The Interaction between Age and Race Composition of School On Cross Race Face Recognition

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ABSTRACT

Stemming directly from research revolving around such phenomena as the cross-race effect and in-group biases, two terms used to describe the discriminatory effect race accounts for when perceiving others, this study examines recognition rates and reaction times on face recognition tasks, by children, on faces of different races. This is studied in conjunction with ideas proposed by the contact hypothesis, where past experience and contact with other races facilitates a reduction in race biases. These effects are looked at with reference to the development of a child, in their first year of primary school and in their the last. Thus the effect of going to a mixed race school on prejudice in white children is explored. It was predicted that contact alone, as well as age with contact, would result in a decrease in cross race effects and that age without contact will result in an increase in cross race effects. The results showed that race composition of the school attended by a child had little effect on cross-race face recognition, with no corresponding decrease in cross-race effect due to contact. The results were however not straight-forward and provided some interesting indications of race bias in South African schools.

Keywords: face recognition; face processing; contact hypothesis; cross-race effect; in-group bias; familiarity; development

Face recognition can be significantly affected by external factors, such as the race of the viewer and the person being viewed, known as the cross race effect. The cross race effect occurs probably because people are more familiar with own-race faces. It is thus interesting to explore face recognition for faces of different races with people who have had high contact with other races and thus have high familiarity with other-race faces. The present study thus looks at the face recognition abilities of children of two different age groups, looking at faces of members of their own race, and members of a different race, and the effect contact has on these measures is assessed.

This study thus intends to answer the following questions: does the contact a child has with other races actually affect their face recognition abilities for members of those other races? And does the age of a child play a role in such race biases? The reason why this study is important is because it combines both age effects and contact effects within a single study. The reason why the combination of effects is important to study is because it allows for the understanding of the current landscape of race biases in South Africa looking at children who are living in different racial settings, with either high contact or low contact with other members of other races. The effects of diminished contact is thus empirically seen. As this is looked at in relation to age differences, a possible window period for race biases and learning faces at these ages is observed. The study thus aims to understand cross race face recognition in South African children across age and contact groups.

It is necessary for a brief summary of some of the most important and interesting studies that have been done in the fields of face recognition and the phenomena of own- and cross-race effects to be explored. This is done in order to investigate the development of face recognition in children, the effect of race on this process, and most importantly to explore how experience might affect this process.

This summary of the theory and the major empirical evidence done in these fields explores cross-race effects and age differences, highlighting possible interactions between race and age effects, both in terms of how these effects may happen and when they happen during development. This research provides an understanding of how race can play a part in the perception of a human face, and thus how children perceive others, and in particular, others of different races. This research also allows for the exploration of how the past experiences and the current context of a child can affect their cognitive abilities (for example: the child's contact with people from other races.) Before one can fully explore the research that has been conducted in these fields, however, some brief definitions must be looked at for some of the key terms used in the research.

Face processing describes the procedure of actually seeing a face and this 'object' being processed in the brain as a face. Experiments in this field have revealed that "our ability to process information about faces is greater than for any other class of visual stimuli" (Johnson & Morton, 1991, pg. 23). Similarly, *face recognition* is the term used to describe this processing *and* the recognition, or recalling from memory, of a face that has been learnt or seen previously.

The *cross-race effect* and *in-group bias* are two terms used to describe the discriminatory effect race accounts for when perceiving others. *Cross-race effect,* in this context, occurs when the rate of recognition for human faces is slower for the processing of other-race faces than of faces of the same race to the viewer (Sangrigoli & de Schonen, 2004). Similarly, *in-group bias* occurs when the rate of recognition is faster for the processing of own-race faces than of faces of a different race to the viewer (Pfeifer, et al., 2007).

The role of past experience with other races has been studied under the rubric of the *contact hypothesis*. This term refers to the idea that under certain conditions contact between various groups will lead to a reduction in the use of stereotypes and prejudice. Conversely, a lack of contact with other races is thought to lead to a higher level of stereotyping and prejudice (Sporer, 2001b). This prejudice can manifest in various ways. In face recognition, in-group bias and cross-race effect can be seen as a form of prejudice, in favour of one's own race and against other races.

Why face recognition and race bias research is important

In empirical studies done within the field of psychology and law, researchers have highlighted the reasons for interest in the field of face recognition and race biases. Stemming directly from eyewitness identification cases, MacLin, MacLin, and Malpass (2001) conducted studies that directly showed which factors involved in face recognition can have drastic effects on the outcome of eyewitness testimony. The factors explored included, amongst others, the race of the viewer and of the 'suspects'. It was seen that race had a particularly significant effect within these experiments and thus within the very real-world situation of eyewitness testimony, where suspects may be convicted of a crime due to other factors such as their race.

These studies begin to give insight into the fact that own-race bias and cross-race effects are real-world phenomena which have vast implications in real-world situations. Thus what is of interest to explore is not simply that these phenomena occur, but how they occur. In so doing, it can be determined what factors may be influencing face recognition and, in particular, race bias in face recognition, and the effect age has on this process. In order for this to be done, a clear summary of the empirical research that has been done on how children learn unknown faces, and the possible interactions between race and age effects, needs to be examined.

Empirical research on face recognition

Face recognition begins from the day we are born. Numerous studies have been done on infants' face recognition, all of which show that infants have strong face recognition abilities. For instance, they take far more interest in an object that is in the configuration of a face than in any other object (Johnson & Morton, 1991, pg. 32). One such empirical study clearly showed that 7 months old infants displayed vast abilities within this task, providing evidence of discrimination and recognition (including evidence of infants' abilities to recognize original faces in different poses) (Fagan, 1976).

Children's initial interest and abilities in face recognition, implies a biological ability to recognize faces, innate in all humans. Conversely much research has shown that this ability is learned through experience (Gauthier & Nelson, 2001). However, it can be viewed that both maturational and experiential factors work within the development of face recognition.

Maturational factors

Much research has been done to explore the development of face recognition in children, from a biological approach, from infancy through to adolescence. Blaney and Winograd (1978) explored this development through the study of face recognition across different age groups, looking specifically at memory. It was found that memory for recognition of faces significantly improved with age. Furthermore, even in matching tasks, where memory is not needed, performance improved dramatically with age (Bruce et al., 2000; De Sonneville et al., 2002).

Similarly, Mondloch, Maurer, and Ahola (2006), found increasing abilities from childhood through adolescence and into adulthood, in noticing subtle differences in the spacing of facial features. It was clearly demonstrated that expertise after age 8 was not shaped by experience but possibly by "general improvements in memory or in perception" (pg. 930).

Further research has been done to explore the performance of different age groups for specific issues within the field of face recognition. In one such study Carey, Diamond, and Woods (1980) assessed the performance of children ranging in age from 6 to 16 years in their abilities to encode unfamiliar faces. Unsurprisingly, they found that performance steadily improved with age.

Carey et al. further showed that younger children use different kinds of information from an unfamiliar face to encode the face, where they encode faces by looking at specific features, as opposed to the entire face. This increase in face recognition abilities is thus not attributed to general information-processing abilities (that develop during the years from 6 to 10 years of age), but rather, the development of the ability to process configurational properties of an unfamiliar face (Carey, Diamond, & Woods, 1980; see also Pedelty, Levine, & Shevell, 1985; Mondloch, Grand, & Maurer, 2002).

This finding regarding children's face recognition 'styles' is however still under debate. Some research has shown that, contrary to findings such as those found by Carey, Diamond and Woods (1980), both adults and children generally use the *same* style of face processing and recognition. Baenninger (1994), found that young children can, in fact, ignore featural information if it has no discriminatory value, and furthermore, that people of all ages actually rely more on information about the configuration of the face than on information about the features within the face, regardless of age. Although these findings do provide support for a similar style of processing throughout development, the debate remains without a definitive answer.

Although some questions remain under debate, these empirical studies have shown that it is undeniable that maturational factors, at a biological level, play a huge role in face recognition where the social experiences of the child are not the only important factor contributing to children's abilities in these tasks. There are, however, many empirical studies that explore precisely this assumption.

Experiential factors

One such study involves the examination of how early experience affects a child's recognition of facial displays of emotion (Pollak & Sinha, 2002). The performance of physically abused children, who presumably had experienced many situations involving threats and aggression by others, was compared to that of a non-abused control group on their ability to recognize expressions of anger. The abused children performed significantly better, indicating that the past experiences of the child significantly affected their later cognitive abilities.

Now that a brief outline of the literature on face recognition has been explored, bringing to light the possible role of various important factors (such as biological developments, familiarity and experience), the literature on race perception, race perception in children and thus the phenomena of race biases will be examined.

Empirical research on race biases

There is much consensus to the fact that race biases are reliable and robust phenomena: the cross race effect is found repeatedly in studies which use a variety of procedures and materials in face recognition tasks (Bothwell, Brigham, & Malpass, 1989; Meissner & Brigham, 2001; Shapiro & Penrod, 1986; Chance & Goldstein, 1996; Valentine, Chiroro, & Dixon, 1995; Wright, Boyd & Tredoux, 2001; Sporer, 2001). The findings throughout these studies have repeatedly shown that people find it far easier to recognize people of their own race as opposed to people of another race. Furthermore these findings have been repeatedly found across ethnic groups, which means that "one can reject the assumption that faces from any one race are intrinsically less discriminable than those of another race" (Sangrigoli & de Schonen, 2004, pg. 1220).

In a meta-analytic review of 39 research articles in the field of own-race bias, Meissner and Brigham (2001) found that 15% of the variance in discrimination accuracy is accounted for solely by own-race bias. They also found that own-race faces yielded a significantly lower proportion of false alarms compared to other-race faces, where one 'recognizes' a face that one has, in fact, never encountered before. Thus suspects in line-ups will more likely be falsely accused if they are a different race to the viewer.

Within the field of race biases there are many empirical studies on these biases from outside of the face recognition field, all of which provide evidence for the fact that the race of the people being perceived has a direct result on the evaluation made by the subject. Included in this research are studies done on children and the difference in age levels by Pfeifer, et al. (2007). This research highlights that negative evaluations of other races increases with age. Furthermore, studies by Black-Gutman and Hickson (1996) have shown that the environment in addition to cognitive factors have a significant influence on the development of prejudice.

In a review of both the literature and theory in the field of face recognition and the cross-race effect, Siegfried Sporer (2001), reiterates the robust nature of race biases. He does however bring attention to the fact that most of these studies are laboratory experiments and are thus severely artificial (Sporer, 2001a). His research highlights that there is a tendency in humans to respond less cautiously with respect to other-race faces (as one might expect) and most importantly, that these biases occur most frequently among groups that have low contact with other groups (Sporer, 2001b). This support for the contact hypothesis is of most interest.

As seen in the discussion of experiential factors that affect face recognition in general, it follows that experience with other faces, facilitates cross-race recognition abilities (as stated by the contact hypothesis). Under the contact hypothesis the cross race effect is a direct reflection of the amount of contact a person has had with people from other races. The empirical studies specifically exploring the contact hypothesis have provided some strong evidence as to the validity of this hypothesis. Increased contact with people of another race has lead to improved abilities in recognizing and discriminating faces of people of this other race, thus decreasing the extent of the cross-race effect (Carroo, 1986; Chiroro & Valentine, 1995; Lavrakas, Buri, & Mayzner, 1976).

These findings revolving around the reasons for race biases and the contact hypothesis are, however, inconclusive. Some research has shown that, contrary to such findings, clear support is seldom seen for the possible reasons for race effects, and that, more specifically, the evidence for the contact hypothesis in terms of individuals' performance on face recognition is sporadic (Maclin and Malpass (2001). Researchers have thus explore the differential experience hypothesis, which suggests that the ability to recognize faces of other races is not a function of the contact an individual has with members of other races, but rather a function of the quality of the contact, and a need to individualize the members of that race (ibid).

In summary, although there is a vast amount of literature in both the fields of face recognition and race-biases, there is little that deals with these two fields, *combined*, within the area of the development of children. One empirical study that does this will be discussed in order to highlight the importance of such studies.

Face recognition and race biases in the development of children

Chance, Turner, and Goldstein (1982) researched race biases across subjects ranging from 6 to 20 years of age. Youngest children recognized both own- and other-race faces equally well, whereas older children recognized own-race faces far better than other-race faces. This supports the hypothesis that over time, in the development of children, memory schemas that are involved in face processing become more effective for familiar faces and less effective for unfamiliar faces. Furthermore, as own-race faces are generally more familiar than other-race faces, this study supports the hypothesis that these memory schemas develop more effectively for own-race faces. These findings hold particular significance because if experience and age make a difference to race bias, it would be of most importance to expose children to other races as early as possible.

Thus, although research that has been done within the fields of face recognition and of race biases clearly shows how common and persistent the phenomena of cross-race effect and own-race bias are, there are very important nuances that need to be explored, and irregularities that need to be resolved. Included in this is research that has been done in the field of the contact hypothesis which has produced irregular results. Furthermore, although this review sampled a vast range of the research that has been done in these fields, it can be seen that studies that combine both fields with their interactions with age effects are few and far between. Most importantly, research that investigates age effects does not include studies that investigate measured contact with other races, and similarly research that investigates measured contact with other races does not investigate the effect age may play in the research.

The Present Study

The present study aimed to examine children’s face recognition abilities, for two different age groups, and taking a measure of the contact with other races that the children have, both age effects and contact effects were explored as factors affecting race-biases.

The particular cognitive ability, face recognition, was assessed because it can be seen as a manifested measure of prejudice against other races and in favour of one's own race (Blaney and Winograd, 1978; Mondloch, Maurer, and Ahola, 2006).

Specifically, the present study aimed to examine the contribution of three factors to face recognition: (a) age over two age groups (6-7, and 12-13 years); (b) in-group bias and (c) cross-race contact.

There are thus three hypotheses that were investigated. Firstly, the more contact with another race a child has had in the past and has currently, will result in diminished race biases in face recognition. Secondly, in children who have a substantial amount of contact with another race, the older the child is, the less race biased they should present, as they have had many more years of contact and exposure to faces of this other race. Lastly, in children who have little to no contact with another race, the age of the child will have a slight effect on the child's race bias in face recognition, where older children may have more biased reactions.

To test these hypotheses a quasi-experiment was conducted. Using a within-subjects design, children from two different schools in the Western Cape were tested on their face recognition performance for faces of their own race and faces of a different race. This study thus allows comparisons to be done that show the different performances across age groups and contact groups.

METHODS

Design

This study used a 2 X 2 X 2 design in which the factors were: contact with other races (high contact vs. low contact), age (6-7 years old and 12-13 years old), and the race of the stimulus face (own vs. other – this was a repeated measures factor). As all the subjects used in the analyses were White the third factor can also be defined as the race of the face being presented (black vs. white). The mean decision reaction times as well as the recognition rate served as the dependent variables. The race of the children was kept constant by sampling only White children.

The recognition rates were calculated by looking at the average number of true hits that occurred, where the average number of original photographs the participants correctly recognized for each race group (own or other) was calculated, and the average number of false alarms that occurred, where the child said they recognized a face they was not actually shown to them. These rates were looked at with methods proposed by signal detection theory.

The contact group that the individual subject falls within was determined through the composition of the school they attend. This composition was assessed by measuring the ratio of different races in the school.

Participants

A total of 37 children from two different age groups and from two different contact groups were tested on their face recognition abilities (n=37). The children came from 2 different schools, differing on the composition of the school in terms of the race of the students and the teachers. The high-contact school was made up of 50% white children, 25% Black children and 25% Coloured children. The low-contact school comprised only White children and teachers. Both schools are in the Western Cape, and are both from very similar SES levels.

After receiving permission from the headmasters for this study to be done in each school, parent consent forms were handed out to all the children who were interested in taking part in the study. (See Appendix A for the parent consent form used.) The children in the 6-7 age group all came from grade 1 classes and the children in the 12-13 age group all came from grade 7 classes. All children who volunteered and brought back the parent consent forms were tested. Verbal assent was received from the children in grade 1 and written assent was received from the children in grade 7 prior to the study being conducted. (See Appendix B for the written assent form used.)

In the high contact school, 20 children were tested, 11 of the children were from grade 1 and 9 from grade 7. The participants in the high-contact school were comprised of both White and Coloured children. For the purposes of the specific hypotheses that were being looked at, the Coloured participants' data will not be looked at. Thus, for this study, there were 7 White participants in grade 1 (4 of which were male) and 6 White participants in grade 7 (4 of which were male), which were included. In the low contact school, 17 children were tested, 10 from grade 1 (4 of which were male) and 7 from grade 7 (2 of which were male), all of which were White.

Table 1

Number of children in each group

	Male	Female	Total
young, low contact group	4	6	10
old, low contact group	2	5	7
young, high contact group	4	4	8
old, high contact group	3	3	6

Materials and apparatus

The stimuli consisted of 48 high-quality portrait photographs of men, ranging in age from 18-24, half of which were White and the other half Black. The photographs came from the University of Cape Town's databases of faces, where the subjects stood facing the camera, all with neutral facial expressions. All the faces were roughly the same size and were chosen as they had no discerning features such as glasses or facial hair. (See Appendix C for samples of the photographs used.)

The original set of 30 photographs that were shown to the children to be learnt (target photographs), were all in black and white. The extended set of 48 photographs, including both the 30 learnt target faces and 18 new, never-before-seen faces (distractor photographs), that were shown later during the recognition task, were all in colour. This was done to ensure that the subjects engaged in face recognition as opposed to picture recognition. The target photographs were displayed one after the other, for 4 seconds, interspersed with a fixation point for one second, on the screen of a laptop that was placed on the desk that the child was sitting at. The reason for this duration of target photographs is that after 5 seconds it is theorized that recognition rate is at 100 %, and thus there would be less differences in performances.

Between presentation of the target faces and the recognition task, a distractor task was given to the children, to prevent rehearsal of the faces. This task involved having to copy a Rey-Osterrieth complex figure, and derivations of the figure. (See Appendix D for samples of the figures used.) The younger children all had to copy the same 3 figures that were adjusted to be quite simple, yet still challenging for the child. The older children had to copy the original Rey-Osterrieth complex figure, and two other figures which were slightly more complicated than those given to the younger children.

In order to measure the actual reaction time for recognition on each face, the computer recorded the amount of time it took from the presentation of a face to the time a button was pressed on the keyboard. The sequential photographic lineup of the extended set was presented one at a time on the screen. The left shift button was pressed by the experimenter if the child responded “yes” to the question of recognition of the presented face, and the right shift button was pressed if the child responded “no” to the question of recognition of the presented face. The measure was thus taken from the instant the photograph was displayed to the instant the child gave a response. Although the experimenter pressed the button, and thus error is introduced, the error remained constant across groups, as the same experimenter collected all the data. This was recorded along with other demographic information (age, sex and race) that was inputted into the computer at the beginning of each session.

Procedure

Each participant was tested individually. Each child participated in 3 sessions (on 3 different days), each about 8 minutes long. The order of these sessions was randomized, so that order effects were erased. Each session consisted of 10 of the target photographs, and similarly, 16 of the respective extended set of photographs (including the 10 target photographs and the 6 distractor photographs.)

At each of the two schools, the study was conducted in a quiet room, separate to the other children. In the room there was a long desk with two chairs facing it. The researcher occupied the one seat. When the participant entered the room, they were offered the other seat. In front of the participant, on the desk, there was a laptop computer. In the first session, the researcher, sitting next to the child, introduced herself to the child and gave brief instructions to the child.

In order to make the child feel less nervous about what they had to do, this began by first asking the child what they had just been doing and whether they knew anything about what the study was about. Then a few questions were asked to ascertain the child's personal details, such as their name and their age. The participants were then told that if at any point they no longer feel like they wanted to continue will the tasks, they were free to say so, and they could stop. This was followed, lastly, by a description of what it was the child would have to do.

It was explained that a black screen would appear, with a small red dot on it, which the child should look at. It was then explained that the computer would show them some faces one after another and that they should simply concentrate on the faces and try to remember them as best they could. It was stated that the computer might go quite quickly so they must not worry, simply sit and focus on the faces as best as they can.

They were then asked if they were ready. If they were, the sequential presentation began. This began with a black screen and small red dot in the middle (for the child to focus on, as this would be where the face would pop up), then the presentation of the target photographs was displayed, one at a time, on the screen. Each face was displayed for 4 seconds with a 1 second gap in between, during which the black screen and red dot was displayed.

The participant was shown 10 photographs of faces (the target photographs) one after the other. This included 5 White faces and 5 Black faces, i.e. 5 faces of the same race as the child and 5 faces of a different race to the child. The presentation ended and the laptop was moved to the side

The child was then given a blank sheet of A4 paper and was given either a box of crayons (for the grade 1s) or a box of pencil crayons (for the grade 7s) and asked to pick any colour. They where then told that they would be shown a picture and that they should try and copy the picture as best they could. They were further told that the picture may be quite complicated, but they only have 2 minutes, so they needn't try to make their copy perfect, just as close to the original picture as possible. The Rey-Osterrieth complex figure or one of the variations were then presented to them on A4 piece of paper.

After this was complete, the pictures were put to the side and the laptop was once again put in front of the child. After inputting the participant number again, the participant was then told that the same black screen would be shown, with the red dot that they should focus on. They were then instructed that the computer would show them some more faces, one at a time, some of which were new, and some of which had already been shown to them earlier. They were told that they should shout out whether they recognize each face as one of the faces they was shown to them earlier or whether they did not recognize this face. They were once again reminded to shout "yes" if they had seen the face before and "no" if they had never seen the face before. Lastly they were informed that if they did not know they should guess as best they could.

The participants were then shown the extended set of 16 photographs that included both the 10 original target photographs and 6 distractor photographs, one after the other. The 6 distractor photographs were made up of 3 White faces and 3 Black faces. For each photograph the participant shouted out 'yes' or 'no' as an indication of whether the face that they are looking at is in fact one that they have seen previously (was in the original set). The reaction times for each photograph was recorded by the computer. Once all 16 photographs had been seen by the participant, they were thanked, told they did a good job and asked whether they wouldn't mind doing this again. All the children said they would want to do it again. The child then left the room and called the next participant.

The next two sessions were conducted with the exact same procedure. The participants were reminded of all the instructions, using roughly the same wording every time, at the beginning of each session. They were informed that although they would be doing the same thing, that today they did not have to remember anything from the time before, because today there was a whole new set of faces to try and remember.

DATA ANALYSIS

The current research involved the study of performance on face recognition with respect to 3 independent variables, namely, contact with other races (high contact vs. low contact), age (6-7 and 12-13), and the relationship between the race of the subject and the race of the face being presented (own/other). As all the subjects used in the analyses were White the third independent variable was the race of the face being presented to the participant (black or white). The general aim of the analyses that follow, therefore, was to examine the differences in performance for white and black faces on the basis of age and contact for evidence of cross-race effects. This was done by looking at reaction times and recognition rates. The recognition rates were examined using methods proposed by Signal Detection Theory. SDT examines the decision making process that someone goes through when they must make a decision between options (such as 'seen' or 'not seen before') and examines any possible response bias (to favor a particular response) the subject may be presenting. In SDT the subject's accuracy or sensitivity (seen in the d' statistic) is deciphered from their possible bias (seen in the β statistic). SDT and the d' and β statistics is used to examine rates because looking at the true hits alone would not account for guessing, and so children who guessed and answered yes to all questions of recognition are not seen as more accurate.

Recognition sensitivity (d') is calculated by looking at the standardized difference between the average true hit rate and false alarm rate for each participant. A d' score of 0 or less indicates that the participant had no idea whether the face was actually seen before. A d' score of 1 indicates that the participant was in fact accurate, and guessed rarely.

Response strategy or response bias (β), independent of recognition sensitivity, is determined by looking at the ratio between yes responses or no responses on true hit and false alarms, the extent to which one response is more probable than another. A β score of 1 indicates no bias towards favoring yes or favoring no as a response. A β score of less than 1 indicates a response bias in favour of answering 'yes' to all questions, whereas a β score of more than 1 indicates a response bias in favour of answering 'no' to all questions.

The descriptive statistics for each independent variable (as seen in Table 2. below) is important in understanding the general landscape of the children's performances, where the differences lie, and most importantly, how the variables of age and contact had an impact of recognition reaction time. The analyses will thus explore the mean reaction times for each group (young and old children in high contact and young and old children in low contact), calculated for both the white face and black face, as well as accuracy of face recognition (seen in the d' scores, where a score of 1 indicates a high probability of true recognition when guessing is factored out, and a score of 0 indicates a zero probability of true recognition, but rather that the subject guessed throughout the task) and recognition strategy (seen in the β scores, where a score higher than 1 indicates that the subject answered 'no' to all questions of recognition, and a score lower than 1 indicates that the subject answered 'yes' to all questions).

Table 2.

Mean results for reaction times and recognition rates in each group.

	High contact Young children	High contact Old children	Low contact Young children	Low contact Old children
Mean reaction time for black faces (in milliseconds)	2016.497 (1.105)	1682.971 (1.122)	2171.328 (1.094)	1469.486 (1.113)
Mean reaction time for white faces (in milliseconds)	1857.268 (1.096)	1666.602 (1.112)	2296.977 (1.086)	1443.557 (1.103)
Mean d' for black faces	0.876 (0.448)	1.279 (0.518)	0.481 (0.401)	1.887 (0.479)
Mean d' for white faces	2.081 (0.681)	1.635 (0.786)	1.921 (0.609)	1.947 (0.728)
Mean B for black faces	0.585 (0.792)	2.216 (0.915)	0.17 (0.709)	1.787 (0.847)
Mean B for white faces	-0.212 (0.982)	1.666 (0.134)	2.88 (0.88)	1.676 (0.878)

As more than one independent variable was used in this study, repeated-measures 3-way-factorial analysis of variance (ANOVA) was performed on the data in order to explore the differences in the recognition reaction times and rates (accuracy and strategy). All analyses included 2 between-subjects factors (age and contact) and 1 within-subjects factor (race of face, which had 2 levels, black faces and white faces).

Reaction Times

The natural logarithms of the reaction times were taken in order to normalize the data. A repeated-measures 3-way factorial ANOVA was conducted on the reaction times of all subjects. The general predictions being tested were that White children will react faster to faces of White people than faces of Black people, and that age and contact group will reduce the difference in performance across races.

As we were looking specifically at cross-race effects, two-way interactions between age and race of face and between contact and race of face were examined, as well as a three-way interaction between age, contact and race of face. The analyses performed showed that age had a significant effect on face recognition abilities $F(1, 27) = 7.77$, $p < 0.0096$, with the older children doing significantly better. Furthermore, it was seen that there was a significant two-way interaction between age and contact, $F(1, 27) = 0.02$, $p < 0.02$, where post hoc comparisons specifically showed that the older children in the low contact school did significantly better than the young children in the low contact school, $p < 0.0033$, which remained significant even after Bonferroni corrections were made. Interestingly the children in the high contact school performed statistically similar for both age groups.

Unfortunately no significant two-way interactions were found between age and the race of the face being shown ($F(1, 27) = 0.042$, $p < 0.84$) or contact and the race of the face being shown($F(1, 27) = 1.24$, $p < 0.275$). This means that age and contact group did not have a significant effect on reaction times in terms of the differences between performance on white faces versus black faces.

What is of interest, although statistically insignificant, is that the interaction between contact groups and race of face showed that the low contact group (both young and old grouped together) reacted slightly quicker for black faces and slightly slower for white faces than the high contact group children (a result contradicting the predictions). This interaction can be seen in figure 1 below.

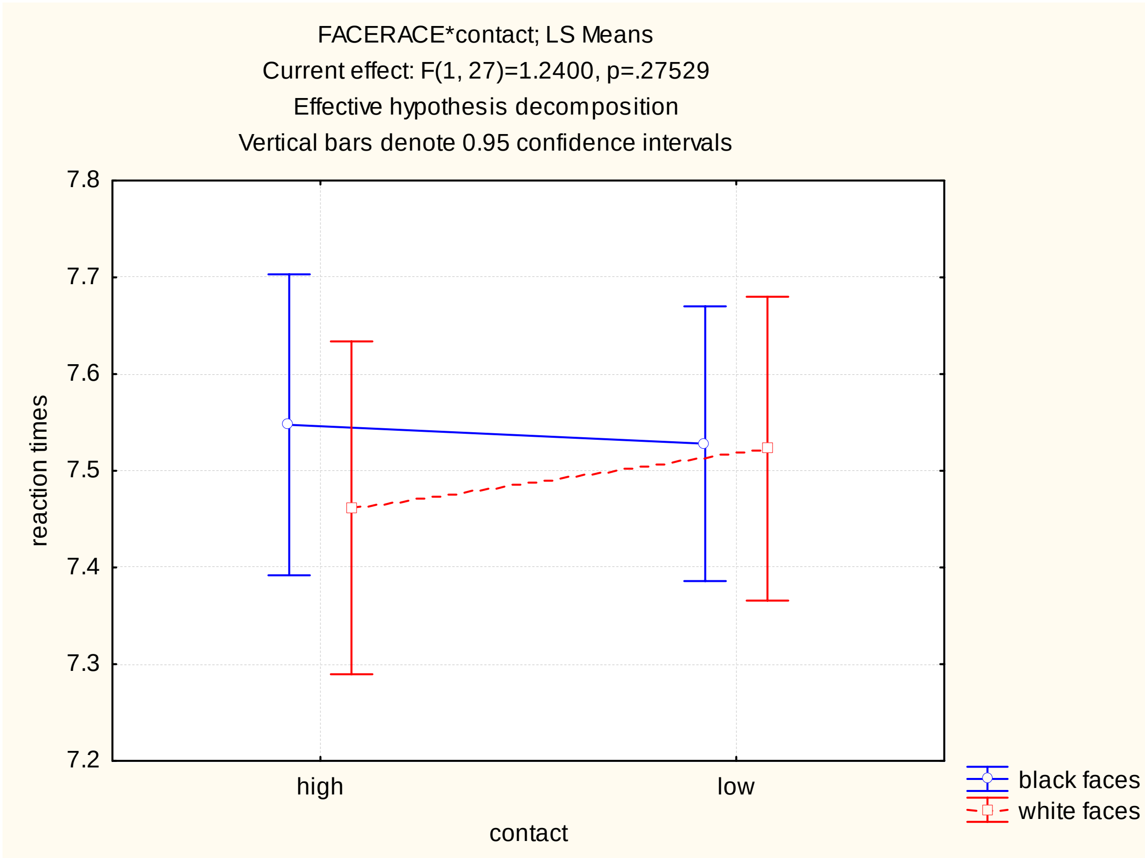

Figure 1. Cell mean plot to show the mean reaction times across contact groups for black and white faces.

Lastly, if we look at the three-way interaction (seen in figure 2. below.), which overall in not significant (F (1, 27) = 0.15, p < 0.702), we can see that reaction times were statistically similar for black and white faces by all groups. This three-way interaction can be seen in figure 2. below. This is also seen in the fact that the main effect of race of face (although in keeping with the predicted pattern of performance, where reaction times for black faces were slightly slower than for white faces, as seen in figure 3. below), was insignificant (F (1, 27) = 1.58, p < 0.2195).

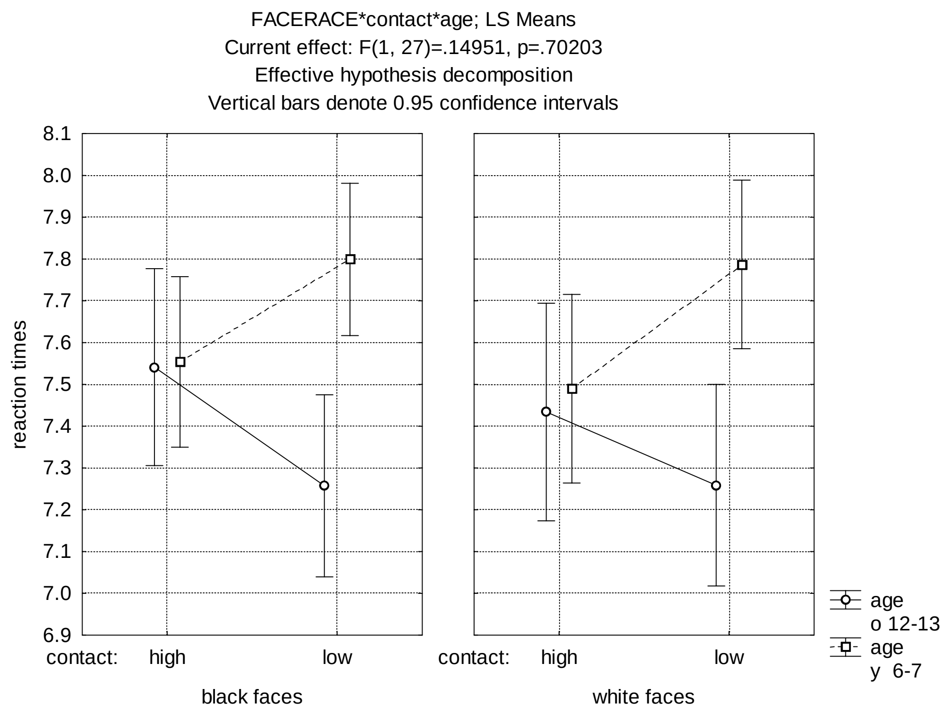

Figure 2. Cell mean plots to show the mean reaction times for both contact groups and both age groups for black and white faces.

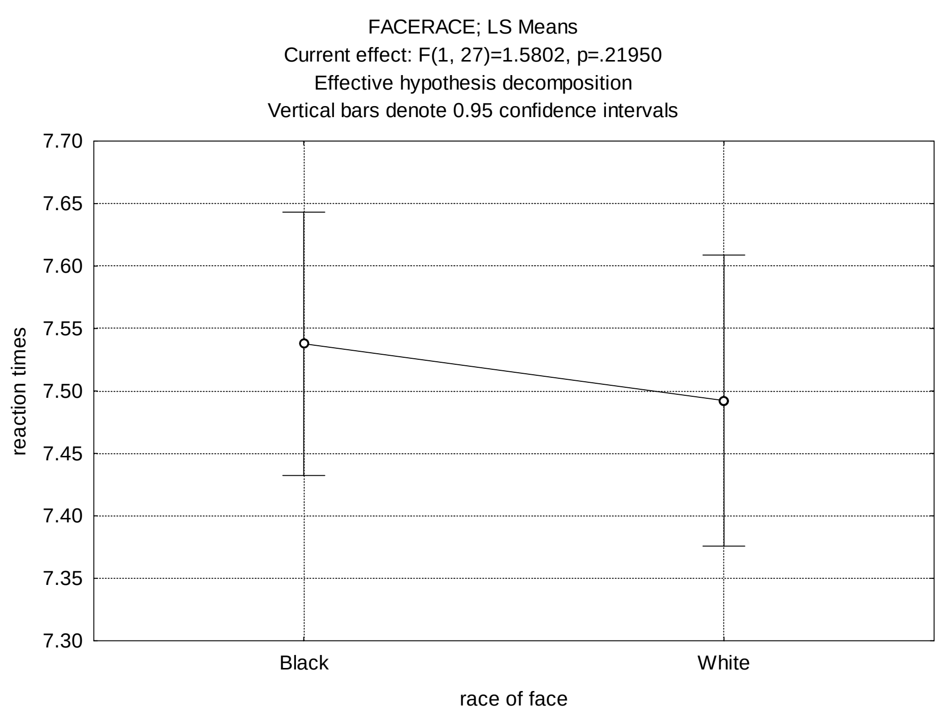

Figure 3. Cell mean plot to show the mean reaction times for black and white faces for all contact groups and age groups together.

Reaction Rates, d prime (d' - recognition accuracy)

A repeated-measures 3-way factorial ANOVA was conducted on the d' scores of all participants, a measure which combines true hits and false alarms into a single measure of accuracy. It was predicted that, in keeping with cross-race effect research, subjects would be less accurate, making more guesses for recognizing faces of another race.

As we were looking specifically at cross-race effects, two-way interactions between age and race of face and between contact and race of face were examined, as well as a three-way interaction between age, contact and race of face.

The one effect that was statistically significant in the analysis of the d' scores was the race of the face being shown to the subject, $F(1.27) = 5.047$, $p < 0.03$. Here it is seen that in general all subjects (for both age and contact groups) were far more accurate for white faces (mean d' = 1.896, std. dev. = 0.352), than for black faces (mean d' = 1.131, std. dev. = 0.232). Furthermore there were no significant two-way interaction effects for race of face and contact ($F(1, 27) = 0.002$, $p < 0.965$) or race of face and age ($F(1, 27) = 2.675$, $p < 0.114$). This means that recognition accuracy for black faces was statistically no worse by younger children or children in the low contact school. Although no other effects and interactions were significant, the interaction between race of face and age was interesting.

Firstly it must be noted that although the analyses performed showed that older children generally guessed less (for both white and black faces) than younger children, this was not statistically significant $F(1.27) = 0.503$, $p < 0.484$, meaning that statistically older children (mean d' score = 1.687, std dev. = 0.372) guessed as much as younger children (mean d' score = 1.34, std dev. = 0.317).

The two-way interaction between race of face and age (seen in figure 4. below)was not significant, $F(1.27) = 2.675$, $p < 0.114$, however examination of the average d' scores shows that there was a *significantly* larger discrepancy between white face recognition accuracy (mean d' score = 2.001, std dev. = 0.457) and black face recognition accuracy (mean d' score = 0.679, std dev. = 0.301) with younger children (post hoc comparisons showed that this difference was significant, $p < 0.0253$), however older children performed statistically similar for white and black face recognition accuracy (post hoc comparisons showed that these amounts were statistically similar, $p < 0.981$).

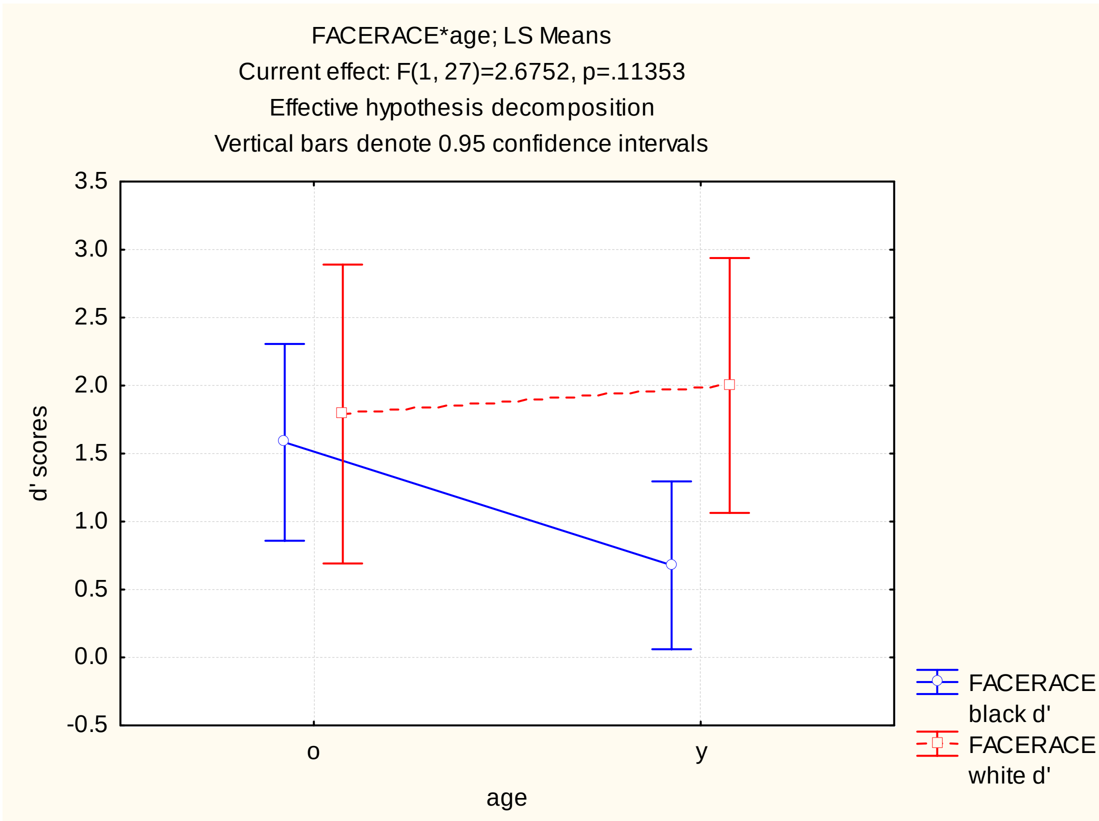

Figure 4. Cell mean plot to show the mean d' scores across age groups.

Lastly, the three-way interaction on d' scores was examined. Once again, although this interaction effect was not significant (F (1, 27) = 0.152, $p < 0.\ 6998$), it provides some interesting indications of the patterns of performances (as seen in figure 5. below). Here it can be seen that although all groups performed more accurately for white faces (as discussed earlier for the significant 'race of face' main effect), younger children from the low contact school performed four times better for white faces (mean d' score = 1.921, std dev. = 0.609) than for black faces (mean d' score = 0.481, std dev. = 0.401), whereas younger children from the high contact school performed only two times better for white faces (mean d' score = 2.08, std dev. = 0.68) than for black faces (0.876, std dev. 0.448).

Specifically, it can be seen that in the high contact group, the older children obtained similar scores on black and white faces (mean d' for black faces = 1.279, std dev. = 0.52, mean d' for white faces = 1.635, std dev. = 0.79), whereas the younger children obtained much lower scores for black faces than white faces (mean d' for black faces = 0.876, std dev. = 0.45, mean d' for white faces = 2.081, std dev. = 0.68). Similarly, in the low contact group, the older children obtained similar scores on black and white faces (mean d' for black faces = 1.887, std dev. = 0.7, mean d' for white faces = 1.947, std dev. = 0.73), whereas the younger children obtained much lower scores for black faces than white faces (mean d' for black faces = 0.481, std dev. = 0.4, mean d' for white faces = 1.921, std dev. = 0.61).

Most importantly this three-way interaction shows that for black faces, older children from the low contact school were actually more accurate than older children from the high contact school (whereas younger children from the low contact school performed less accurately than younger children from the high contact school).

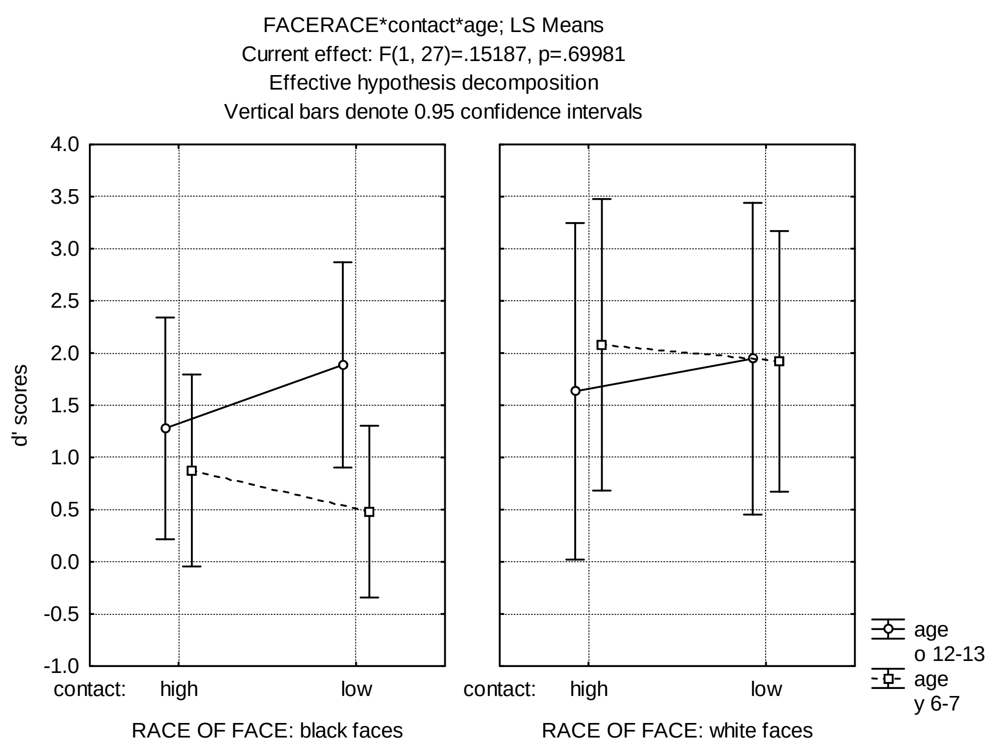

Figure 5. Cell mean plots to show the mean d' scores for both contact groups and both age groups for black and white faces.

Reaction Rates, Beta (ß - recognition strategy/ possible response bias)

A repeated-measures 3-way factorial ANOVA was conducted on the ß scores of all subjects, a measure which combines true hits and false alarms rates and the probability a certain response, into a single measure of bias. It was predicted that, in keeping with cross-race effect research, subjects would be less bias, being more accurate, for recognizing faces of their race.

Low contact children were generally more biased in their responses (for both white and black faces together) showing a bias in favour of answering 'no' more often, showing a more conservative strategy to answering (with a mean ß score of 1.628, std dev. =0. 439, compared to the high contact mean ß score of 1.064, std dev. = 0.481). This main effect was, however, not significant, $F\ (1, 27) = 0.752$, $p < 0.394$. Similarly older children were generally more biased in their responses (for both white and black faces together), showing a bias in favour of answering 'no' more often (with a mean ß score of 1.836,std dev. = 0.495, compared to the younger group mean ß score of 0.855, std dev. = 0.422). However this main effect was also not significant, $F\ (1, 27) = 2.273$, $p < 0.1433$.

A main effect that is of interest is the within-subjects factor; race of face shown. In keeping with cross-race effect research it was predicted that participants would show far less bias (either by favoring 'yes' or 'no') for white faces, however the analysis showed the opposite, with a black faces mean ß score = 1.1896 (std dev. = 0.4096) and a white faces mean ß score = 1.5023 (std dev. = 0.508), which means that participants actually showed more bias (in favoring a 'no' response) for white faces. This means that although participants still favoured answering 'no' for all faces, this was less for black faces, with almost zero bias (0.1890 more than neutral). This main effect was, however, not significant ($F\ (1, 27) = 0.229$, $p < 0.6364$).

The 2- way interaction effect between age and contact also provided some interesting results (as seen in figure 6. below). This interaction, although not significant ($F\ (1.27) = 1.414$, $p < 0.2448$), showed that younger children from the low contact school were generally (for both black and white faces) more likely to be biased towards answering 'no' (mean ß score = 1.5, std dev. = 0.563) than younger children from the high contact school, who were more biased towards answering 'yes' (mean ß score = 0.1866, std dev. = 0.629).

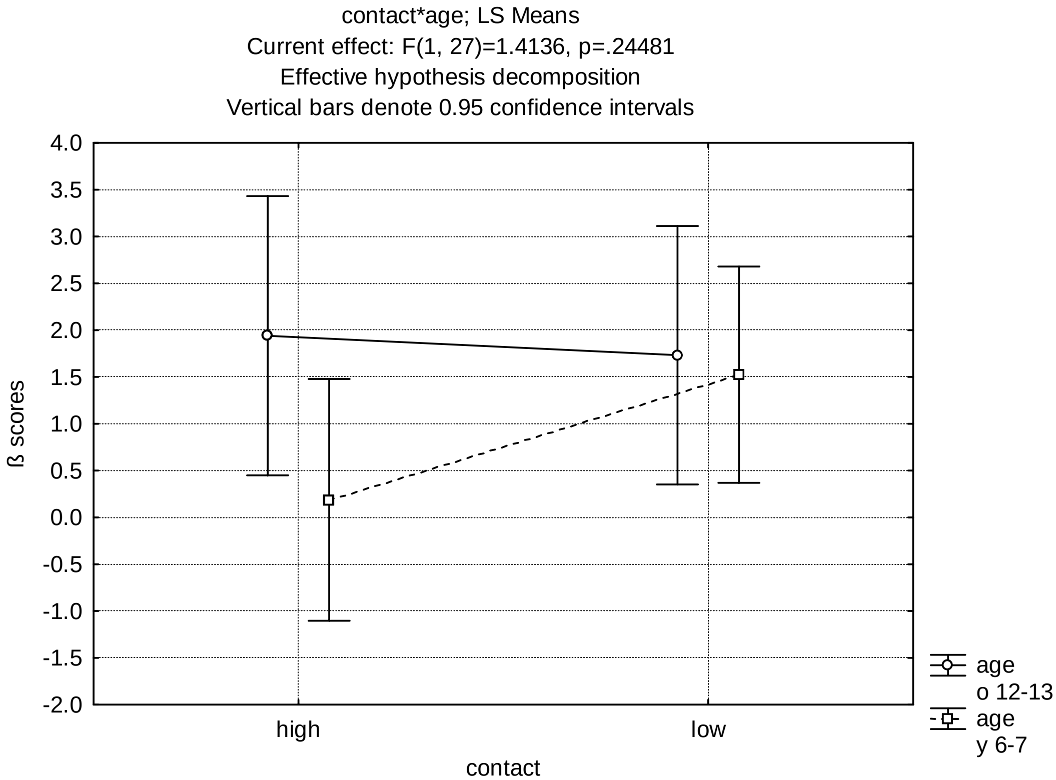

Figure 6. Cell mean plot to show the mean β scores for both contact groups and both age groups for all faces.

If this is further broken down, by looking at the 3-way interaction effect between age, contact and race of face, the young children's performance is made clearer (as seen in the graph below). Here it can be seen that if their performance is separated into white face recognition and black face recognition, the younger children at both the high and low contact schools were similarly biased for black faces (favouring the 'yes' response) and this similar bias is present in the high contact children's performance on white faces (mean ß score = 0.585 (0.792), 0.1698 (0.709), and -0.212 (0.982) respectively). The difference is seen in the low contact children's performance on white faces. On this recognition the children favoured a 'no' response that was more than twice as biased as any of the other groups on either type of face (mean ß score = 2.879, std dev. = 0.878).

Even though this 3-way interaction effect is not significant (F (1, 27) = 1.3753, $p <$ 0.2511), the findings do help to understand the data better.

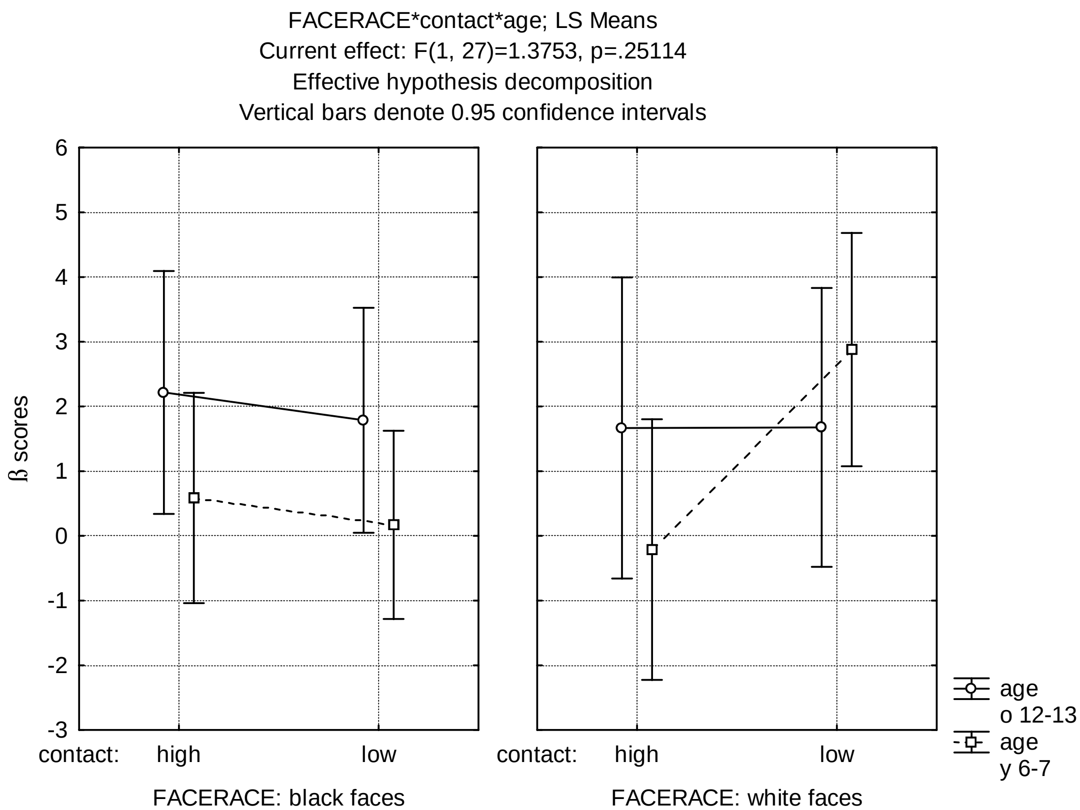

Figure 7. Cell mean plots to show the mean β scores for both contact groups and both age groups for black and white faces.

DISCUSSION

The purpose of this study was to address whether going to a school with a mixed composition of different races (thus allowing for a high amount of contact between races), is associated with a decrease in children's cross-race bias. This was looked at for two age groups, children in their first year of primary school and children in their last year of primary school.

By assessing the age-related changes in children's face recognition abilities over the two age groups (6-7, and 12-13 years); assessing the age-related changes in White children's racial attitudes (cross-race prejudice and in-group bias) toward one other racial group (Black South Africans) over the two age groups; and assessing the contact-related changes in White children's racial attitudes over the two age groups, three hypotheses that were investigated. Firstly, the more contact with another race a child has had in the past and has currently, will result in diminished race biases in face recognition (the contact hypothesis. Secondly, in children who have a substantial amount of contact with another race, the older the child is, the less race biases they should present, as they have had many more years of contact and exposure to faces of this other race. And Finally, in children who have little to no contact with another race, the age of the child will have a slight effect on the child's race biases in face recognition, where older children may have more biased reactions.

It is important to state from the beginning that due to small sample size, few main or interaction effects were significant, however these results show clear indications of what the patterns of performances were. The primary findings suggest that the effects of age and contact are not as clear as one might assume from the literature.

The Effect of Race of Face

Firstly, we found that the race of the face had only a slight effect on the reaction times of all the children grouped together. Although it was seen that black faces took slightly longer to process than white faces, the fact that this different was so small (and thus non significant) is important to examine, as it contradicts almost all findings presented in race bias research. (Bothwell, Brigham, & Malpass, 1989; Meissner & Brigham, 2001; Shapiro & Penrod, 1986; Chance & Goldstein, 1996; Valentine, Chiroro, & Dixon, 1995). However, when the children's performances were assessed for recognition accuracy, it was seen that the race of face factor was significant, with all the children performing significantly more accurately for white faces than for black faces. If the children in the study were confused when attempting to recognize certain faces, it is plausible that they just gave up sooner, and so guessed quicker. For this reason recognition accuracy may be a far more appropriate measure of performance of face recognition tasks than the time it takes children to react.

If one then looks at the ß score analyses on this factor, it is interesting to find that, although in keeping with the literature, where it was found that own-race faces yield a significantly lower proportion of false alarms compared to other-race faces (Meissner & Bringham, 2001), participants showed more bias (in favoring a 'no' responses) for white faces. However participants showed almost zero bias (for a particular response) for black faces. Thus not only was the effect not significant, but it was almost opposite to the predictions.

The Effect of Age

Secondly, it was examined whether the age of a child has an effect on race biases. A positive effect (a reduction in race biases) can be seen in terms of the fact that the older children have many more years of contact, or in terms of the fact that older children are merely better at face recognition. If it is the contact that is having an effect, the differences in performance across races should be reduced in older children, as opposed to merely performing equally better for both groups.

In order to understand the children's performance in terms of age groups, the main effects of age and the possible two-way and three-way interactions need to be understood.

Firstly it was seen that age had a significant effect on the overall face recognition abilities, with older children reacting far quicker to all faces than younger children. This was expected as it is in line with all the literature on face recognition in children (Blaney and Winograd, 1978; Mondloch, Maurer, and Ahola, 2006). Following from this finding, the analysis of the accuracy of children's recognition showed that, although surprisingly not a significant effect, older children were also slightly more accurate than younger children. The last finding on age effect that was particularly interesting (although not significant) came form the ß score analysis. Here it was seen that older children were more biased (to answering no) than younger children, showing a more conservative strategy, being more reluctant to say yes if not sure. And that younger children were only slightly more biased to answering yes. The possible reasons for this are not within the scope of this empirical research, however, as the attitudes of all the children were observed, the younger children's eagerness to please the researcher, and the older children attempt to seem mature and serious could have affected recognition responses.

The Effect of Contact

As this study was based primarily on ideas supposed by the contact hypothesis (a specific hypothesis of this study being that the more contact with another race a child has had in the past and has currently, will result in diminished race biases in face recognition), the effect of contact was a very important factor to analyze. This factor is however only meaningful when looked at in terms of the performance across races, not face recognition abilities in general. Thus only possible two-way and three-way interactions can explore the effect of contact meaningfully.

At a most basic level, the reaction time analyses showed that contact has no significant effect on the performance across different race faces; low contact children reacted just as quickly to white faces as high contact children, and, more importantly, low contact children reacted just as quickly to black faces as high contact children. The fact that this effect was not significant means that the composition of the school a child attends has little effect on the amount of time it takes to make a decision about other-race face recognition, a finding which contradicts research done on the contact hypothesis (Carroo, 1986; Chiroro & Valentine, 1995; Lavrakas, Buri, & Mayzner, 1976; Sporer, 2001a). However it is in line with research that has shown the contact hypothesis to produce sporadic results (Maclin and Malpass, 2001).

Similarly, the d' analysis of a possible three-way interaction showed that, for black faces, older children from the low contact school were actually more accurate than older children from the high contact school. Although this effect was not significant, it does contradict the contact hypothesis.

These contradictory results are however not seen throughout the analyses on the effect of contact on recognition accuracy and possible biases. The three-way interactions between age, contact, and race of face, (although not significant) produced some interesting results. Firstly (with regard to d' scores) the high contact young children were slightly more accurate for black faces than the low contact young children. But more importantly, younger children from the low contact school performed four times better for white faces than for black faces, whereas younger children from the high contact school performed only twice as well for white faces than for black faces. These results clearly show that contact had a positive effect on recognizing faces of other races.

But further into the analyses it could be seen that the sporadic effects of contact are present once again. In the analysis of a possible three-way interaction with the ß score performances, (an interaction effect that was not significant), it was seen that the younger children at both the high and low contact schools were similarly biased for black faces (favouring the 'yes' response), and that performance on white faces indicated that low contact younger children were twice as biased for white faces (favouring a 'no' response) than the high contact children. Although at first it seems the responses are generally just more biased towards white faces, and therefore contradictory to the reserach, this finding is, in fact, in keeping with the literature, where other-race faces elicit higher false alarms (Meissner & Bringham, 2001).

These analyses begin to explore two of the main hypotheses that are being examined in this study. Specifically; in children who have a substantial amount of contact with another race, the older the child is, the less race biases they should present, and; in children who have little to no contact with another race, the age of the child will have a slight effect on the child's race biases in face recognition, where older children may have more biased reactions.

In exploring the first of these hypotheses, it was seen that, as correctly predicted, for the children in the high contact school, the older children were less biased than the younger children (in terms of similarity of accuracy across races). However this trend continues into the low contact school; it was seen that the older children were in fact less biased (in terms of similarity of accuracy across races) than the younger children. This contradicts the last hypothesis specifically.

This can further be seen in the analysis on the interaction effect of race of face and age of the d' scores, which provided some interesting results. Although the overall interaction effect was not significant, there was a significant difference between white face and black face recognition accuracy for the younger children (both contact groups together), but no significant difference for older children. This shows that age actually positively affect cross race effects regardless of contact.

Other interactions of interest - Age and Contact

The reaction time analysis of the possible two-way interaction between age and contact, a significant effect, showed that the younger children in the low contact school performed significantly slower than the older children in the low contact school. As the slow reaction times for the young low contact children were present for both black and white faces, it seems that there must have been a confounding effect. (The children in the high contact school performed statistically similar for both age groups.)

Limitations

This research has shown some interesting results which contradicts some of the major research done in the field of race biases, and the contact hypothesis. However, as stated previously, due to the small sample size in this study, few of the main effects and the interaction effects were significant. Thus, although interesting patterns of performances were seen, the results do not have statistical significance.

One general reason for the insignificant and contradictory results accounted for by the contact factor, may be that, living in South Africa, the children in the low contact school, although not exposed to other races within the school, are presumably exposed to a substantial number of people of other races when outside of school. This fact, however, does not affect the hypotheses of this study; this study is looking specifically at the effect of contact *within* the school setting.

Lastly, one possible limitation of the analysis is that reaction time is greatly compromised by the fact that children who guess will give an answer quickly, and thus reaction times for confusing faces (which will elicit more guesses) may actually be quicker than for faces which the child recognizes. However recognition accuracy analysis has recently been given far more importance in research such as this.

Future Directions for Research

In order for these contradictory and interesting results to have significance, a larger sample will need to be tested. This will not only provide the statistical significance that is lacking within this study, but will also produce results that are more reliable. Furthermore future research may also benefit from taking a measure of contact within the school setting for children from the high contact school and a measure of contact outside of the school setting for children from both the high contact and the low contact schools.

Conclusion

In conclusion, although there are some limitations in a study of this size, the analyses examined here do contribute to a more interesting understanding of the effects age and contact have on race biases in face recognition. By exploring the main effects of age, contact and race of face, and examining the possible two and three-way interactions that are present in this sample's performances, this study provide some findings that support the contact hypothesis and some that do not. Furthermore, the findings show that the age of the child has a positive effect on race biased face recognition, regardless of contact. This means that, according to this study, all children in South Africa become less biased in terms of the effect of race on face recognition, as they get older, regardless of the composition of the school they attend. These findings suggest that continued research into cross race face recognition will provide some important results.

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Appendix A: Parent consent form.

UNIVERSITY OF CAPE TOWN

Consent Form for Participation in Face Recognition Study

Dear Parent\Guardian

This form is a request for permission for your child's participation in a study dealing with the recognition of faces. This study is part of research being done at the University of Cape Town in the Department of Psychology.

This study examines the face recognition abilities of children. This involves measuring the reaction times of each child when performing tasks of face recognition. This study will be done by asking each child to study a group of photographed faces. Then, after a short drawing task, the child will be shown a larger set of photographs which includes the original faces that they learnt and new unseen faces, and the child will have to say whether or not they recognize each face. One session will include 16 photographs and will take about 10 minutes. Three sessions will needed to be done with each child.

There is at no time, any apparent source of physical or psychological risk to the participants in this study. All children participating in the study will remain anonymous and a child's participation can be terminated at any stage during the study if they wish to stop.

A detailed description of this study has been considered and approved by the University of Cape Town's Research Ethics Board as well as by the school.

If you have any questions regarding the study please feel free to contact me, Michaela Ashley-Cooper on 0832473954 or email me at ashmic005@mail.uct.ac.za. My thesis supervisor, David Nunez, would also be happy to answer any questions you may have. He can be contacted during office hours on (021) 6504606.

Please fill in the following.

Please tick the appropriate box:

☐ I consent to the participation of my child in this study.

☐ I **do not** consent to the participation of my child in this study.

Child's Full Name: ______________________________________

Grade: _________

Parent's Signature: ___________________________________

Appendix B: Written assent form.

Assent Form for Child Participants

1. Name of Participant ("Study Subject")

____

I am going to be asked some questions about photographs of faces that I will be shown. The person who is going to ask me the questions has told me that I can stop if I am feeling tired and need to take a break, and that nobody else will be see my answers to the questions.

______________________________________ ______________________

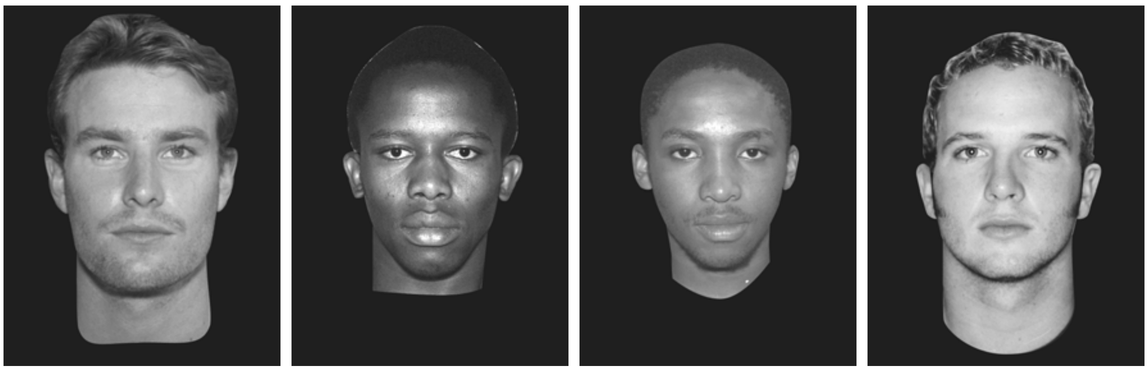
Signature of Child Date

______________________________________ ______________________

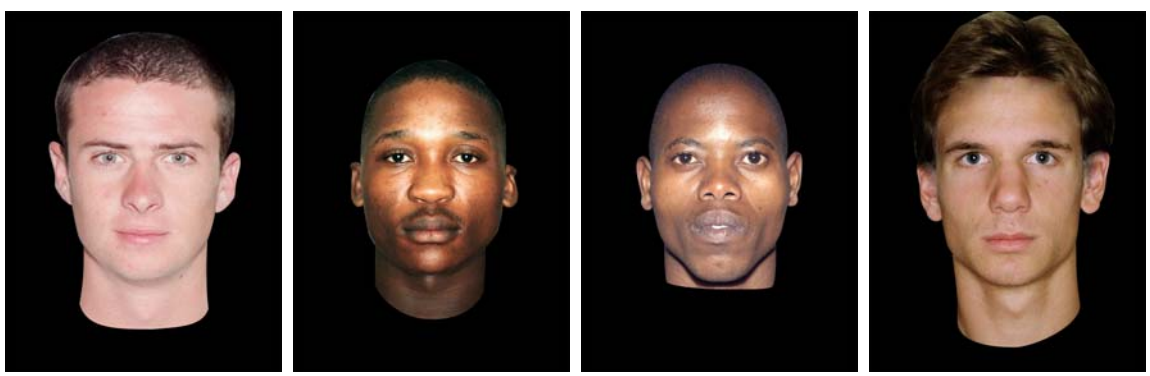
Signature of Researcher Date

Appendix C: Sample of photographs used.

Original photographs shown.

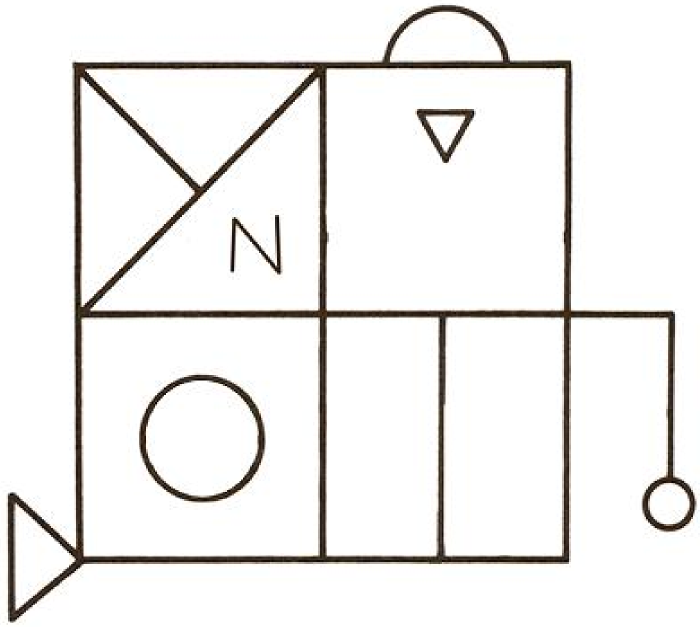


Distractor photographs shown in the extended set.

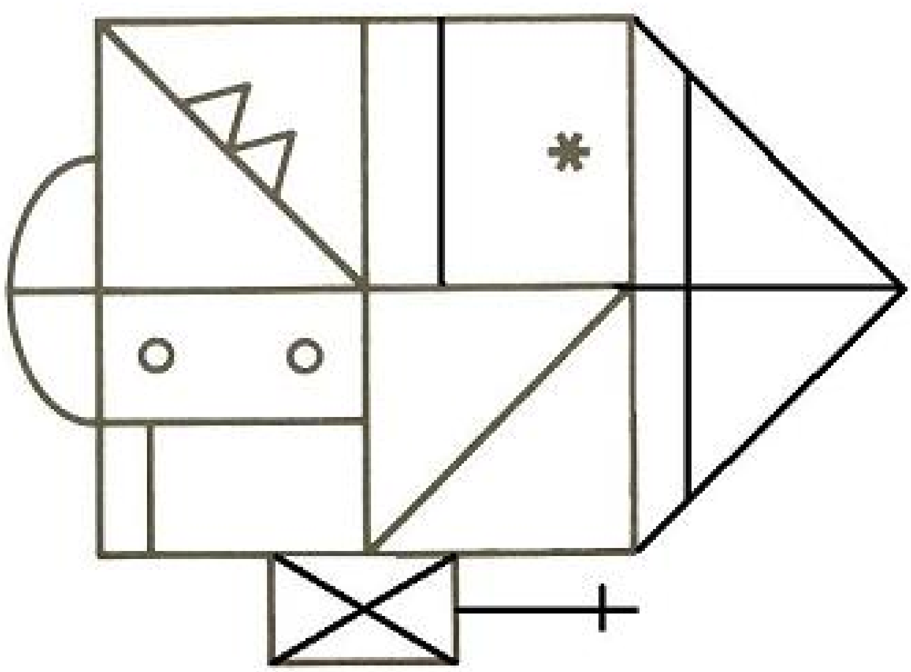


Appendix D: Figures used in distractor task.

One of the figures for the younger children.



One of the figures for the older children.



Plagiarism Form

Declaration

1. I know that plagiarism is wrong. Plagiarism is to use another's work and pretend that it is one's own.
2. I have used the APA convention for citation and referencing. Each contribution to, and quotation in, this thesis from the work(s) of other people has been attributed, and has been cited and referenced.
3. This thesis is my own work.
4. I have not allowed, and will not allow, anyone to copy my work with the intention of passing it off as his or her own work.

Student Name: Michaela Ashley-Cooper

Student number: ASHMIC005

Signature: ____________________________