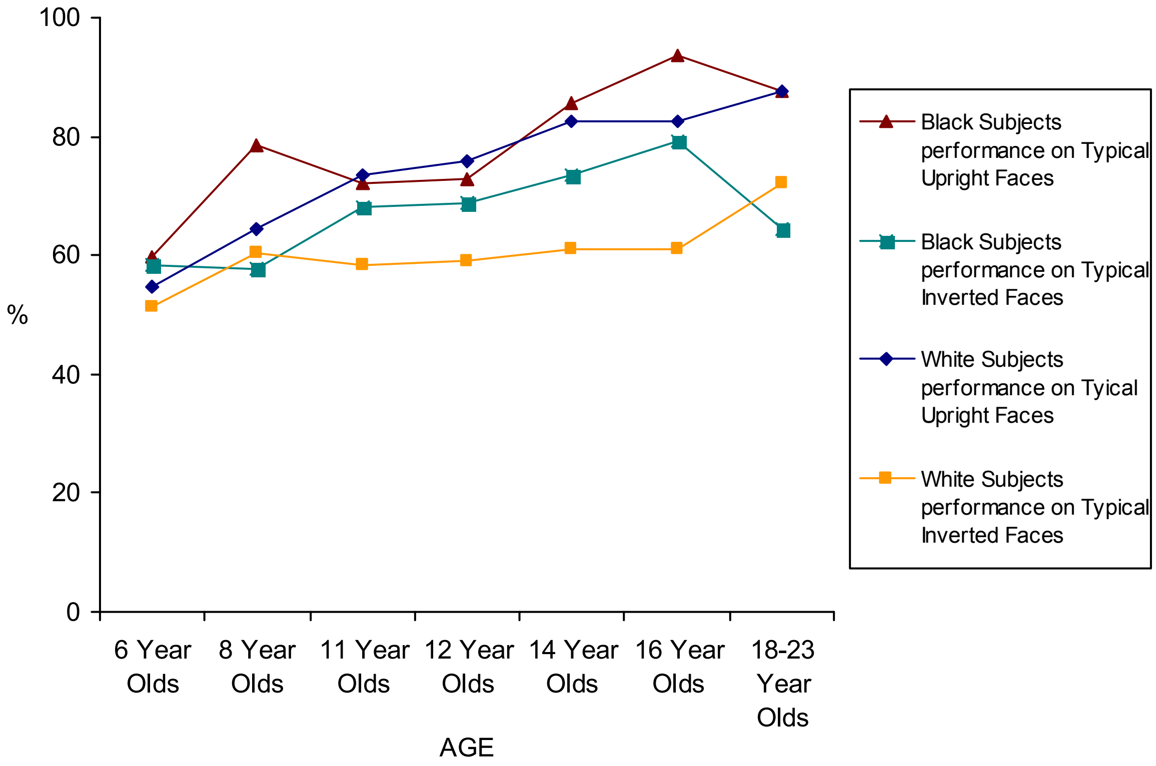
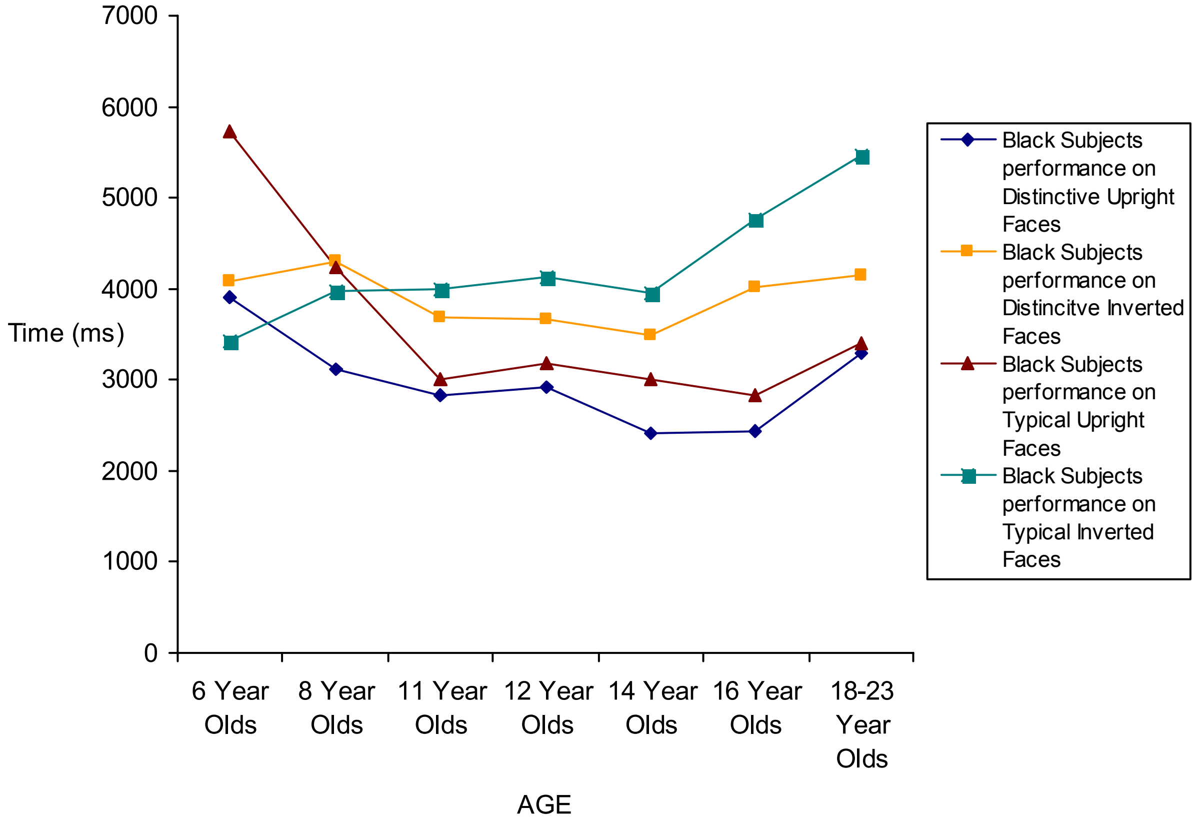
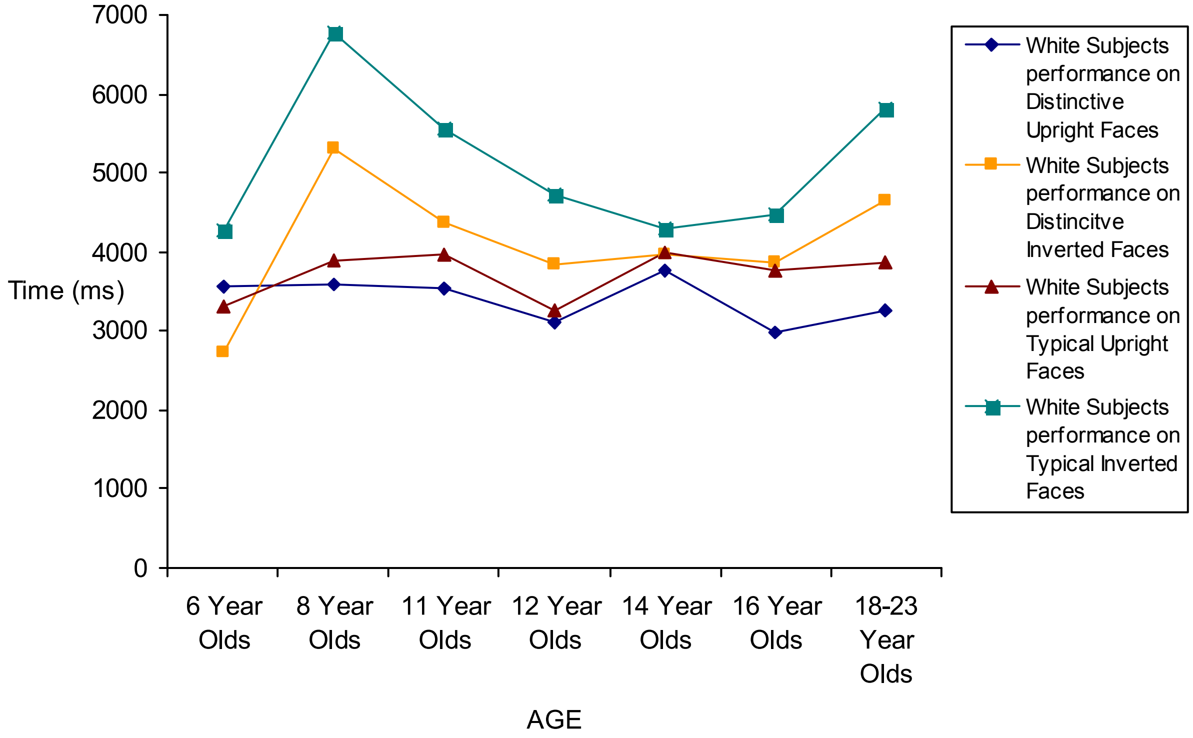


Figure 8(k): A developmental trend chart showing the interaction between age of subject x race of subject x distinctiveness of face x orientation of the face based on percent correct scores.


7000
6000
5000
4000
3000
2000
1000
0
Time (ms)
6 Year Olds
8 Year Olds
11 Year Olds
12 Year Olds
14 Year Olds
16 Year Olds
18-23 Year Olds
AGE
Black Subjects performance on Distinctive Upright Faces
Black Subjects performance on Distincitve Inverted Faces
Black Subjects performance on Typical Upright Faces
Black Subjects performance on Typical Inverted Faces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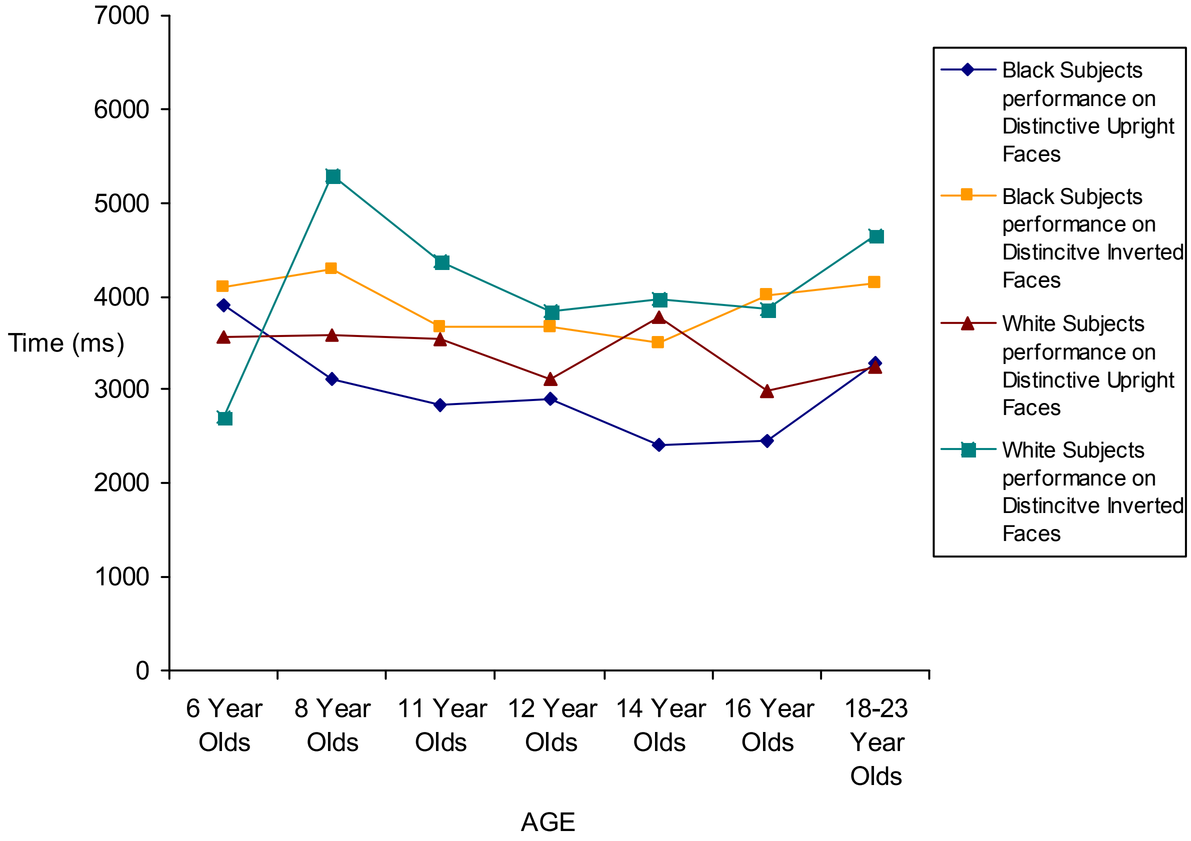
Time (ms)
6 Year Olds
8 Year Olds
11 Year Olds
12 Year Olds
14 Year Olds
16 Year Olds
18-23 Year Olds
AGE
White Subjects performance on Distinctive Upright Faces
White Subjects performance on Distincitve Inverted Faces
White Subjects performance on Typical Upright Faces
White Subjects performance on Typical Inverted Faces



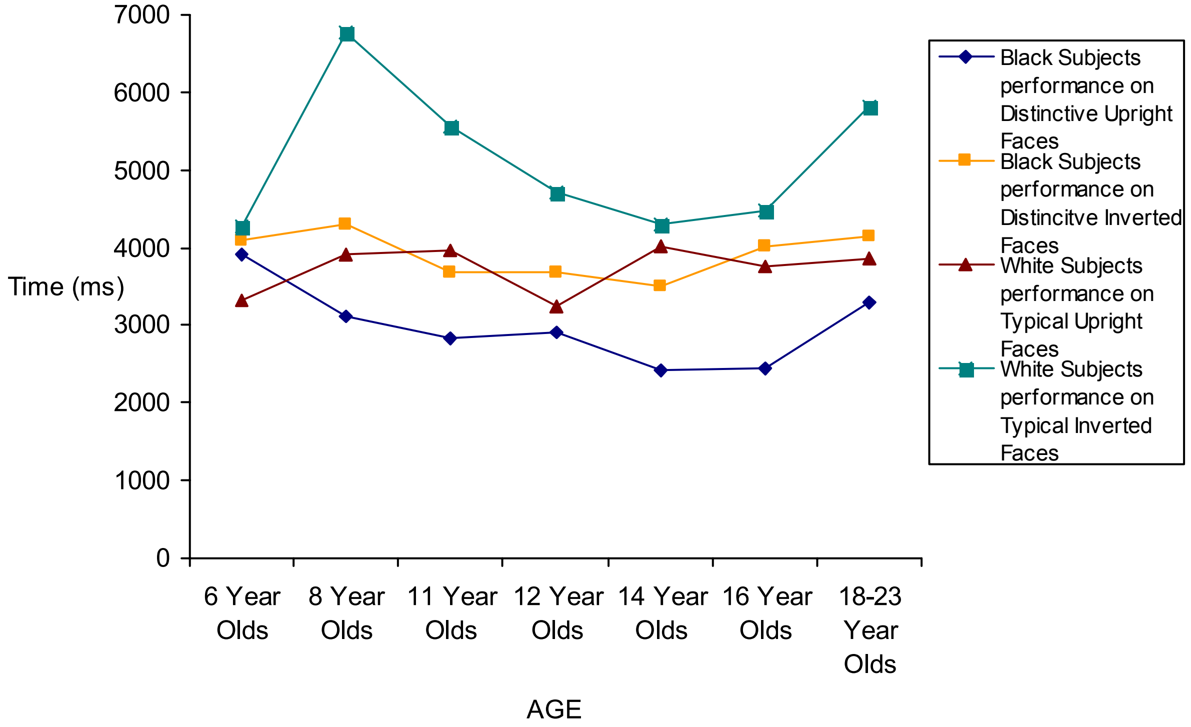


Figure 8(l): A developmental trend chart showing the interaction between age of subject x race of subject x distinctiveness of face x orientation of the face based on reaction time for hits.

Lastly, there was a significant interaction between the distinctiveness of the face, orientation of the face and the race of the subject based on reaction time for hits (*F*(1, 152) = 8.819, p<0.05). Black subjects were quicker at recognising distinctive upright faces (*M*=2990.165, *SD*=164.738) than distinctive inverted faces (*M*=3913.749, *SD*=189.540) as were white subjects quicker at recognising distinctive upright faces (*M*=3401.278, *SD*=164.738) than distinctive inverted faces (*M*=4102.768, *SD*=189.540). Furthermore, black subjects were quicker at recognising typical upright faces (*M*=3627.130, *SD*=169.131) than typical inverted faces (*M*=4244.081, *SD*=274.080) as were white subjects quicker at recognising typical upright faces (*M*=3720.508, *SD*=169.131) than typical inverted faces (*M*=5133.081, *SD*=274.080). These trends can be found tabulated in figure 8(m).

	Distinctive Faces		**Typical Faces**	
	Upright	**Inverted**	**Upright**	**Inverted**
Black Subjects	2990.165 (164.738)	3913.749 (189.540)	3627.130 (169.131)	4244.081 (274.080)
White Subjects	3401.278 (164.738)	4102.768 (189.540)	3720.508 (169.131)	5133.081 (274.080)

Figure 8(m): The interaction between race of subject x distinctiveness of the face x orientation of the face.

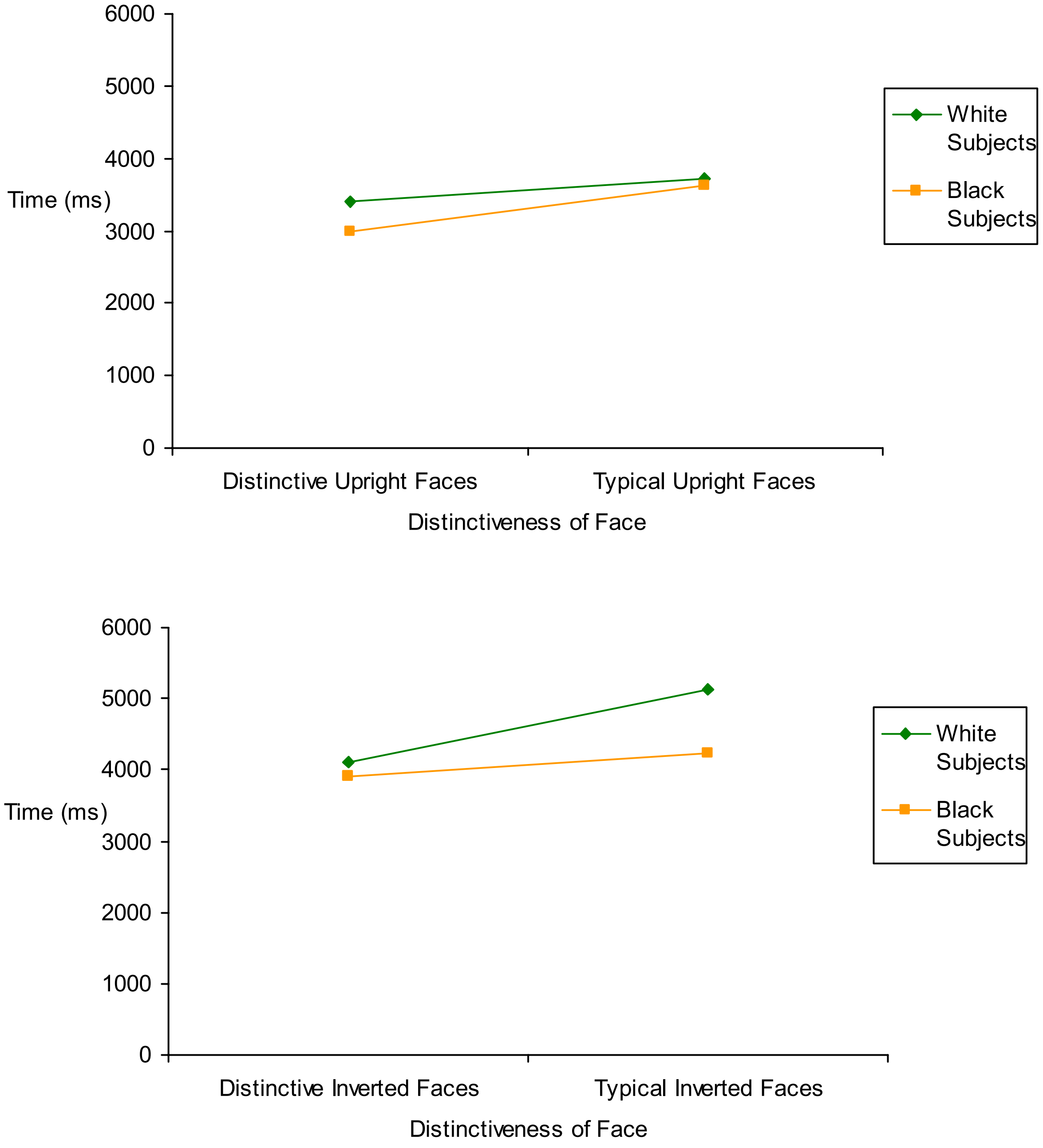


Figure 8(n): The cross-over effect for the interaction between race of subject x distinctiveness of the face x orientation of the face.

There were no other significant interactions found where $p<0.05$.

Discussion

The main finding from the results supported the hypotheses where the distinctiveness effect and the inversion effect were present. Distinctive faces were recognised significantly more accurately and quickly than typical faces and inverted faces were not recognised as accurately and quickly as the upright faces. There was also a significant main effect for age of subject based on percent correct scores. Doing a post hoc HSD test allowed for an understanding of how different age groups performed in the face recognition forced-choice task as well as which age groups could be clustered together or kept separately. Furthermore, there is a developmental trend that emerged where the older the subject got, the more accurate they would be in recognising the faces. There is a clear indication that 6 years olds were the worst off in terms of recognition accuracy for faces. This would mean that the 6-year-olds used in this study would not have developed an effective ability to recognise faces as well as the next group (i.e. 8-year-olds, 11-year-olds and 12-year-olds). The same was true for the 8-year-olds, 11-year-olds and the 12 years olds in comparison to the 14 -year-olds, 16-year-olds and adult group. The developmental trend that was found amongst different age groups suggests that there is a learning process regarding faces.

The main effect that was found regarding race of subject means that black subjects performed significantly better than white subjects. This is in contrast to what had been found in the previous experiment. Not many studies have found this phenomenon where black subjects have outperformed white subjects in a face recognition task. One possibility for this finding is that white subjects may have shown more confidence in the experiment and performed the recognition task slightly quicker than black subject and thus resulting in more errors among white subjects. Another explanation could be attributed to the amount of contact a person has had with another race group. This would include the premise that black subjects would have had more exposure to white faces due to socio-economic reasons, school representative ratio reasons or socio-political reasons. The opposite would be true for the white subjects where their contact with the black population in South Africa would have been limited due to the above mentioned reasons. Further investigation into this finding would be recommended.

The hypothesis of a cross-race effect was not as expected in this experiment. There was a significant relationship between race of face and race of subject but black subjects tended to recognise their other-race face more accurately than their own-race face. One reason for this finding could be attributed to the fact that the majority of the black subjects, under the age of 18 years, used in this study would form part of the higher socio-economic class. This would mean that these individuals would possibly have had more contact with the white population of South Africa and thus would possibly have developed a perceptual learning technique for recognising white faces as well as black faces. The contact hypothesis has received a lot of support in various studies sited earlier and would thus offer a reasonable account for this finding. Apart from this finding, there was an own-race bias amongst white subjects where they recognised their own-race face (white faces) significantly better than their other-race face (black faces). To explore this finding further, a contrast analysis of the interaction between race of subject, race of face and age of subject showed that there was an own-race bias for white subjects throughout the developmental span of age groups used in this study. This was absent for black subjects where no developmental trend emerged from the data. To further expound on the reasoning for such a finding could also be attributed to the former and current situation in South Africa. White South Africans have mostly lived in isolation from the black majority. Most white South African children would only come in contact with a few black South Africans who form part of the higher socio-economic circles in the country. The school that was used in the study was predominantly made up of white pupils and only a small percentage consisted of black pupils. Those who were older than 18 years had already entered into a university that had a ratio of 60% white, 40% black. This would explain why a cross-race effect was more present in black and white subject over the age of 18 years. However, the question that emerges from this finding is whether these results are dependent on the age of the subject.

There was no significant interaction between age of subject, race of subject and race of face based on percent correct. However, looking at these findings in a more in-depth manner, the contrast analysis that was run on the data to determine whether there was a developmental trend that would emerge from the data and whether this cross-race difference was evident across the various age groups; revealed that there was a significant interaction for white subjects but absent for black subjects. Looking further at the findings, the developmental trend that emerges explained that the own-race bias among white subjects increased and became more evident as the respondents got older. The question that must be posed is whether the contact with the other race also diminished as the subject became older.

The interactions that have been described thus far have ignored the inversion effect when a significant main effect for orientation of the face was found in the study.

Findings in this study suggest that the orientation of the face has an enormous impact in recognising the faces. There was a significant interaction between age of subjects and orientation of the face based on both percent correct scores and reaction time for hits. As the subjects got older, they recognised upright faces significantly better than inverted faces. Except at the age of 6 years where there was little disparity between the recognition of upright versus inverted faces. The reaction time for hits for 6-year-olds in this regard was slightly quicker on the inverted faces which showed that the task of recognising the inverted face was more of a guess than an actual determination to recognise the face. The sudden increase in time taken to recognise upright faces from the age of 6 years to 8 years (as illustrated in figure 8(f)) indicates that there was still a tendency to guess the upright faces among the 6-year-old group. However, the ease the 6-year-old would have in recognising the upright face more correctly than the inverted face allowed the subject to take their time in recognising the upright faces. From 8 years old to adulthood, the performance in recognising upright versus inverted faces remained relatively constant, as seen in figure 8(d). There was still a constant developmental pattern where the ability to recognise the upright and the inverted faces increased gradually up to the age of 14 years before it levelled out.

The significant interaction between age of subject, orientation of the face and race of subject based on reaction time for hits reveals that upright faces were more quickly recognised than inverted faces by black subjects older than 8 years. It seemed from the data that black subjects aged 6 years were more likely to take longer in recognising the upright faces than they did on inverted faces and as they got older, the time taken became shorter for upright faces. White subjects on the other hand took equally as long in recognising the upright and inverted faces at the age of 6 years. This would indicate that 6-year-old black subjects seemed keener at taking their time in recognising faces that were easier for them than the harder ones. White subjects aged 6 years seemed to have developed a way of recognising upright faces because the time taken there after did not change much. However, the time taken to recognise inverted faces among white subject between the ages of 6 years and 8 years increased substantially. This was the same trend found in the interaction between age of subject and orientation of the face based on reaction time for hits.

There was a cross-race effect for upright faces based on reaction time for hits. This was not the case for inverted faces. This means that for upright faces, own-race faces were recognised more quickly than other race faces. This finding may suggest that on an overall level, upright own-race faces may be easier to recognise but the time additional time taken to recognise the other-race face seemed to only help the black subject recognise the other-race faces better in comparison to the white subjects.

The significant interaction between orientation of face, age of subject and race of face based on percent correct scores shows that white inverted faces were recognised significantly worse than white upright faces for all age groups, as well as black inverted faces were recognised significantly worse than black upright faces for all age groups. Based on the significant main effect for race of face, it is not surprising for most age groups that white upright faces were better recognised that black upright faces as well as white inverted faces being better recognised than black inverted faces. These findings indicate that an inversion effect was present regardless of race of face. The data from this finding indicates that children aged 6 years would not have developed an inversion effect. This would support the literature where featural information in a face plays a dominant role in recognising faces at a young age. This was further supported by the significant interaction between orientation of face, age of subject and race of face based on reaction time for hits. In the 6-year-old group, the time taken to recognise the black upright versus black inverted faces and white upright versus white inverted faces differed considerably in comparison to the subsequent age groups. However, for those older than 8 years, black upright faces were recognised more quickly than black inverted faces and white upright faces were recognised more quickly than white inverted faces. The time taken to recognise inverted for both race groups' faces became quicker as the subjects became older but slowed down from the age of 14 years and eventually taking longer to recognise the inverted faces thereafter. This would suggest that as age increased, there was a habituation to configural information but as age increased further there was a concern for making sure about their perceptual accuracy of the configural information present in the face.

The interaction regarding distinctiveness, orientation, race of subject and age of subject was found to be significant for percentage correct scores and reaction time for hits. This means that the performance of an individual in a face recognition task would be affected significantly when the race and the age of the subject is considered during the recognition of a certain face's distinctiveness and orientation. Distinctive inverted faces were recognised significantly worse than distinctive upright faces for all age and race groups, as well as typical inverted faces were recognised significantly worse than typical upright faces for all age and race groups. Distinctive upright faces were better recognised than typical upright faces all race and age groups but one. The black 8-year-old group recognised the typical upright faces better than the distinctive upright faces. Distinctive inverted faces were recognised more accurately than typical inverted faces when taking age and race of the subject into account. However, there were cases where typical inverted faces were recognised more accurately than the distinctive inverted faces (i.e. black 6 years olds and 8 white -year-olds).

Distinctive upright faces were correctly recognised more quickly than typical upright faces when considering the age and race of the subject but this differed only amongst the white 6-year-old subjects where they recognised the typical upright faces more quickly than the distinctive upright faces. The typical inverted faces took longer than the distinctive inverted faces when taking the age and race of the subject into account. This was not the case for subjects because the black 6-year-old group and the black 8-year-old group took longer on the distinctive inverted faces than the typical inverted faces. This finding shows that reaction time for hits regarding the interaction between, age of subject, race of subject, distinctiveness of the face and the orientation of the face has a similar trend to the number of correct responses. After the age of 8 years old, participants tended to perform more quickly and more accurately on the distinctive faces whether upright or inverted versus the typical faces in the same orientation. Furthermore, there was a developmental trend regarding this interaction. As the age increased, so the recognition accuracy increased and response time to correctly recognise the face decreased regarding the orientation and distinctiveness of the faces.

Chapter 4

General Discussion, Conclusion and Recommendations

The results from this study provide further empirical evidence for the existence of a distinctiveness effect, a cross-race effect and an orientation effect in recognition memory for faces. When participants of different age groups were tested, the results showed a significant main effect for race of face and a main effect for race of subject. It is not uncommon to find a main effect for race of subject in such studies but this study differed to previous studies in the same field. Black subjects tended to out perform white subjects on the face recognition task. However, this could be explained by white faces being significantly easier to recognise than black faces. It is possible that this may have resulted from black subjects having had greater and more meaningful contact with white South Africans than white subjects had with black South Africans. However, the overall interaction between race of face and race of subject was significant in the predicted direction. However, black subjects recognised white faces better than their own race group's face. This pattern of results has been reported in adoption studies such as the done by Sangrigoli *et al.* (2005) where a specific race group could recognise other-race faces better than their own. This suggests that there was possibly a bias among black subjects in recognising white South African faces for various reasons as stipulated in the previous discussions. However, this bias was absent among 12-year-olds and the adult group of black subjects.

When doing a contrast analysis of race of subject, race of face and age of subject, the own-race bias among white subjects continued to increase from the age of 8 years to young adulthood. This finding may suggest that there is no “reward” for white South Africans to remember black faces even though black South Africans may be in the majority. This finding could be explained by the contact hypothesis but there is something deeper that has emerged from this study. Black subjects have no own-race bias but white subjects were found to have this bias yet it continued to increase with age even though contact with black South Africans should have increased with age.

One of the main findings that have emerged from this study is the impact of the orientation of the face. The interaction between age of subject and orientation of the face suggests that people develop specific criteria when having to recognise faces as they get older. This is best explained by the sudden development of remembering the configural information of a face. When a face is inverted, the configural information that was memorised becomes affected and only after some time, does the face occasionally become recognisable. There was a clear developmental pattern that emerged from the data where 6-year-olds appeared not to have developed as good an ability to perceptually gather information about a face in comparison to the 8-year-olds. Thus, enabling the respondent to use that information they have perceptually processed in recognising the face later. More often than not, a face became recognisable for a 6-year-old if they saw unique featural characteristics within the face that was distinguishable from the other faces and thereby made the face easier to learn. Only by the age of 8 years do these perceptual learning criteria begin to take effect. Once an individual reaches the age of a 14 year old does the ability of learning faces perceptually reach that similar to an adult’s ability. Therefore, the older the individual gets, the more the inversion effect or the cross-race effect or the distinctiveness effect is likely to affect face recognition performance.

Face recognition studies have provided the criminal justice system and various other establishments a way to understand how we recognise faces and what affects our abilities to recognise certain faces. The three main factors that continue to affect our ability to recognise faces include the inversion effect, the cross-race effect and the distinctiveness effect.

This study showed that these three effects were still present in a person's ability to recognise faces. From a developmental perspective, these three effects only become more defined after the age of 8 years. This study found that 6-year-olds were able to recognise faces but their ability to distinguish between different faces is lacking significantly more than those who were aged 2 years older. These three effects were not fully evident in the 6-year-old group, regardless of race of subject. Therefore, perceptual learning of faces does not develop amongst South Africans as early as most research has suggested. The distinctiveness effect seems to be present in children aged around 6 years but as for the cross-race effect and the inversion effect, the evidence is lacking in this study.

Thus, it can be said that if children as young as six years had to identify a perpetrator from a crime they had witnessed, they may not have developed any perceptual hindrances as yet but they would none the less be poorer at recognising the perpetrator than an older child or even an adult. However, a 6-year-old's competence at recognising faces cannot be completely ruled out as this study has not imitated reality where anxiety may be involved in recognising and remembering a face during a crime.

Another limitation is that the faces used in the study do have differences based on ethnic backgrounds. There is research that suggests people do not necessarily have an own-race-bias but more specifically an ethnic group bias (Chiroro, Tredoux, Radaelli & Meissner, in press). Not all black faces used in the study were from one specific ethnic group but rather mixed. Therefore, a black respondent who may have grown up in KwaZulu-Natal and exposed more to ethnic groups such as the Zulus and few Xhosas could have struggled to remember faces from other ethnic groups like the Bapedis and South Sotho groups. This may suggest why white faces were recognised more easily than black faces. However, one cannot exclude the differences among white faces in the South African context as well.

The following limitation could have had little to no effect on the results but two respondents (i.e. one respondents was 21-years-old and the other was 16-years-old) reported that looking at faces in an inverted position was natural to them as they had been exposed to faces in an inverted position due to their participation in gymnastics from a young age. Being a gymnast, exposure to inverted faces comes with the sport as it was explained by these respondents that the majority of their world is inverted during their performances. Therefore, this limitation should be considered for future research in the field of both face recognition research and understanding the inversion effect.

Lastly, certain recommendations may be necessary for future research in the same field. The level of contact a person is exposed to regarding different race groups to one's own needs to be controlled and included in future research. A possible reason for the dip from 16-year-olds to adulthood in most interactions could be as a result of the adults coming from a different geographical environment and perhaps socio-economic environment. The dip from 16 years to adulthood is not normally found in face recognition studies. In future research, adults should be chosen from the same educational, socio-economic and geographical location to that of children.

Most studies have not used the entire spectrum of age groups in face recognition research because of the disparities between possible floor and ceiling effects if different methodologies are used. This study has shown that the distinctiveness effect, the inversion effect and the cross-race effect can still be produced across age groups by using a forced-choice procedure. Perhaps, using a "yes-no" face recognition task across different age groups (from as young as 5 years) could possibly give the same results as a forced choice face recognition task but this is another suggestion for future research. Furthermore, comparing both face recognition procedures may offer more light on procedural differences and limitations.

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Appendix A

	Upright Faces	**Inverted Faces**
6-year-olds	58.333 (2.091)	54.514 (2.110)
8-year-olds	74.306 (2.091)	60.243 (2.110)
11-year-olds	78.125 (2.091)	67.014 (2.110)
12-year-olds	77.951 (2.091)	66.840 (2.110)
14 -year-olds	86.285 (2.091)	71.528 (2.110)
16-year-olds	90.799 (2.091)	74.653 (2.110)
18-23 -year-olds	88.542 (2.091)	74.132 (2.110)

Figure 9(a): Percent correct mean scores for the interaction between age of subject x orientation of the face based on percent correct scores.

	Upright Faces	**Inverted Faces**
6-year-olds	4126.141 (290.035)	3628.332 (394.920)
8-year-olds	3707.914 (283.660)	5084.575 (386.239)
11-year-olds	3337.982 (283.660)	4406.458 (386.239)
12-year-olds	3112.495 (290.035)	4090.057 (394.920)
14 -year-olds	3299.113 (283.660)	3926.782 (386.239)
16-year-olds	3008.257 (283.660)	4280.492 (386.239)
18-23 -year-olds	3451.489 (283.660)	5022.242 (386.239)

Figure 9(b): The interaction between age of subject x orientation of the face based on reaction time for hits.

		Upright Faces	Inverted Faces
6-year-olds	**Black Subjects**	4817.645 (401.156)	3755.558 (545.225)
	White Subjects	3434.638 (418.993)	3501.105 (570.514)
8-year-olds	**Black Subjects**	3676.116 (401.156)	4132.266 (546.225)
	White Subjects	3739.712 (401.156)	6036.884 (546.225)
11-year-olds	**Black Subjects**	2924.536 (401.156)	3839.580 (546.225)
	White Subjects	3751.428 (401.156)	4973.336 (546.225)
12-year-olds	**Black Subjects**	3043.677 (418.993)	3898.898 (570.514)
	White Subjects	3181.312 (401.156)	4281.216 (546.225)
14 -year-olds	**Black Subjects**	2712.513 (401.156)	3720.358 (546.225)
	White Subjects	3885.713 (401.156)	4133.207 (546.225)
16-year-olds	**Black Subjects**	2637.037 (401.156)	4393.515 (546.225)
	White Subjects	3379.478 (401.156)	4167.469 (546.225)
18-23 -year-olds	**Black Subjects**	3349.008 (401.156)	4812.230 (546.225)
	White Subjects	3553.971 (401.156)	5232.255 (546.225)

Figure 9(c): The interaction between age of subject x race of subject x orientation of the face based on reaction time for hits.

	Black Faces		White Faces	
	Upright	Inverted	Upright	Inverted
6-year-olds	57.639 (2.661)	55.208 (2.579)	59.028 (2.382)	53.819 (2.939)
8-year-olds	69.792 (2.661)	59.722 (2.579)	78.819 (2.382)	60.764 (2.939)
11-year-olds	79.167 (2.661)	62.500 (2.579)	77.083 (2.382)	71.528 (2.939)
12-year-olds	76.042 (2.661)	67.014 (2.579)	79.861 (2.382)	66.667 (2.939)
14 -year-olds	83.681 (2.661)	70.833 (2.579)	88.889 (2.382)	72.222 (2.939)
16-year-olds	87.500 (2.661)	67.708 (2.579)	94.097 (2.382)	81.597 (2.939)
18-23 -year-olds	85.764 (2.661)	70.833 (2.579)	91.319 (2.382)	77.431 (2.939)

Figure 9(d): The interaction between age of subject x race of face x orientation of the face based on percent correct scores.

	Black Faces		**White Faces**	
	Upright	**Inverted**	**Upright**	**Inverted**
6-year-olds	3822.309 (332.470)	4257.499 (512.748)	4429.973 (346.955)	2999.165 (465.759)
8-year-olds	3864.914 (325.162)	4653.706 (501.477)	3550.914 (339.329)	5515.444 (455.522)
11-year-olds	3428.837 (325.162)	4370.751 (501.477)	3247.127 (339.329)	4442.165 (455.522)
12-year-olds	3391.477 (332.470)	4171.945 (512.748)	2833.512 (346.955)	4008.169 (465.759)
14 -year-olds	3518.182 (325.162)	4075.989 (501.477)	3080.044 (339.329)	3777.576 (455.522)
16-year-olds	3176.469 (325.162)	4510.453 (501.477)	2840.046 (339.329)	4050.531 (455.522)
18-23 -year-olds	3754.134 (325.162)	5084.905 (501.477)	3148.845 (339.329)	4959.580 (455.522)

Figure 9(e): The interaction between age of subject x race of face x orientation of the face based on reaction time for hits.

		Distinctive Faces		**Typical Faces**	
		Upright	**Inverted**	**Upright**	**Inverted**
6-year-olds	**Black Subjects**	60.417 (3.623)	54.167 (3.959)	59.722 (3.706)	58.333 (4.115)
	White Subjects	58.333 (3.623)	54.167 (3.959)	54.861 (3.706)	51.389 (4.115)
8-year-olds	**Black Subjects**	73.611 (3.623)	63.194 (3.959)	78.472 (3.706)	57.639 (4.115)
	White Subjects	80.556 (3.623)	59.722 (3.959)	64.583 (3.706)	60.417 (4.115)
11-year-olds	**Black Subjects**	83.333 (3.623)	71.528 (3.959)	72.222 (3.706)	68.056 (4.115)
	White Subjects	83.333 (3.623)	70.139 (3.959)	73.611 (3.706)	58.333 (4.115)
12-year-olds	**Black Subjects**	81.250 (3.623)	71.528 (3.959)	72.917 (3.706)	68.750 (4.115)
	White Subjects	81.944 (3.623)	68.056 (3.959)	75.694 (3.706)	59.028 (4.115)
14 -year-olds	**Black Subjects**	90.972 (3.623)	77.778 (3.959)	85.417 (3.706)	73.611 (4.115)
	White Subjects	86.111 (3.623)	73.611 (3.959)	82.639 (3.706)	61.111 (4.115)
16-year-olds	**Black Subjects**	97.222 (3.623)	82.639 (3.959)	93.750 (3.706)	79.167 (4.115)
	White Subjects	89.583 (3.623)	75.694 (3.959)	82.639 (3.706)	61.111 (4.115)
18-23 -year-olds	**Black Subjects**	88.889 (3.623)	84.028 (3.959)	87.500 (3.706)	64.583 (4.115)
	White Subjects	90.278 (3.623)	75.694 (3.959)	87.500 (3.706)	72.222 (4.115)

Figure 9(f): The interaction between age of subject x race of subject x distinctiveness of face x orientation of the face based on percent correct scores.

		Distinctive Faces		Typical Faces	
		Upright	Inverted	Upright	Inverted
6-year-olds	**Black Subjects**	3911.457 (433.052)	4092.140 (498.250)	5723.833 (444.600)	3418.976 (720.485)
	White Subjects	3561.998 (452.308)	2720.802 (520.405)	3307.277 (464.370)	4281.409 (752.522)
8-year-olds	**Black Subjects**	3121.152 (433.052)	4293.644 (498.250)	4231.080 (444.600)	3970.888 (720.485)
	White Subjects	3579.956 (433.052)	5296.511 (498.250)	3899.468 (444.600)	6777.256 (720.485)
11-year-olds	**Black Subjects**	2834.034 (433.052)	3679.443 (498.250)	3015.038 (444.600)	3999.717 (720.485)
	White Subjects	3547.172 (433.052)	4383.111 (498.250)	3955.684 (444.600)	5563.561 (720.485)
12-year-olds	**Black Subjects**	2911.909 (452.308)	3674.317 (520.405)	3175.445 (464.370)	4123.480 (752.522)
	White Subjects	3109.392 (433.052)	3840.489 (498.250)	3253.233 (444.600)	4721.942 (720.485)
14 -year-olds	**Black Subjects**	2420.661 (433.052)	3491.344 (498.250)	3004.364 (444.600)	3949.371 (720.485)
	White Subjects	3769.158 (433.052)	3969.546 (498.250)	4002.268 (444.600)	4296.868 (720.485)
16-year-olds	**Black Subjects**	2445.860 (433.052)	4015.412 (498.250)	2828.215 (444.600)	4771.618 (720.485)
	White Subjects	2993.425 (433.052)	3857.504 (498.250)	3765.531 (444.600)	4477.435 (720.485)
18-23 -year-olds	**Black Subjects**	3286.084 (433.052)	4149.940 (498.250)	3411.932 (444.600)	5474.521 (720.485)
	White Subjects	3247.847 (433.052)	4651.413 (498.250)	3860.095 (444.600)	5813.096 (720.485)

Figure 9(g): The interaction between age of subject x race of subject x distinctiveness of the face x orientation of the face based on reaction time for hits.

		Black Faces				**White Faces**			
		Distinctive		**Typical**		**Distinctive**		**Typical**	
		Upright	**Inverted**	**Upright**	**Inverted**	**Upright**	**Inverted**	**Upright**	**Inverted**
6-year-olds	**Black Subjects**	66.667 (4.758)	54.167 (5.254)	54.167 (5.088)	54.167 (5.597)	54.167 (4.313)	54.167 (5.304)	65.278 (4.922)	62.500 (5.822)
	White Subjects	51.389 (4.758)	62.500 (5.254)	58.333 (5.088)	50.000 (5.597)	65.278 (4.313)	45.833 (5.304)	51.389 (4.922)	52.778 (5.822)
8-year-olds	**Black Subjects**	63.889 (4.758)	62.500 (5.254)	77.778 (5.088)	62.500 (5.597)	83.333 (4.313)	63.889 (5.304)	79.167 (4.922)	52.778 (5.822)
	White Subjects	77.778 (4.758)	58.333 (5.254)	59.722 (5.088)	55.556 (5.597)	83.333 (4.313)	61.111 (5.304)	69.444 (4.922)	65.278 (5.822)
11-year-olds	**Black Subjects**	86.111 (4.758)	63.889 (5.254)	72.222 (5.088)	69.444 (5.597)	80.556 (4.313)	79.167 (5.304)	72.222 (4.922)	66.667 (5.822)
	White Subjects	77.778 (4.758)	62.500 (5.254)	80.556 (5.088)	54.167 (5.597)	88.889 (4.313)	77.778 (5.304)	66.667 (4.922)	62.500 (5.822)
12-year-olds	**Black Subjects**	81.944 (4.758)	77.778 (5.254)	72.222 (5.088)	66.667 (5.597)	80.556 (4.313)	65.278 (5.304)	73.611 (4.922)	70.833 (5.822)
	White Subjects	77.778 (4.758)	62.500 (5.254)	72.222 (5.088)	61.111 (5.597)	86.111 (4.313)	73.611 (5.304)	79.167 (4.922)	56.944 (5.822)
14 -year-olds	**Black Subjects**	84.722 (4.758)	79.167 (5.254)	90.278 (5.088)	73.611 (5.597)	97.222 (4.313)	76.389 (5.304)	80.556 (4.922)	73.611 (5.822)
	White Subjects	83.333 (4.758)	68.056 (5.254)	76.389 (5.088)	62.500 (5.597)	88.889 (4.313)	79.167 (5.304)	88.889 (4.922)	59.722 (5.822)
16-year-olds	**Black Subjects**	94.444 (4.758)	75.000 (5.254)	93.056 (5.088)	77.778 (5.597)	100.000 (4.313)	90.278 (5.304)	94.444 (4.922)	80.556 (5.822)
	White Subjects	84.722 (4.758)	66.667 (5.254)	77.778 (5.088)	51.389 (5.597)	94.444 (4.313)	84.722 (5.304)	87.500 (4.922)	70.833 (5.822)
18-23 -year-olds	**Black Subjects**	90.278 (4.758)	81.944 (5.254)	88.889 (5.088)	63.889 (5.597)	87.500 (4.313)	86.111 (5.304)	86.111 (4.922)	65.278 (5.822)
	White Subjects	83.333 (4.758)	66.667 (5.254)	80.556 (5.088)	70.833 (5.597)	97.222 (4.313)	84.722 (5.304)	94.444 (4.922)	73.611 (5.822)

Figure 10(a): The mean scores for the interaction between age of subject x race of subject x race of face x distinctiveness of face x orientation of the face based on percent correct scores.

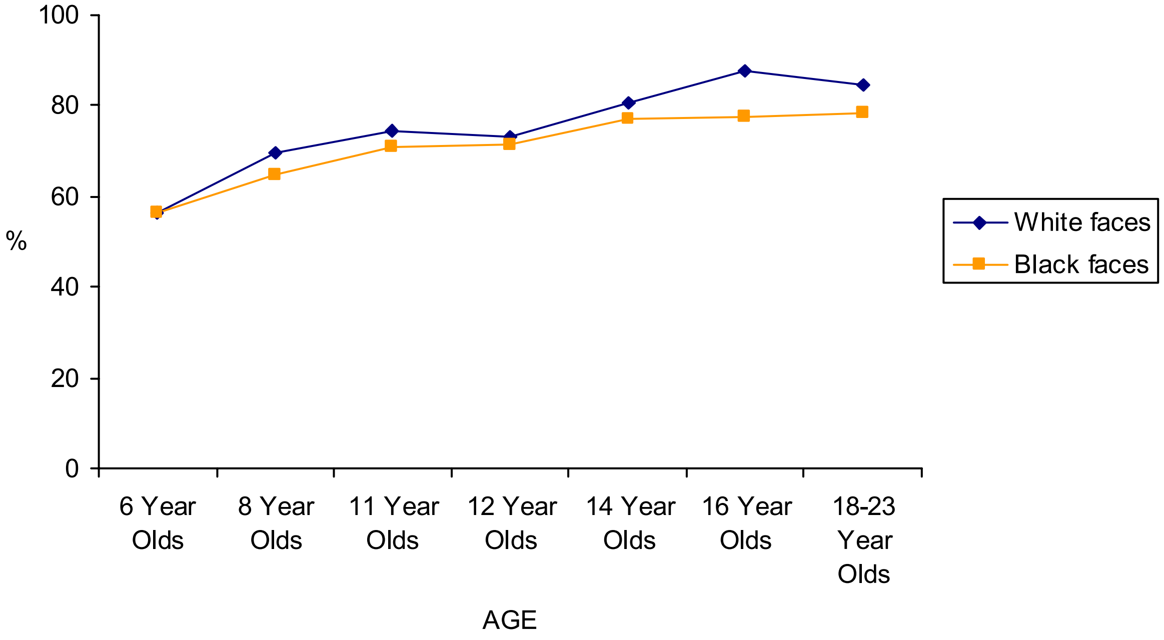


Figure 10(b): Developmental trend of the interaction between age of subject x race of face based on percent correct scores.

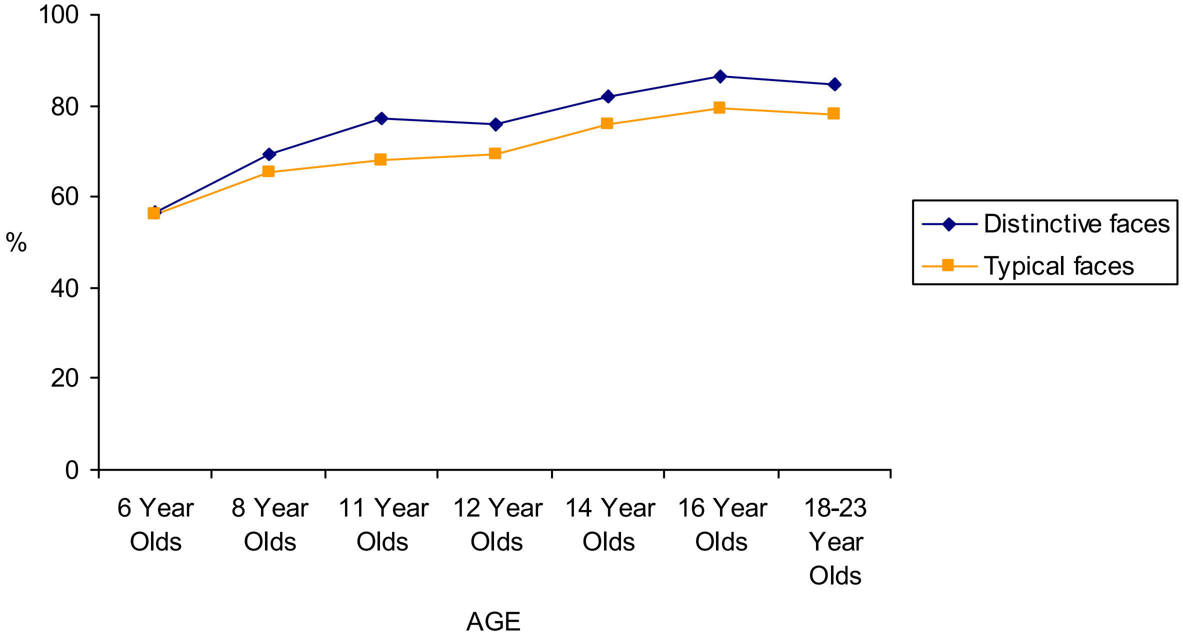


Figure 10(c): Developmental trend of the interaction between age of subject x distinctiveness of the face based on percent correct scores.

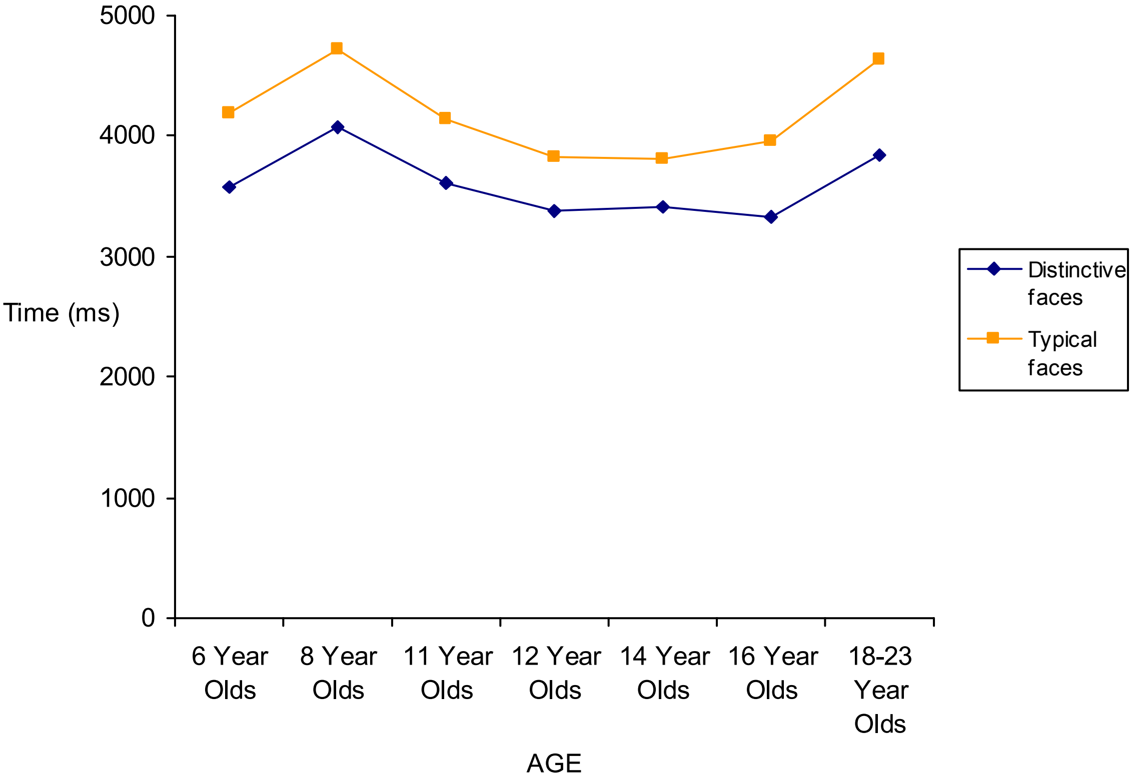
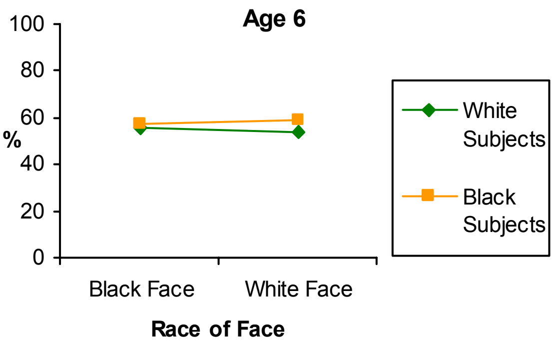
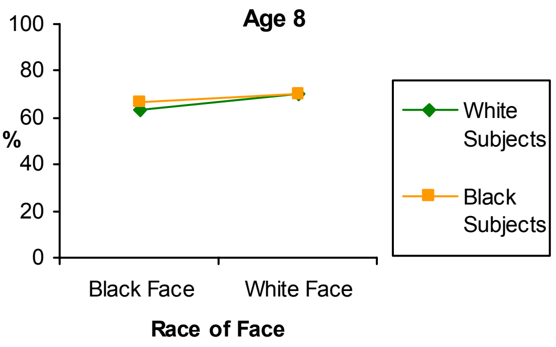


Figure 10(d): Developmental trend of the interaction between age of subject x distinctiveness of the face based on reaction time.





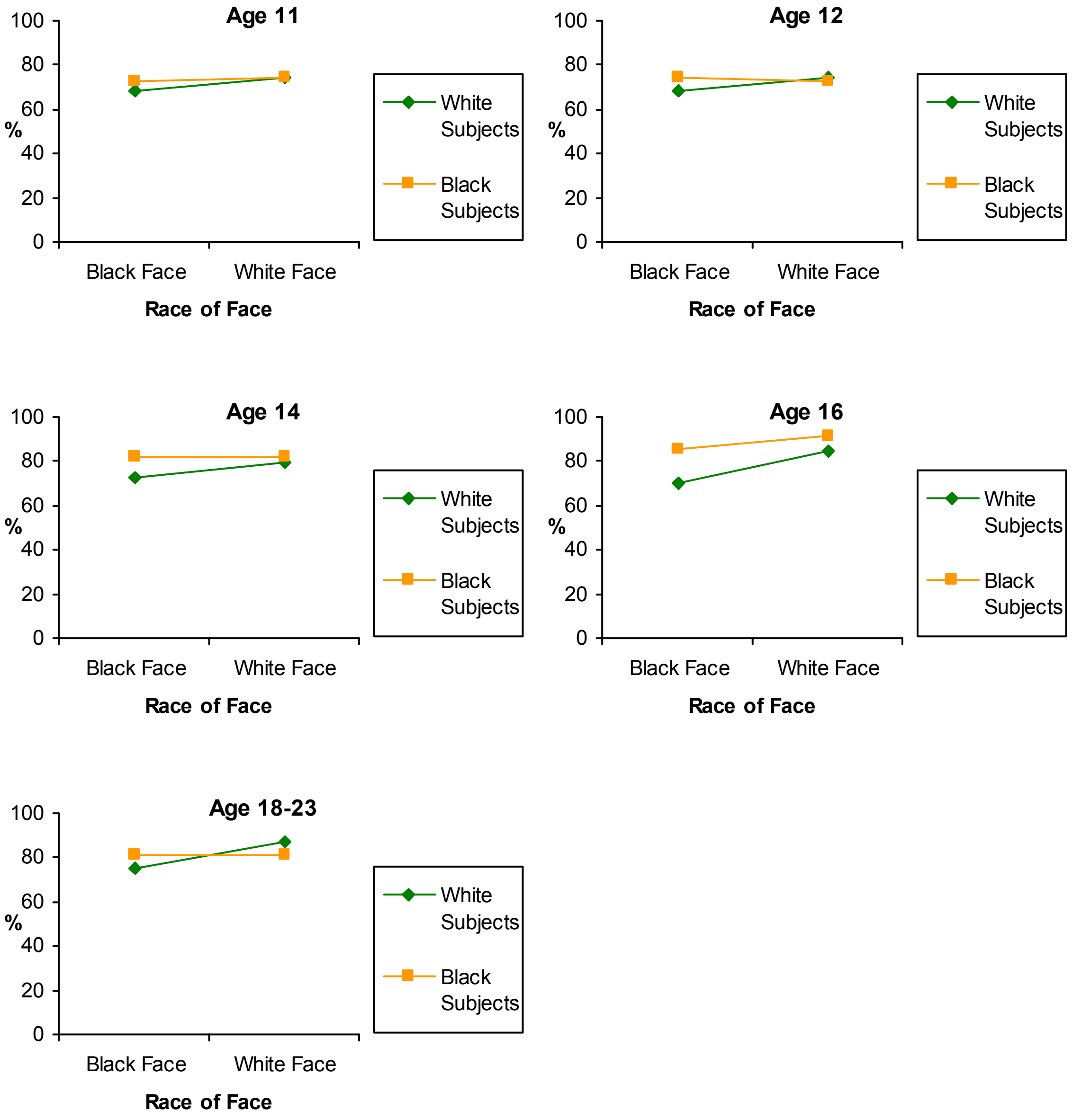
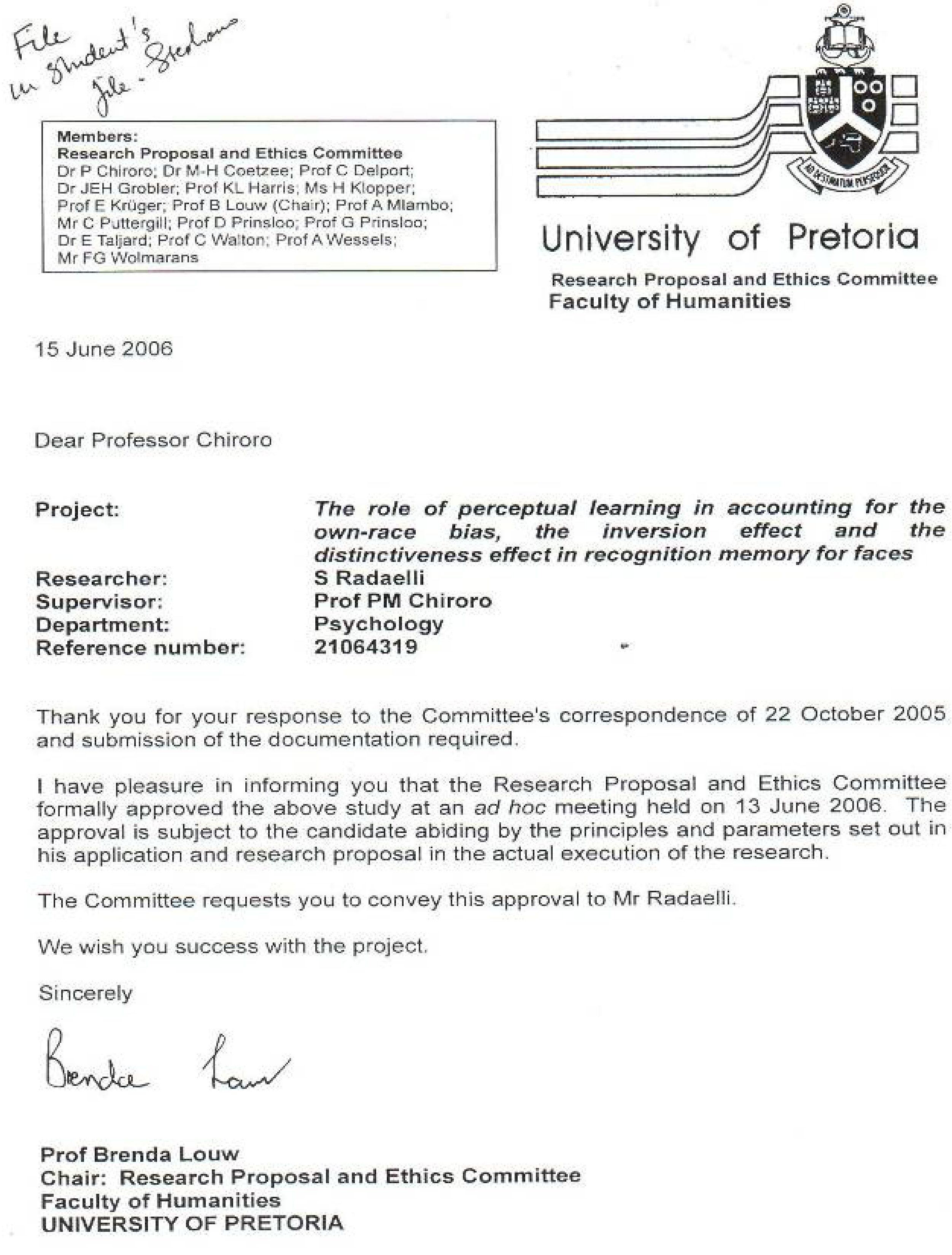


Figure 10(e): Illustration of the interaction between age of subject x race of subject x race of face based on percent correct scores.

Appendix B



File
in student's
file - Stefano

Members:
Research Proposal and Ethics Committee
Dr P Chiroro; Dr M-H Coetzee; Prof C Delport;
Dr JEH Grobler; Prof KL Harris; Ms H Klopper;
Prof E Krüger; Prof B Louw (Chair); Prof A Mlambo;
Mr C Puttergill; Prof D Prinsloo; Prof G Prinsloo;
Dr E Taljard; Prof C Walton; Prof A Wessels;
Mr FG Wolmarans

University of Pretoria
Research Proposal and Ethics Committee
Faculty of Humanities

15 June 2006

Dear Professor Chiroro

Project:	***The role of perceptual learning in accounting for the own-race bias, the inversion effect and the distinctiveness effect in recognition memory for faces***
Researcher:	**S Radaelli**
Supervisor:	**Prof PM Chiroro**
Department:	**Psychology**
Reference number:	**21064319**

Thank you for your response to the Committee's correspondence of 22 October 2005 and submission of the documentation required.

I have pleasure in informing you that the Research Proposal and Ethics Committee formally approved the above study at an *ad hoc* meeting held on 13 June 2006. The approval is subject to the candidate abiding by the principles and parameters set out in his application and research proposal in the actual execution of the research.

The Committee requests you to convey this approval to Mr Radaelli.

We wish you success with the project.

Sincerely

Brenda Louw

Prof Brenda Louw
Chair: Research Proposal and Ethics Committee
Faculty of Humanities
UNIVERSITY OF PRETORIA

ST STITHIANS COLLEGE

POLICY DOCUMENT

EDUCATIONAL SURVEYS & RESEARCH

1. Only written requests to conduct an educational survey or research at St Stithians College will be considered.

2. All requests are to be forwarded to the Rector, for discussion with the relevant Head/s of school.

3. Such written requests will include the following information:

   3.1 The full details of the student/person wishing to conduct the survey;

   3.2 The university and course for which the researcher is registered;

   3.3 Details of whether the proposed research has the approval of the university;

   3.4 The name and contact details of the university supervisor/ promoter overseeing the research;

   3.5 The purpose of the research and why the survey is being done;

   3.6 An undertaking from the researcher that the information gleaned from the survey would remain strictly confidential and would only be seen by those people involved in the assessment of the researcher.

4. If such a request is approved, the Rector will formally write to the researcher informing him/her that the request had been approved and the conditions under which the research will be conducted.

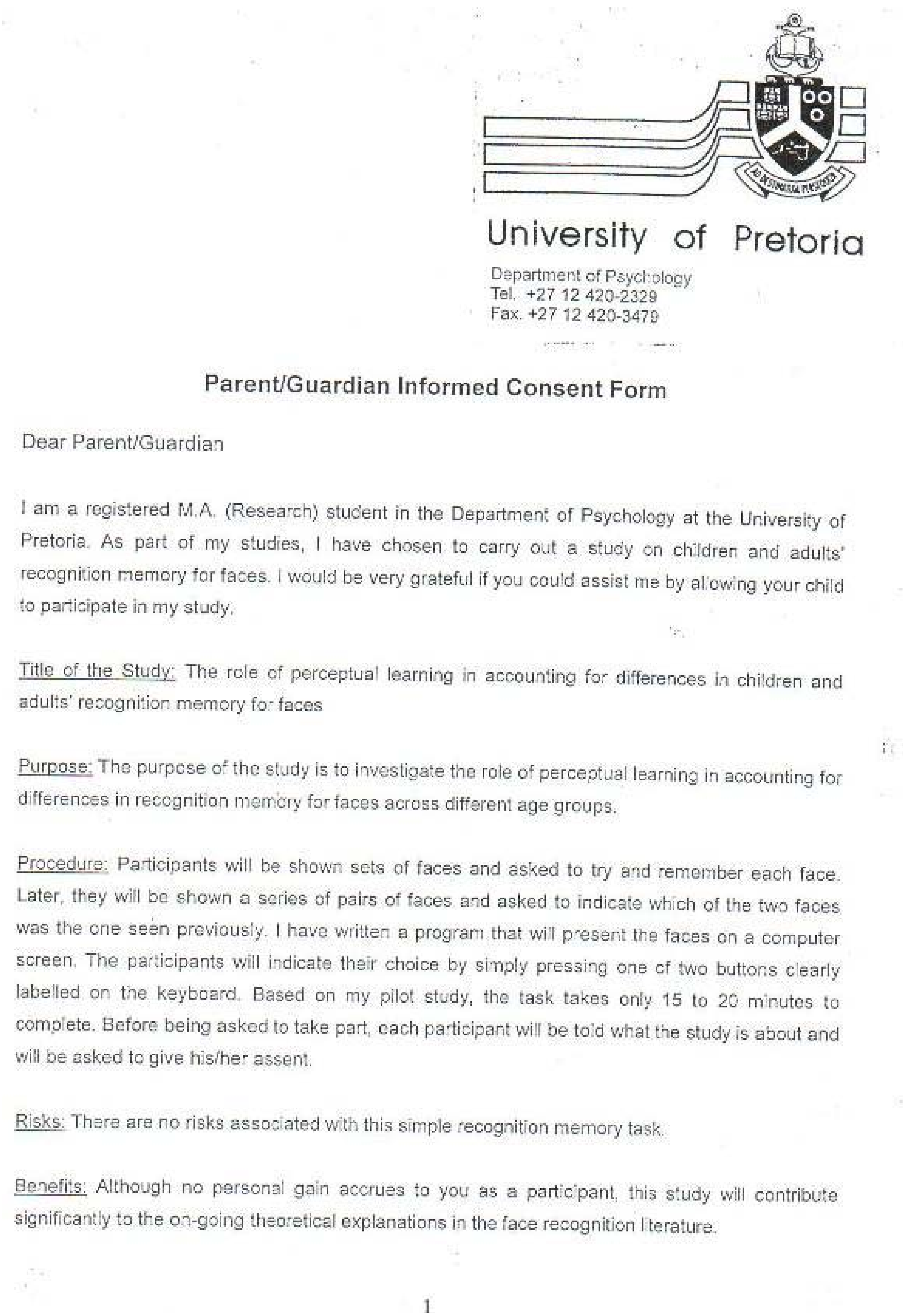
5. One copy of the completed dissertation/thesis/essay that the research results in must be provided (at the expense of the researcher) to the Rector of St Stithians College as soon as possible after the study has been completed.

6. The Rector, in consultation with the person/student undertaking the research, will decide on the dissemination of the results of the research both internally and externally.

POLICY ADOPTED BY THE COLLEGE EXECUTIVE ON 29 SEPTEMBER 2003. DETAILS CIRCULATED BY E-MAIL TO ST STITHIANS COLLEGE STAFF ON 01 OCTOBER 2003.

sbl/bj/admin/policy-educ surveys/10 sept 2003

Appendix C



University of Pretoria

Department of Psychology
Tel. +27 12 420-2329
Fax. +27 12 420-3479

Parent/Guardian Informed Consent Form

Dear Parent/Guardian

I am a registered M.A. (Research) student in the Department of Psychology at the University of Pretoria. As part of my studies, I have chosen to carry out a study on children and adults' recognition memory for faces. I would be very grateful if you could assist me by allowing your child to participate in my study.

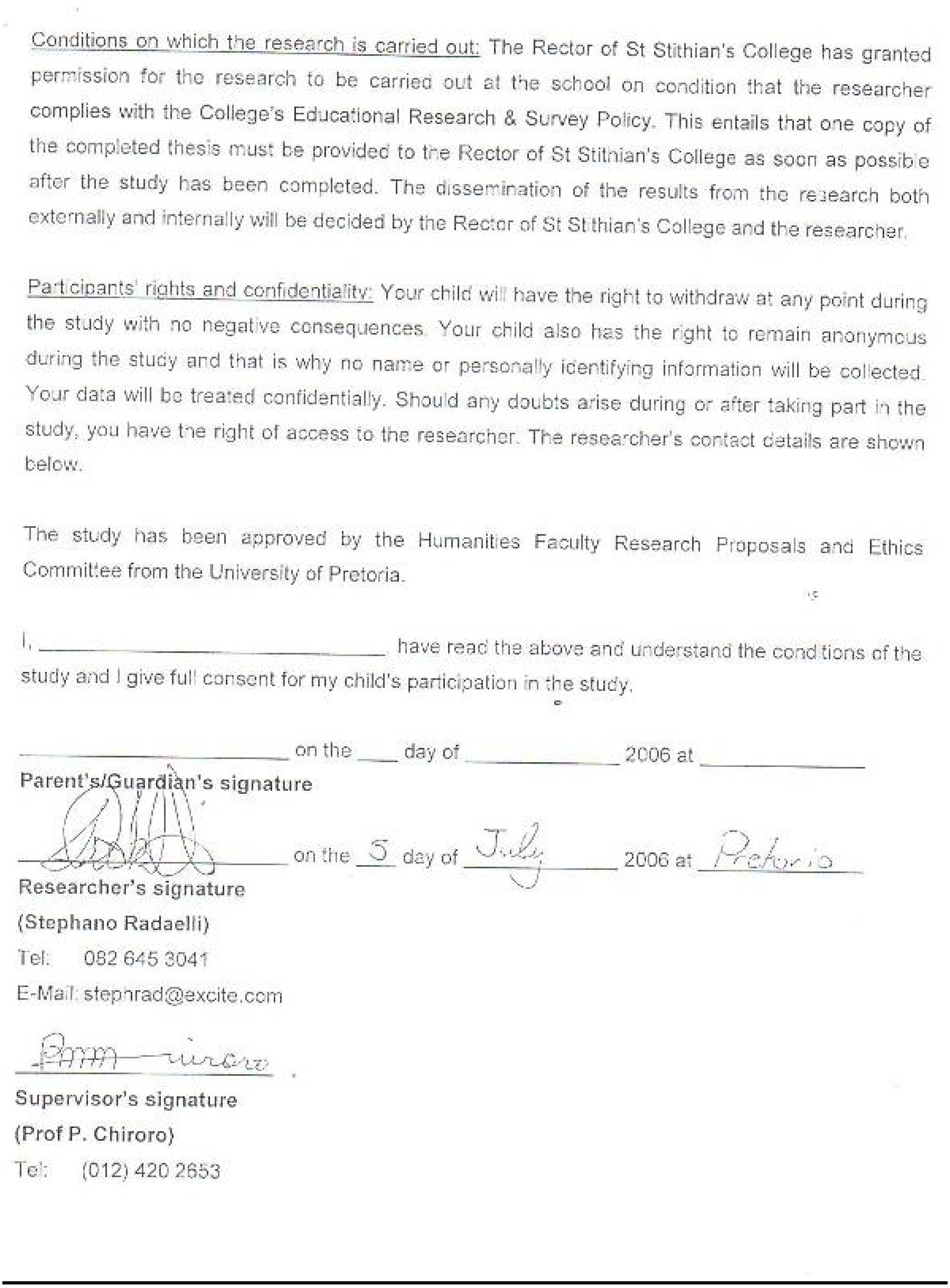
Title of the Study: The role of perceptual learning in accounting for differences in children and adults' recognition memory for faces

Purpose: The purpose of the study is to investigate the role of perceptual learning in accounting for differences in recognition memory for faces across different age groups.

Procedure: Participants will be shown sets of faces and asked to try and remember each face. Later, they will be shown a series of pairs of faces and asked to indicate which of the two faces was the one seen previously. I have written a program that will present the faces on a computer screen. The participants will indicate their choice by simply pressing one of two buttons clearly labelled on the keyboard. Based on my pilot study, the task takes only 15 to 20 minutes to complete. Before being asked to take part, each participant will be told what the study is about and will be asked to give his/her assent.

Risks: There are no risks associated with this simple recognition memory task.

Benefits: Although no personal gain accrues to you as a participant, this study will contribute significantly to the on-going theoretical explanations in the face recognition literature.



Conditions on which the research is carried out: The Rector of St Stithian's College has granted permission for the research to be carried out at the school on condition that the researcher complies with the College's Educational Research & Survey Policy. This entails that one copy of the completed thesis must be provided to the Rector of St Stithian's College as soon as possible after the study has been completed. The dissemination of the results from the research both externally and internally will be decided by the Rector of St Stithian's College and the researcher.

Participants' rights and confidentiality: Your child will have the right to withdraw at any point during the study with no negative consequences. Your child also has the right to remain anonymous during the study and that is why no name or personally identifying information will be collected. Your data will be treated confidentially. Should any doubts arise during or after taking part in the study, you have the right of access to the researcher. The researcher's contact details are shown below.

The study has been approved by the Humanities Faculty Research Proposals and Ethics Committee from the University of Pretoria.

I, ______________________________ have read the above and understand the conditions of the study and I give full consent for my child's participation in the study.

______________________ on the ___ day of ____________ 2006 at ______________

Parent's/Guardian's signature

______________________ on the 5 day of July 2006 at Pretoria

Researcher's signature

(Stephano Radaelli)

Tel: 082 645 3041

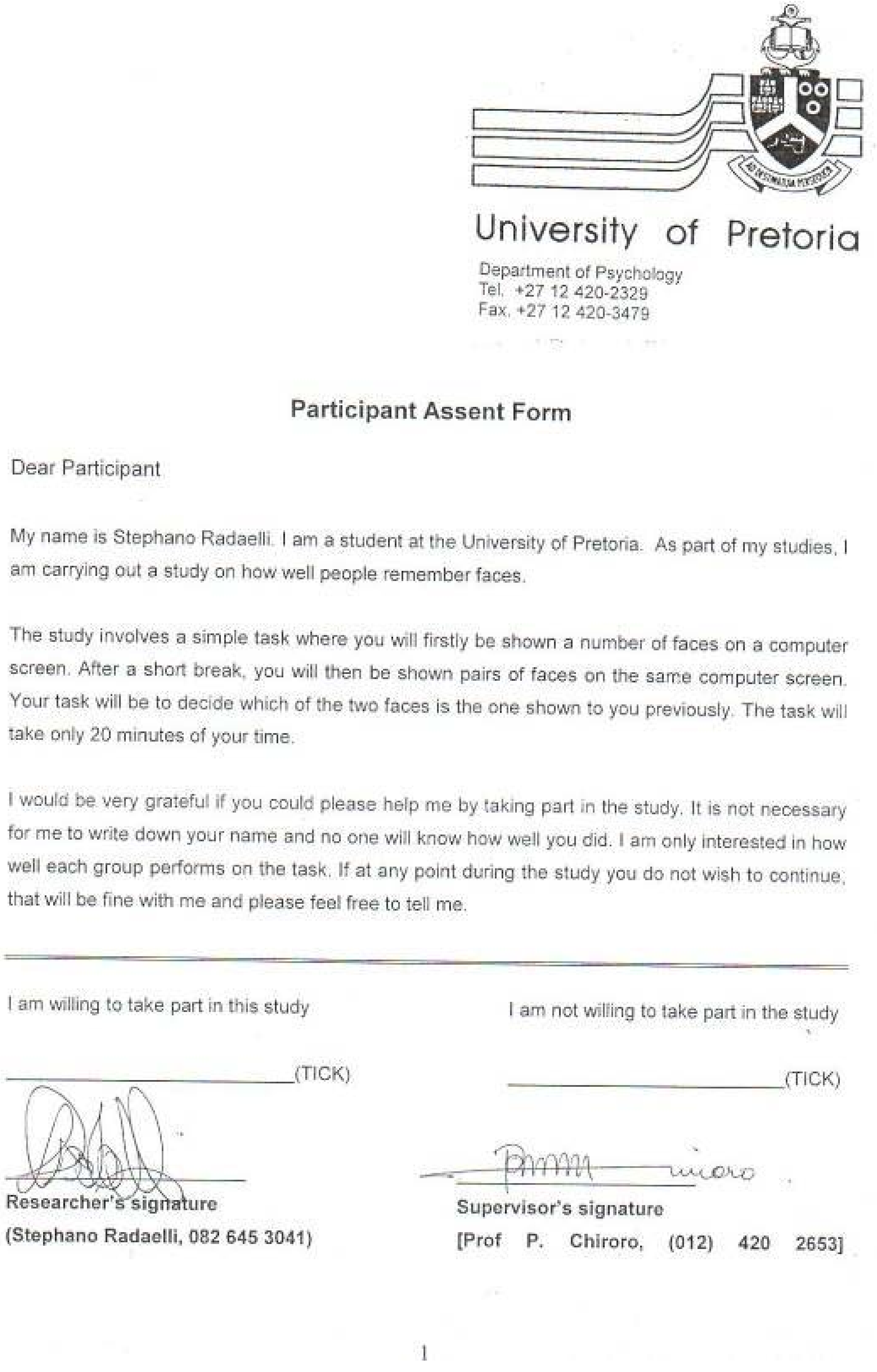
E-Mail: stephrad@excite.com

Supervisor's signature

(Prof P. Chiroro)

Tel: (012) 420 2653

Appendix D



University of Pretoria
Department of Psychology
Tel. +27 12 420-2329
Fax. +27 12 420-3479

Participant Assent Form

Dear Participant

My name is Stephano Radaelli. I am a student at the University of Pretoria. As part of my studies, I am carrying out a study on how well people remember faces.

The study involves a simple task where you will firstly be shown a number of faces on a computer screen. After a short break, you will then be shown pairs of faces on the same computer screen. Your task will be to decide which of the two faces is the one shown to you previously. The task will take only 20 minutes of your time.

I would be very grateful if you could please help me by taking part in the study. It is not necessary for me to write down your name and no one will know how well you did. I am only interested in how well each group performs on the task. If at any point during the study you do not wish to continue, that will be fine with me and please feel free to tell me.

I am willing to take part in this study

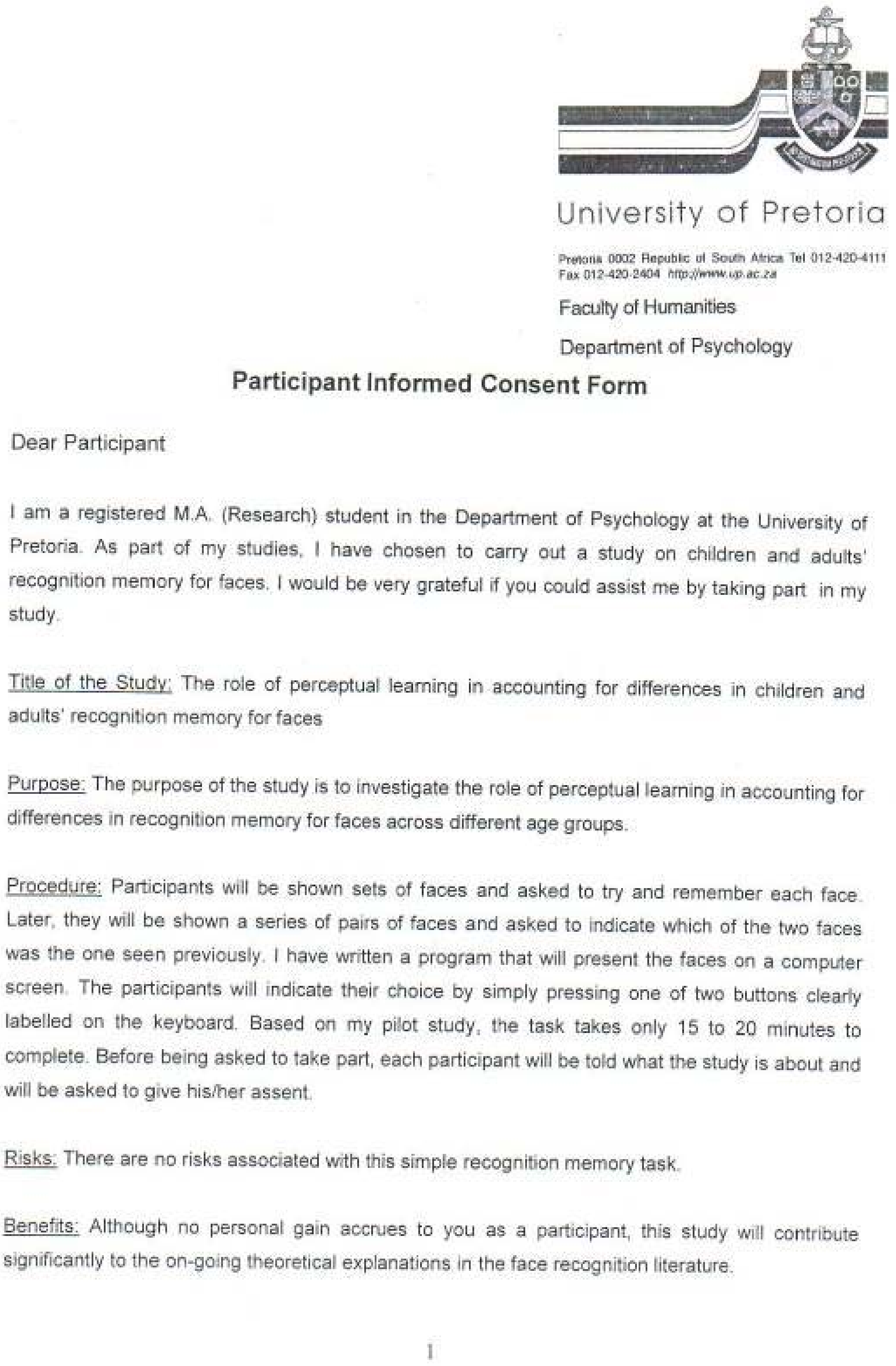
____________________(TICK)

I am not willing to take part in the study

____________________(TICK)

Researcher's signature
(Stephano Radaelli, 082 645 3041)

Supervisor's signature
[Prof P. Chiroro, (012) 420 2653]



University of Pretoria

Pretoria 0002 Republic of South Africa Tel 012-420-4111
Fax 012-420-2404 http://www.up.ac.za

Faculty of Humanities

Department of Psychology

Participant Informed Consent Form

Dear Participant

I am a registered M.A. (Research) student in the Department of Psychology at the University of Pretoria. As part of my studies, I have chosen to carry out a study on children and adults' recognition memory for faces. I would be very grateful if you could assist me by taking part in my study.

Title of the Study: The role of perceptual learning in accounting for differences in children and adults' recognition memory for faces

Purpose: The purpose of the study is to investigate the role of perceptual learning in accounting for differences in recognition memory for faces across different age groups.

Procedure: Participants will be shown sets of faces and asked to try and remember each face. Later, they will be shown a series of pairs of faces and asked to indicate which of the two faces was the one seen previously. I have written a program that will present the faces on a computer screen. The participants will indicate their choice by simply pressing one of two buttons clearly labelled on the keyboard. Based on my pilot study, the task takes only 15 to 20 minutes to complete. Before being asked to take part, each participant will be told what the study is about and will be asked to give his/her assent.

Risks: There are no risks associated with this simple recognition memory task.

Benefits: Although no personal gain accrues to you as a participant, this study will contribute significantly to the on-going theoretical explanations in the face recognition literature.

1

Participants' rights and confidentiality: You will have the right to withdraw at any point during the study with no negative consequences. You also have the right to remain anonymous during the study and that is why no name or personally identifying information will be collected. Your data will be treated confidentially. Should any doubts arise during or after taking part in the study, you have the right of access to the researcher. The researcher's contact details are shown below.

The study has been approved by the Humanities Faculty Research Proposals and Ethics Committee from the University of Pretoria.

I, ______________________________, have read the above and understand the conditions of the study and I give full consent for my child's participation in the study.

________________________ on the ___ day of _____________ 2006 at _______________
Participant's signature

________________________ on the 14 day of August 2006 at Pretoria
Researcher's signature
(Stephano Radaelli)
Tel: 082 645 3041
E-Mail: stephrad@excite.com

____
Supervisor's signature
(Prof P. Chiroro)
Tel: (012) 420 2653

2