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PhD thesis

Are there developmental differences in face processing?

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Abstract

This thesis examines whether there are developmental differences in face processing. Performance on face processing tasks improves steadily with age, however, there is no consensus over whether this improvement is quantitative or qualitative in nature. This research aims to determine whether children process faces in the same way as do adults and become more efficient as they get older, indicative of quantitative improvements, or, whether children process faces differently from adults and undergo a qualitative shift that can account for the observed improvement with age.

The experiments in this thesis investigate whether there are developmental differences in face processing in three specific areas. The first strand examines whether children show the adult advantage for recognising familiar faces from the internal features. The second strand explores whether children show the same difficulties, as do adults, when trying to recall the names of familiar people. Finally, the third strand draws these two areas of research together and examines how children and adults process and remember unfamiliar faces and explores how face representations change as unfamiliar faces become more familiar. In each of these experiments, the aim is to determine whether age-related differences on these tasks can be attributed to quantitative or qualitative change. The results show that when age-appropriate stimuli are used, the same pattern of results is obtained in children aged 7-12 years and adults, indicating gradual quantitative improvement on these tasks with increasing age.

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Declaration

I declare that this thesis is my own work carried out under the normal terms of supervision.

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Publications

Chapter 2, (Experiments 2a and 2b), has been accepted for publication -

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Chapter 1 General Introduction

1.1 Introduction

The purpose of this thesis is to determine whether there are qualitative differences in face processing between children and adults. That children's performance on face processing tasks improves with age is not surprising. The purpose of the research carried out in this thesis is to examine the nature of this improvement. Ultimately, this research seeks to determine whether children undergo a qualitative shift in face processing that accounts for the observed pattern of development or whether the same processes operate in children and adults, but are performed less efficiently by children.

This chapter will begin with a brief overview of the developmental course of face processing skills. Some theories of the development of face processing are then outlined. Key concepts in adult face processing are defined. Studies reporting qualitative differences in face processing between children and adults are then reviewed. These are concerned with the inversion effect, paraphernalia effects, distinctiveness effects, the own-race effect, and configural and featural processing. Each experimental chapter begins with its own review of the relevant literature, therefore this chapter reviews developmental differences in face processing in general. Details of the specific face processing skills that are investigated in this thesis are provided in the related experimental chapter.

1.2 The developmental course of face recognition

Many face processing skills are present during infancy. Newborn infants turn their heads and eyes more to follow a moving face than a moving scrambled face or a blank face (e.g. Goren, Sarty & Wu, 1975; Johnson, Dziurawiec, Ellis & Morton, 1991). Within days, infants can discriminate their mother's face from a stranger's face (Bushnell, Sai & Mullin, 1989) and by the age of 5-6 months they are able to discriminate old from new faces and male from female faces (Fagan, 1972). Despite this impressive start, unfamiliar face processing skills improve markedly throughout childhood, in particular between the ages of 6 and 10 years. For example, recognition memory for unfamiliar faces improves during the years 5-13 (e.g. Blaney & Winograd, 1978; Ellis & Flin, 1990; Goldstein & Chance, 1964). Improvement is also observed on tasks requiring no memory for faces. The ability to match photographs of target faces changed in facial expression, age, hairstyle, background, etc shows great improvement between 6 and 10 years of age (e.g. Diamond & Carey, 1977; Ellis, 1992; Markham, Ellis & Ellis, 1991). The ability to match different identities for shared facial expression, gaze direction and facial speech also develops between the ages of 4 and 10 years (Bruce, Campbell, Doherty-Sneddon, Import, Langton, McAuley & Wright, 2000).

Some studies report a small decline in performance around 12 years of age (e.g. Carey, Diamond & Woods, 1980). However, the research concerning the developmental dip is equivocal, with some studies finding a dip in performance at different ages (e.g. Flin, 1980, found a decline at 11-12 years, whilst Carey et al, 1980, report a fall in performance at 12-14 years), while others report no evidence of a decline in this same age group (e.g. Diamond & Carey, 1977). Further, with very few studies measuring performance at each age throughout childhood, it is very difficult to conclude whether the dip noted in these studies is a reliable phenomenon and whether it applies to all or only some face processing skills.

Thus, the ability to recognise unfamiliar faces improves with age throughout childhood. There has been very little research carried out on children's recognition of familiar faces, which is partly due to the difficulty in finding suitable stimuli that are familiar to children of different ages. Most of the studies reviewed in this chapter therefore address developmental changes in the recognition of unfamiliar faces, unless otherwise stated. Children's recognition of familiar faces will be discussed later in Section 1.5.

1.3 What is developing?

Several explanations for the improvement in face processing skills have been proposed and are outlined briefly in this section. For example, age differences in performance on face recognition could be attributed to increased specialisation of the right hemisphere. However, studies of lateral differences for face processing have provided no support for this hypothesis. For example, Young & Ellis (1976) showed that a right hemisphere advantage for recognising faces was present in 5, 7 and 11-year-olds and that the size of this advantage did not increase with age. Some studies report no sign of a right hemisphere advantage (e.g. Reynolds & Jeeves, 1978) but

Young (1986) concludes that, in addition to some procedural problems, these studies find no evidence of a right hemisphere advantage at one age and then find an adult-like pattern at the next age. Young (1986) concludes that such a dramatic shift is most likely due to a change in strategy used to solve the task rather than evidence of cerebral specialisation.

Other accounts of age-related differences in face processing focus on cognitive factors. One possibility is that young children do not encode faces as deeply as do adults. If this were the case, then instructions to encode faces more deeply would have a greater effect on young children. However, encoding instructions have been found to have an equal effect on young and older children and adults – all remembered faces they had judged for pleasantness better than faces they had judged for gender (Carey et al, 1980) or features (Blaney & Winograd, 1978). Thus, deep encoding of unfamiliar faces benefits subsequent recognition at all ages.

Goldstein (1975) & Goldstein & Chance (1980) proposed that as children get older, they are exposed to more and more faces and that this exposure increases their schematic knowledge of faces as a class. We are used to seeing faces upright and have more experience of seeing faces of our own-race. These factors lead to the development of a face schema that is finely tuned to upright, own race faces and one that finds it difficult to recognise inverted and other-race faces. According to this theory, improvement in the recognition of upright, own-race faces with age reflects increasing efficiency in the use of the face schema. Support for the face schema account of development comes from studies reporting a lack of inversion and own-race effects in younger children. However, other studies have found inversion and own-race effects in young children (see sections 1.4.2 and 1.4.6 for a full review of inversion and own-race effects). Thus, the child data only provides mixed support for the development of a face schema as an account of age-related improvements in face processing.

In a similar vein, Johnston & Ellis (1995a) propose that as children get older, they are better able to discriminate among faces. They propose that children represent faces using fewer dimensions than adults and so find it more difficult to discriminate among faces. Valentine (1991, 1995) has proposed a multi-dimensional face-space model of face recognition that can explain why some faces are easier or harder to discriminate from others. The centre of the face-space represents the average value of the population on a set of dimensions used to discriminate between faces. At present the exact number and nature of these dimensions are unspecified, but it is assumed that the many typical faces will lie close to the centre as they have a similar value on many of the dimensions whereas distinctive faces will have different values from typical faces and so will lie further away from the centre. This face-space model can explain why adults recognise distinctive faces faster than typical faces (Valentine & Bruce, 1986). Johnston & Ellis (1995a) propose that children may represent faces using fewer dimensions than adults and so would find it harder to discriminate between faces than adults. In support, Ellis (1992) reported that 5-year-olds were less accurate than 8, 11 and 19-year-olds when asked to classify distracter faces that were very similar to a famous target face, but all age groups were equally accurate when the distracter faces were dissimilar to the target face. The 5, 8 and 11-

year-olds rejected the similar distracter faces slower than the dissimilar distracter faces, whereas the 19-year-olds showed no difference in response times between similar and dissimilar distracter faces. Johnston & Ellis (1995b) also found that young children do not show an advantage for recognising distinctive faces, suggesting that perhaps they do not encode the same types of facial information as do adults. However, there is some evidence of sensitivity to distinctive facial information when task difficulty is reduced (see section 1.4.7 for a full review of distinctiveness effects), suggesting that children do encode distinctive facial information.

Carey & Diamond (Carey, 1978, 1981; Carey & Diamond, 1977; Carey et al, 1980; Diamond & Carey, 1977) proposed that there is an encoding shift that accounts for age-related differences in face processing. They argued that young children encode faces as a set of independent features whereas older children, like adults, encode the facial features as a configuration and encode the spatial distances between the different features within this configuration. Children's recognition ability improves with age due to an increase in knowledge about faces and an improved ability to encode the spatial relations among features. Evidence for the encoding-shift hypothesis will be evaluated in full in Section 1.4.3.

Chung & Thomson (1995) propose that there is no qualitative shift in face processing and that young and older children encode faces in the same way. Older children, however, encode faces more efficiently and this enables them to encode more facial information than younger children. There is some evidence to support this theory of age-related differences in face processing. Pedelty, Levine & Shevell (1985) asked 7, 9 and 12-year-olds and adults to perform similarity judgements on a set of unfamiliar faces. They found that all age groups used the same features to form the basis of these judgements, but that the 7 and 9-year-olds used fewer features at a time than the 12-year-olds and adults. Ellis & Flin (1990) showed that 10-year-olds' recognition performance benefited from a longer encoding time whereas 6-year-olds were just as accurate when remembering faces they had studied for two, three or six seconds.

Thus, most researchers agree that the encoding process is the locus of age-related differences in face processing. At the heart of the debate is whether young children encode different information (e.g. encoding-shift hypothesis) or whether young children encode the same type of information as do adults, but do so less efficiently. The next section will outline the research indicating that children may be doing something differently from adults.

1.4 Are there developmental differences in face processing?

1.4.1 Some definitions

This section will investigate whether children process faces in the same way as do adults. One area that will be reviewed is whether children process faces 'configurally'. The term 'configural processing' has been defined in different ways by different researchers and is used inconsistently in the literature. It is often contrasted with 'holistic processing' by some researchers whereas other researchers use the terms 'configural' and 'holistic' interchangeably. It is therefore necessary at this point to specify what these terms mean for the current context.

There are various types of configural information contained within a face. First of all, 'configural processing' is sometimes used to refer to the perception of the face as a whole (also known as holistic processing). Secondly, the term has also been used to refer to fact that faces share an overall configuration whereby the eyes are found above a nose, which is located above a mouth and so on. Finally, 'configural processing' is also used to refer to the processing of the spatial distances between the features of the shared configuration, for example, the distance between the eyes. These different types of configural information are similarly distinguished by Maurer, le Grand & Mondloch (2002) who also point out the inconsistency in the literature with these terms with some researchers using the term configural to refer to one of these types of processing whilst others apply the term to all three types and do not discriminate between them.

Configural processing has been contrasted with 'holistic processing' by some researchers. For example, Tanaka and Farah (1993) define holistic processing as a template-like representation of the whole face, where the constituent parts (e.g. eyes, nose) are not explicitly represented. These holistic representations contain information about the spatial layout of the facial features, but this information is not explicitly represented. Tanaka & Farah (1993) provided evidence that faces are processed holistically when they found that it was easier to recognise facial parts when they were presented within the whole face than when they were presented in isolation. This benefit was not found for scrambled faces, inverted faces or houses. This definition of holistic processing is very similar to the first definition of configural processing noted above. For this reason, many researchers assume that holistic and configural processing are really the same thing and use the terms interchangeably. In fact, Tanaka & Farah (1993) concede that "the concepts of configurational representation and holistic representation are highly similar, and possibly identical." (page 242). For the purposes of clarity, the term 'configural processing' will be used in the following review in a general sense and will refer to the processing of the facial features as a whole. Configural processing in this sense therefore includes processing of the spatial distances between these features, but will not specify whether this information is explicitly represented. When experiments purposefully manipulate only one type of configural information, then this will be specified.

'Configural processing' is often contrasted in the literature with the processing of independent facial features, referred to by different authors as 'featural processing', 'piecemeal processing', 'local processing' and 'analytic processing'. Again, for clarity, the term 'featural processing' will be used in this thesis to refer to the processing of the independent facial features.

Maurer et al (2002) review the development of featural processing and the three types of configural processing defined in this section. These different kinds of processing appear to reach adult levels at different times, with featural and holistic processing almost adult like by the age of 6, whilst the sensitivity to the distances between the different features takes longer to reach adult levels of performance. These differences in the development of featural and configural processing are discussed in full in Section 1.4.4 and Section 1.4.5.

This section will now review the relevant literature on developmental differences in face processing. This will include the inversion effect, paraphernalia effects, the own-race effect, distinctiveness effects and the contributions of both configural and featural processing to the development of face processing skills.

1.4.2.1 Inversion effect

In a classic study carried out by Yin (1969), it was found that adults were less accurate and slower to recognise faces that had been presented upside down than faces presented upright. The detrimental effect of inversion was found to be much larger for faces than for other types of mono-oriented stimuli, such as houses. It is generally held that inversion disrupts configural processing whilst featural processing is little affected by inversion (e.g. Bartlett & Searcy, 1993; Freire, Lee & Symons, 2000; Leder & Bruce, 1998, 2000; Rhodes, Brake & Atkinson, 1993). However, there is some disagreement over the type of configural processing that inversion disrupts with some researchers arguing that inversion disrupts the encoding of the spatial relations between facial features, such as the distance between the eyes and the mouth, (e.g. Diamond & Carey, 1986), whilst others argue that inversion disrupts holistic encoding (Farah, Tanaka & Drain, 1995).

1.4.2.2 Do children show an inversion effect?

Carey & Diamond (1977) investigated whether children would be affected by inversion. Six, 8 and 10-year-old children were presented with a series of pictures of faces and houses, half of which were presented upright and the remaining inverted. After inspection of the photographs, children were presented with pairs of stimuli (in the same orientation as the study phase) and had to indicate which of the two houses or faces they had seen previously. Six and 8-year-olds' recognition of houses and faces was affected equally by inversion, whereas the 10-year-olds were much worse at recognising inverted faces than inverted houses. Children's recognition of upright faces improved significantly between 6 and 10 years whereas recognition of inverted faces remained constant. Carey et al (1980) presented upright and inverted faces to 6 and 10-year-old children and obtained the same pattern of results. The 6-year-olds recognised upright and inverted faces equally well whereas the 10-year-olds recognised upright faces more accurately than inverted faces. Thus, children less than 10 years of age showed a different pattern from older children and adults.

These results indicated that there were qualitative differences in face processing between younger children and adults and suggested that young children may not be using configural face processing. As configural processing is disrupted by inversion and featural processing is not disrupted by inversion, Carey & Diamond hypothesised that young children were processing both upright and inverted faces featurally and that there is an encoding switch around 10 years of age to configural processing of upright faces.

However, it has been argued that the lack of an inversion effect in Carey & Diamond's (1977) study was possibly due to a floor effect, perhaps caused by the large number of stimuli used. For example, Flin (1985) found evidence of an inversion effect in 7, 10-13 and 16-year-olds using an easier task. Children viewed a set of ten upright faces and then completed an old/new recognition test with the original ten faces and ten distracter faces. This procedure was then repeated with a different set of faces that were shown inverted at study and at test. At all ages, recognition of the upright faces was better than the inverted faces. Task difficulty may therefore have masked a possible inversion effect in 6-year-olds in the original studies. Carey (1981) herself has found an inversion effect in children as young as three years when a set size of one face was used.

More recent work supports the existence of an inversion effect in young children. Brace, Hole, Kemp, Pike, Van Duuren & Norgate (2001) created a storybook where 2-11-year-olds learned the faces of two characters by reading the story. Children were then presented with face arrays containing the target face and eight distracter faces from which they had to select the target. Arrays were presented upright and inverted and reaction times showed an inversion effect from the age of 5 years, whereby upright target faces were identified faster than inverted targets. However, the youngest children, 2-4-year-olds, showed the opposite pattern and responded to the inverted faces faster than the upright faces. Further work is required to establish whether this is a reliable result and not due to a strategy the younger children were using. If replicated in further work, this may indicate a developmental difference between the ages of 2-4 years.

Pascalis, Demont, de Haan & Campbell (2001) also provided evidence of an inversion effect in 5-year-olds. Five-eight-year-olds were presented with a target face for a few seconds and then saw two faces from which they had to identify the target. Human, monkey and sheep faces were presented upright and inverted. The same pattern was found for all ages and for adults. Performance was better on upright than inverted human and monkey faces with no inversion effect found for sheep faces. Finally, there is some indication from infancy studies that 5-7-month-olds find it harder to distinguish between inverted photographs of faces than upright photographs (Fagan, 1972). Infants were habituated to a photograph of one face and then were presented with pairs of faces containing the habituated face and a novel face, shown either upright or inverted. When the faces were shown upright, infants looked longer at the novel face, indicating that they recognised the habituated face, whereas when the faces were shown inverted, there was no preference for either face.

In summary, early work by Carey & Diamond (1977) had suggested that children younger than 10 years of age do not show the classic face inversion effect found in adults (e.g. Yin, 1969). Subsequent research has, however, found evidence of a detrimental effect of inversion upon face recognition in children as young as 3-5 years (Brace et al, 2001; Carey, 1981) when more developmentally sensitive tasks were used, and has even been found in infancy studies. It is clear that children are affected by inversion much earlier than previously suggested. The inversion effect obtained in these studies therefore indicates some level of configural processing in young children.

1.4.3 Paraphernalia effects and the encoding shift hypothesis

Diamond & Carey (1977) carried out a series of face matching experiments to investigate whether young children would be fooled by changes in facial expressions and paraphernalia (e.g. whether the person was wearing a hat, a wig, glasses). The matching task involved children looking at a study photograph for five seconds and then identifying this person from a pair of test images. Facial expression and paraphernalia were manipulated to either help children pick the correct face or fool them into choosing the distracter face. For example, in a paraphernalia-to-fool/expression to help trial, the target has the same facial expression in the study and test photographs, but if the target is wearing a hat in the study photograph, then the distracter is wearing this same hat in the test photograph. The aim of this study was to examine whether children could look beyond the misleading paraphernalia and facial expressions and select the correct test image. The same children performed two versions of this test. The first time, the study image was covered up after inspection and investigated whether children could identify the target from memory and the second time, the study photograph was not removed and was available for comparison with the two test images.

The results showed clear improvement on this task with increasing age up until around age 10 and little change up to 16 years. This improvement was due to better performance on the paraphernalia-to-fool trials with age. Six and 8-year-olds tended to base their identity decisions on isolated features, i.e. the paraphernalia. The same pattern of results was found in both versions of the test, thus even when the study image is available to young children at the test phase, they are still fooled by the misleading paraphernalia.

Children aged 12-16 years appear to use a different type of information to solve these trials as they found expression-to-help trials harder than expression-equal trials. The authors propose that the older children are representing the faces configurally and that it is easier for them to identify the matching configuration when the target and distracter have the same expression than when they have different expressions. Age 10 appears to be a transitional group. They do not show the same pattern as the younger children (greater reliance on isolated features), but nor do they show the same pattern as the older children (greater reliance on configural representations). Diamond and Carey concluded that improvement on this task reflects a qualitative change in the way that younger and older children process faces, with younger children relying on a piecemeal representation (or isolated features) and older children using a configural representation. This is known as the 'encoding shift hypothesis' and received further support from Carey & Diamond's (1977) study of inversion effects where children younger than 10 years showed no evidence of an inversion effect. The lack of an inversion effect indicates a lack of configural processing. Carey & Diamond (1977) and Diamond & Carey (1977) proposed that young children use piecemeal or featural processing when recognising both upright and inverted faces and so therefore do not show an inversion effect. Older children, on the other hand, are using configural processing to recognise upright faces and so are affected by inversion like adults.

Hay & Cox (2000) provided some limited support for the encoding-shift hypothesis. Six and 9-year-old children viewed a familiar or unfamiliar face for five seconds and then after a gap of ten seconds were presented with two faces or two features and had to indicate which one they had seen previously. The facial features used were the eyes, nose and mouth. The task was carried out with both upright and inverted images. The results showed that the younger children recognised more eye features than the older children did and an inversion effect for the recognition of whole faces was found only for the older children. These results have been interpreted as evidence for a decline in featural processing with the older children performing less accurately than the younger children on the isolated feature trials (however, this was only the case for the eyes) and as evidence for configural processing in the older children as their recognition of whole faces was impaired by inversion. However, the strength of these conclusions has been questioned as the decline in featural processing was found only for the eye area and may reflect a strategy adopted by the younger children for this task. For example, if the younger children were using a feature strategy to solve this task, then it makes sense that they would be more accurate on the eyes as it has been shown previously that the eyes are especially salient to both children and adults (e.g. Hood, Macrae, Cole-Davies & Dias, 2003; Pellicano & Rhodes, 2003). Further, the same photograph of the target was used as the study and test image, which may reflect recognition memory for a picture rather than a face. Replication of these results with different photographs of the same person at study and at test is therefore required before these results can be taken as support for a decline in piecemeal processing.

As their claims concerning the lack of inversion effects in young children have been criticised, so too has Diamond & Carey's (1977) claim that there is a shift from piecemeal to configural face processing in childhood. The original studies have been criticised for using tasks that are too difficult for young children. Some researchers have argued that the results reflect floor effects or a tendency for younger children to be distracted more easily by the paraphernalia rather than a genuine difference in face processing between younger and older children. For example, Flin (1985) repeated Diamond & Carey's paraphernalia task with 4-8-year-olds, but varied the similarity of the target and the distracter faces. Flin used only one type of paraphernalia, a hat, and paraphernalia was manipulated as follows. If the target study face was pictured wearing the hat, then the test images showed the distracter face wearing the hat and the target face hatless. If the target study face was not wearing a hat, then the test images showed the target face wearing a hat and the distracter face hatless. The results showed that 4-6-year-olds were fooled by this manipulation much more often than 8-year-olds when the target and distracter faces were similar, but no age differences were found when the faces were dissimilar. Thus, when this task is made more difficult by using similar looking distracter and target faces, young children base their choice on the paraphernalia cues, but when the task is easier, they are less likely to be influenced by these same paraphernalia cues.

Baenninger (1994) examined whether children could ignore the paraphernalia cues in the Diamond & Carey (1977) paradigm if they were made uninformative. The results showed that 6, 8 and 10-year-old children were much more accurate at recognising the target when paraphernalia were held constant and were present in the study image and both the target and distracter test images than when the paraphernalia cues were only present on the test images. Thus, when paraphernalia cues are made redundant, there is evidence that young children can use the relevant facial information to recognise the target face. It appears that young children are more easily distracted by the paraphernalia than older children or that paraphernalia make the target and the distracter faces look more similar as wholes to young children than the target with the paraphernalia and the target without the paraphernalia.

Lundy, Jackson & Haaf (2001) argued that younger children's poorer performance on the Diamond & Carey (1977) paraphernalia task may be attributed to the small size of the stimuli used in the original study. They found that increasing the size of the stimuli increased 7-year-old children's accuracy on a similar task, while 10-year-olds performed equally well with the small and the larger stimulus size. Lundy et al argue that the young children in Diamond & Carey's study may have encoded the faces and the paraphernalia holistically and that increasing the size of the stimuli helped them to differentiate the paraphernalia from the facial information.

In summary, Diamond & Carey (1977) found that young children based identity decisions on misleading paraphernalia much more than older children. This led them to propose that young children process faces feature by feature rather than as a whole configuration. Further evidence for a lack of configural processing in young children came from their inversion studies (Carey & Diamond, 1977; Carey et al, 1980). However, Flin (1985) found that 4-8-year-olds could perform the paraphernalia task successfully if the target and the distracter faces were dissimilar and Baenninger

(1994) found that 6-8-year-old children could ignore the paraphernalia and select the correct target face when the paraphernalia were made uninformative. Taken together, the results of these experiments and the finding of an inversion effect in children younger than 6 years suggest that Diamond & Carey's (1977) and Carey & Diamond's (1977) results were due to task difficulty or a strategy used by younger children and therefore cannot be accepted as sufficient evidence to conclude that young children encode faces featurally while older children and adults encode faces configurally.

1.4.4 Configural processing

There is good evidence that 6-year-olds, like adults, can process faces configurally. The term configural processing in this context refers to a representation of the face as a whole (or holistic processing, Tanaka & Farah, 1993). Tanaka, Kay, Grinnell, Stansfield & Szechter (1998) carried out a series of experiments to determine whether children would find it easier to recognise facial features if presented in the context of the whole face or if presented in isolation. Six, 8 and 10-year-olds learned four faces with names and in the test phase had to identify these people from two test images. In individual feature trials, they were presented with two features and were required to indicate which one belonged to one of the people they had learned. For example, they could be presented with two noses, and be asked to point to Tom's nose. In whole face trials, they were presented with two whole faces, differing only in one feature (eyes, nose or mouth) and would be asked to point to (for example) Tom. The results showed that all age groups were more accurate when the facial feature was presented within the context of the whole face than when the feature was presented in isolation. This was the case when the faces were upright, but not when they were inverted and indicates that children as young as six years are encoding faces configurally, in the sense that they represent the facial features as a whole.

Carey & Diamond (1994) investigated whether children encode faces configurally using a technique devised by Young, Hellawell & Hay (1987). Young et al (1987) presented adults with the top half of one famous face and the bottom half of a different famous face. The two halves were either joined to form one new face (composite face) or were set apart (non-composite face). These images were presented upright and inverted and the task was to name the person in the top half of the picture. Young et al reported that adults were slower at naming the top half when the two faces had been joined together than when they were set apart. They argue that when the two faces are fused together, adults automatically process the two face parts as a new whole face and that this interferes with recognition of the top person. This effect disappears when the faces are inverted and is therefore presented as evidence that adults automatically encode the composite face as a new configuration when shown upright. Carey & Diamond (1994) carried out the same study with 7 and 10-year-olds to examine whether they would show the same effect using personally familiar faces and a set of unfamiliar faces that were learned with a name. Both groups of children made more errors and were slower when the two faces were joined together than when the two faces were set apart, but only when the images were presented upright. There were no age-related differences in the size of this composite effect, but performance was increasingly affected by inversion with increasing age. These results were taken as evidence for configural processing in children, in the sense that the facial features are represented as a whole rather than separately. This type of configural processing has reached adult levels by the age of 6 years. However, the size of the inversion effect increased with age and Carey & Diamond attribute this pattern to an increasing reliance on another type of configural information, that is, the spatial distances between the facial features, and claim that this skill develops beyond the age of six.

Carey & Diamond (1994) therefore revised their original hypothesis that there is an encoding shift in childhood that accounts for the improvement on face processing tasks with increasing age. Instead, they propose that children's improved performance on face processing tasks is due to a greater reliance on the configural information contained within faces. As children become older and have more experience with faces, they become more proficient at encoding the spatial relationships between facial features. In turn, children become more sensitive when these spatial relationships are disrupted and so become increasingly affected by inversion. Thus, there is evidence that young children can encode faces configurally, but that this ability develops. This development is indicated by the increasing detrimental effect that inversion has on recognition with increasing age in this study.

Donnelly & Hadwin (2003) provided further evidence of configural processing in 6-year-olds using a different method. They presented participants with pairs of faces and asked them to select which face was the odd looking one. Pairs of faces contained the original face and a thatcherised version of the same face with the eyes and mouth inverted. Thatcherised faces look strange when upright, but adults fail to detect this unusual appearance when the faces are inverted (Thompson, 1980) because inversion disrupts the configural information contained within the faces and makes it difficult to detect these subtle configural changes. Donnelly & Hadwin (2003) found that 6, 7, 8 and 10-year-olds were able to detect the unusual face much more accurately when the faces were upright than when the faces were inverted, suggesting that children behave like adults and are less likely to notice these configural disruptions in inverted faces. In a second version of this experiment, the task was made harder as performance in all age groups on the upright faces was at ceiling in the first experiment. This time, there was no difference in accuracy between upright and inverted faces for the 6-year-olds, reiterating the suggestion that the presence or absence of a particular face processing skill in younger children can often depend on task difficulty (e.g. Brace et al, 2001; Carey, 1981; Flin, 1985).

Cohen & Cashon (2001) have provided evidence of configural processing and inversion effects in 7-month-old infants. Infants were habituated to two faces and then a composite face was created consisting of the internal features of one of the habituated faces and the external features of the other habituated face. This composite face was presented with a familiar face to investigate whether infants would perceive the composite face as a new facial configuration. Infants looked longer at the composite face when the face pairs were presented upright, but not when they were inverted. Cohen & Cashon argue that when the composite face is upright, it is processed as a new configuration whereas when it is inverted, it is processed as independent features, which infants are already familiar with from the habituation phase.

In summary, there is good evidence that young children process faces configurally in the sense that they process faces as a whole. Six and 10-year-olds show a composite effect like adults (Carey & Diamond, 1994) and are more accurate at recognising facial features when they are presented in the context of a whole face than when presented in isolation (Tanaka et al, 1998). Even 7-month olds looked longer at a new configuration made from two previously habituated faces than at a familiar face (Cohen & Cashon, 2001). These studies also provide further evidence of an inversion effect in children whereby configural processing is disrupted in inverted faces (Carey & Diamond, 1994, 10-year-olds only; Cohen & Cashon, 2001; Donnelly & Hadwin, 2003; Tanaka et al, 1998). Thus there is a growing body of evidence showing that children process faces configurally in the sense that the face is represented as a whole, whilst the increase in the size of the inversion effect with age found by Carey & Diamond (1994) suggests that the ability to process the spatial relations between the facial features may still be developing.

1.4.5 The development of configural and featural processing

This section will review studies that have investigated whether children's face recognition is disrupted more by manipulations made to featural information or whether recognition is disrupted more by manipulations to configural information.

Here, configural manipulations typically involve changing the spatial relations between the facial features.

Baenninger (1994) investigated whether children and adults would be equally impaired by disruptions to featural and configural facial information. In her experiments, an intact target face was presented for study for five seconds and then a pair of faces was presented from which participants had to identify the target. Configural information was disrupted while maintaining the featural information by altering the positions of the internal features, for example, the eyes were placed below the mouth. Eight and 11-year-olds and adults were affected equally by this disruption to configural information, with all groups finding recognition of the target face harder when none of the internal features were in their normal positions than when one feature was in its normal position. Featural information was disrupted and configural information was held constant, for example, by placing two circles where the eyes would be. Eight and 11-year-olds were not as accurate as adults and were affected equally by this disruption to the featural information. There was general improvement with age on both the configural and featural tasks, but no evidence of younger children being more impaired by the disruption to featural information than older children or older children being more impaired by the disruption to configural information than younger children. The results therefore provide no evidence for a qualitative shift in processing modes and suggest that children and adults rely more on configural information than featural information as disruptions to configural information made recognition harder than disruptions to featural information.

However, some researchers have argued that Baenninger has not manipulated featural and configural information independently and that the images she used were very unnatural. Subsequent attempts to compare the processing of configural and featural facial information have striven to manipulate one type of information without affecting the other type in a more natural looking face. For example, Mondloch, Le Grand & Maurer (2002) investigated children's ability to detect configural and featural changes made to the same face. They used one target face and modified this face to create distracters that differed in the spacing of the internal features (spacing set), the shape of the internal features (featural set) and the external contour (contour set). A face was presented on screen for study and then after a short gap, a second face was presented. Participants had to decide if the second face was exactly the same as the first face. Six, 8 and 10-year-olds and adults carried out this task and completed upright and inverted trials. On upright trials, all age groups were as accurate as adults when the change was made to the external contour; 6 and 8-year-olds were less accurate than adults, but 10-year-olds were as good as adults at detecting featural changes; and all age groups were worse than adults when the change had been made to the spacing of the internal features. On inverted trials, accuracy was highest when the change had been made to one of the features, and worst when the change had been made to the internal spacing for all age groups. The size of the inversion effect increased with age on the spacing set, but not on the contour or the featural sets. Adults showed the biggest inversion effect on the spacing set, which indicates that these changes disrupt configural processing. Thus, as in Carey & Diamond's (1994) study, there is evidence of configural processing at 6 years of age as performance was above chance on the spacing set when the faces were upright. However, the ability to detect the configural changes and the effect of inversion on the spacing set increased during the ages 6-10. These results, however, are limited by the use of only one face in this study.

Mondloch, Geldart, Maurer & Le Grand (2003) created five tasks where participants had to decide which of three faces matched a target face on the basis of identity (with changed head orientation or changed facial expression), facial expression, gaze direction and sound being spoken. Two different groups of adults carried out these tasks, one group saw the images upright and the other group inverted, in order to determine which skills were most affected by inversion. Adults were more accurate when matching identity with a change in head orientation when the images were upright than when inverted and they were just as accurate on the four other tasks when the images were upright and inverted. Matching facial identity despite changes in head orientation requires the use of configural information as the shape of the features may change when the orientation of the head changes. Thus, participants must rely on the configural information available in the face and this information is disrupted when faces are inverted. The authors therefore concluded that only this task requires the use of configural facial information. Six, 8 and 10-year-olds then performed the same tasks upright. The 6-year-olds performed less accurately than adults on all five tasks; the 8-year-olds made more errors than adults when matching identity with change in head orientation and change in facial expression and when matching gaze direction; and the 10-year-olds made more errors than adults only when matching identity with a change in head orientation. These results are consistent with Mondloch et al (2002) and indicate that the development of configural processing requires longer to reach adult-like performance than featural processing.

Freire & Lee (2001) investigated how easily 4-7-year-olds could identify a target face from four faces containing the original face and three distracters. Distracters differed from the target face in either the spacing between the internal features (configural change) or the shape and size of the internal features (featural changes). Four-seven-year-olds performed at above chance levels of recognition on both the featural and the configural changes, showing evidence of configural processing in 4-year-olds for the first time. However, in line with the results from Mondloch et al (2002), performance was more accurate on the featural than the configural changes.

In summary, it is clear that children's performance on face recognition tasks involving unfamiliar faces improves as they get older. This improvement appears to be related to the development of configural processing, but it seems unlikely that children switch from a featural to a configural processing mode (e.g. there is evidence of configural processing even in infancy). It appears that the ability to detect featural changes has reached adult levels of performance earlier than the ability to detect changes to the spacing between the features (Freire & Lee, 2001; Mondloch et al, 2002). This provides support for Carey & Diamond's (1994) hypothesis that sensitivity to the spatial relations between facial features develops throughout childhood.

1.4.6 Own-race effect

A robust finding from the adult literature is that recognition of own-race faces is better than recognition of other-race faces (see Meissner & Brigham, 2001, for a review). A few studies have examined whether this own-race effect is present in children, and the results reported have been inconsistent. Feinman & Entwisle (1976) compared African-American and Caucasian children's recognition memory for photographs of African-American and Caucasian faces. They found that 6, 7, 8 and 11-year-olds recognised more photographs showing faces of their own-race. Chance, Turner & Goldstein (1982) and Goldstein & Chance (1980) investigated Caucasian children's ability to recognise photographs of Caucasian and Japanese faces. Chance et at (1982) did not find evidence of an own-race effect in 6-7-year olds, but 10-11-year-old children recognised more Caucasian faces than Japanese faces and the size of the own-race effect increased with age. Goldstein & Chance (1980) did not find an own-race effect until 12-13-years of age. Recently, Pezdek, Blandon-Gitlin & Moore (2003) tested African-American and Caucasian child and adult participants' recognition memory for a African-American man and a Caucasian man that were presented on video. The following day, participants were presented with two video line-ups, one showing the African-American man and five distracters and the other showing the Caucasian man and five distracters. For each face, they had to use a confidence scale to indicate whether that was the man they had previously seen. These confidence scores revealed an own-race effect at each age tested (5 years, 8 years and adults) and the size of the effect did not vary with age.

Thus there is evidence of an own-race effect in some studies in 5-6-year-olds whereas other studies have failed to find an advantage for recognising own-race faces in this same age group. These inconsistencies across studies may be due to methodological differences. For example, Chance et al (1982) and Goldstein & Chance (1980) did not test Japanese children and it is therefore unknown whether Japanese children would show an own-race effect for the Japanese faces used. The inclusion of Japanese participants would have provided a better indication of whether the results were reliable or partly due to the stimuli used. The recognition scores in Chance et al's study were also below chance levels for the 6-7-year-olds, which raises the possibility that an own-race effect was masked by a floor effect in their study. Pezdek et al (2003) used only two target faces and found evidence of an own-race effect in 5-year-olds. Thus, as with the previous sections regarding inversion and paraphernalia effects, perhaps younger children's skills concerning recognition of own-race faces have been underestimated.

In summary, there is some evidence to suggest that young children do not show the adult advantage for recognising people of their own-race more easily than people from other-races (Chance et al, 1982; Goldstein & Chance, 1980). However, other studies have found evidence of an own-race advantage (Feinman & Entwisle, 1976; Pezdek et al, 2003). It is therefore concluded that these equivocal results are due to differences in methodology and that young children do show evidence of an own-race effect when tasks are developmentally sensitive (e.g. using two target faces). Further work is required to establish whether the size of the own-race effect increases with age.

1.4.7 Distinctiveness effect

The effect of distinctiveness in adult face processing has been measured in two ways. First, in recognition memory tasks, performance is better for distinctive faces than typical ones (e.g. Valentine & Bruce, 1986). Second, in face-nonface classification tasks, performance is better for typical faces (Valentine & Bruce, 1986). These effects have been attributed to norm or face-space representations, whereby typical faces are closer to a central norm and so are more easily detected in the face-nonface classification task. Distinctive faces are further away from the central norm and so are less easily confused with neighbouring faces and are remembered better in recognition memory tasks.

There is some evidence to suggest that young children do not show a recognition advantage for distinctive faces, indicative of differences in processing between adults and children. Johnston & Ellis (1995b) claimed that the distinctiveness effect on memory did not emerge until 9 years of age. However, children as young as 5 years showed the distinctiveness effect in the face-nonface classification task when no memory was required. Gilchrist & McKone (2003) argued that the failure to find a distinctiveness effect in recognition memory by Johnston & Ellis was due to a floor effect in the 5-year-olds. Gilchrist & McKone investigated the effects of distinctiveness by adapting a paradigm from Leder & Bruce (1998) where distinctiveness is manipulated by altering featural and configural information. Featural information was altered, for example, by making the eyebrows bushier and configural information was manipulated, for example, by increasing the distance between the eyes. Adults rated faces with alterations of both kinds as more distinctive than unaltered faces. In a study phase, 7-year-olds and adults were presented with unaltered faces, faces with a featural change and faces with a configural change. In the recognition phase, they were presented with pairs of faces containing the original study image and a distracter face and had to indicate which face they had seen before. Both adults and children showed the same pattern. When faces were presented upright, they showed better recognition memory for the more distinctive faces (both featural and configural changes), and when faces were presented inverted, they showed better recognition for the distinctive faces with featural changes only. Gilchrist & McKone adapted their task so that it was easier for the 7-year-olds by presenting fewer faces per study block across more study-test cycles. They stress that task difficulty must be controlled for younger subjects as very often the lack of an effect in younger age groups is caused by a floor effect.

The distinctiveness effect has also been demonstrated in adults by using caricatures. Caricatures are often recognised more quickly than veridical line drawings and judged as the best likeness of well-known individuals (e.g. Rhodes, Brennan & Carey, 1987). Children also appear to be sensitive to the distinctive information contained within caricatures. For example, Ellis (1992) has shown that children as young as 4 and 5 years show a preference for caricature images when asked for the best likeness for a celebrity. Chang, Levine & Benson (2002) showed that 6, 8 and 11-year-olds perceived caricatures as the most distinctive and anti-caricatures as the least distinctive face from a selection of faces containing caricatures, anti-caricatures and veridical images. However, 6-year-olds showed the smallest effect. All age groups also named caricatures faster than anti-caricature images. Finally, Stevenage (1995) demonstrated 6-year-olds' sensitivity to distinctive faces in a learning task. Six, 7 and 8-year-olds all required fewer learning trials to associate names with caricature faces than veridical faces. Thus, there is evidence that children are sensitive to the distinctive information contained within faces, but that perhaps they are not as sensitive to this information as are adults.

In summary, some studies had suggested that young children may not be sensitive to distinctive facial information (Johnston & Ellis, 1995b). However, by adjusting task difficulty for younger children, Gilchrist & McKone (2003) showed that 7-year-olds, like adults, remembered more distinctive faces with featural and configural changes when upright, but only showed this recognition advantage for faces made more distinctive by featural changes when faces were inverted. Four-six-year-old children show a preference for caricatures (Chang et al, 2002; Ellis, 1992) and 6 and 8 year-old children learned caricature faces faster than veridical faces (Stevenage, 1995), thus showing sensitivity to the distinctive information available within faces. However, they may not be as sensitive to this information as are adults (Chang et al, 2002).

1.5 Developmental differences in familiar face processing

The research described in the above review has concerned children's recognition of unfamiliar faces (except where stated in the experiments carried out by Carey &

Diamond, 1994; Chang et al, 2002; Ellis, 1992, and Hay & Cox, 2000). Much less research has been carried out on children's familiar face recognition because it is so difficult to find a set of faces with which children of different ages are familiar to the same extent. This problem has been encountered by many researchers (e.g. Abdel Rahman, Sommer & Olada, 2004; Carey, 1981; Ellis, 1992; Ellis, Ellis & Hosie, 1993). However, the few studies that have managed to find a set of familiar faces have found little evidence of qualitative differences in face processing between children and adults.

Goldstein & Mackenberg (1966) used photographs of children's classmates to investigate whether they could recognise their classmates when only certain parts of the face were made available (for example, by presenting only the top half or the bottom half of the face, or presenting the forehead and the hair only). They found that recognition increased between the ages 4 and 10, but found no developmental differences in the types of facial information used to recognise classmates. Young and older children found recognition hardest when presented with just one facial feature (such as an eye, a nose or a mouth) and easiest when presented with the top half of a face or a right hand portion of a face. Young & Bion (1981) investigated laterality effects by presenting 7 and 11-year-olds and adults with photographs of personally familiar faces (classmates or colleagues) to be named. They found an advantage for faces presented to the left visual hemifield, which was stable across age groups. Five-six-year-olds were able to carry out Diamond & Carey's (1977) paraphernalia task accurately when the faces used were those of their classmates. Carey & Diamond (1994) found the same pattern in 6 and 10-year-olds as adults using personally familiar faces in the face composite task. Ellis, Ellis & Hosie (1993) have shown adult-like patterns of repetition priming in 5-year-olds and demonstrated that familiarity speeded responses on a gender decision task, but not an expression decision task, as has been found in adults (Bruce, 1986). Thus, children's processing of familiar faces appears to be similar to adults.

There are, however, two notable exceptions suggesting that there may be developmental differences in familiar face processing. First, there is some evidence to suggest that, unlike adults, children do not use the internal features for familiar face recognition and that, instead, they find it easier to recognise familiar faces from the external features (Campbell & Tuck, 1995; Campbell, Walker & Baron-Cohen, 1995; Campbell, Coleman, Walker, Benson, Wallace, Michelotti & Baron-Cohen, 1999). Secondly, there is some evidence to suggest that children may not show the adult disadvantage for remembering the names of familiar people (Scanlan & Johnston, 1997). One of the primary aims of this thesis is to investigate these effects further. As very few studies have found differences in familiar face processing between children and adults, it was felt necessary to establish whether the external advantage and the name advantage found with children are reliable effects or whether they may have been due to the stimuli used. Three out of the four studies in question used famous faces and it is difficult to obtain a set of famous faces that children of different ages will be familiar with. For this reason, it is difficult to ascertain whether the results reflect reliable developmental differences or whether they reflect differing levels of familiarity with the famous faces used. This problem of interpretation is acknowledged by Carey (1981, p.31): - " it is extremely difficult to equate across age groups for familiarity with the stimuli....what appears as developmental differences across ages in recognition processes for familiar faces may reflect the failure to equate for degree of familiarity".

1.6 Structure of this thesis

The aim of this thesis is to explore whether there are developmental differences in face processing. The first experimental chapter investigates whether children rely on the same facial features as do adults when recognising familiar and unfamiliar faces. The primary question under investigation is whether children, like adults, find the internal features of familiar faces more useful for recognition than the external features. Famous faces were used in two of the three studies reporting an absence of an internal feature advantage for familiar faces in children. Famous faces may not be the most reliable stimulus to use in this type of research, therefore the experiments in Chapter 2 attempt to establish whether there is a genuine developmental difference in the features used to recognise familiar faces.

The experiments carried out in Chapter 3 are concerned with face naming. A robust finding in the adult literature is that the names of familiar people are harder to recall than other information about these people such as their occupation or nationality. One study has investigated whether similar patterns occur in childhood and reported that, in contrast to adults, children were faster when recalling names than other semantic information about known people (Scanlan & Johnston, 1997). This study also used famous faces as stimuli with a wide age range of children and therefore face naming was explored in depth in Chapter 3 to establish whether there are differences in the ways that children and adults represent knowledge for familiar people.

Very little is known about how children learn new faces and how the representation of an unfamiliar face changes as it becomes more familiar. Chapter 4 therefore investigates children's recognition of unfamiliar faces and attempts to track any representational changes occurring when new faces are learned. It also examines whether the changes that take place during familiarisation are the same for children and adults.

Chapter 2 Matching and Recognising Familiar Faces from the Internal and External Features

2.1 Introduction

The purpose of this thesis is to investigate whether there are developmental differences in the ways that children and adults recognise and learn faces. This chapter focuses on whether children find it easier to recognise familiar and unfamiliar faces from different parts of the face showing either the inner or outer facial features. It begins with a review of the matching and recognition studies carried out with adults, and then provides an overview of the results found with children using these tasks. The aim of the experiments that follow is to resolve some of the inconsistencies in the child literature.

Accuracy data from two matching studies are reported. In Experiment 1, 7-8-year-olds, 10-11-year-olds and young adults matched pairs of famous faces. In Experiment 2, children aged 10-11 years (Experiment 2a), 7-8 years (Experiment 2b) and 3-5 years (Experiment 2c) carried out matching and recognition tasks on personally familiar faces. The results show the standard effects of familiarity when highly familiar faces are used and call into question the appropriateness of using famous faces with children in this type of research.

2.2 Processing of the internal and external features

2.2.1 Adult studies

Different types of facial information are more useful for recognition depending on the familiarity of a face. The internal features comprise the inner part of the face (eyes, nose and mouth) and the external features show the outer part of the face (hair and face outline). Recognition rates for famous people are higher from the internal than the external features, (Ellis, Shepherd & Davies, 1979; Young, 1984). In contrast, the external and internal features of unfamiliar faces are recognised equally well (Ellis et al, 1979).

Young, Hay, McWeeny, Flude & Ellis (1985b) found similar results using a matching task. Participants were presented with pairs of faces, one showing a whole face image and the other showing either the internal or external features. Their task was to decide if the two images were of the same person or different people. Response times indicated that it was easier to match the internal features of a familiar face than an unfamiliar face whereas the external features of familiar and unfamiliar faces were matched equally as fast. There was no difference in response times between familiar internal and familiar external features, but unfamiliar external features were matched quicker than unfamiliar internal features. Bruce, Henderson, Greenwood, Hancock, Burton & Miller (1999) also found that the external features of unfamiliar faces were matched more accurately than the internal features to a whole face video image.

In summary, across recognition and matching tasks, the internal features of familiar faces are recognised more easily and are matched quicker than the internal features of unfamiliar faces. In contrast, there is no such difference between familiar and unfamiliar faces for the external features. Depending on the task and dependent measure used, performance on the internal features of familiar faces is either better than or equal to performance on the external features, whereas for unfamiliar faces performance on the internal features is either worse than or equal to performance on the external features.

2.2.2 Processing of the internal and external features - review of child studies

In contrast to these results, recognition tasks with children suggest that they recognise familiar people more accurately from their *external* features. Campbell, Walker & Baron-Cohen (1995) carried out a recognition task with children aged from 3-5-years, 5-7-years, 7-9-years and 9-11-years. Two sets of children were recruited at each age so that, for a specific age group, a child would see the photos of the children in his or her class (familiar faces) and the photos of the children of the same age from the second school or pre-school (unfamiliar faces). Photographs showed the whole face, the external or the internal features and on each trial the children were asked whether that person went to their school or not.

Different results were found for each age group. In the two youngest groups, accuracy was higher from the external than the internal features. The 7-9-year-olds were just as accurate with the internal and external features. In contrast, the oldest group (9-11-years) showed the adult pattern. They were more accurate with the internal than the external features. To check whether this was a reliable difference between young children and adults, Campbell & Tuck (1995) carried out a parallel study with adult faces in case these results were due in any way to a lack of variability in the internal features of child faces.

Campbell & Tuck (1995) tested 5-10-year-olds on a recognition task with famous faces that were mainly TV presenters and cartoon characters. The children were presented with photographs showing the whole face, the internal or the external features and were asked to name the face or provide other information that identified the person. The first analysis on the data included the human faces only and excluded the cartoon faces. Both the 5-6-year olds and the 7-8-year-olds showed no difference in recognition rates between the internal and external features. The 9-10-year-olds, however, did show a difference and recognised more people from their internal than external features. The second analysis included the cartoon faces and found the same effects as before for the two oldest groups. However, the youngest group recognised more faces from the external than the internal features. Thus, they found different results depending on which faces were included in the analysis. This raises the possibility that different famous faces may produce different results, especially with younger children.

Campbell, Coleman, Walker, Benson, Wallace, Michelotti & Baron-Cohen (1999) carried out one final study with 5-15-year-olds to check that the previous results were not due to the way the faces had been cropped to reveal the inner and outer parts of the face. The motivation behind this study was that these cropped images may have appeared unnatural to children and so prevented recognition from the internal features. Campbell et al (1999) therefore decided to blur the images so that the whole face was intact and either the internal or external features were blurred. Adults recognised more famous people when the outer part of the face was blurred leaving the inner part clear. However, 5-11-year-olds recognised more people from their external than their internal features, 12-13-year-olds showed no difference in recognition rates for the inner and outer face parts and it was only at age 14-15 years when recognition accuracy was higher for the internal than the external features.

Thus, all three recognition studies found evidence of better identification from the external features of familiar faces in children. However, there is need for caution before accepting the conclusion that there are differences between children and adults in their representations of familiar faces. Firstly, Campbell et al (1995) used personally familiar faces that showed some of the children's clothing in the external pictures. In some cases, children may have recognised the clothing and this extra cue may have increased recognition from the external features. Secondly, different presentation formats have produced different results with famous faces. The cropped images produced the adult advantage for the internal features in 9-10-year-olds whereas the blurred images produced an external advantage in this same age group. On a similar note, different results were obtained in the youngest group in Campbell & Tuck's study depending on which faces were included in the analysis. Finally, the recognition rates of famous people from the whole face images were quite low especially for the youngest children. (For example, the mean percentage of correct identifications from the whole face for 5-6-year-olds in both studies was 37%). These inconsistencies suggest that famous faces may not be the most suitable stimuli to investigate this ability in children, especially given the low recognition rates from even the whole face image.

These recognition studies also conflict with matching data (Newcombe & Lie, 1995). In this study, 5-year-old children matched familiar faces from their pre-school and unfamiliar faces from a different pre-school and showed a similar pattern of results as Young et al (1985b) found with adults using reaction times. The children matched the external and internal features of personally familiar faces equally well, they were more accurate when matching the internal features of familiar faces than the internal features of unfamiliar faces and were more accurate on the external than the internal features of unfamiliar faces. However, unlike adults, these children were also more accurate when matching the external features of familiar faces than the external features of unfamiliar faces. Thus, 5-year-olds' performance on this task is quite like adults in some respects. Importantly, there is no indication of an external or an internal advantage for matching familiar faces in this age group.

2.2.3 Processing of the internal and external features - review of infant studies

A few studies have tried to establish exactly when infants can recognise their mother's face from her internal or external features and have produced mixed results. Pascalis, de Schonen, Morton, Deruelle & Fabre-Grenet (1995) used a visual preference paradigm and found that 4-day-old infants could distinguish their mother from a stranger when the whole face was available, but could not do so when both women wore headscarves and the hair and face contour were not available. Bushnell (1982) found that from the age of 4 months, infants could make the distinction between mother and stranger's face when both women wore bathing caps. Bartrip, Morton & de Schonen (2001) compared looking times of infants aged 19-155 days for mother and stranger when the full face was available, the external features only were available and the internal features only were available. They found that 35-40-day-old infants could make the discrimination between mother and stranger when both women wore headscarves, whereas not until around 115-125 days could they make the discrimination when both women wore a face mask leaving only the external features available. These results conflict with Bushnell (1982) who found that infants could not make the discrimination when the external features were concealed until four months. These mixed results may reflect differences in methodology such as whether live faces or photographs are used.

It is therefore unclear from the child and infancy studies whether children represent the inner and outer features of familiar faces differently from adults or whether reported differences have been influenced by the different methodologies and stimuli used. The aim of the following experiments is to address these issues by investigating children's matching performance using both famous and personally familiar faces.

2.3 Experiment 1

The purpose of Experiment 1 was to examine 7-8 and 10-11-year-olds' performance on a face matching task. Recognition and matching tasks have both shown an internal advantage for familiar faces with adults. Recognition tasks with children, however, have found evidence of an *external* feature advantage for familiar faces. The matching task has only been used with 5-year-olds to date and found that external and internal features of familiar faces were matched equally well. Experiment 1 uses the matching task with 7-11-year-olds to determine whether they show a similar pattern of responses as adults or whether there is an external advantage for matching familiar faces in this age group.

Method

Participants

Thirty-six children (18 in each age group) took part. The younger group had a mean age of 7 years, 8 months, (age range = 7,0 - 8,10) and were made up of 10 girls and 8 boys. The older group had a mean age of 10 years, 6 months, (age range = 10,1 – 11,2) and were made up of 9 girls and 9 boys. A group of young adults who were likely to know the famous faces used were included for comparison. These were 18 undergraduate students at the University of Glasgow, with a mean age of 17 years, range from 16-20 years. Written parental consent was obtained for all children who were recruited from local primary schools in the Glasgow area.

Materials

Young et al (1985b) have shown that the difference between matching the internal features of familiar and unfamiliar faces only occurs when the two images of the same person are taken from different photographs of that person. Two full face photographs were therefore collected of nine British and nine American celebrities (unknown in the U.K.) from magazines and internet sites. Pilot work had helped to establish what British celebrities the 7-12 age group would be familiar with and American celebrities were chosen on the basis that this age group were unlikely to know any of these people. In addition, a distracter face for each target was obtained for use in the different trials. These images were all transformed to grey-scale and edited to a standard size (200 pixels wide x 300 pixels high) using image software. The external and internal features were taken from a duplicate of the whole face images and were created by cutting out a circle containing the eyes, nose and mouth. Face pairs were then created whereby two whole faces, two external feature images or two internal feature images were presented side by side. Same trials were made up of the two different images of the same person. Different trials consisted of one photograph of a target face and one of the distracter faces. These were printed out on A4 and made into booklets. See Figures 1a and 1b for some examples showing adult faces that were not used in either study.

Figure 1a Example of an external same person trial.

Figure 1b Example of an internal different people trial.

Design & Procedure

A mixed design was used with age as the between-subjects factor (7-8-year-olds, 10-11-year-olds and adults) and familiarity (familiar or unfamiliar), part of face (whole face, external features or internal features) and response (same or different) as the within-subject factors.

The matching task consisted of 36 trials, 18 showing familiar (i.e. the British) faces, and 18 showing unfamiliar (i.e. the American) faces. For familiar and unfamiliar faces, there were three same and three different whole face trials; three same and three different external feature trials; and three same and three different internal feature trials. Each target face was used twice, once in a same trial and once in a different trial. In order to counterbalance the faces so that each face appeared in each type of trial an equal number of times, three booklets with different stimuli were constructed. An equal number of participants in each age group was tested with each booklet. The order of stimuli was randomised throughout each booklet.

Testing took place in small groups. For each face pair, participants had to put a tick if they thought the two pictures were of the same person or a cross if they thought they were pictures of two different people. They were given practice with this procedure using faces that were not used in the experiment proper. Participants worked through their booklet at their own pace. Once they had completed their booklet, they were asked to name or give other information to identify each target face used to verify that they recognised the British faces and did not recognise the American faces. The data from any British faces participants could not identify and any American faces that they did identify were removed from the analysis.

Results

The mean percentage of correct answers obtained in each condition is displayed in Table 1 for each age group. Two types of analyses were carried out. Firstly, the data from all age groups was analysed together to check for any developmental trends and then the data from each age group was analysed separately to confirm whether the overall effects were present at each age group. Both types of analysis are performed for each experiment throughout this thesis.

Table 1: This table shows the mean percentage of correct answers in each condition for 7-8-year-olds, 10-11-year-olds and adults in Experiment 1 (with standard deviations in parenthesis).

Type of Trial	Whole		External		Internal	
	Familiar	Unfamiliar	Familiar	Unfamiliar	Familiar	Unfamiliar
			7-8-year-olds			
Same	64 (40)	69 (33)	42 (39)	39 (27)	62 (30)	60 (24)
Different	56 (44)	63 (34)	54 (33)	64 (30)	80 (30)	75 (32)
Overall	60 (26)	66 (26)	48 (26)	51 (15)	71 (25)	67 (16)
			10-11-year-olds			
Same	74 (31)	82 (22)	42 (32)	56 (39)	74 (31)	76 (27)
Different	87 (20)	67 (34)	67 (32)	75 (31)	70 (28)	74 (33)
Overall	80 (21)	74 (18)	54 (21)	65 (21)	72 (20)	75 (18)
			Adults			
Same	95 (14)	87 (18)	46 (35)	67 (32)	88 (20)	77 (27)
Different	96 (11)	91 (15)	81 (18)	75 (24)	80 (26)	76 (26)
Overall	95 (8)	89 (13)	63 (22)	71 (24)	84 (15)	75 (17)

Overall analysis

A 3 (age) x 2 (familiarity) x 3 (part of face) x 2 (response) analysis of variance (ANOVA) was performed on the accuracy data. This revealed a significant main effect of age $F(2,102) = 16$, $p<0.01$. For this main effect, a Tukey Honestly Significant Difference (HSD) test ($p<0.05$) revealed that adults (mean = 80%) were more accurate than 10-11-year-olds (mean = 70%) who were more accurate than 7-8-year-olds (mean = 60%). There was no difference in accuracy between familiar and unfamiliar faces, $F(1,51)<1$. There were main effects of part of face $F(2,102) = 23$, $p<0.01$ and response $F(1,51) = 4.4$, $p<0.05$, which were qualified by a significant two-way interaction $F(2,102) = 9.5$, $p<0.01$. Simple main effects were carried out to explore this interaction. This revealed that there was an effect of part of face for same decisions, $F(2,204) = 32$, $p<0.05$, but not different decisions, $F(2,204) = 2.1$, $p>0.05$. A Tukey HSD test ($p<0.05$) revealed that on same decisions, accuracy was higher on the whole face (mean = 78%) and the internal features (mean = 73%) than the external features (mean = 49%). Simple main effects analyses also revealed an effect of response for external features $F(1,153) = 19$, $p<0.01$, but not the whole face $F(1,153)<1$ or internal features $F(1,153)<1$. Accuracy on same decisions (mean = 49%) for the external features was significantly lower than on different decisions (mean = 69%). This was the case for familiar and unfamiliar faces and for all age groups. Even adults found it extremely difficult to decide that the external features showed the same person (overall mean = 56%). This suggests that matching performance on the external features may reflect difficulties with those particular stimuli rather than a genuine advantage for matching the internal features. This effect was also found for unfamiliar faces resulting in an *internal* benefit for *unfamiliar* faces which has never been reported before for adults or children and is therefore highly questionable.

There were no other significant interactions in the analysis, all Fs<1 except the interactions between age and part of face, $F(4, 102) = 1.7$, $p>0.05$; familiarity and part of face, $F(2,102) = 3$, $p>0.05$; age, familiarity and part of face, $F(4,102) = 1$, $p>0.05$; age, familiarity and response, $F(2,51) = 1.2$, $p>0.05$; age, part of face and response, $F(4,102) = 1.7$, $p>0.05$ and the four-way interaction, $F(4,102) = 1.7$, $p>0.05$.

Analysis by age groups

7-8-year-olds

A 2 (familiarity) x 3 (part of face) x 2 (response) within-subjects ANOVA was carried out on the percentage of correct responses. This revealed a main effect of part of face, $F(2,34) = 5.3$, $p<0.01$. The effect of familiarity was not significant, $F(2,34)<1$ and the effect of response was not significant, $F(1,17) = 1.6$, $p>0.05$. There was a significant interaction between part of face and response $F(2,34) = 3.8$, $p<0.05$. Simple main effects analyses revealed an effect of part of face for same, $F(2,34) = 5$, $p<0.01$, but not different trials, $F(2,34) = 2.9$, $p>0.05$. A Tukey HSD test revealed that on same trials, accuracy was lower on the external features (mean = 40%) than on whole face trials (mean = 66%), $p<0.05$. There were no other significant interactions: interaction between familiarity and part of face, $F(2,34) <1$; interaction between familiarity and response, $F(1,17) <1$ and three-way interaction, $F(2,34) <1$.

10-11-year-olds

The same ANOVA was carried out on the 10-11-year-olds' data and revealed an effect of part of face $F(2,34) = 10$, $p<0.01$. The main effect of familiarity was not significant, $F(1,17) <1$ and the main effect of response was not significant, $F(1,17) <1$. There was a significant interaction between part of face and response $F(2,34) = 3.3$, $p<0.05$. Analysis of the simple main effects revealed an effect of part of face for same decisions, $F(2,34) = 15$, $p<0.01$, but not different decisions, $F(2,34) <1$. A Tukey HSD ($p<0.05$) test revealed that, on same decisions, accuracy on the external features (mean = 49%) was significantly lower than on the internal features (mean = 75%) and the whole face (mean = 78%). There were no other significant interactions: interaction between familiarity and part of face, $F(2,34) = 2.2$, $p>0.05$; interaction between familiarity and response, $F(1,17) = 1.9$, $p>0.05$; three-way interaction, $F(2,34) = 1.4$, $p>0.05$.

Adults

The same analysis was performed on the adult data and revealed a main effect of part of face, $F(2,34) = 14$, $p<0.01$. The main effect of familiarity was not significant, $F(1,17) = 1.6$, $p>0.05$, and the main effect of response was not significant, $F(1,17) = 3.1$, $p>0.05$. There was a significant interaction between part of face and response, $F(2,34) = 7.7$, $p<0.01$ and a significant three-way interaction between familiarity, part of face and response, $F(2,34) = 4.3$, $p<0.05$. The interaction between familiarity and part of face was not significant, $F(2,34) =2.2$, $p>0.05$ and the interaction between familiarity and response was not significant, $F(1,17) <1$. To explore the three-way interaction, a 3 x 2 ANOVA was carried out on the familiar and unfamiliar data separately.

For familiar faces, there was an effect of part of face $F(2,34) = 17$, $p<0.01$, the effect of response was not significant, $F(1,17) = 2.8$, $p>0.05$, however, the interaction between part of face and response was significant, $F(2,34) = 16$, $p<0.01$. Simple main effects analysis revealed an effect of part of face for same decisions, $F(2,34) = 22$, $p<0.01$, but not different decisions, $F(2,34) = 2.7$, $p>0.05$. A Tukey HSD test ($p<0.05$) revealed that on same decisions, accuracy on the whole face (mean = 95%) and internal features (mean = 88%) was better than the external features (mean = 46%). There was also an effect of response for the external features, $F(1,17) = 13$, $p<0.01$, but not the whole face $F(1,17) <1$ or the internal features $F(1,17) <1$. On external trials, accuracy was higher on different (mean = 81%) than same decisions (mean = 46%).

The same 3 (part of face) x 2 (response) ANOVA was performed on the data from the unfamiliar faces. There was a significant main effect of part of face $F(2,34) = 3.6$, $p<0.05$. A Tukey HSD test ($p<0.05$) revealed that accuracy was lower on external trials (mean = 71%) than whole face trials (mean = 89%). The effect of response was not significant, $F(1,17) <1$, and the interaction between part of face and response was not significant, $F(2,34) <1$.

Discussion

In summary, the internal features were matched more accurately than the external features by all age groups, but this was the case for familiar *and* unfamiliar faces. An advantage for the internal features of unfamiliar faces has never been found before in adult studies. It appears that this effect has been caused mainly by the difficulty of matching two external pictures of the *same* person. The fact that this effect has been found in all age groups suggests that the pattern of results found reflects difficulties with the stimuli rather than an internal advantage for matching faces. It appears that two images of the same person quite often look like two different people. Perhaps this problem is exacerbated more when using images of famous people who change their hairstyles frequently.

A further problem when using famous faces is that not all children know the same faces and know them to the same extent. The verification task, carried out at the end of the matching task, revealed that not all children, especially the younger children, could identify most of the familiar faces. The mean number of familiar faces that were removed from the data was 1.9 (21%) for the younger children and 1.7 (19%) for the older children and the mean number of unfamiliar faces that were removed was 0.5 (5%) for the younger children and 2 (22%) for the older children. Despite removing the familiar faces that were not recognised, there was no overall benefit for familiar faces in any age group. Further, several of the American celebrities were identified by some children and although performance on these faces was removed, there may have been other children who *recognised* these people, but could not *identify* them. Thus, there may have been some sort of implicit advantage for these *unfamiliar* faces. This may have contributed towards the internal advantage found for the unfamiliar faces. It is suggested that the use of famous faces by Campbell et al is responsible for the mixed results found in their own studies, for example, sometimes getting an internal advantage at age 9-10 and other times finding an external advantage in this age group.

It is therefore clear that famous faces are not a suitable stimulus to use when investigating children's familiar face processing, as it is unlikely that all children taking part in a particular study will recognise all of the famous faces used. Other researchers have noted these difficulties when trying to find a set of suitable stimuli to investigate children's naming of familiar faces. For example Scanlan & Johnston (1997) highlight "the difficulty in generating stimuli that are familiar to all members of a population of children", page 186. Abdel Rahman, Sommer and Olada (2004) experienced similar problems in finding appropriate stimuli - "it is difficult to find a set of real persons that are highly familiar to all children participating in the study", page 822. Thus, the children who take part in a particular experiment will differ in their knowledge of the famous faces used in that experiment and their level of familiarity with the stimulus faces cannot be controlled. This problem has resulted in unreliable findings in the child literature with different famous faces producing different results. This leads us to the question of where we might find a set of suitable familiar stimuli to use with children.

One source of familiar faces is children's classmates. These are people that they see and interact with every day and so familiarity with these faces is assured. Further, each child will be familiar with the other children in the class to roughly the same extent. The use of children's classmates as the familiar stimuli consequently resolves the problems outlined above when carrying out this type of research with famous faces.

Personally familiar faces have been used in previous research with children. Campbell et al (1995) showed children pictures of their classmates from the external and internal features and asked participants whether the person in each picture went to their school or not. Children aged from 3-7 years were more accurate with the external features, 7-9-year-olds showed no difference and only at age 9-11-years were children more accurate with the internal features. However, as mentioned previously, the external photographs showed some of the children's clothing and this extra cue could possibly have increased the results from the external pictures in the younger groups. Campbell et al (1999) also carried out an experiment using personally familiar faces. They tested children with learning disabilities who attended a Saturday activity school on the faces of family members and helpers from the school. These children recognised more people from the external features than the internal features. Six typically developing children were also tested on these faces as controls. These children were recruited from the families of the carers or were friends of the experimental participants and were also more accurate at recognising people from the external than the internal features. However, there were only six children in this sample and there is no indication of how familiar they are with the people used as stimuli. It is unlikely that the children are as familiar with these people as they are with their classmates. It is therefore possible that these faces, like famous faces, may not be the most reliable stimuli with which to investigate children's familiar face recognition.

Stimulus familiarity was fully controlled in the following experiments by using the faces of children's classmates as the familiar stimuli and the faces of children who were the same age from a different school as the unfamiliar stimuli. In this way, all children are highly familiar with the familiar faces and are definitely unfamiliar with the unfamiliar faces. This technique also ensures that the results are not due to the visual characteristics of any particular faces as each face will be familiar to half of the participants and unfamiliar to the other half of participants.

2.4 Experiments 2a, 2b & 2c - Introduction

The matching task is employed in the following three experiments, however, this time personally familiar faces are used rather than famous faces. The reason for using personally familiar faces is that an unusual and unpredicted pattern of results was obtained in Experiment 1 with famous faces. It was found that the internal features of both familiar and unfamiliar faces were matched more accurately than the external features. This result appears to have been influenced by the particular stimuli used in this experiment whereby both children and adults found it very difficult to match the external features of the same person. The use of famous faces with children has previously led to mixed results with different famous faces producing a different pattern of results (e.g. Campbell & Tuck, 1995; Campbell et al, 1999). It was therefore concluded that the particular images used in Experiment 1 have influenced the results and that famous faces are not a reliable stimulus to use with children in this type of research.

Children's familiarity with the stimulus faces is assured in the following experiments by using photographs of their classmates. However, using personally familiar faces for this type of research brings its own set of problems. First of all, it is necessary to acquire parental permission to take photographs of the children and to use them in the experiment. Secondly, it is necessary to obtain permission for a reasonable number of children from the same class to generate enough stimuli for the experiment. The first school that agreed to take part in this experiment could not be used because only five parents agreed for pictures of their child to be taken. It was therefore necessary to recruit children from another school. Thus, it is a difficult and time-consuming process to get enough pictures of children from the same class to use as stimuli. However, the use of personally familiar faces overcomes the difficulties with famous faces outlined above and the results obtained will be reliable findings rather than a reflection of the visual characteristics of the stimulus faces or the differing levels of familiarity children have with the particular famous faces used.

The matching task is employed in the following experiments where the familiar faces are children's classmates and the unfamiliar faces are children of the same age from a different school. The data from three age groups are reported separately as different stimuli are used for each age group. This is in contrast to the previous experiment where all participants were tested with the same stimuli. After the matching data are reported, details of the same children's performance on a recognition task are provided.

2.4.1 Experiment 2a

Method

Participants

These were 38 10-11-year-old children, 23 girls and 15 boys, with a mean age of 10 years, 10 months (age range of 10 years, 4 months – 11 years, 4 months).

Materials

Two photographs were taken of each child – one frontal image and one from a 3/4 viewpoint. Glasses were removed and children were asked to smile. The two photographs were taken on the same day, therefore the external features in each picture were very similar. This should prevent any difficulties with external feature matching that occurred in Experiment 1. All photographs were converted to grey scale and edited to a standard size (200 pixels wide x 300 pixels high) using image software. A picture showing the internal features and one showing the external features were then created from a duplicate of each photograph. As in Experiment 1, these pictures were used to make up face pairs showing the whole face, the external features and the internal features. As before, same trials were made up of the two different images of the same person. Different trials consisted of two images of different people. The different pairs were selected from children of the same sex and race from the same class. See Figures 2a and 2b for examples of an external same person trial and an internal different people trial.

Figure 2a: Example of an External Same Person Trial

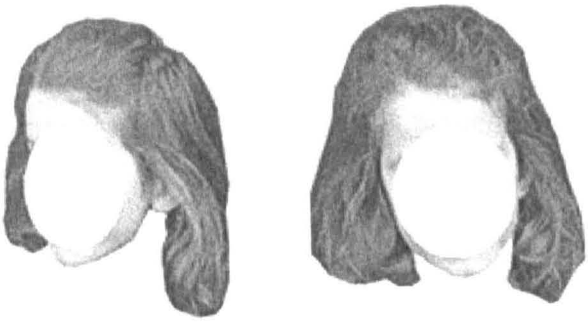


Figure 2b: Example of an Internal Different People Trial.

Design & Procedure

These were the same as Experiment 1 except for the following details. The images were printed out on A4 and three folders were constructed with the same number of trials in each condition as in the previous experiment. The children were tested individually in a quiet room within the school. They completed the same six practice trials using famous faces and then carried out the 36 experimental trials. Each child was given one of the three folders and was asked to look at each pair of faces and to decide if the two pictures were of the same person or different people. The experimenter noted each response, which each child gave vocally, saying either "Same" or "Different" for each face pair. They were told to guess when they were not sure. The order of stimuli was randomised for each child. Once they had completed these trials, they carried out a verification test whereby they had to identify each person from their class from the whole face frontal images. They were also shown the faces of the children from the other school in case they could identify any of these children. Each child successfully identified the other children from their own class and no child ever identified someone from the other school, thus ensuring that all unfamiliar faces were indeed unfamiliar to the relevant participants.

Results

The mean percent correct obtained on each type of trial is displayed in Table 2a. A 2 x 3 x 2 within-subjects ANOVA was carried out on the percentage of correct answers with familiarity, part of face and response as factors. This revealed a main effect of familiarity F(1,37) = 67, p<0.01, a main effect of part of face F(2,74) = 12.8, p<0.01, and a significant interaction between these two factors F(2,74) = 9.7, p<0.01. The main effect of response was not significant, F(1,37) <1.

Table 2a shows the mean percentage of correct answers (with standard deviations) obtained in each type of trial.

Type of Trial	Whole		External		Internal	
	Familiar	Unfamiliar	Familiar	Unfamiliar	Familiar	Unfamiliar
			10-11-year-olds			
Same	98 (7)	91 (17)	85 (21)	81 (23)	97 (9)	77 (26)
Different	100 (0)	85 (20)	90 (15)	83 (20)	95 (14)	68 (27)
Overall	99 (4)	88 (13)	88 (14)	82 (18)	96 (10)	72 (14)

To explore the interaction between familiarity and part of face, simple main effects analyses were carried out. There was an effect of familiarity for the whole face, F(1,37) = 14.7, p<0.01, and the internal features, F(1,37) = 69, p<0.01, but not the external features, F(1,37) = 4, p>0.05. Thus, familiarity with a face improved matching performance on the whole face and the internal features, but not the external features. There was an effect of part of face for both familiar, F(2,74) = 7.9, p<0.01 and unfamiliar faces, F(2,74) = 14.7, p<0.01. Tukey HSD tests (p<0.05) revealed different patterns of responses for familiar and unfamiliar faces. On familiar faces, accuracy was higher on both the whole face (mean = 99%) and the internal features (mean = 96%) than the external features (mean = 88%). In contrast, on unfamiliar faces, accuracy on both the whole face (mean = 88%) and the external features (mean = 82%) was better than the internal features (mean = 72%).

There was a significant interaction between part of face and response $F(2,74) = 3.4$, $p<0.05$. Simple main effects analyses were carried out to explore this interaction. This revealed an effect of part of face for same, $F(2,74) = 8.2$, $p<0.01$ and different responses, $F(2,74) = 7.5$, $p<0.01$. Tukey HSD tests ($p<0.05$) revealed that on same responses, accuracy was higher on the whole face (mean = 95%) than both the internal (mean = 87%) and the external features (mean = 83%). On different responses, accuracy on the whole face (mean = 92%) was significantly higher than on the internal features (mean = 81%) only.

There were no other significant interactions: interaction between familiarity and response, $F(1,37) = 2.3$, $p>0.05$ and three-way interaction, $F(2,74) <1$.

Recognition task

After the matching and verification tasks had been carried out, each child participated in a recognition task. Here, they saw the faces of the children in their class only. Half of these faces showed the external features and half of these faces showed the internal features for one half of participants and vice versa for the other half of participants. Children had to name the person in each photo or give other information to identify them. More class mates were identified from their internal features (mean = 88% correct) than their external features (mean = 78% correct), $t(37) = 3.1$, $p<0.01$.

Discussion

The adult advantage for the internal features of familiar faces was found in 10-11-year-olds. Matching performance was more accurate on the internal features of familiar than unfamiliar faces and there was no difference between the external features of familiar and unfamiliar faces. Performance was better on the external than the internal features of unfamiliar faces, a result that has also been found with adults (Bruce et al, 1999). Similarly, these 10-11-year-olds recognised more familiar faces from the internal than the external features. This is consistent with Campbell & Tuck (1995) and Campbell et al (1995) who found that children aged 9-11-years recognised more familiar people from the internal features. In Experiment 2b, these abilities are investigated in younger children to determine whether an internal advantage will be found in this age group.

2.4.2 Experiment 2b

Method

Participants

These were 46 7-8-year-old children, recruited from two primary schools. There were 30 girls and 16 boys, with a mean age of 7 years, 11 months (age range = 7 years, 3 months – 8 years, 7 months).

Materials, Design & Procedure

These were identical to Experiment 2a except that the stimuli showed the faces of these 7-8-year-old children.

Results

The mean percent correct obtained on each type of trial is displayed in Table 2b.

Table 2b shows the mean percentage of correct answers (with standard deviations) obtained in each type of trial.

Type of Trial	Whole		External		Internal	
	Familiar	Unfamiliar	Familiar	Unfamiliar	Familiar	Unfamiliar
			7-8-year-olds			
Same	96 (10)	72 (29)	68 (31)	64 (28)	87 (22)	68 (33)
Different	94 (14)	69 (27)	72 (26)	64 (32)	80 (26)	57 (32)
Overall	95 (11)	70 (15)	70 (18)	64 (15)	83 (17)	62 (20)

A 2 x 3 x 2 within-subjects ANOVA was carried out on the percentage of correct answers with familiarity, part of face and response as factors. This revealed a main effect of familiarity $F(1,45) = 89$, $p<0.01$; a main effect of part of face $F(2,90) = 25$, $p<0.01$, and a significant interaction between these two factors $F(2,90) = 9.9$, $p<0.01$. The main effect of response was not significant, $F(1,45) <1$.

To explore the interaction between familiarity and part of face, simple main effects analyses were carried out. There was an effect of familiarity for the whole face, $F(1,45) = 63$, $p<0.01$ and the internal features, $F(1,45) = 44$, $p<0.01$, but not the external features, $F(1,45) = 3.1$, $p>0.05$. As was found with the older children in Experiment 2a, familiarity with a face improved performance on the whole face and the internal features, but not the external features. There was an effect of part of face for both familiar, $F(2,90) = 32$, $p<0.01$, and unfamiliar faces, $F(2,90) = 3.5$, $p<0.05$.

Tukey HSD tests ($p<0.05$) revealed different patterns of response for familiar and unfamiliar faces. On familiar faces, accuracy was higher on the whole face (mean = 95%) than the internal features (mean = 83%) which was in turn higher than on the external features (mean = 70%). On unfamiliar faces, accuracy on the whole face (mean = 71%) was higher than the internal features only (mean = 63%).

No other interactions were significant: interaction between familiarity and response, $F(1,45) <1$; interaction between part of face and response, $F(2,90) = 1.6$, $p>0.05$ and three-way interaction, $F(2,90) <1$.

Recognition task

More class mates were identified from their internal features (mean = 69% correct) than their external features (mean = 51% correct), $t(45) = 5.4, p<0.01$.

Discussion

Like the older children in Experiment 2a, 7-8-year-olds were more accurate when matching the internal than the external features of these familiar faces. There was no difference between performance on the external and internal features on unfamiliar faces. They were also more accurate on the internal than the external features in the recognition task. Like the 10-11-year-olds in Experiment 2a and adults in the Young et al (1985b) study, familiarity with a face improved matching of the internal but not the external features. This is the first time the adult pattern has been found in children as young as 7. Newcombe & Lie (1995) found that 5-year-olds matched the internal and external features of personally familiar faces equally well, therefore Experiment 2c examined whether similar effects would be found with even younger children.

2.4.3 Experiment 2c

Method

Participants

Children aged between 3 and 5 years of age were recruited from two nurseries. They consisted of 25 children, 14 girls and 11 boys, with a mean age of 3 years, 10 months (age range = 3,0 - 4,11).

Materials, Design & Procedure

These were identical to Experiments 2a & 2b except for the following details. The stimuli used were the faces of the children in the two nurseries and the practice stimuli were not the famous faces used with the older children but pictures of cars with the 'inner' part and 'outer' part edited to approximate the internal and external features of the faces.

Results

The mean percent correct obtained on each type of trial is displayed in Table 2c.

Table 2c: This table shows the mean percentage of correct answers in each condition in Experiment 2c with standard deviations in parenthesis.

Type of Trial	Whole		External		Internal	
	Familiar	Unfamiliar	Familiar	Unfamiliar	Familiar	Unfamiliar
			3-5-year-olds			
Same	87 (19)	56 (30)	48 (33)	49 (36)	49 (31)	37 (34)
Different	92 (14)	75 (29)	92 (14)	67 (33)	76 (25)	71 (31)
Overall	89 (11)	65 (14)	70 (17)	58 (17)	62 (16)	54 (19)

A 2 x 3 x 2 within-subjects ANOVA was carried out on the percentage of correct answers with familiarity, part of face and response as factors. This revealed a main effect of familiarity $F(1,24) = 51$, $p<0.01$; a main effect of part of face $F(2,48) = 19$, $p<0.01$; and a main effect of response $F(1,24) = 16.5$, $p<0.01$. There were also significant interactions between familiarity and part of face $F(2,48) = 3.9$, $p<0.05$; between part of face and response $F(2,48) = 3.7$, $p<0.05$, and a significant three-way interaction between familiarity, part of face and response $F(2,48) = 4.1$, $p<0.05$. The interaction between familiarity and response was not significant, $F(1,24) <1$.

Separate analyses were carried out on the data for familiar and unfamiliar faces to explore the three-way interaction.

A 3 (part of face) x 2 (response) within-subjects ANOVA performed on the familiar data revealed an effect of part of face $F(2,48) = 20$, $p<0.01$; an effect of response $F(1,24) = 24$, $p<0.01$ and a significant interaction between these two factors $F(2,48) = 8.6$, $p<0.01$. Analysis of the simple main effects revealed an effect of part of face for same, $F(2,48) = 26$, $p<0.01$, and different responses, $F(2,48) = 4.5$, $p<0.05$. Tukey HSD tests ($p<0.05$) revealed that on same trials, the whole face (mean = 87%) was matched more accurately than the external (mean = 48%) and internal features (mean = 49%). On different trials, the whole face (mean = 92%) and external features (mean = 92%) were matched more accurately than the internal features (mean = 76%). There was also an effect of response for the external, $F(1,24) = 24$, $p<0.01$, and the internal features $F(1,24) = 8.8$, $p<0.01$, but not the whole face, $F(1,24) <1$. Accuracy on the external and internal features was much higher on different than same trials whereas performance was equal on the whole face on same and different trials.

The same 3 (part of face) x 2 (response) ANOVA was performed on the data from the unfamiliar faces. There was an effect of part of face $F(2,48) = 3.6$, $p<0.05$. A Tukey HSD test ($p<0.05$) revealed that the whole face trials (mean = 65%) were matched more accurately than the internal features (mean = 54%). There was a significant main effect of response, $F(1,24) = 7.4$, $p<0.05$, whereby different trials (mean = 71%) were matched more accurately than same trials (mean = 47%). The interaction between part of face and response was not significant, $F(2,48) = 1.1$, $p>0.05$.

Recognition task

Children recognised more people from their external features (mean = 43%) than the internal features (mean = 36%), but this difference failed to reach significance, $t(24) = 1.9$, $p = 0.06$.

Discussion

In contrast to the two older groups, there is some evidence of an *external* advantage for familiar faces in this youngest group. This can be seen on different trials, where accuracy was higher on external than internal features and on the recognition task where there was a trend for class mates to be more easily identified from the external features. Evidence of an external advantage has previously been reported in this age group (Campbell et al, 1995) when cartoon faces were included in the analysis. Further work is required to establish whether these are reliable differences between 3-5-year-olds and older children and adults or whether they reflect a response bias as the external advantage was only found on different trials in the matching task.

2.5 General Discussion

The aim of this thesis is to investigate whether there are differences in the ways that children and adults recognise familiar and unfamiliar faces. A robust finding with adults is that they recognise familiar faces more easily from the internal than the external features (Ellis et al, 1979; Young et al, 1985b). Studies with children, however, suggest that they are better at recognising familiar faces from the *external* features up until around age 10-11 years and that the adult internal advantage may not be fully developed until 14-15 years of age (Campbell et al, 1999). However, there were several inconsistencies in these child studies that needed to be addressed before concluding that there are differences in the ways that children and adults represent familiar faces.

The major issue concerns the suitability of famous faces in this type of research. Previous experiments with famous faces found different results in 9-11-year-olds. Campbell & Tuck (1995) found an internal advantage for recognising famous faces whereas Campbell et al (1999) found an external advantage in the same age group. Further, Campbell & Tuck (1995) found an external advantage in 5-6-year-olds, but only when certain famous faces were included in the analysis. Here, children's matching performance using famous faces was investigated and revealed unpredicted results. There were no differences in matching performance between familiar and unfamiliar faces, even with adults. Accuracy was higher on the internal than the external features of both familiar and unfamiliar faces. This was the case when deciding whether two images were of the same person but not when the images were of different people. It is concluded that the results from Experiment 1 reflect difficulties with the external stimuli rather than a genuine advantage for matching the internal features. The particular famous faces used by Campbell & Tuck (1995) and Campbell et al, (1999) may also have influenced previous results obtained with children. The reliability of using famous faces in this type of research is therefore seriously questioned. This problem occurs again in the following chapter concerning children's naming of famous faces.

Even when personally familiar faces have been used in previous research, the stimuli have not been ideal for investigating children's familiar face recognition. In the Campbell et al (1995) study using pictures of children's classmates, an extra cue was available to children in the external condition as clothing was visible, which may have improved children's performance in this condition. Finally, the personally familiar faces used by Campbell et al (1999) may have not been very familiar to the control participants as the stimulus faces were family members and helpers of learning disabled children attending a Saturday school which the control participants did not actually attend.

In an attempt to resolve these issues, Experiments 2a, 2b and 2c used the faces of children's classmates. In this way, familiarity was guaranteed and the children were highly familiar with the stimuli. Further, each face was familiar to half of the participants and unfamiliar to the other half of participants. This rules out the possibility that the results could be due to the visual characteristics of any particular faces, a factor that may have influenced the results in Experiment 1. The two photographs of each child were taken on the same day to overcome the difficulties participants had in Experiment 1 when matching the external features of the same person.

Experiments 2a and 2b showed that 7-8 and 10-11-year-olds were more accurate at matching the internal features of familiar faces than unfamiliar faces. In contrast, the ability to match the external features was comparable for familiar and unfamiliar faces in both age groups. This is the pattern of results obtained with adults using response times by Young et al (1985b) and suggests that by the age of 7, children are using the same types of processing strategies as adults to match familiar and unfamiliar faces. Like adults, different types of facial information are more helpful depending on the familiarity of the face. When faces were familiar, both age groups were more accurate at matching the internal than the external features. In contrast, when faces were unfamiliar, both age groups were poorer at matching the internal than the external features. In the younger group, this difference was not significant, consistent with the adult pattern reported by Young et al (1985b). In the older group, the external features of unfamiliar faces were matched more accurately than the internal features, consistent with the data from Bruce et al (1999). Thus, slightly different results for the unfamiliar faces were found for the 7-8 and 10-11-year-olds, but both patterns have previously been found with adults.

Further, like adults, both 7-8 and 10-11-year-olds recognised more classmates from the internal features than the external features. Taken together, the evidence from both the matching and recognition tasks suggests that from the age of 7, there is evidence that children process familiar faces in the same way as adults when appropriate stimuli are used to examine their familiar face processing skills.

These results show, for the first time in a group as young as 7, an advantage for internal features in familiar face matching. What about even younger children? Newcombe & Lie (1995) found that 5-year-olds matched the external and internal features of personally familiar faces equally well. Experiment 2c extended this work by investigating 3-5-year-olds' matching performance. This provided some preliminary evidence indicating an *external* advantage for familiar faces. Accuracy was higher on the external than the internal features on different trials, but not same trials. Performance was higher on different than same trials overall and this pattern was also found by Newcombe & Lie (1995). Perhaps very young children genuinely find different trials easier than same ones, or perhaps there is a response bias towards different when they are unsure. There was also a trend in the recognition data for more faces to be recognised from the external features. It is recommended that the results from Experiment 2c be regarded as a preliminary study as there is only evidence of an external advantage on different trials. Further replication is required to determine whether this is a reliable result in this youngest age group.

Taken together, the evidence from Experiments 2a and 2b suggests that adult-like processing is in place from the age of 7 and that there are gradual, quantitative improvements with increasing age. According to the present results, any qualitative shift that takes place in children's face processing should occur between the ages of 3-7, much earlier than previous studies have suggested. Further work is required with this age group to determine whether there is an external advantage in 3-5-year-olds as suggested by Experiment 2c and to identify when any qualitative shift in this skill takes place. It would also be worthwhile to investigate these skills in children aged 12-13 who have recently moved to secondary school and are in the process of meeting a lot of new people. Some researchers have reported a dip in face recognition performance at this age (Carey, et al, 1980; Flin, 1980), raising the possibility that 12-13-year-olds may not show an internal advantage for faces of their new classmates.

What factors may account for the development of an internal feature advantage in the matching task? Children's ability to process eye gaze, facial expressions, and to read lip movements improves steadily between the ages of 6 and 11 (Bruce et al, 2000) and the development of these skills may be related to an enhanced mental representation of the inner facial features. Children's ability to use the configural information (i.e. the spatial relationships between the different features) from faces also develops between these ages (e.g. Carey & Diamond, 1994; Hay & Cox, 2000; Mondloch, Le Grand & Maurer, 2002). Carey & Diamond (1977) and Diamond & Carey (1977) proposed that younger children represent faces as independent features and that by the age of 10 they represent the configurational information from faces. It is not known from the current data whether the internal features are represented configurally or featurally by the younger or older children. There is some evidence that younger children may represent the internal features separately. Hay & Cox (2000) found that 6-7-year-olds recognised more target faces when the eyes alone were presented at test than 9-10-year-olds, indicative of a decline in featural processing. However, this difference was found only for the eyes and not the nose or mouth. Further work is therefore required to determine whether children of different ages represent the internal features separately or as a configuration.

This chapter has resolved some of the inconsistencies in the child literature regarding the development of an internal advantage for familiar faces. It is argued that famous faces are unsuitable stimuli to investigate children's familiar face processing and that this has contributed to the mixed results from previous studies and the results from Experiment 1. When appropriate stimuli were used, in this case highly familiar faces, adult-like processing was found in children as young as 7 years. Both 7-8 and 10-11-year-olds matched the internal features of familiar faces more accurately than the external features and also recognised more of their classmates from the internal features. It is still unclear what developments are taking place in children under 7 years, although there is some evidence of an external feature advantage in 3-5-year-olds. This possibility requires further investigation.

This chapter has found clear differences between familiar and unfamiliar face processing in children. This is consistent with most models of adult face recognition (e.g. Bruce & Young, 1986; Hancock, Bruce & Burton, 2000). There is very little information about the process of how faces become familiar. Having established that there are differences in the matching of familiar and unfamiliar faces, this thesis addresses the question of how children learn new faces and how representations of the internal and external features change as faces become more familiar in Chapter 4. The next chapter compares naming of famous and personally familiar faces to determine whether there are qualitative differences between adults and children in their abilities to recall the names of familiar people.

Chapter 3 Recall of the names and semantic information of familiar people

3.1 Introduction

The purpose of this thesis is to determine whether there is anything qualitatively different about the way in which children and adults process faces. The previous chapter investigated whether children show the adult advantage for recognising familiar faces from the internal features. The standard effects of familiarity reported for adults were found with 7-11-year-olds when personally familiar faces were used, but not when famous faces were used. This chapter examines children's naming of both famous and personally familiar faces to determine whether children show the same difficulties as adults when trying to remember names.

3.2 Name retrieval difficulties - evidence from adult studies

Evidence from several areas shows that adults have more difficulties remembering names than other types of biographical knowledge about familiar people. This has been demonstrated in naturally occurring incidents where people frequently report experiencing difficulties in retrieving someone's name whilst being able to remember other information such as the person's occupation or where they would usually be seen (Cohen & Faulkner, 1986; Young, Hay & Ellis, 1985a). In contrast, being able to name someone and yet not know anything else about that person was not reported by any of the diarists in Young et al's (1985a) study.

Similar effects have been reported in laboratory studies. Upon presentation of famous faces, it is common for participants to be able to recall someone's occupation whilst being unable to retrieve their name whereas it is extremely rare for the name of a celebrity to be remembered but not their occupation (e.g. Hanley & Cowell, 1988; Hay, Young & Ellis, 1991).

Studies comparing response latencies have shown that face naming takes longer than categorising faces by their occupation or nationality. For example, Sergent (1986) found that Psychology students were faster at classifying members of the department as professors or non-professors than they were at naming these people. Young, McWeeny, Ellis, & Hay, (1986b) demonstrated that face naming took longer than semantic categorisation even when a small stimulus set was used and participants had practised naming the faces prior to the experiment proper. One possible explanation for these results is that classifying faces by semantic category is easier than producing names as there are only two options to consider in the semantic category (for example politician or non-politician) whereas in the naming task quite a range of responses are required. However, when response requirements are equated across the two tasks, difficulties in name retrieval still persist. Matching tasks have shown that it takes longer to decide whether two faces share the same first name than it does to decide if they share the same occupation, the same nationality or whether the two people are both alive or dead (Carson, Burton & Bruce, 2000; Johnston & Bruce, 1990; Young, Ellis & Flude, 1988).

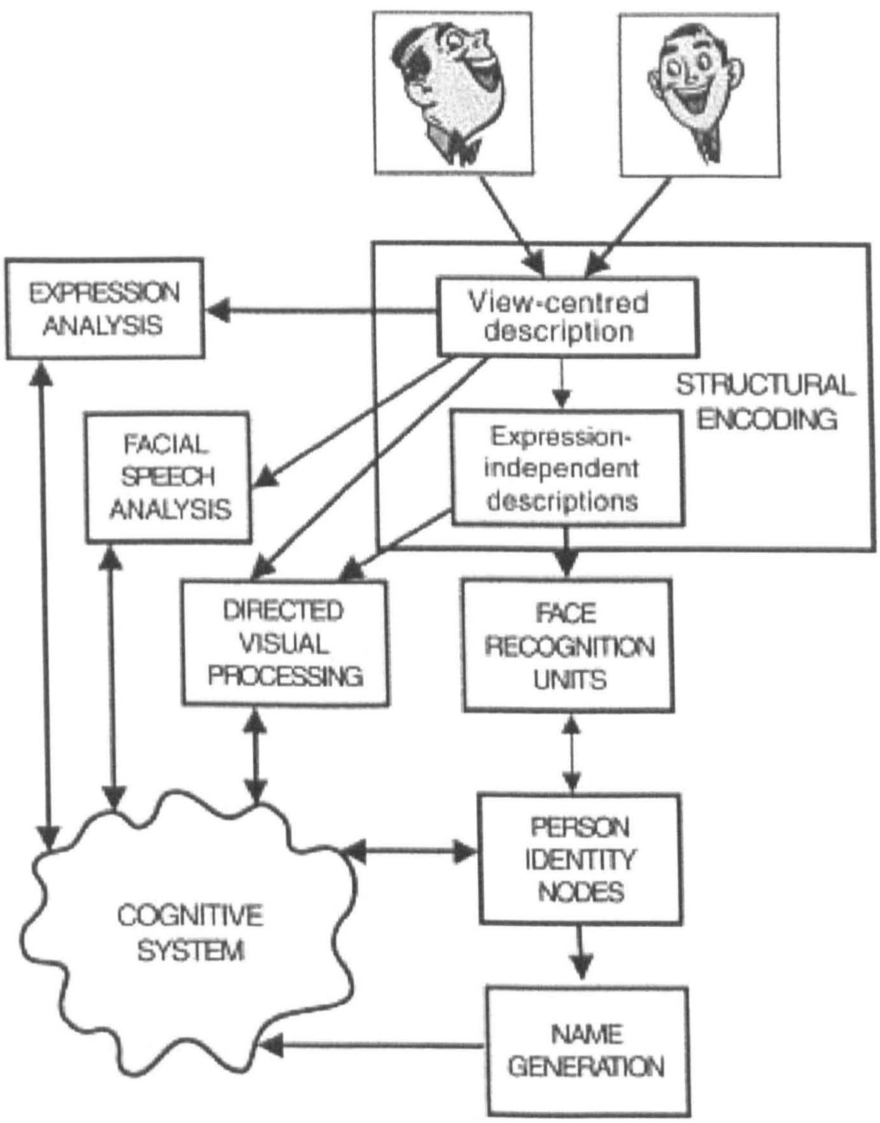
Burton, Jenkins & McNeill (2002) compared response latencies using a voice response for both the name and the semantic task. They used a set of just four famous faces, comprising two politicians and two pop stars where one person from each category was called Peter and the other one was called Paul. Despite practice at saying the names and occupations and repeated experimental trials, participants still took significantly longer to name these faces than to say the person's occupation. A different group of participants were asked to read aloud the printed words Peter, Paul, politician and pop star and showed no difference in articulation latencies when reading these words.

Difficulties in name recall have also been observed in neuropsychological studies where patients are able to recall the occupations but not the names of famous faces (e.g. Flude, Ellis & Kay, 1989) and in learning studies where it is harder to remember someone's name than their occupation (e.g. Carson, et al, 2000; Cohen & Faulkner, 1986; Stanhope & Cohen, 1993). This is the case even when the same word is used as an occupation and as a name (McWeeny, Young, Hay & Ellis, 1987). Thus it is harder to learn that someone is called Mr Baker than it is to remember that he is a baker. Chapter 4 will investigate children's ability to learn new faces and will examine whether they experience the same difficulties as adults when trying to remember the names of newly learned people. The focus of this chapter is on children's recall of the names of familiar people and whether they experience the same difficulties with name retrieval as do adults. If children do show a different pattern from adults and instead find it easier to recall the names of familiar people than semantic information about them, then current explanations of naming difficulties will require some revision to account for this developmental difference.

3.3 Theoretical accounts of naming difficulties

Early theories of face and person recognition (e.g. Bruce & Young, 1986; Hay & Young, 1982) detail a hierarchy of stages whereby a face is firstly recognised as familiar, then biographical information is retrieved and finally the person's name may be recalled. The Bruce & Young (1986) model of face recognition and identification shown in Figure 3.1 illustrates this serial process. This influential model of face recognition accounts for difficulties in name retrieval by suggesting that names are stored separately from other semantic information and that names can only be retrieved after some semantic information has been accessed. The process of face naming proceeds as follows. We must first recognise that a face is familiar by matching information from the visual properties of the face with stored representations we have for each face known to us (these stored representations are referred to as face recognition units or FRUs). We then try to work out why a particular face is familiar by accessing semantic information from the person identity nodes (PINs). Only upon retrieval of this identity specific semantic information can we then access name codes. This sequential model can therefore explain why it takes longer to retrieve someone's name than semantic information such as occupation. It can also account for the pattern of difficulties reported above in diary and experimental situations whereby it is common to know that a face is familiar and be able to say something about the person, but be unable to retrieve his or her name. It can also explain the absence of a case where we can provide someone's name and no semantic information about him or her.

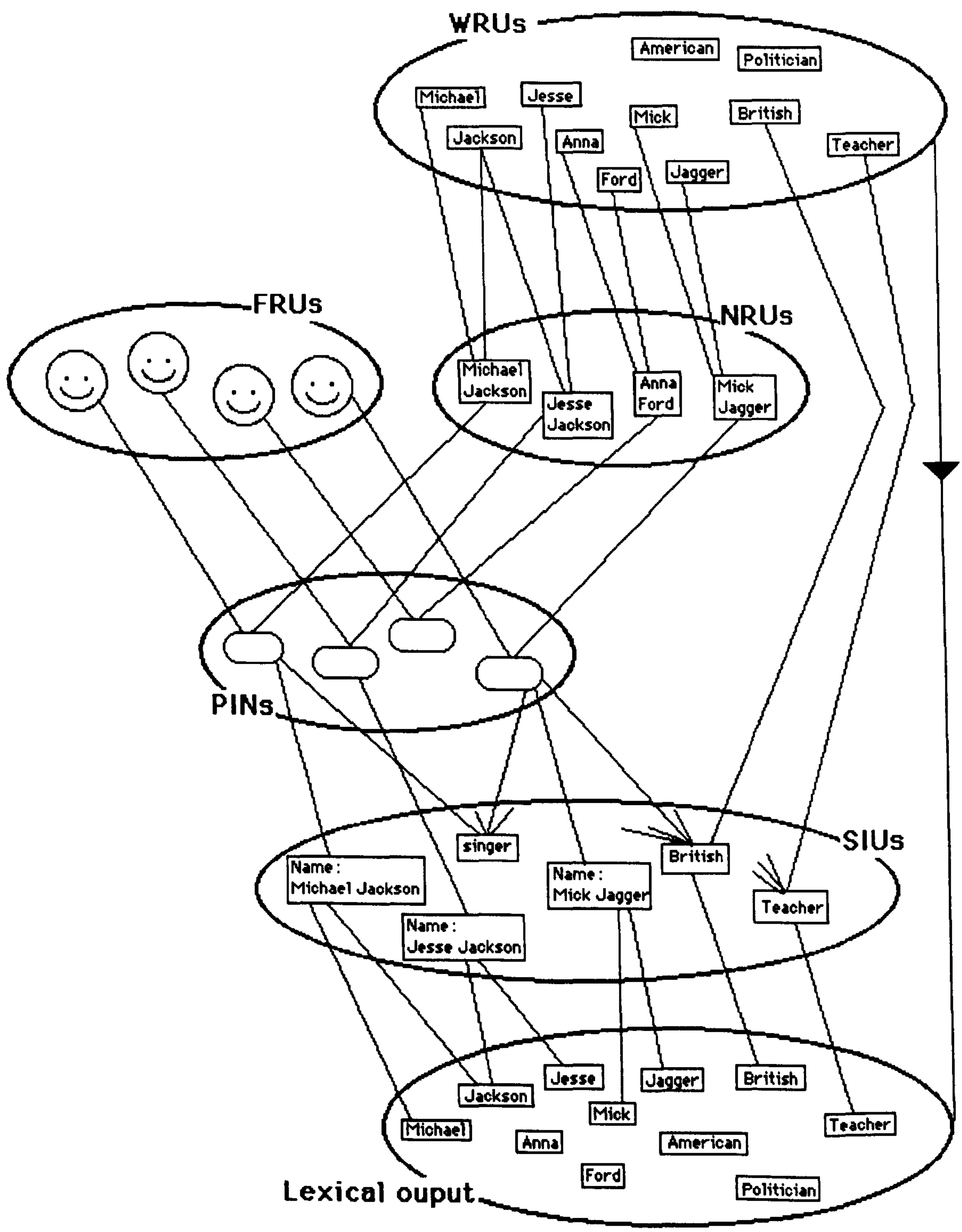
Figure 3.1 Bruce & Young (1986) functional model for face recognition



An alternative explanation for difficulties in name retrieval is provided by interactive activation and competition (IAC) models of person recognition (e.g. Brédart, Valentine, Calder & Gassi, 1995; Burton, Bruce & Johnston, 1990). In contrast to earlier models that proposed serial access of name and semantic information, these IAC models allow name and semantic information to be retrieved in parallel. The architecture of Burton, Bruce & Johnston's (1990) IAC model of person recognition is illustrated in Figure 3.2. In this model, processing units are divided into three pools of units. Units within these pools inhibit each other and there are bi-directional excitatory links between units in different pools. Like the Bruce & Young (1986) model, the first pool of units are face recognition units (FRUs) which become active upon presentation of a particular familiar person's face. Upon presentation of a known face, the corresponding FRU spreads activation to the corresponding person identity node (PIN) by means of the excitatory between-pool links. Activation is then passed to the semantic information unit (SIU) pool. Unlike the Bruce & Young (1986) model, the PINs do not contain specific biographical information but act as a modality-free gateway to the semantic information units (SIUs). While each FRU is linked to only one PIN, a PIN can be linked to many SIUs depending on how much information we know about a given person. Burton & Bruce (1992) explain the disadvantage for name retrieval in terms of the structural properties of the IAC architecture. Names are stored alongside all other semantic information in the SIUs but are accessed slower than semantic facts because names are typically unique and associated with just one person whereas semantic facts such as occupation are shared by many people. The speed at which an SIU is activated is influenced by the number of PINs linked with it, therefore activation in the name SIUs rises more slowly because names are usually unique and linked to fewer PINs than other SIUs. Thus, in

IAC models, names and semantic information are retrieved in parallel, but name SIUs gain activation more slowly.

Figure 3.2 Burton, Bruce & Johnston (1990) - an interactive activation model of person recognition.



3.4 Do children find it difficult to recall names?

Very little research has been carried out investigating children's naming of familiar faces. The primary reason for this is that it is very difficult to find a set of faces that a wide age range of children will know well. Such difficulties have previously been raised in this thesis and were also encountered by Scanlan & Johnston (1997) and Abdel Rahman, Sommer & Olada (2004) when they examined children's naming of familiar faces. The results of these two studies will now be discussed as they suggest a possible difference between children and adults in name recall.

Scanlan & Johnston (1997) carried out a matching task with 7, 9, 12 and 15-year-olds. A famous face was presented on the computer screen, followed by a name, an occupation or a nationality. In one condition (face-label), participants had to decide if the information following the face was correct or incorrect. In a second condition (label-face), the information preceded the face and participants had to decide if the face matched the preceding information. Adults were faster to verify someone's occupation or nationality than their name when the face was presented before the information, but they were faster to verify someone's name than their occupation or nationality when the information preceded the face. Seven and 9-year-olds did not show this interaction between information type and presentation order. Overall, they responded to names faster than occupations and nationality decisions. Twelve-year-olds responded to names faster than nationality and occupations only in the label-face condition and showed no differences in response times between name, nationality and occupation decisions in the face-label condition. Fifteen-year-olds showed the same interaction as adults, whereby names were matched quickest in the label-picture condition and slowest in the picture-label condition.

In a second experiment, participants were required to name or give someone's occupation vocally on presentation of a face. Seven and 9-year-olds named the faces faster than they were able to provide the person's occupation whereas adults were slower at naming the faces than saying the person's occupation. There was no difference in response latencies between the three age groups when naming famous faces, but adults were much faster than both child groups when producing occupations. This result suggests that the naming advantage found in children in these two experiments may reflect children's difficulties with the semantic category relative to adults.

Such a proposal is supported by recent work by Abdel Rahman et al (2004). They found that both children and adults were faster at classifying cartoon characters on semantic decisions than when deciding if the character's name was made up of one or two words. They argue that when children are familiar with the stimulus items and the semantic category, they are slower to respond to names like adults. This argument was further supported when children were found to be slower at classifying a set of learned faces on a semantic category that they were not very familiar with (political party membership) than deciding whether the surnames had two or more syllables. A naming advantage was also reported in adults who were trained on a set of unfamiliar faces. They learned a name and some unfamiliar semantic information with each face and at test they were faster when deciding whether the person's surname had two or more syllables than they were at classifying them by uncommon occupations. These studies suggest that children and adults represent knowledge for familiar people in the same way, and that the name advantage found by Scanlan & Johnston (1997) could have been caused by children's unfamiliarity with the stimuli and/or the semantic categories used. However, if the results found by Scanlan & Johnston can be replicated, then this would indicate a genuine difference in child and adult face processing. The following experiments were therefore carried out to examine children's naming of familiar faces and to determine whether there is a developmental difference in face naming.

3.5 Experiment 3

The purpose of this experiment was to try to replicate the pattern of results found by Scanlan & Johnston (1997). In two experiments they found that 7 and 9-year-olds were faster when retrieving the names of famous people than other semantic information about them. Their data suggests that there may be developmental differences in the ways that children and adults represent knowledge for known people and that the adult pattern may not be fully developed until age 15.

However, before accepting these conclusions, it is necessary to replicate the results found by Scanlan and Johnston because of methodological weaknesses in their experiments. Firstly, only six children in a particular age group were tested in each condition in their matching experiment and these children produced high errors rates (as much as 34% in some conditions with a chance score of 50%). Further, the name advantage for 7 and 9-year-olds was found when data for the picture-label (when a face preceded the information) and label-picture (when the information preceded a face) conditions were collapsed. As adults, 12 and 15-year-olds were all faster at matching names in the label-picture condition, the name advantage found in the younger children may have been influenced more by this condition than the picture-label condition. Therefore, the following experiment tests participants in the picture-label condition only as this is where the robust finding of a name disadvantage was found with adults and older children. In Scanlan & Johnston's (1997) second experiment, participants were required to give a voice response and had to say the names and the occupations of several famous faces. Prior to the experiment, all children named and provided the occupation of the 12 faces used. However, in the experiment proper, the error rates were still relatively high (approximately 15% in 9-year-olds and 19% in 7-year-olds). Finally, Abdel Rahman et al (2004) have demonstrated that the pattern of results obtained with both children and adults can be influenced by how familiar participants are with the semantic category used. This experiment therefore only uses occupation as the semantic category and restricts this to pop stars and actors/actresses as children are likely to be more familiar with these categories than the occupation of comedian and nationalities used in Scanlan & Johnston's experiment.

The aim of Experiment 3 is therefore to try to replicate the effect found by Scanlan & Johnston (1997) with higher participant numbers and an easier semantic decision. Eight and 11-year-olds were tested in order to draw comparisons between this study and later experiments with personally familiar faces, however some preliminary data are presented for 7, 9 and 12-year-olds to allow comparison with Scanlan & Johnston's age groups.

Method

Participants

Eighteen 8-year-olds, 18 11-year-olds and 18 adults took part. The youngest group had a mean age of 8 years, 7 months (age range 8,0 - 9,2) and was made up of 10 boys and 8 girls. The older group had a mean age of 11 years, 7 months (age range 11,1 - 12,0) and comprised 7 boys and 11 girls. The children were tested at the local Science Centre, Glasgow, after obtaining written parental consent. Adults were undergraduates at the University of Glasgow, with a mean age of 21 years, (range = 18-28).

Materials

Twenty-four famous faces were used, 6 actors, 6 actresses and 12 pop stars (6 male and 6 female). The images were obtained from internet sites and magazines. Magazine images were scanned onto computer and all images were transformed into grey-scale and converted to a standard size (200 pixels high x 300 pixels wide). Thirty-one children aged between 6 and 13 rated these faces on a familiarity scale from 1 (don't know this person) to 7 (very familiar person). The mean familiarity rating for these faces was 4.8. These children did not take any further part in the experiment.

Procedure

Participants were tested individually on a portable computer. A trial consisted of a face being presented for 750ms followed by a blank screen for 1000ms and then either a name or an occupation was presented for 750ms or until a response was made. There followed a two-second gap before the next trial began. Participants were instructed to press one key if the information that followed the face was correct and a different key if the information that followed was incorrect for the person who had preceded it. They were given six practice trials (three name and three occupation decisions) with faces that were not used in the experiment proper. The 24 experimental trials consisted of 12 name and 12 occupation decisions, six true and six false within each of these categories. Trials were presented in a different randomised order for each participant. Participants were encouraged to guess quickly if they did not recognise the face on any particular trial.

Results

Response times (RTs) were calculated from the medians as opposed to means due to the tendency for children's RT data to be quite varied. Median RTs have been used in similar research (e.g. Ellis et al, 1993; Geldart, Mondloch, Maurer, de Schonen &

Brent, 2002; Mondloch et al, 2002, 2003). The means of these medians and the mean percentage of correct responses are presented in Table 3 below.

Table 3 shows the mean percentage of correct answers and the mean reaction times in each experimental condition in Experiment 3 (with standard deviations in parenthesis).

	Names		**Occupations**	
	True	**False**	**True**	**False**
8-year-olds				
mean RT	1849 (576)	2138 (683)	1599 (652)	1790 (476)
percent correct	80 (17)	75 (24)	74 (16)	72 (23)
11-year-olds				
mean RT	1294 (328)	1287 (421)	1017 (237)	1104 (199)
percent correct	89 (13)	91 (13)	92 (12)	91 (10)
Adults				
mean RT	946 (293)	913 (270)	761 (142)	868 (297)
percent correct	92 (10)	92 (12)	92 (12)	87 (13)

Overall analysis

A 3 (age) x 2 (information type) x 2 (response) mixed analysis of variance (ANOVA) was carried out on the RT data. Age was the between-subjects factor (8-year-olds, 11-year-olds and adults), and information type (names and occupations) and response (true and false) were the within-subjects factors. This analysis revealed a significant main effect of information type, $F(1,51) = 44$, $p<0.01$, whereby names (mean = 1404ms) were responded to slower than occupations (mean = 1190ms). There were main effects of age, $F(2,102) = 31$, $p<0.01$, and response $F(1,51) = 7.9$, $p<0.01$, which were qualified by an age x response interaction, $F(1,51) = 3.2$, $p<0.05$. Simple main effects analyses revealed an effect of age for true, $F(2,102) = 24$, $p<0.01$, and false responses $F(2,102) = 38$, $p<0.01$. Tukey HSD tests revealed that both adults and 11-year-olds were faster than 8-year-olds on true and false decisions. There was also a significant effect of response for 8-year-olds, $F(1,51) = 13.6$, $p<0.01$, who were faster on true than false decisions. There was no effect of response for the 11-year-olds or adults, $F(1,51)<1$.

The same 3 (age) x 2 (information type) x 2 (response) ANOVA was performed on the accuracy data. This revealed a main effect of age only $F(2,51) = 16$, $p<0.01$. For this main effect, Tukey HSD tests revealed that the adults (mean = 91%) and the 11-year-olds (mean = 91%) were significantly more accurate than the 8-year-olds (mean = 75%). The effect of information type was not significant, $F(1,51) = 1.1$, $p>0.05$ and the effect of response was not significant, $F(1,51) = 1.2$, $p>0.05$. There were no significant interactions, all $Fs<1$.

Analysis by age groups

8-year-olds

A 2 (information type) x 2 (response) within-subjects ANOVA was performed on the response time data. This revealed main effects of information type $F(1,17) = 16$, $p<0.01$ and response $F(1,17) = 6.5$, $p<0.05$. Occupations (mean = 1694) were matched faster than names (mean = 1993ms) and true decisions (mean = 1724ms) were matched faster than false decisions (mean = 1964ms). The interaction between information type and response was not significant, $F(1,17)<1$. The same analysis was performed on the accuracy data and revealed no differences between the experimental conditions: main effect of information type, $F(1,17) = 1.6$, $p>0.05$; main effect of response, $F(1,17)<1$, and interaction between information type and response, $F(1,17)<1$.

11-year-olds

The same analysis was carried out on the 11-year-olds' response time data and revealed a significant main effect of information type only, $F(1,17) = 22$, $p<0.01$ whereby occupations were matched faster than names (means = 1061ms and 1291ms respectively). The effect of response was not significant, $F(1,17)<1$, and the interaction between information type and response was not significant, $F(1,17) = 1.1$, $p>0.05$. The same analysis performed on the accuracy data revealed no differences between the experimental conditions: main effect of information type, $F(1,17) <1$;

main effect of response, $F(1,17)<1$, and interaction between information type and response, $F(1,17)<1$.

Adults

The same analysis carried out on the response time data revealed a main effect of information type $F(1,17) = 8.7$, $p<0.05$ with names (mean = 930ms) responded to slower than occupations (mean = 814ms). The effect of response was not significant, $F(1,17) <1$ and the interaction between information type and response was not significant, $F(1,17) = 3.8$, $p>0.05$. Analysis of the accuracy data revealed no differences between the experimental conditions: main effect of information type, $F(1,17) = 1$, $p>0.05$; main effect of response, $F(1,17)=1.1$, $p>0.05$, and interaction between information type and response, $F(1,17)<1$.

The original study by Scanlan & Johnston (1997) compared 7, 9, 12 and 15-year-olds. Here, 8 and 11-year-olds were tested to allow comparisons between naming personally familiar faces (in later experiments) and famous faces. However, some data were collected for 7, 9 and 12-year-olds and these show a similar pattern with longer response times to match names than occupations. [At 7 years of age, names were matched slower (mean = 2239ms) than occupations (mean = 2123ms), but this difference was not significant, $F(1,9) = 1.3$, $p>0.05$. At 9 years, occupations (mean = 1311ms) were matched significantly faster than names (mean = 1561ms), $F(1,9) = 7$, $p<0.05$. At 12 years, names were matched slower (mean = 1201ms) than occupations (mean = 1050ms), but this difference was not significant, $F(1,9) = 2.6$, $p >0.05$].

Discussion

The aim of Experiment 3 was to determine whether the finding of faster naming in children found by Scanlan & Johnston (1997) could be replicated or whether their results would be better explained by methodological factors such as low participant numbers, high error rates or a harder semantic than name task. The current experiment failed to replicate the results of Scanlan & Johnston. In fact, the *opposite* pattern of results was found. Eight-year-olds, 11-year-olds and adults all took longer to verify someone's name than their occupation after being presented with their face. These results are consistent with many other adult studies showing longer response latencies for names than occupation decisions (e.g. Johnston & Bruce, 1990; Sergent, 1986; Young et al, 1986b). Children showed the same pattern of responses as adults and became more accurate and faster at responding with age, indicative of a quantitative rather than a qualitative change as children become older. The current results suggest that Scanlan & Johnston's results are most likely due to methodological factors than a genuine difference between child and adult face processing.

One possible explanation of the different results found here from the original study is that some of the famous faces used may not have been known by some of the children. The suitability of using famous faces with children has previously been discussed in this thesis (Experiment 1) as has the possibility that different famous faces may produce a different set of results. It is therefore possible that the different stimuli used by Scanlan & Johnston and in the current experiment may have contributed to the different results because children are not familiar with all the faces used nor are they familiar with the different faces to the same extent. Indeed, Abdel Rahman et al (2004) have argued that the pattern of results obtained by Scanlan & Johnston (1997) is due in part to children's unfamiliarity with the stimulus faces.

To explore this possibility, an analysis was carried out on the six most familiar faces as rated by a different set of children. The 8 year-olds' reaction time data revealed a significant two-way interaction between information type and response, $F(1,17) = 8.5$, $p<0.01$. Analysis of the simple main effects revealed an effect of information type for false decisions only, $F(1,17) = 6.1$, $p<0.05$, whereby names were responded to significantly slower than occupations. There was also an effect of response for names $F(1,17) = 7.1$, $p<0.05$ whereby response times to true names were significantly faster than false names. The 11-year-olds' reaction time data revealed a main effect of information type (F1,17) = 7.9, $p<0.05$, whereby names (mean = 1524ms) were responded to more slowly than occupations (mean = 1132ms). The adults' reaction time data also revealed a significant main effect of information type, $F(1,17) = 5.8$, $p<0.05$, with slower responses to names (mean = 940ms) than occupations (mean = 840ms). Thus, even when only the most familiar faces are used in the analysis, and errors are very low, there is still evidence of a name disadvantage in both 8 and 11-year-olds. This is consistent with Abdel Rahman et al's (2004), proposal that the name difficulties experienced by adults are found in children only when they are familiar with the faces and the semantic decisions used.

One alternate explanation of the current results is that the occupation task was easier than the name task because there were only two occupations that could follow a face, but an unlimited number of names that could follow a face. One discrepancy between the present study and the original is that Scanlan & Johnston also used a nationality decision. Thus, on presentation of a face, a name, an occupation (actor, singer, comedian) or a nationality (British, American or Australian) could follow. In Experiment 3, however, only occupations were used and these were restricted to pop stars and actors to ensure that children would be familiar with the semantic category used. Thus, perhaps the name disadvantage found in Experiment 3 was a reflection of the difficulty of the name task compared to the occupation task (any name could follow a face whereas only two occupations could follow). If this is the case, then the name advantage found by Scanlan & Johnston should be found when the name and occupation task are made equivalent by having only two names and two occupations that could follow a face. This possibility was tested in Experiment 4.

3.6 Experiment 4

The purpose of Experiment 4 was to determine whether children would show evidence of a name advantage if the name decision was easier than in the previous experiment. This was achieved by using a paradigm from the adult literature that employs a small number of faces and requires participants to perform binary classifications. For example, Young, Ellis & Flude (1988) used eight faces, four of whom were politicians and four of whom were non-politicians. Within each occupation category, there were two people called David and two people called

Michael. Response latencies were longer when classifying the faces by name than when classifying the faces by occupation. Carson, Burton & Bruce (2000) carried out a similar study with nationality as the semantic decision. When presented with pairs of faces, participants took longer to decide if they shared the same first name than to decide if they shared the same nationality. Using a voice response, Burton, Jenkins & McNeill (2002) found that people took longer to say whether someone was called Peter or Paul than to say whether they were a politician or a pop star. Thus, even when task difficulty is equated and participants are given practice at naming the faces prior to the experiment proper, there is still a temporal disadvantage for retrieving names. The following experiment uses a binary classification task to investigate whether there is a name advantage for children when task difficulty for names and occupations is equated.

Method

Participants

These were 18 8-year-olds, 18 11-year-olds and 18 adults. The youngest group had a mean age of 8 years, 6 months (age range = 8,1 - 8,11) and was comprised of 10 boys and 8 girls. The older group had a mean age of 11 years, 4 months (age range 11,0 -11,11) and was comprised of 9 boys and 9 girls. The children were tested at the local Science Centre, Glasgow, on acquisition of written parental permission. The adults were undergraduates at the University of Glasgow with a mean age of 22 years, age range 18-28 years.

Materials

Only four famous faces were used. They were David Beckham (footballer), David Sneddon (pop star), Brian Dowling (TV presenter) and Brian McFadden (pop star). These famous people can be categorised by first name (David or Brian) and by occupation (pop star or not pop star). One image of each person's face was obtained and edited to a standard size (200 pixels wide by 300 pixels high) and transformed to grey-scale.

Procedure

Before starting the experiment, each participant was shown the four faces and was required to give their name and occupation. Anyone who could not give this information for all four faces did not take any further part. The people who could give this information for all four faces carried out two blocks of trials. In one block, they had to categorise the faces by first name and in the other block, they had to categorise the faces by occupation. Half of the participants carried out the name trials first and the other half of participants classified the faces by occupation first.

The faces were presented on a portable computer that recorded reaction times. Each block began with eight practice trials with each of the four faces presented twice in a random order. The experimental trials consisted of 16 trials with each face shown four times in a random order. After a short break, participants carried out the second block of trials. In the name task, participants were instructed to press one key for

David and a different key for Brian. In the occupation task, they had to press one key for pop star and a different key when the person was not a pop star. They were instructed to do so as quickly and as accurately as they could.

Design

This is a mixed design with age as the between-subjects variable (8 years, 11 years and adults) and information type as the within-subjects variable (names and occupations).

Results

Median reaction times were calculated for each condition. The means of these medians are displayed with the mean percentage of correct responses in Table 4.

Overall analysis

A 3 (age) x 2 (information type) mixed ANOVA was carried out on the reaction time data. This revealed a main effect of age, $F(2,51) = 15.6$, $p<0.01$. Tukey HSD tests revealed that adults (mean reaction time = 717ms) responded significantly faster than both 8 (mean reaction time = 1293ms) and 11-year-olds (mean reaction time = 1056ms). The two child groups did not differ significantly from each other. Response times for names (mean reaction time = 1006ms) and occupations (mean reaction time

= 1039ms) were not significantly different, F(1,51)<1, and the interaction between age and information type was not significant, F(2,51)<1.

Table 4: Mean reaction times and percentage of correct classifications in Experiment 4 (with standard deviations).

	Classification Task	
	Names	**Occupations**
8-year-olds		
mean RT	1268 (335)	1317 (460)
percent correct	94 (7.4)	94 (8.8)
11-year-olds		
mean RT	1050 (499)	1063 (324)
percent correct	95 (8.2)	95 (6)
Adults		
mean RT	699 (131)	735 (149)
percent correct	97 (3.2)	99 (2.7)

The same analysis was carried out on the accuracy data and revealed no significant differences between conditions: main effect of age F(2,51) = 2.6 p >0.05; main effect of information type F(1,51) <1, and age and information type interaction F(2,51) <1.

Additional analyses were carried out with first task as a between-subjects factor to determine whether there was any difference between participants who carried out the name task first and those who carried out the occupation task first. These revealed no effect of what task was carried out first (for RTs $F(1,48) = 2.5$, $p>0.05$, and for accuracy $F(1,48) <1$. Task order did not enter any higher interactions by accuracy or by RTs, all $Fs<1.1$).

Analysis by age groups

8-year-olds

Related-pairs t-tests carried out on the reaction time and accuracy data revealed no significant differences between names and occupations, $t(17) = 0.56$, $p>0.05$, and $t(17) = 0.36$, $p>0.05$, respectively.

11-year-olds

Related-pairs t-tests carried out on the reaction time and accuracy data revealed no significant differences between names and occupations, $t(17) = 0.16$, $p>0.05$, and $t(17) = 0$, $p>0.05$, respectively.

Adults

Related pairs t-tests were carried out on the reaction time and accuracy data and revealed no significant differences between names and occupations, $t(17) = 1.2$, $p>0.05$, $t(17) = 1.1$, $p>0.05$.

Discussion

Experiment 3 found that children took longer to verify someone's name than their occupation after presentation of a face. However, any name could follow a face whereas only two occupations could follow a face. Therefore, the occupation task may have been easier than the name task and the results could have reflected differences in task difficulty rather than differences in the way occupations and names are stored for familiar people. This possibility was tested in Experiment 4 by using only four famous faces, which could be classified by first name as David or Brian, and by occupation as a pop star or not a pop star. Any name advantage should be found in this experiment where task difficulty was equated. However, there was no evidence of a name advantage. Names and occupations were classified as quickly and as accurately as each other by both adults and children. There was no evidence of the disadvantage for classifying faces by first name found with adults by Young, Flude & Ellis (1988). This may be due to differences in the number of faces used in the two experiments, with Young et al (1988) using eight faces and the current experiment using only four faces. The important point to note is that there is no indication of a name advantage in children when task difficulty is equated.

Thus, in two experiments, the name advantage reported by Scanlan & Johnston (1997) has not been replicated. It is concluded that their results may have been influenced by methodological factors such as low participant numbers or unfamiliarity with the semantic categories. Abdel Rahman et al (2004) have shown that familiarity with the stimulus faces and with the semantic decisions used can influence the pattern of results obtained with both adults and children. The findings of Experiments 3 and 4 combined with those of Abdel Rahman et al suggest that there is no difference between children and adults in the organisation of biographical information and names. Rather, the results obtained depend on children and adult's level of familiarity with the stimuli and the semantic decisions used in a particular experiment. In conclusion, there was no evidence of a qualitative difference in face naming in Experiments 3 and 4. Children and adults showed the same pattern of responses and quantitative gains were made with children becoming more accurate and faster with age.

The case of *highly* familiar faces is now considered and the question of whether children experience difficulties in retrieving the names of the people that they see and interact with every day is examined. The following two experiments investigate children's face naming using faces that are highly familiar to them (i.e. their classmates) to determine whether there is a temporal disadvantage when naming these faces.

3.7 Experiment 5

No study has directly examined children's naming of highly familiar faces. However, anecdotal evidence suggests that they can name their classmates easily. Carey & Diamond (1994) carried out a study with 6 and 10-year-olds using photographs of their classmates. The top half of one face was presented with the bottom half of another face and children were required to name the person in the top half of the picture. The aim of this experiment was to determine whether children would find it more difficult to name the person in the top half when the two halves were aligned to form a new face than when the two halves were set apart. Before the experimental trials began, the children were shown just the top half of the faces and could easily name them, "Subjects at all ages found it very easy to name the top halves alone", page 260. Diamond & Carey (1977) tested young children's ability to identify a target face from a pair of faces, one of which could be disguised (e.g. the target or distracter face could be wearing a hat). In one version of these experiments, they used photographs of children from the same class. Before selecting the target face from the two test images, the children were asked to name the target face. Both 5 and 6-year-olds were able to correctly name the target on 83% and 84% of the trials respectively. These indirect reports of children's naming of their classmates give a good indication that they are able to name these people accurately.

The purpose of this experiment was to compare children's retrieval of the names of highly familiar people with some type of semantic information. Studies with adults typically use famous faces and the semantic category of occupation, and this semantic decision has been used previously with children (Scanlan & Johnston, 1997; Experiments 3 & 4). The following study uses personally familiar faces, however, and as children do not have occupations the semantic decision used was number of siblings. After consultation with a number of primary school teachers, it was felt that this was a valid semantic decision with which names could be compared.

Method

Participants

These were the same children who took part in the matching study (experiments 2a and 2b) with personally familiar faces. Children from only one of the original schools were recruited. These children were now aged 8 and 11. Eighteen children from both age groups took part. The younger group now had a mean age of 8 years, 7 months (range = 8,2 - 9,1) and were made up of 11 girls and 7 boys. The older group now had a mean age of 11 years, 7 months (range = 11,1 - 12,0) and were made up of 12 girls and 6 boys.

Materials

The same photographs that were used in the matching study (experiments 2a and 2b) served as stimuli. These were black and white frontal images of the children from the relevant classes.

Design

There was one between factor, age, with two levels - 8 and 11-year-olds. The two within factors were information type (names and siblings) and response (true and false).

Procedure

There were photographs of 22 of the younger children and 18 of the older children that could be used as stimuli. Four blocks of trials were created so that each face was presented in a true name, a false name, a true sibling and a false sibling condition. This totalled 88 trials for the younger children and 72 trials for the older children.

The younger children carried out three blocks of trials as it was felt that they would become tired or lose interest if asked to complete all 88 trials. This meant that they carried out 66 trials, comprising 33 name and 33 sibling decisions. Sixteen of these trials were true and 17 false for one category whilst the other category was made up of 17 true and 16 false decisions. This composition was reversed for half of the participants. The older children completed 72 trials, 36 name and 36 sibling, 18 true and 18 false decisions in each of these categories. The difference in trial numbers was due to unequal numbers of stimuli in each age group.

A trial consisted of a face being presented on the computer screen for 750ms, followed by a blank screen for 1000ms, followed by either the true name of that person, a false name (the name of someone else in the class), the true number of siblings that person had or a false number of siblings. This information was presented for a maximum of 750ms or until participants had made a response. Participants were required to press one key on the computer keyboard to indicate a true match and a different key for a false match and were encouraged to guess quickly if they were unsure. They were given eight practice trials with famous faces (two of each kind of response) to ensure they understood the procedure and get them used to the presentation rate and response keys. There was a few minutes rest between each block.

Results

Median RTs were calculated and the means of these medians and the accuracy data for true and false decisions are presented in Table 5. A 2 x 2 x 2 mixed analysis of variance (ANOVA) was carried out on the RT data. Age was the between-subjects factor (8 and 11-year-olds) and information type (name or siblings) and response (true or false) were the within factors. There was a main effect of age $F(1,34) = 24$, $p<0.01$, and a main effect of information type $F(1,34) = 45$, $p<0.01$. The older children (mean = 1190ms) responded faster than the younger ones (mean = 1969ms) and responses to names (mean = 1386ms) were made faster than to siblings (mean = 1773ms). The main effect of response was not significant, $F(1,34) = 1.4$, $p>0.05$.

There was a significant interaction between information type and response, $F(1,34) = 7.2$, $p<0.05$. Analysis of the simple main effects indicated that there was a difference between true and false decisions for siblings, $F(1,68) = 7.4$, $p<0.01$, but not for names, $F(1,68) <1$. When making a sibling decision, children were faster when the answer was false (mean = 1667ms) than true (mean = 1879ms). There were also significant simple main effects of information type for both false, $F(1,68) = 9.4$, $p<0.01$, and true decisions, $F(1,68) = 45$, $p<0.01$, whereby names were responded to significantly faster than siblings on both true and false decisions.

Table 5 shows the mean reaction time and accuracy in each experimental condition in Experiment 5 (with standard deviations in parenthesis).

	Names		**Siblings**	
	True	**False**	**True**	**False**
8-year-olds				
mean RT	1707 (611)	1780 (588)	2392 (1076)	1999 (623)
percent correct	79 (12)	76 (18)	52 (17)	65 (18)
11-year-olds				
mean RT	988 (215)	1069 (202)	1367 (326)	1335 (245)
percent correct	95 (11)	96 (8)	86 (12)	92 (7)

The same 2 x 2 x 2 ANOVA was carried out on the accuracy data. This revealed main effects of age, $F(1,34) = 78.9$, $p<0.01$, and information type, $F(1,34) = 31.9$, $p<0.01$, which were qualified by a significant age x information type interaction, $F(1,34) = 7.0$, $p<0.05$. Analysis of the simple main effects indicated that there was an effect of information type for both 8, $F(1,68) = 34$, $p<0.01$, and 11-year-olds, $F(1,68) = 4.5$, $p<0.05$, with accuracy higher on name than sibling decisions for both age groups. There were also significant simple main effects of age for both types of information, where $F(1,68) = 27$, $p<0.01$, for names and $F(1,68) = 73$, $p<0.01$ for siblings. Eleven-year-olds responded to both names and siblings more accurately than 8-year-olds. The main effect of response was not significant, $F(1,34) = 3.4$, $p>0.05$. However, there was a significant interaction between information type and response $F(1,34) = 11.1$, $p<0.01$. Analysis of the simple main effects revealed that there was an effect of response for siblings, $F(1,68) = 11$, $p<0.01$, but not for names, $F(1,68) <1$. Accuracy was higher on false sibling decisions than true sibling decisions. There were also significant main effects of information type for both true, $F(1,68) = 43$, $p<0.01$, and false decisions $F(1,68) = 8$, $p<0.01$. In both cases, names were responded to more accurately than sibling decisions.

Analysis by age groups

8-year-olds

A 2 (information type) x 2 (response) within-subjects ANOVA was carried out on the response time data. This yielded a main effect of information type $F(1,17) =18.5$, $p<0.01$, and an interaction between information type and response $F(1,17) = 5.2$, $p<0.05$. The effect of response was not significant $F(1,17) = 2.1$, $p>0.05$.

To explore this interaction, simple main effects analyses were carried out. There was an effect of information type for true responses only, $F(1,17) = 21$, $p<0.01$ where names were responded to more quickly than siblings. Although names were responded to more quickly than siblings on false decisions, this difference was not significant, $F(1,17) = 2.2$, $p>0.05$. There was an effect of response for siblings $F(1,17) = 6.5$, $p<0.05$, but not for names $F(1,17) <1$. On sibling decisions, false responses were made more quickly than true responses.

The same 2 x 2 ANOVA was carried out on the accuracy data. This revealed a main effect of information type $F(1,17) = 27$, $p<0.01$, and an interaction between information type and response $F(1,17) = 9.5$, $p<0.01$. The effect of response was not significant $F(1,17) = 1.2$, $p>0.05$.

To explore this interaction, simple main effects analyses were carried out. There was an effect of information type for true, $F(1,17) = 27$, $p<0.01$, and false decisions $F(1,17) = 4.7$, $p<0.05$, where accuracy was higher on names than siblings for both types of trials. Responses were just as accurate on true and false decisions for names, $F(1,17) <1$, and siblings, $F(1,17) = 3.9$, $p>0.05$.

11-year-olds

A 2 (information type) x 2 (response) within-subjects ANOVA carried out on the response time data revealed a main effect of information type only $F(1,17) = 43$, $p<0.01$, with names (mean = 1029ms) responded to faster than siblings (mean = 1351ms). True and false decisions were made equally quickly, $F(1,17) <1$, and the interaction between information type and response was not significant, $F(1,17) = 2.9$, $p>0.05$

The same 2 x 2 ANOVA carried out on the accuracy data revealed main effects of information type $F(1,17) = 6.1$, $p<0.05$, and response $F(1,17) = 5.2$, $p<0.05$, and no interaction between these two factors $F(1,17) = 1.9$, $p>0.05$. Names (mean = 95%)

were responded to more accurately than siblings (mean = 89%) and false responses (mean = 94%) were more accurate than true (mean = 90%) responses.

Discussion

Both 8 and 11-year olds were quicker and more accurate to respond to name than siblings trials when highly familiar faces were used. This is in contrast to performance on the famous faces in Experiment 3. This is the first time highly familiar faces have been used with children to examine face naming and the data appear to indicate a different manner of processing for highly familiar faces where names are recalled more easily than other information about that person. Given the fact that the children see and interact with the faces used in this experiment every day and frequently recall their names, the pattern of data obtained here makes intuitive sense. Carson et al (2000) have suggested that the frequency with which we recall a person's name may influence the time taken to recall the name. They found that practice at naming the famous faces used in their experiment did help to reduce response times in their matching task. Burton & Bruce (1993) have also suggested that the mechanisms for recalling the names of personally familiar people may differ from those for famous people or acquaintances less well known to us. They proposed that we are much more likely to store the names of people that we know well as first names rather than as full names. These first names are more likely to be shared than full names because we are likely to know several people called Margaret, for example, whereas we probably only know one person called Margaret Thatcher.

Such a difference in storage would predict that it would be easier to recall the names of highly familiar people than people less well known to us.

However, the current results are not the first time that a name advantage for children has been found. Scanlan & Johnston (1997) also found that children were faster when verifying someone's name than their occupation or nationality. One of the criticisms of their study is the high error rates that suggest that the children were not very familiar with the famous faces used. This explanation does not apply in the current experiment as the faces used are the children's classmates and are highly familiar to them. Another criticism of the Scanlan & Johnston methodology, made by Abdel Rahman et al (2004), is that children are not familiar with the semantic decisions of occupation and nationality. This explanation could account for the name advantage found in the present experiment if we consider the responses on sibling decisions.

Where names are concerned, children were just as accurate and just as fast to respond regardless of whether the name that followed was correct or incorrect. On sibling information, however, false responses were both quicker and more accurate than true responses, indicating that perhaps the children do not know the number of siblings of their classmates for certain. The sibling decision seems to have been particularly difficult for the younger children, with them performing just above chance (mean = 58% correct). This may therefore not be the ideal semantic decision to compare with names. It could be that the name advantage has occurred here because children are not as familiar with the semantic category of siblings and so find the name task easier. Abdel Rahman et al (2004) have reported this pattern of results with children and adults. When participants were unfamiliar with the semantic decision used (e.g. political party membership), a name advantage was found. Thus the results from Experiment 5 may simply be a reflection of task difficulty rather than a difference in the ways that information about highly familiar and less well-known people are represented. The following experiment consequently employs an easier semantic task and also requires children to give a vocal response when they see the faces of the people in their class. On presentation of the face, participants have to either name that person or respond "Yes" if the person is in their maths work group at school or "No" if they are not in the same maths group.

3.8 Experiment 6

Method

Participants

These were the children from the second school who took part in the matching study (Experiments 2a and 2b) but did not take part in the previous study. These children were now aged 8 and 11. Seventeen children from both age groups took part. The younger group now had a mean age of 8 years, 8 months (range = 8,4 - 9,5) and were made up of 10 girls and 7 boys. The older group now had a mean age of 12 years, 0 months (range = 11,5 –12,5) and were made up of 11 girls and 6 boys.

Materials

The same photographs that were used in the matching study (Experiments 2a and 2b) served as stimuli. These were black and white frontal images of the children from the relevant classes.

Design

There was one between factor, age, (8 and 11-year-olds) and one within factor, information type (names and maths group membership).

Procedure

There were photographs of 21 of the younger children and 16 of the older children that could be used as stimuli. These were presented one at a time on a portable computer. Children completed two blocks of trials, one where they were required to give the first name of the faces presented and one where they were required to say "Yes" or "No" depending upon whether that person was in their maths work group. Half of the children completed the name block first and the other half completed the maths group block of trials first. The face stayed on the screen until children had made a response. These responses were recorded by the experimenter as were any recording errors.

Results

Two children from each class had left the school in the last year, therefore trials showing their faces were excluded. Trials that involved a particular child's own face were also excluded as children tended to giggle or stay silent upon seeing their own face. Any recording errors were also excluded.

Median response times were calculated and the means of these medians are presented in Table 6 with the percentage of correct answers.

Table 6 shows the mean reaction time and accuracy in each experimental condition in Experiment 6 (with standard deviations in parenthesis).

Trial Type	Name	Maths Group
8-year-olds		
Mean Rt	1152 (258)	1372 (280)
Percent Correct	99 (3)	96 (6)
11-year-olds		
Mean Rt	908 (169)	1017 (145)
Percent Correct	100 (0)	97 (4)

Overall analysis

A 2 x 2 mixed analysis of variance (ANOVA) was carried out on the RT data. Age was the between-subjects factor (8 and 11-year-olds) and information type (name or group membership) was the within factor. There were main effects of age $F(1,32) = 18.5$, $p<0.01$, and of information type $F(1,32) = 31$, $p<0.01$. The older children (mean = 963ms) responded faster than the younger ones (mean = 1262ms) and responses to names (mean = 1030ms) were made faster than to maths group decisions (mean = 1195ms). The interaction between these two factors was not significant $F(1,32) = 3.5$, $p>0.05$.

The same ANOVA was carried out on the accuracy data and revealed a main effect of information type $F(1,32) = 8.5$, $p<0.01$, whereby names (mean = 99.6%) were more accurately recalled than group membership (mean = 96.7%). The main effect of age was not significant, $F(1,32) = 1.9$, $p>0.05$, and the interaction between age and information type was not significant, $F(1,32) <1$. Thus the two decisions (maths group and names) appear to be equally easy for both groups in terms of accuracy, however the names of these highly familiar faces are recalled a lot quicker.

Analysis by age groups

8-year-olds

Related pairs t-tests revealed that faces were named faster than maths group decisions were made, $t(16) = 4.4$, $p<0.01$, and that naming and maths groups decisions were just as accurate, $t(16) = 1.9$, $p>0.05$.

11-year-olds

Related pairs t-tests revealed that faces were named faster than maths group decisions were made, $t(16) = 3.5$, $p<0.01$, and that naming was more accurate than maths groups decisions, $t(16) = 2.6$, $p<0.05$.

Discussion

Using a different mode of response, a voice response, the name advantage found in Experiment 5 for highly familiar faces has been replicated. An easier semantic task was employed with which to compare performance on naming familiar faces and accuracy was near ceiling for each type of decision (names and maths group membership) for both age groups. Thus, despite using an easier semantic task than Experiment 5, the name advantage is still found. This is in contrast to famous faces and unfamiliar faces. The results from both Experiments 5 and 6 suggest that information about highly familiar people may be represented in different ways than people that are less well known. In order to determine whether this is the case, adult comparisons have to be made. So far, no one has investigated adults' naming of highly familiar faces, therefore it is not known whether they will be able to name these faces faster than they will be able to retrieve other information about them. This was investigated in the following two experiments.

3.9.1 Experiments 7a & 7b - Introduction

The purpose of these experiments was to determine whether adults would show a temporal advantage for name retrieval of highly familiar faces when compared to retrieval of other semantic information about these people. There are six researchers who work in the area of face recognition in the Department of Psychology at the University of Glasgow who have known each other for at least three years and who see each other on a daily basis. These people served as stimuli and participants in the following experiments.

3.9.2 Experiment 7a

Method

Participants

These were six people working in close contact in the Psychology Department at Glasgow University. One was a professor, two were research fellows and three were postgraduate students. Three of these people share an office while two of the others share an office, thus these people are highly familiar and see each other every weekday. It was felt that this was a good equivalent of children sharing a classroom.

Materials

The same people served as the stimuli. Several photographs of these people were taken on different days. These were transformed into grey-scale and edited to remove any background and clothing. Four photographs of each person were selected for use in the experiment.

Procedure

The task was the same as the one used in Experiments 3 and 5. A face was presented on screen for 750ms followed by a blank screen of 1000ms and then a name or an occupation was presented on screen for 750ms or until a response was made. The name or occupation that followed each face could be true for that person or false. The faces of the six people in the research group were used and each one was seen four times followed by either the true name of that person; by the name of a different person in the research group (of the same sex); the true occupation of that person; and the wrong occupation of that person. Thus, there were 24 trials in total. The occupations were professor, research fellow and postgraduate. Participants were instructed to press one key for a true match and one key for a false match. They were asked to respond as quickly and as accurately as they could and were given practice trials with famous faces.

Results

The means of the median reaction times and the percentage of correct answers for each condition are displayed in Table 7a.

Table 7a shows the mean reaction time and accuracy in each experimental condition in Experiment 7a (with standard deviations in parenthesis).

	Names		**Occupations**	
	True	**False**	**True**	**False**
mean RT	678 (218)	775 (203)	933 (284)	978 (323)
percent correct	100 (0)	100 (0)	83 (15)	91 (9)

The reaction time data were subjected to a 2 (information type) x 2 (response) within-subjects ANOVA. This revealed a main effect of information type, $F(1,5) = 19.7$, $p<0.01$, with names (mean = 727ms) responded to faster than occupations (mean = 955ms). There was no difference in response times between true (mean = 805ms) and false (mean = 876ms) decisions, $F(1,5) = 3.8$, $p>0.05$, and the interaction between the two factors was not significant, $F(1,5) <1$. The same analysis carried out on the accuracy data also revealed a main effect of information type, $F(1,5) = 7.2$, $p<0.05$ with names (mean = 100%) responded to more accurately than occupations (mean = 87%). There was no difference in accuracy for true (mean = 92%) and false (mean = 96%) responses, $F(1,5) = 4.9$, $p>0.05$, and the interaction between these two factors was not significant, $F(1,5) = 4.9$, $p>0.05$.

Discussion

Like the children in Experiment 5, adults were much faster at matching a name than matching an occupation to a highly familiar face. They were also more accurate with name decisions than occupation decisions. This is the first time an advantage for naming has been found with adults and suggests that children and adults represent names and semantic information about highly familiar people in a different way from less familiar people. The robustness of this effect in adults was tested in Experiment 7b using a voice response.

3.9.3 Experiment 7b

This task was the equivalent of Experiment 6 where children had to name the people in their class and say whether or not each person was in their maths work group. Here, participants were required to name the six faces and to say the nationality (German, Scottish or English) of each person.

Method

Participants & materials

These were exactly the same as Experiment 7a except that six different photographs of the six face researchers were used as stimuli.

Procedure

Participants completed two blocks of trials, one where they were required to say the first name of the faces presented and one block where they were required to say the person's nationality (English, German or Scottish). Half of the participants completed the name block first and the other half completed the nationality block of trials first. Before each block of trials, participants completed six practice trials where they saw one picture of each of the six people and had to either name that person or provide their nationality. In the experimental trials five different pictures of each person were presented at random for participants to name or state the nationality of the person. This resulted in 30 name and 30 nationality trials. Each face stayed on the screen until a response had been made and there was a two-second gap before the next face was presented. The experimenter noted all responses and any recording errors.

Results

The means of the median response times and the percentage of correct answers are displayed in Table 7b. No errors were made on this task, therefore accuracy will not be discussed further.

Table 7b shows the mean reaction time and accuracy in each experimental condition in Experiment 7b (with standard deviations in parenthesis).

Trial Type	Name	Nationality
Mean Rt	678 (54)	840 (101)
Percent Correct	100 (0)	100 (0)

A related pairs t-test was carried out on the response time data. This revealed that names were produced significantly faster than nationalities, $t(5) = 7.1$, $p<0.01$.

Discussion

As in Experiment 7a, the names of highly familiar faces were recalled faster than the nationalities of these same people, even although there were only three options for nationality in comparison to the six different first names that were required. Taken together, the results of experiments 5-7 have shown that both children and adults are faster at face naming when they are highly familiar with the faces. This is in contrast to all other studies with adults showing that faces are named slower and suggests that the relative ease of name retrieval depends on the level of familiarity of a particular person. As in the previous experiments, there is no evidence of a developmental difference when naming highly familiar faces. Both children and adults were faster when naming highly familiar faces than when accessing semantic information about these people. As before there is evidence only of a quantitative change with age with children performing faster and more accurately on these tasks as they get older.

3.10 General Discussion

The purpose of this chapter was to investigate whether there are developmental differences in naming familiar faces. Evidence from several areas has shown that adults experience difficulties in name retrieval more often than they experience difficulties in retrieving semantic information about people (e.g. Hay, Young & Ellis, 1991; Young et al, 1985a) and that they take longer to classify faces by names than by semantic categories such as occupation (Young et al, 1988) or nationality (Carson, et al, 2000; Johnston & Bruce, 1990). Such results have influenced models of person recognition and explanations of how information about familiar people is stored and accessed (e.g. Bruce & Young, 1986; Burton et al, 1990).

Very little comparative work has been carried out with children, therefore it is not known whether they represent knowledge for familiar people in the same way as do adults and experience the same kinds of difficulties when trying to remember the names of familiar people. The aim of the experiments carried out here was to investigate whether there are differences between the ways in which children and adults represent knowledge for familiar people.

Scanlan & Johnston (1997) reported that children were faster to decide if a name that followed a famous face was correct or incorrect than when a nationality or an occupation followed a famous face. Their results suggested that there were developmental differences in face naming whereby the adult disadvantage for face naming was not found until 15 years of age. However, as discussed earlier, these results could be explained by methodological factors such as low participant numbers or unfamiliarity with the semantic decisions. The first experiment in this chapter therefore attempted to replicate Scanlan & Johnston's results to determine whether their results indicate a genuine developmental difference.

It was found in Experiment 3, however, that children were *slower* when matching a name to a face than an occupation to a face. Even when only the most familiar faces (as rated by a different set of children) were considered, and error rates were extremely low, both children and adults were slower when matching a name to a face than an occupation. Abdel Rahman et al (2004) also found that children were slower on name than semantic decisions when more familiar faces were used (e.g. cartoon faces). Task difficulty was equated in Experiment 4 using a binary classification task to verify that the name disadvantage found in Experiment 3 was not due to the semantic task being easier than the name task. No evidence of faster naming in children was found when task difficulty was equated in this way. The name advantage originally reported by Scanlan & Johnston was therefore not replicated and it is concluded that their results are most likely due to other factors such as high error rates and low participant numbers. There was only evidence of a quantitative change in face naming in Experiments 3 and 4, reflected by improved accuracy and processing speed with age, and no indication of any qualitative differences in face naming.

Experiments 5 and 6 compared children's naming of highly familiar faces (their classmates) with retrieval of semantic information. These tasks showed that, in contrast to Experiments 3 and 4 using famous faces, children were *faster* when accessing the names of highly familiar people. The name advantage found here might be a reflection of difficulties with the semantic task. Indeed this may have been the case in Experiment 5 when children had to match faces to the number of siblings these people have. The accuracy data show that this was quite difficult for younger children. Abdel Rahman et al (2004) have shown that when adults and children are unfamiliar with a semantic category, there is a naming advantage. Therefore difficulties with the semantic decision may have contributed in part to the results of Experiment 5. In Experiment 6, however, accuracy on a different semantic task was at ceiling, yet children were still faster to name their classmates.

No experiments have been carried out with adults using highly familiar faces, so it is uncertain whether there is a developmental difference when we consider naming highly familiar faces. Sergent (1986) found that undergraduate students were faster at classifying members of the Psychology Department as professors or non-professors than they were at naming them. This may suggest that children and adults show a different pattern of responses when naming personally familiar faces. However, the name task used by Sergent is harder than the semantic classification task that only requires one of two responses (professors or non-professors). Further the faces used, although familiar, may not be as familiar to the undergraduates as classmates are to the children used in Experiments 5 and 6. Experiments 7a and 7b therefore examined face naming in adults with highly familiar faces. Like the children, adults were faster when naming these faces than when retrieving semantic information about them. This is the first time an advantage for naming faces has been reported in adults. It therefore appears that naming of highly familiar people is not subject to the difficulties encountered when naming less well-known people. It is proposed that the naming advantage found here is not unique to people known personally to us, but applies to people with whom we are highly familiar. Thus, it is predicted that a name advantage would be found for a set of famous faces that a group of participants were highly familiar with, such as fans of a particular television show or film that they have watched many times.

Together, the results of the experiments conducted here suggest that children and adults represent name and semantic information for familiar people in the same way and that the ease of name retrieval depends on the level of familiarity with a particular individual. It is argued here that when faces are highly familiar, name recall is easier and faster for both children and adults. When faces are not as familiar, both children and adults experience difficulties in name retrieval if they are familiar with the semantic category used. Sequential models of face and person recognition such as Bruce & Young (1986) can account for the longer response latencies to names in both children and adults in Experiment 3. However, they cannot account for the pattern of data found here with highly familiar faces as there is no direct link from a face recognition unit (FRU) to name generation. The Bruce & Young model states that a name cannot be accessed before biographical details about that person are accessed. However, Bruce & Young do state that it is not necessary to retrieve all the semantic information one knows about a person before retrieving his or her name, thus raising the possibility that some semantic information (probably less well known information) could be retrieved after a name. In order to account for the results from Experiments 5-7, serial models would need to specify the conditions when semantic information could be retrieved before names and those conditions when semantic information could be retrieved after names. These conditions are likely to vary depending on the level of familiarity we have with particular people and for this reason it is hard to accommodate the results of Experiments 5-7 within a serial model of person recognition.

The results obtained here can however be explained by IAC models of person recognition which allow parallel access to name and semantic information. In these models (e.g. Brédart et al, 1995; Burton et al, 1990), name retrieval is not contingent upon retrieval of semantic information. These models can account for circumstances when name retrieval is slower than retrieval of semantic information (as in Experiment 3) in terms of the activation that names and semantic information units receive. The results of Experiment 3 showing slower retrieval of names in children are explained in terms of the slower and smaller activation of name units compared to other semantic information units (SIUs) such as nationality. However, these parallel models cannot explain the faster naming of highly familiar faces found in Experiments 5-7 without some modification. In these models, all links are bi-directional and all associative connections have equal strength. This set up may not be representative of a real situation where certain attributes may be more strongly associated with certain individuals as raised by Burton & Bruce, (1992) - "there will almost certainly be some semantic information, unique to individuals, which has a very high associative strength". In this way, the names of highly familiar people will have stronger links between the PIN and the corresponding name unit than other SIUs such as nationality and occupation. This would lead to faster activation of the name unit in the case where someone is highly familiar. Thus, parallel models can account for the large body of literature showing slower retrieval of names for the majority of people we know fairly well and faster name retrieval for the smaller set of people we know very well by assuming stronger links between the names of highly familiar people and their relevant PINs.

This chapter has shown that children and adults show the same patterns when naming famous and highly familiar faces. When famous faces were used (Experiment 3), both children and adults were slower to make a name decision than an occupation decision. When faces are highly familiar, however, this pattern is reversed. Both adults and children were faster to name these faces than to make a semantic decision. Thus, there is no evidence of a developmental difference in face naming. Development in face naming occurs by way of improved processing speed and accuracy as children get older. Similarly, the previous chapter found no evidence of a developmental difference in internal feature processing of familiar faces. The next chapter combines these two areas of research to address the question of what changes as faces become more familiar. It begins by establishing the contribution of the internal and external features to unfamiliar face recognition and by comparing the recall of names and occupations of unfamiliar faces. It then tracks the changes that take place as faces become more familiar in a learning experiment. The learning experiment seeks to determine whether it is possible to track a shift towards an internal feature advantage and a name retrieval advantage as an unfamiliar face becomes familiar.

Chapter 4 Recognition of the internal and external features and the retrieval of names and semantic information of unfamiliar and newly learned faces

4.1 Introduction

The purpose of this thesis is to establish whether there are developmental differences in face processing. The previous two chapters examined whether children show the adult advantage for recognising familiar faces from the internal features and whether children show the same difficulties as adults when recalling the names of familiar people. In this chapter, these two strands of research are brought together to determine what types of information children and adults remember about unfamiliar people. In the first experiment, I aim to determine whether certain facial features of unfamiliar faces are easier to remember. In Chapter 2, I investigated matching performance of unfamiliar faces, however, the matching task did not test memory for these unfamiliar faces as participants could look at the faces until a response was made. Experiment 8 will therefore examine recognition memory for the internal and external features of unfamiliar faces. In Experiment 9, I will establish whether particular information (names and occupations) about new people is easier to remember. In the previous chapter, it was shown that children and adults find it more difficult to remember names than other biographical information, but do not experience these difficulties with name recall when the people are highly familiar to them. Experiment 9 will therefore examine whether children find it difficult to recall the names of unfamiliar people. In the final experiment, participants will be trained on a set of unfamiliar faces that they will learn with a name and some semantic information. After the learning phase, I will investigate their name recall and recognition of the internal and external features of these familiarised faces to determine whether there is any evidence of a shift towards an internal advantage and a name advantage for these familiarised faces. In each of these experiments, I will compare the performance of children aged 8 and 11 years and adults to determine whether children of different ages encode and remember the same types of information about unfamiliar faces as adults.

4.2 Recognition of the internal and external features of unfamiliar faces

Adult studies have shown that it is easier to recognise unfamiliar faces from the external features or that there is no difference between the internal and external features. For example, Ellis, Shepherd & Davies (1979) showed participants 15 unfamiliar faces, each for six seconds. After a 15-minute interval, they were shown 30 faces consisting of the 15 faces they had been shown earlier and 15 faces that they had not seen before. Some participants saw the whole face, others saw the external features and another group saw the internal features in this recognition test. For each face, they had to decide if it was one of the faces they had seen previously or whether it was a face they had not seen before. Performance scores indicated that recognition of these relatively unknown faces was just as good from the internal and external features.

Children's recognition of unfamiliar faces has been investigated in several recent studies. Tanaka, Kay, Grinnell, Stansfield & Szechter (1998) investigated whether children encode unfamiliar faces holistically. In one experiment, a target whole face was presented for study for five seconds and then two whole faces or two features were presented and children had to identify which of the two whole faces or which of the two features belonged to the target. The features under investigation were the eyes, nose and mouth and in the whole condition, the distracter face was identical to the target face except for one of these critical features. Six, 8 and 10-year-old children all correctly identified the target features more often from the whole face image than when the feature was presented in isolation, providing evidence of holistic encoding. However, the data for the eyes, nose and mouth trials were collapsed and it is therefore unknown whether any of the internal features were identified more often than others.

More recent work has compared children's recognition of unfamiliar faces from the eyes, nose and mouth regions separately. Pellicano and Rhodes (2003) carried out the same task as Tanaka et al (1998) with 4 and 5-year-olds. These younger children recognised more features from the whole face images than when the features were presented in isolation and recognised the eyes more often than the mouth and the nose in the whole face condition. Hay & Cox (2000) also used the same paradigm and examined 6 and 9-year-olds' recognition memory for the internal features of unfamiliar faces. As above, both groups of children recognised the eyes more accurately than the nose or the mouth. However, none of these studies measured recognition of the external features of unfamiliar faces and so no comparisons between the external and internal features of unfamiliar faces can be made.

Recognition of unfamiliar faces from the external and internal features was investigated in a recent study carried out by Want, Pascalis, Coleman & Blades (2003) using a recognition memory task with 5, 7 and 9-year-old children and adults. Participants watched a three-second video clip of an unfamiliar face that turned from a profile shot to face the camera. Each person said a few words as they turned their head so that each face was seen moving rigidly (e.g. the head moving from a profile to a frontal view) and non-rigidly (e.g. the person speaking). Then, participants were presented with two static photographs from which they had to identify the person they had just seen in the video. These static images showed the whole face, the external features or the internal features of the person from the video and a distracter face. The 5 and 7-year-olds were more accurate on the external than the internal features whereas the 9-year-olds and adults were just as accurate on the internal and external features. All age groups were quicker at identifying the target from the external than the internal features. These results are consistent with previous work with adults showing that the internal features of unfamiliar faces are never recognised better than the external features. Adult studies show that the external features are either more useful for processing unfamiliar faces (Want et al, 2003; Young et al, 1985b) or that the external and the internal features are equally useful for recognition of unfamiliar faces (Ellis et al, 1979).

4.3 Familiarisation Studies

Evidence that the internal advantage reported for familiar faces requires a substantial period of familiarisation to occur has been provided by adult learning studies. These studies rely on the fact that different facial features are more useful in the recognition of familiar and unfamiliar faces and have attempted to track the shift towards a greater reliance on the internal features as faces become more familiar. The first attempt to compare recognition of the internal and external features over a long period of time was carried out by Ellis and Shepherd in an unpublished study in 1987 (cited in Ellis & Shepherd, 1992). They demonstrated a shift towards an internal feature advantage for new faces over a four-week long experiment. At the beginning, the middle and end of the four-weeks, participants were presented with whole face images, internal and external features of both faces that they had been learning and unfamiliar faces in a standard recognition task. They reported a shift in accuracy from no difference in performance on the external and internal features on the first and second recognition tests to a significant difference for internal over external features on the third test.

In support of these findings, O'Donnell & Bruce (2001) have shown that the eyes play an important role when learning new faces. Participants were asked to learn seven new faces that were shown repeatedly on video until they could be identified correctly. Each face was viewed for approximately six minutes. Participants then carried out a matching task where they were asked to decide whether pairs of faces were identical or different. "Different" face pairs contained the original face alongside the same face that had been altered in one feature (eyes, mouth, chin or hair). Performance on pairs that differed in the eyes alone was selectively enhanced for faces that had been familiarised compared with unfamiliar faces.

Bonner, Burton & Bruce (2003) investigated face matching performance on a set of faces that were learned over the course of three days. On the first day, participants carried out the matching task and were unfamiliar with all of the faces. Accuracy on the external features was higher than on the internal features. Participants were then familiarised with half of the faces by watching videos on three consecutive days. After watching the videos, they completed the matching task. Familiarisation benefited learning of the internal features such that, on days two and three, accuracy on the external and internal features of the familiarised faces was equivalent, indicative of more improvement on the internal than the external features.

4.4 Child Familiarisation Studies

Very little research has been carried out to examine the processes involved in learning new faces with adults and even less comparative work has been conducted with children. Newcombe & Lie (1995) briefly familiarised a group of 5-year-olds and a group of adults with 20 unfamiliar child faces. Each face was presented individually with a short story about the person. A standard recognition test followed, whereby whole face images of these 20 faces and a set of 20 distracter faces were presented. Both adults and children showed above-chance levels of recognition, with children making more errors than adults. Participants then carried out a face matching task on these briefly familiarised faces and a set of unfamiliar faces. Adults were again more accurate than the 5-year-olds, but both groups made the same types of errors. Accuracy was higher in both groups when matching the external than the internal features of both the unfamiliar faces and the faces with which they had been briefly familiarised. Thus, this brief exposure was not sufficient to produce differences in matching performance between familiarised and unfamiliar faces. Experiment 10 will extend this research and investigate the effects of familiarisation in older children.

Tanaka et al (1998) carried out a series of experiments to investigate children's recognition of unfamiliar faces. In one experiment, children learned four faces to the criterion where they were able to produce the correct name of each person on two consecutive trials. After learning the faces, children were presented with two faces or two features (eyes, nose or mouth) and had to identify which ones belonged to the faces they had learned. The target features were recognised better within the whole face than from the isolated features; however, they did not compare recognition of the internal and external features. Experiment 10 will extend this research and will specifically compare recognition of the internal and external features of familiarised faces.

4.5 Recall of the names and semantic information of unfamiliar people

This chapter will also examine children's ability to remember the names of unfamiliar people. It was shown in the previous chapter that children experience the same kinds of difficulties as do adults when trying to remember the names of familiar people, but that both adults and children do not experience these difficulties with highly familiar people. There is a coherent corpus of data showing that adults also find it difficult to remember the names of unfamiliar people. In these experiments, participants typically learn a set of unfamiliar faces paired with a name and some semantic information, usually an occupation. Recall of the names and semantic information shows that it is harder to associate a name to an unfamiliar face than it is to associate some type of semantic information to an unfamiliar face (e.g. Carson, Burton & Bruce, 2000; Craigie & Hanley, 1997, Stanhope & Cohen, 1993).

McWeeny, Young, Hay & Ellis (1987) provided a striking demonstration of name retrieval difficulties when learning new faces by using words that could be a name and an occupation, such as baker and butcher. In this way, word frequency, imageability and meaningfulness were all controlled because the same word was learned as an occupation by some participants (e.g. this person is a baker) and as a name by another group of participants (e.g. this person is called Mr Baker). Participants were trained to associate a name and an occupation with a set of 16 unfamiliar faces. In the recall test, they produced more correct occupations than correct names. This was the case for both ambiguous words, (e.g. baker and butcher), and unambiguous words (e.g. Mr Hyde, grocer). Thus, even when the same word is learned as a name and as an occupation, it is still harder to recall an unfamiliar person's name than their occupation.

Burton, Jenkins & McNeill (2002) carried out a similar study where participants learned four faces each with a name and an occupation. They used labels that could be either a name or an occupation (baker, potter, parson and barber). One set of participants learned the names baker and parson and the occupations barber and potter and this was reversed for the other set of participants. They were trained to say the names and occupations on presentation of the faces and had to meet strict criterion before proceeding to the test phase. In the test phase, they were asked to produce the name or occupation of the person presented. Voice onset latencies showed that it took longer to say the names than the occupations. When the same participants were asked to read the same words presented on the computer screen, there was no difference in response times to read the names or occupations. Thus, even when the same words are used as names and occupations, adults find it harder to remember the names associated with unfamiliar faces.

4.6 Are there age differences in name retrieval?

Cohen & Faulkner (1986) investigated whether there were differences in name recall difficulties between younger and older adults. Participants listened to fictitious biographies containing four pieces of information about each person (the person's name, where they lived, their occupation and a hobby). They were then presented with a written form of the biographies and had to supply the information that was missing. Recall of names was poorer than recall of the other kinds of information. Adults from four different age groups were tested in this study (ranging from 20 to over 70 years) and all age groups showed the same pattern with names recalled less often than other semantic information.

Bruyer, Van der Linden, Lodewijck, Nelles, Schils, Scweich & Brédart (1992) carried out a similar study as Cohen & Faulkner to compare age differences in name retrieval, but used faces. Young (mean age = 24 years) and elderly adults (mean age = 61 years) learned 12 faces with a name and an occupation. Bruyer et al used ambiguous words that were learned by some participants as names and by other participants as occupations. The elderly participants recalled less information overall than the younger adults, but both groups produced the same pattern of results. Name recall was worse for both age groups than recall of occupations. Thus, age was not found to influence the types of information recalled, only the amount of information recalled. The purpose of Experiments 9 and 10 is to extend this research to include children and to determine whether they show the same difficulties as do adults when learning new names.

4.7 Children's Learning of Names

Very few face learning studies have been carried out with children. Stevenage (1995) and Carey & Diamond (1994) have shown that children find it extremely difficult to associate names with unfamiliar faces. Stevenage (1995) used a learning paradigm to investigate whether children show an advantage, like adults, for recognising caricatured faces. Six, 7 and 8-year-olds learned the names of ten unfamiliar faces in a paired associate learning task. Half of the participants learned the faces from caricatures and the remaining participants learned the faces from veridical images. The dependent measure was the number of trials each child required to put the correct face with the correct name without any help. The main finding was that children of all ages required fewer trials to match the names and faces correctly with caricatured images. However, for the present purposes, we are interested in children's learning of the names of unfamiliar faces. On average, (when the number of trials for caricature and veridical faces are collapsed), 6 and 7-year-olds required seven trials before they were able to match each face with the correct name and 8-year-olds required five trials. This provides some indication of the level of difficulty experienced by children when learning names of unfamiliar people, however the children in this study were not required to recall the names.

Carey & Diamond (1994) investigated name recall indirectly in 6 and 10-year-olds. They describe the difficulties experienced by 6-year-olds when learning the names of six unfamiliar faces, which could take up to 40 minutes in some cases. The primary aim of their study was to examine configural face processing in children. The top half and the bottom half of two faces were fused together or were set apart and the task was to name the person in the top half. Both groups made a large number of errors (21% and 17%) on this task, indicative of their difficulties in recalling the names of these unfamiliar faces. However, this is only indirect evidence of children's difficulties as the purpose of this study was to examine how children were affected when the two face halves were fused together. Further, no study to date has compared children's recall of names with their recall of other information about unfamiliar people to determine whether they experience the same difficulties as do adults. Children's recall of the names and occupations of unfamiliar people is therefore investigated directly in Experiment 9.

Experiment 10 then investigates name recall of a set of familiarised faces. A similar study has been carried out recently by Abdel Rahman et al (2004) who taught children a set of eight politicians' faces, each learned with the person's name, political party and nationality. Children performed a set of classification tasks on these faces whereby they had to decide if each person was a member of the government or opposition party, whether they were a foreign or a domestic politician and whether their surname had more than two syllables or less than two syllables. In the learning phase, the faces were presented on a computer screen together with the relevant semantic information. The faces were then presented without the semantic information and children were asked to produce the relevant information for each face. This was repeated until all the correct information could be provided for each face. The results of the classification task showed that children were faster on the name and nationality decisions than the political party membership decisions whereas adults took longer on the name decisions. These results indicate that there may be a difference between children and adults when learning the names of new people.

This chapter reports three studies investigating children's recognition of unfamiliar faces. Experiment 8 employs a similar design as Want et al (2003) and compares recognition memory for the internal and external features of unfamiliar faces. Experiment 9 uses a similar paradigm to that used with adults to compare recollection of names and occupations of unfamiliar faces. In Experiment 10, children and adults are briefly familiarised with a set of faces and then recall of the names and recognition of the internal features of these faces are examined.

4.8 Experiment 8

The aim of this experiment is to examine recognition memory for the internal and external features of unfamiliar faces. In Chapter 2, children were required to match the internal and external features of unfamiliar faces. Experiments 2a and 2b showed that 7-8-year-old children were just as accurate when matching the internal and external features of unfamiliar faces and 10-11-year-olds were more accurate at matching the external features of unfamiliar faces. Both of these patterns have previously been reported with adults (Bruce et al, 1999; Young et al, 1985b). However, the matching task does not test memory for the features of the unfamiliar faces as the faces are presented in front of participants until a response is made. This experiment therefore examines children's recognition memory for the internal and external features of unfamiliar faces.

Method

Participants

These were 18 8-year-olds, 18 11-year-olds and 18 adults. The younger group had a mean age of 8 years, 4 months (age range 7,10-8,10), and was made up of 8 boys and 10 girls. The older group had a mean age of 11 years, 4 months (age range 10,9-12,0) and was made up of 6 boys and 12 girls. Children were recruited from local schools and the adults were students at Glasgow University (mean age = 27 years, range = 18–32 years). Written parental consent was obtained for all children and testing was carried out within the school or the University.

Design

A mixed design was used with age as the between-subjects factor (8 years, 11 years and adults) and part of face (whole face, external features and internal features) as the within-subjects factor.

Task

A recognition memory task was used. A still video image was presented on the computer screen for five seconds and participants were instructed to try to remember the face. The face was then replaced with a fixation cross which remained on the screen for five seconds. Then photographs of two different faces were presented –

one was the target face and the other a similar looking distracter. Children had to select which of these two faces they had seen previously.

Materials

These were 24 male faces taken at random from the Home Office database of police trainees (full details of which can be found in Bruce et al, 1999). A still video image and a high quality photograph were obtained for each of these 24 target faces. A high quality photograph of a similar looking distracter was also obtained for each target. An example is shown in Figure 5. The video images were edited to a standard size (200 pixels wide x 300 pixels high). A duplicate was made from each of the whole face photographs and was edited to produce an image of the external features and the internal features for each of the target and distracter faces. Test stimuli consisted of a pair of images that showed the whole face of both target and distracter, the external features of both target and distracter or the internal features of both target and distracter.

Figure 5 shows an example of a target video image that was presented for five seconds and examples of the target and distracter test pairs showing the whole face, the external features and the internal features.

Video image shown for five seconds

Whole face test image

External Features test image

Internal Features test image

Procedure

Children were tested individually in a quiet corner within the classroom and adults were tested in a quiet area of the University. They began by completing six practice trials using famous faces to illustrate how the task worked. They then completed two blocks of 12 trials with the unfamiliar faces, with a short break between each block. For each trial, the video image of the target face was presented for five seconds. This was then removed and a fixation cross was presented in the centre of the screen for five seconds. Then the photographs of the target face and the distracter face were presented, showing either the whole face, external or internal features. These remained on screen until a response was made. Participants were instructed to press one key if they thought the face on the left was the one they had just seen and another key if they thought it was the face on the right. They were told they could take as long as they wanted to respond. There followed a five second break and then the next target face appeared. No feedback was given. In each block there were four trials showing the whole face, four trials showing the external features and four trials showing the internal features. The target appeared on the left six times and on the right six times within each block and this was counterbalanced across stimuli and participants by making six different versions of each block.

Results

Table 8 shows the percentage of correct decisions in each type of trial and the means of the median response times. Performance, measured by both accuracy and response times, improved steadily with age on each type of trial, and was best on the whole face and roughly equal on both the internal and external features in each age group. Formal analyses were carried out to test these observations.

Table 8: Mean percent correct and mean reaction times on each type of trial (with standard deviations in parenthesis).

Type of Trial	Whole		External		Internal	
	Accuracy	RT	Accuracy	RT	Accuracy	RT
8-year-olds	88 (15)	4438 (1380)	67 (18)	4851 (1428)	69 (23)	4748 (1604)
11-year-olds	87 (12)	3589 (1104)	74 (14)	3923 (1598)	77 (18)	3566 (840)
Adults	93 (15)	2135 (540)	85 (14)	3293 (1530)	85 (16)	2684 (757)

Overall analysis

A 3 (age) x 3 (part of face) mixed ANOVA was carried out on the accuracy data with age (8, 11-year-olds, adults) as the between-subjects factor and part of face (whole face, external and internal features) as the within-subjects factor. This revealed a main effect of age $F(2,51) = 6.3$, $p<0.01$, a main effect of part of face $F(2,51) = 15.3$, $p<0.01$, and no interaction between the two factors, $F(4,102) = 1.2$, $p>0.05$.

For the main effect of age, a Tukey HSD test revealed that adults (mean = 88%) were significantly more accurate than the 8-year-olds (mean = 74%), $p<0.01$. For the main effect of part of face, a Tukey HSD test revealed that accuracy was significantly higher on the whole face (mean = 89%) than both the external (mean = 75%) and the internal features (mean = 77%), $p<0.01$, which did not differ significantly from each other.

The same 3 (age) x 3 (part of face) mixed ANOVA was carried out on the response time data. This revealed a main effect of age $F(2,51) = 19$, $p<0.01$, a main effect of part of face $F(2,51) = 5.3$, $p<0.01$, and no interaction between these two factors $F(4,102) = 1$, $p>0.05$. For the main effect of age, a Tukey HSD test revealed that adults (mean = 2704ms) were significantly faster than the 11-year-olds (mean = 3693ms) who were in turn faster than the 8-year-olds (mean = 4679ms), $p<0.01$. For the main effect of part of face, Tukey HSD tests revealed that response times to the whole face (mean = 3387ms) were significantly faster than the external features (mean = 4023ms) only, $p<0.01$. Response times on the internal features (mean = 3666ms) were not significantly different from either the whole face or the external features.

Analysis by age groups

8-year-olds

A one-way ANOVA was carried out on the accuracy data with part of face as the within factor. There was a significant main effect of part of face $F(2,34) = 8$, $p<0.01$. For this main effect, a Tukey HSD test revealed that accuracy on whole face(mean = 88%) trials was significantly better than both the external (mean = 67%) and internal feature (mean = 69%) trials ($p<0.01$), which did not differ significantly from each other. The same analysis performed on the response time data revealed no significant differences between experimental conditions, $F(2,34)<1$.

11-year-olds

A one-way ANOVA was carried out on the accuracy data with part of face as the within factor. There was a significant main effect of part of face $F(2,34) = 5$, $p<0.05$. For this main effect, a Tukey HSD test revealed that accuracy was significantly higher on the whole face trials than the external feature trials, $p<0.05$. Performance on the internal features (mean = 77%) did not differ significantly from the whole face (mean = 87%) or the external features (mean = 74%). The same analysis performed on the response time data revealed no significant differences between experimental conditions, $F(2,34)<1$.

Adults

A one-way ANOVA was carried out on the accuracy data with part of face as the within factor. The effect of part of face was not significant, $F(2, 34) = 2.5$, $p>0.05$. The same analysis performed on the response time data revealed a significant main effect of part of face, $F(2,34) = 6.3$, $p<0.01$. For this main effect, a Tukey HSD test revealed that the whole face was responded to faster than the external features, $p<0.01$. Response times on the internal features (mean = 2684ms) did not differ significantly from the whole face (mean = 2135ms) or the external features (mean = 3293ms)

Discussion

The overall analysis revealed the same pattern of results in each age group such that accuracy was highest and response times fastest when the whole face was shown as the test image. There were no differences in performance on the external and internal features and the data indicate that there are gradual quantitative improvements on this task with children becoming faster and more accurate with age. However, when the data for each age group were analysed separately, small differences between the age groups were observed. The main difference is that the adults took significantly longer to respond to the external features than the whole face whereas the two child groups showed no significant differences in response times between the three conditions. If we look at the means from the children's data, however, we can see that response times are longest in the external features condition for both of the child groups. In addition, the 8 and 11-year-olds were significantly more accurate on the whole face than the external features. These observations suggest that when the external features were shown at test, participants found it rather difficult to decide which image they had seen before.

This makes sense if we look more closely at the stimuli used in this experiment. The faces were taken from a database of police trainees and the majority of these people have very similar external features. Most of them have dark, short hair and are clean shaven (refer to Figure 5). The two external images that were presented at test therefore appear to be more similar than the two internal images that were presented at test. This difficulty with the external feature decisions is the most likely explanation for the different results found when the age groups were analysed separately. Participants were not instructed to respond as quickly as they could and it appears that the adults were deliberately taking longer to decide which of the two external images they had seen before.

The similarity of the two external images may help to account for the different results found here and the results from a similar study by Want et al (2003). In their study, participants watched a three-second video clip of an unfamiliar face and then had to choose which of two static photographs matched the person they had seen in the video clip. The photographs showed the whole face, the external features or the internal features. Children aged 5-9 and adults were all fastest when the test photographs showed the whole face and were also faster when the test photographs showed the external than the internal features. Five and 7-year-olds were more accurate on the external than the internal features, and 9-year-olds and adults were just as accurate on the external and internal features. Response times to the external features were faster than the internal features in Want et al's study whereas in the current study there was no difference in response times on the external and internal features. Both of these patterns have been reported in previous research with adults (e.g. Ellis et al, 1979; Young et al, 1985b) and are most likely due to differences in methodology. For example, Want et al (2003) instructed participants to respond as quickly as they could and they used moving video clips. In the current study, static video images were presented and participants were not instructed to respond as quickly as they could. Further, the target and distracter images used in the current study shared very similar external features and this has most likely resulted in the longer response times on the external features. It is important to note that even although the external images used in this experiment were probably more similar and therefore more difficult than in other experiments, there is still no difference in performance on the external and internal features in any of the age groups. The current data provide support for gradual quantitative improvements on this unfamiliar face-processing task and give no indication that children of different ages are processing unfamiliar faces differently from adults.

4.9 Experiment 9

The aim of this study was to examine 8 and 11-year-olds' recall of the names and occupations of unfamiliar people. Several studies have shown that adults can recall more occupations than names of briefly learned faces (e.g. Carson et al, 2000; Craigie & Hanley, 1997; Stanhope & Cohen, 1993). Further, McWeeny et al (1987) and Burton et al (2002) have shown that even when the same word is used as a name and an occupation (e.g. this man is a baker/This man is called Mr Baker), occupations are still easier to remember. A similar method is used here to investigate whether children will also recall more names than occupations of briefly learned faces.

Method

Participants

Twenty-four 8-year-olds, 24 11-year-olds and 24 adults took part. The youngest group had a mean age of 8 years, 4 months (age range 7,11 - 8,10) and was made up of 10 boys and 14 girls. The second group had a mean age of 11 years, 6 months (age range 11,0 - 11,11). This group was made up of 12 boys and 12 girls. The adults were 24 undergraduate students at the University of Glasgow with a mean age of 34 years (range 18-46). Written parental permission was acquired for all children before participating in the study. Child testing took place in a local primary school and at the local Science Centre, Glasgow, and adults were tested in a quiet room at the University of Glasgow.

Materials

Six unfamiliar faces were selected at random from a large database held at Glasgow University. Three of these were female and three were male. Two images of each person were used, one frontal image and one three-quarter view. All images were edited to a standard size (200 pixels wide x 300 pixels high) and were printed out on A4 in grey scale. Each face was learned with a name and an occupation. Each participant learned two faces with an ambiguous name and an unambiguous occupation (e.g. this is Mr Baker, the doctor); two faces with an unambiguous name and an ambiguous occupation (e.g. this is Mr Young, the cook); and two faces with both an unambiguous name and an unambiguous occupation (e.g. this is Miss Wilson, the teacher). The ambiguous words could be a surname and an occupation. They were baker, butcher, cook and gardener. Half of the participants learned the words baker and gardener as names and butcher and cook as occupations whilst the other half of participants learned butcher and cook as names and baker and gardener as occupations. The unambiguous words were Young, Shaw, Wilson and Jackson for surnames and teacher, policeman/woman, doctor and nurse for occupations. The ambiguous and unambiguous words were rotated around the six faces so that each participant learned the same information, but with different faces. The names and occupations were written underneath each face. Half of the participants read the person's name first and the other half read the person's occupation first. Thus, participants either read "This man is called Mr Young. He is a butcher" or "This man is a butcher. He is called Mr Young". Half of the participants studied the faces in the frontal view and the other half studied the faces from the three-quarter image. After learning the faces, each participant received a booklet with the six faces only. These faces were in the opposite view from the learning booklet. Thus if participants learned the face from the frontal view, they saw the faces in the three-quarter view at recall and vice versa. They were required to write the names and occupations that they could remember beside the correct face.

Procedure

Participants were presented with a booklet with six faces. The name and occupation of each person was written underneath. They were instructed to try to remember each face along with the person's name and occupation. They were given 30 seconds to study each face and were told by the experimenter when to turn the page over to study the next person. When all six faces had been studied, they were given a different booklet with a different image of the six faces. They were instructed to write down as many names and occupations as they could remember beside the appropriate person.

Results

The data for ambiguous information (e.g. baker, butcher) and unambiguous information (e.g. teacher, Mr Young) were scored separately. The mean number of correctly recalled items by each age group is presented in Table 9. The maximum number of ambiguous items that could be correctly recalled was 2 and the maximum number of correctly recalled unambiguous items was 4.

Overall analysis

A 3 (age) x 2 (information type) mixed analysis of variance (ANOVA) was carried out on the ambiguous data with age as the between-subjects factor (8 year-olds, 11-year-olds and adults) and information type as the within-subjects factor (names and occupations). This revealed a main effect of age, $F(2,69) = 12.2$, $p<0.01$. A Tukey HSD test ($p<0.05$) revealed that adults recalled significantly more information (mean = 1.44) than both the 8- and 11-year-olds (means = 0.85 and 0.73 respectively).

Table 9: Mean number of correctly recalled items in each condition (with standard deviations).

	Names		Occupations	
	Ambiguous	**Unambiguous**	**Ambiguous**	**Unambiguous**
8-year-olds				
Number correct	0.79 (0.72)	0.79 (0.98)	0.92 (0.88)	1.79(0.98)
Percent correct	39%	20%	46%	45%
11-year-olds				
Number correct	0.67 (0.7)	1.5 (1.18)	0.79 (0.66)	2.54 (1.14)
Percent correct	33%	37%	39%	63%
Adults				
Number correct	1.37 (0.65)	2.71 (1.33)	1.6 (0.66)	3.37 (1.09)
Percent correct	68%	68%	75%	84%

The effect of information type was not significant, $F(1,69) = 1.2$, $p>0.05$, with occupations (mean =1.07) recalled just as often as names (mean = 0.94). The interaction between age and information type was not significant, $F(2,69) <1$.

A 3 (age) x 2 (information type) mixed analysis of variance (ANOVA) was carried out on the unambiguous data with age as the between factor (8 year-olds, 11-year-olds and adults) and information type as the within factor (names and occupations). This revealed a significant main effect of age $F(2,69) = 21$, $p<0.01$. A Tukey HSD ($p<0.05$) test revealed that adults recalled significantly more unambiguous information (mean = 3.04) than the 11-year-olds (mean = 2.02) who recalled significantly more information than the 8-year-olds (mean = 1.29). There was a significant main effect of information type $F(1,69) = 37$, $p<0.01$, with occupations (overall mean = 2.57) recalled correctly significantly more often than names (overall mean = 1.67). The interaction between age and information type was not significant, $F(2,69) <1$.

Analysis by age groups

8-year-olds

Related pairs t-tests were carried out on the ambiguous and unambiguous data separately. This revealed no effect of information type, $t(23) = 0.5$, $p>0.05$, for the ambiguous words and a significant effect of information type for the unambiguous words, $t(23) = 4$, $p<0.01$.

11-year-olds

Related pairs t-tests were carried out on the ambiguous and unambiguous data separately. This revealed no effect of information type, $t(23) = 0.7$, $p>0.05$, for the ambiguous words and a significant effect of information type for the unambiguous words, $t(23) = 4$, $p<0.01$.

Adults

Related pairs t-tests were carried out on the ambiguous and unambiguous data separately. This revealed no effect of information type, $t(23) = 0.7$, $p>0.05$, for the ambiguous words and a significant effect of information type for the unambiguous words, $t(23) = 2.6$, $p<0.05$.

Unrelated t tests were used to compare groups of participants in each age group who had learned the same word (baker, butcher, cook and gardener) as an occupation or as a name. None of these comparisons were significant.

Discussion

The aim of this experiment was to determine whether children and adults remember the same kinds of information about unfamiliar people. A common paradigm used with adults is to associate a name and some type of semantic information with a set of unfamiliar faces. Later, participants are presented with the faces and are asked to recall the name and semantic information that was learned with each face. It has consistently been demonstrated that adults remember the names of these people much less often than the semantic information associated with each person (e.g. Carson et al, 2000; Craigie & Hanley, 1997; McWeeny et al, 1987). It has been shown that this is the case for both young and older adults (Bruyer et al, 1992; Cohen & Faulkner, 1986). However, no study to date has investigated whether children find it more difficult to recall the names of unfamiliar faces. The purpose of this experiment was therefore to examine children's recall of the names and occupations of unfamiliar faces to determine the kinds of errors made on this task by younger participants.

Eight and 11-year-olds learned to associate a name and an occupation with six unfamiliar faces. Some of the words used in this experiment were ambiguous and could be an occupation or a name (e.g. this man is Mr Cook or this man is a cook). Thus, half of the participants learned these words as names and the other half of participants learned these words as occupations. The rest of the words were unambiguous such as Mr Young and teacher. After studying the faces, participants were required to recall the name and occupation of each person. More occupations were correctly recalled than names by 8 and 11-year-olds and a group of adults. This difference was more pronounced for the unambiguous words and the data indicate that there are clear quantitative improvements with age. Children and adults show the same pattern with occupations always recalled more often than names and there is a steady increase in performance as children get older. The pattern on the ambiguous words was not as strong, but there was some evidence of a trend whereby recall of occupations was a little higher than recall of names. Performance on these ambiguous words was quite poor and suggests that children had difficulty remembering names and occupations when an ambiguous item that could be a name or an occupation was used in this experiment. Children's difficulty with these ambiguous words is indicated in the lack of improvement between the ages of 8 and 11, compared with the improvement on the unambiguous words during these years. The data on the unambiguous words do however show a clear pattern and extend the research in this area to include children as well as adults. When presented with the name and an occupation of a new face, it is much easier to remember the semantic information associated with that face than the name.

The experiments conducted in this thesis so far have illustrated differences in the processing of familiar and unfamiliar faces. When a face is familiar, both children and adults find the internal features more useful than the external features for recognition and can recall the names of highly familiar faces faster than other semantic information. In contrast, when a face is unfamiliar, children and adults either find the external features more useful for recognition or find the external and internal features equally useful for recognition and find the names of unfamiliar people harder to recall than other semantic information. The experiment that follows attempts to track the changes that take place as an unfamiliar face becomes familiar. It explores whether the external or internal features contribute more to the recognition of faces that have been briefly learned and whether the names of these familiarised faces are harder to remember than other semantic information.

4.10 Experiment 10

The purpose of this experiment was to explore some of the factors involved in face learning. Very little is known about the process of how initially unfamiliar faces become familiar. A few recent studies have begun to investigate this learning process in adults, but even fewer attempts have been made to explore the learning process in children.

It has been shown that when recognising unfamiliar faces, the external features are more useful or the external and internal features are equally useful. In contrast, when a face is familiar, the internal features are more useful for recognition. Learning studies with adults have tried to track this shift towards the internal features as faces become more familiar. For example, O'Donnell & Bruce (2001) have shown that participants were able to detect changes made to the configuration or shape of the eyes of familiarised faces much more accurately than unfamiliar faces. Bonner et al (2003) demonstrated that matching of the internal features of a set of familiarised faces improved over the course of a three-day learning experiment. At the beginning of the three days, matching accuracy on the internal features was worse than the external features. However, by the end of the experiment, matching performance on the external and internal features of the familiarised faces was equivalent. Both of these studies indicate that as faces become familiar, performance on the internal features improves. One study has investigated whether similar effects are found with children. Newcombe & Lie (1995) briefly familiarised 5-year-olds and adults with a set of faces. They then carried out a face matching task and performance was better on the external than the internal features of both the familiarised and the unfamiliar faces. This was the case for both the 5-year-olds and the adults and suggests that the familiarisation period was not long enough to produce a significant improvement on the internal features as there was no overall benefit on performance for the familiarised faces. The current experiment will extend these findings by investigating older children's recognition of the internal and external features of familiarised faces.

The present experiment also investigates whether children and adults experience difficulties in remembering the names of these briefly familiarised faces. In line with the results from experiment 9, it is predicted that both children and adults will find it harder to remember the names of these familiarised faces than the semantic information that they learn with the faces. However, some recent research suggests that there may be differences between children and adults. Abdel Rahman et al (2004) trained children on a set of politician's faces that they learned with a name, nationality and details of the person's political party. After the familiarisation phase, children performed a speeded classification task on these faces and were faster on the name and the nationality decisions than the political party decisions. This may be a reflection of children's difficulty with the semantic category of political parties, but could reflect a difference between children and adults if replicated in further research.

In the current experiment, participants learn a set of unfamiliar faces with a name and some semantic information. The faces are presented as two families, the Smiths and The Jones', and the task is to associate each face with the correct name and the correct number of siblings. There then follows a test phase, where a face is presented and followed by either a name or number of siblings. The task is to decide whether the information that follows the face is correct or incorrect for that particular person. Accuracy and response times to the names and the sibling decisions are compared to determine whether children and adults respond quicker and more accurately to names or the semantic (sibling) information. Participants then perform a standard old/new recognition test to determine whether the learned faces are better recognised from the internal or external features. The results of this study will extend the current knowledge of how faces become familiar and will establish whether the same types of processes are taking place in children and adults.

Method

Participants

These were 15 8-year-olds, 18 11-year-olds and 18 adults. The younger group had a mean age of 8 years, 8 months (age range = 8,0 – 9,1) and was made up of 8 girls and 7 boys. The older group had a mean age of 11 years, 2 months, (age range = 10,7 – 11,11) and was made up of 10 boys and 8 girls. The children were tested in a quiet area of the school upon acquisition of written parental permission. The adults were undergraduates at the University of Glasgow and had a mean age of 26 years (range = 18-29 years).

Materials

A small set of child faces was available for use as the stimulus faces. These were originally developed for use in a study by Bruce et al, (2000). This database contains many different photographs of the children from a variety of viewing angles and showing several different facial expressions. Participants were familiarised with six of the children from this database in the learning phase. Ten different photographs of these six children were selected as the learning images, a further three photographs were used in the verification phase, four additional photographs were selected for the test images and a further three photographs were used in the recognition test. Each of the photographs was transformed into grey-scale and edited to a standard size (200 pixels wide x 300 pixels high). The six faces were allocated to one of two families (the Smith family and the Jones family), with three children in each family. Participants learned the name of each child and the number of brothers and sisters each child had.

Procedure

Learning phase: Participants were familiarised with the six faces in the learning phase. They were shown the full-face neutral photographs of each of the six children, one at a time, and the name of each child was read aloud by the experimenter. The names of each child were written in bold letters underneath each of these pictures. The six photographs were spread out at the top of the table, so that the three children from each family were placed together. The experimenter explained that the children belonged to two families, the Smiths and the Jones', and pointed out the sibling relationships of each child (for example, this is Jill Smith, she has one brother, John, and one sister, Jane). The participants were then given 54 pictures, which consisted of nine different photographs of each of the six children. They were instructed to look at each photograph carefully and to place it underneath the person whom they thought it was from the six photographs at the top of the table. The experimenter told participants to look more closely if they put a picture underneath the wrong person and this continued until the picture was matched to the correct person. While sorting the pictures, participants were encouraged to try to remember the names and the siblings of each person.

Verification phase: In the verification phase, the faces of the six familiarised faces were presented one at a time and participants were required to name each person and to state the number of brothers and sisters each person had. Mistakes were corrected when they occurred. This process was repeated until the names and siblings of each person were correctly provided on two consecutive presentations. This criterion has been used previously with children in this type of study (e.g. Tanaka et al, 1998).

Test phase: The same format as Experiments 3, 5 and 7a was used. A face was presented on the computer screen and was followed by a piece of information. This information could either be the person's correct name, an incorrect name (the name of one of the other six children of the same sex), the correct number of siblings or an incorrect number of siblings. A trial consisted of a face being presented for 750ms followed by a blank screen for 750ms and then either a name or the number of siblings was presented for 750ms or until a response was made. Participants were instructed to press one key if the information following the face was correct and a different key if the information that followed was incorrect for the person who had preceded it. They were given six practice trials (three name and three sibling) with famous faces. There were 24 experimental trials, consisting of 12 name (six true and six false) and 12 sibling (six true and six false) decisions. The experimental trials showed a different image of each of the six familiarised faces on each trial. Trials were presented in a different random order for each participant. Participants were encouraged to guess quickly when they were unsure of the correct response.

Recognition Test: After the test phase, participants carried out a recognition task if time permitted. Here, the whole face, the external features and the internal features of each of the six familiarised faces and a set of six unfamiliar faces were presented. Participants had to press one key if they thought the face was one of the six children they had been learning and a different key if they thought they had not seen that person before. Due to time constraints during the testing, not all children took part in the recognition phase. Nine of the 15 8-year-olds took part, mean age = 8 years, 8 months (range 8,0 – 9,1); 10 of the 18 11-year-olds took part, mean age = 11 years, 1 month, (range = 10, 10 – 11,11) and 12 of the adults took part (mean age = 25 years).

Results

The means of the median response times and the percentage of correct answers from the test phase are presented in Table 10.

Overall analysis

A 3 (age) x 2 (information type) x 2 (response) mixed ANOVA was carried out on the response time data. Age (8 years, 11 years and adults) was the between-subjects factor and information type (names and siblings) and response (true and false) were within-factors. This revealed a main effect of age only, $F(2,48) = 7.9$, $p<0.01$. For this main effect, a Tukey HSD test revealed that the adults (mean = 1497ms) responded significantly faster than the 11-year-olds (mean = 2271ms) and the 8-year-olds (mean = 2382ms), $p<0.01$. The effect of information type was not significant, $F(1,48) = 2.4$, $p>0.05$, and the effect of response was not significant, $F(1,48) <1$. There were no significant interactions: interaction between age and information type, $F(2,48) = 2.5$, $p>0.05$, all other Fs<1.

Table 10 shows the mean response time and the mean percent correct for each condition in the test phase (standard deviations in parenthesis).

	Names		Siblings	
	True	**False**	**True**	**False**
8-year-olds				
Mean RT	2283 (1167)	2141 (751)	2598 (961)	2506 (840)
% correct	82 (17)	72 (22)	83 (17)	81(22)
11-year-olds				
Mean RT	2286 (1303)	2278 (913)	2218 (677)	2301 (966)
% correct	89 (16)	76 (26)	89 (14)	92 (12)
Adults				
Mean RT	1390 (523)	1586 (595)	1466 (317)	1547 (697)
% correct	92 (10)	82 (14)	90 (14)	97 (8)

The same ANOVA was carried out on the accuracy data. This revealed a main effect of age, $F(2,48) = 3.9$, $p<0.05$. For this main effect, a Tukey HSD test revealed that the adults (mean = 90%) responded significantly more accurately than the 8-year-olds (mean = 80%). There was a significant main effect of information type, $F(1,48) = 11.7$, $p<0.01$, with accuracy higher on sibling decisions (mean = 89%) than name decisions (mean = 83%). The effect of response was not significant, $F(1,48) = 3.3$, $p>0.05$. There was a significant interaction between information type and response, $F(1,48) = 13$, $p<0.01$. To explore this interaction, simple main effects analyses were carried out. This revealed an effect of information type for false, $F(1,96) = 26$, $p<0.01$, but not true, $F(1,96)<1$ decisions. On false decisions, accuracy was lower on names (mean = 77%) than siblings (mean = 90%). There was an effect of response for names, $F(1,96) = 14.6$, $p<0.01$, but not siblings, $F(1,96) = 1.3$, $p>0.05$. Accuracy was higher on true names (mean = 88%) than false names (mean =77%). There were no other significant interactions, all $Fs<1$.

Analysis by age groups

8-year-olds

A 2 (information type) x 2 (response) within-subjects ANOVA was performed on the response time data. This revealed a significant main effect of information type, $F(1,14) = 4.7$, $p<0.05$. Responses to names were significantly faster (mean = 2212ms) than siblings (mean = 2552ms). The effect of response was not significant, $F(1,14) <1$ and the interaction between information type and response was not significant, $F(1,14)<1$. The same analysis performed on the accuracy data revealed no significant differences between experimental conditions: main effect of information type, $F(1,14) = 1.1$, $p>0.05$; main effect of response, $F(1,14) = 1.8$, $p>0.05$ and interaction between information type and response, $F(1,14) = 1.9$, $p>0.05$.

11-year-olds

The same 2 (information type) x 2 (response) within-subjects ANOVA was performed on the response time data. This revealed no significant differences between experimental conditions: main effect of information type, $F(1,17) < 1$; main effect of response, $F(1,17) < 1$, and interaction between information type and response, $F(1,17) < 1$. The same analysis performed on the accuracy data revealed a significant main effect of information type, $F(1,17) = 8.5$, $p<0.01$. The effect of response was not significant, $F(1,17) = 1.3$, $p>0.05$. There was a significant interaction between information type and response, $F(1,17) = 4.6$, $p<0.05$. Simple main effects analyses were carried out to explore this interaction. This revealed an effect of information type for false, $F(1, 17) = 17$, $p<0.01$, but not true, $F(1,17) < 1$ decisions. On false decisions, accuracy was lower on names (mean = 76 %) than siblings (mean = 92%). There was an effect of response for names, $F(1,17) = 5.2$, $p<0.05$, but not siblings, $F(1,17) < 1$. Accuracy was higher on true names (mean = 89%) than false names (mean = 76%).

Adults

The same 2 (information type) x 2 (response) within-subjects ANOVA was performed on the response time data. This revealed no significant differences between experimental conditions: main effect of information type, $F(1,17) < 1$; main effect of response, $F(1,17) = 1.9$, $p>0.05$, and interaction between information type and response, $F(1,17)<1$. The same analysis was performed on the accuracy data. This revealed a significant main effect of information type, $F(1,17) = 8.3$, $p<0.05$. The effect of response was not significant, $F(1,17) <1$. There was a significant interaction between information type and response, $F(1,17) = 9.3$, $p<0.01$. Simple main effects analyses were carried out to explore this interaction. This revealed an effect of information type for false, $F(1, 17) = 25$, $p<0.01$, but not true, $F(1,17)<1$ decisions. On false decisions, accuracy was lower on names (mean = 82%) than siblings (mean = 97%). There was an effect of response for names, $F(1,17) = 6.2$, $p<0.05$, but not siblings, $F(1,17) =3.4$, $p>0.05$. Accuracy was higher on true names (mean = 92%) than false names (mean = 82%).

Recognition Test

Tables 11a and 11b show the response time and accuracy data from the recognition test. Formal analysis of the recognition test is presented below and can be summarised as follows. For target faces, accuracy was higher and response times were faster on both the whole face and the external features than the internal features. Adults and 11-year-olds were faster than 8-year-olds, but there were no significant age effects from the accuracy data. For distracter faces, accuracy was higher on the whole face than the internal features and response times were faster on the whole face than both the internal and external features. Adults were more accurate than the 11-year-olds and there were no significant age effects from the response time data. Thus, the same pattern of responses was observed in each age group with better performance on the external than the internal features of the familiarised faces and comparable performance on the internal and external features of the unfamiliar faces. This is consistent with previous research showing that the internal and external features of unfamiliar faces are recognised equally well by adults (Ellis et al, 1979) and that adults and 5-year-olds remember the external features of briefly familiarised faces better than the internal features (Newcombe & Lie, 1995).

Table 11a: Mean percent correct and mean reaction times on target faces (with standard deviations in parenthesis).

Type of Trial	Whole		External		Internal	
	Accuracy	RT	Accuracy	RT	Accuracy	RT
8-year-olds	98 (6)	1309 (248)	100 (0)	1440 (271)	67 (22)	2108 (761)
11-year-olds	98 (5)	1082 (211)	97 (7)	1179 (284)	73 (18)	1485 (368)
Adults	100 (0)	993 (266)	100 (0)	1067 (224)	85 (15)	1432 (658)

Table 11b: Mean percent correct and mean reaction times on distracter faces (with standard deviations in parenthesis).

Type of Trial	Whole		External		Internal	
	Accuracy	RT	Accuracy	RT	Accuracy	RT
8-year-olds	92 (12)	1347 (269)	90 (9)	1877 (445)	89 (18)	1894 (901)
11-year-olds	90 (9)	1367 (437)	83 (16)	1932 (827)	77 (14)	1635 (581)
Adults	100 (0)	1143 (319)	93 (11)	1503 (575)	96 (10)	1574 (538)

Overall analysis

A 3 (age) x 3 (part of face) mixed ANOVA was performed on the response time data for target faces. Age was the between factor (8 years, 11 years, and adults) and part of face was the within factor (whole face, external features, internal features). This revealed a main effect of age, $F(2,28) = 6.5$, $p<0.01$. For this main effect, a Tukey HSD test revealed that adults (mean = 1164ms) and 11-year-olds (mean = 1248ms) responded significantly faster than 8-year-olds (mean = 1619ms), $p<0.05$. There was a main effect of part of face, $F(2,28) = 22$, $p<0.01$. For this main effect, a Tukey HSD test revealed that response times to the whole face (mean = 1113ms) and the external features (mean = 1211) were significantly faster than the internal features (mean = 1645ms), $p<0.01$. The interaction between age and part of face was not significant, $F(4,56) = 1.3$, $p>0.05$.

The same 3 (age) x 3 (part of face) mixed ANOVA was performed on the response time data for the distracter faces. There was a main effect of part of face, $F(2,28) = 8.9$, $p<0.01$. For this main effect, a Tukey HSD test revealed that response times to the whole face (mean = 1274ms) were significantly faster than the external features (mean = 1686ms) and the internal features (mean = 1750ms), $p<0.01$. The effect of age was not significant, $F(2,28) = 1.5$, $p>0.05$, and the interaction between age and part of face was not significant, $F(4,56) = <1$.

The same 3 (age) x 3 (part of face) mixed ANOVA was performed on the accuracy data for target faces. There was a main effect of part of face, $F(2,28) = 51$, $p<0.01$. For this main effect, a Tukey HSD test revealed that accuracy on the whole face (mean = 99%) and the external features (mean = 99%) was significantly higher than the internal features (mean = 76%), $p<0.01$. The effect of age was not significant, $F(2,28) = 2.9$, $p>0.05$, and the interaction between age and part of face was not significant, $F(4,56) = 2.3$, $p>0.05$.

A 3 (age) x 3 (part of face) mixed ANOVA was performed on the accuracy data for the distracter faces. This revealed a main effect of age, $F(2,28) = 7.2$, $p<0.01$. For this main effect, a Tukey HSD test revealed that the 11-year-olds (mean = 83%) were significantly less accurate than adults (mean = 96%), $p<0.01$. There was a main effect of part of face, $F(2,28) = 3.3$, $p<0.05$. For this main effect, a Tukey HSD test revealed that accuracy on the internal features (mean = 88%) was significantly lower than on the whole face (mean = 94%), $p<0.05$, $p<0.01$. The interaction between age and part of face was not significant, $F(4, 56) <1$.

Analysis by age groups

8-year-olds

A one-way ANOVA was performed on the response time data for target faces with part of face as the within factor. This revealed a main effect of part of face, $F(2,16) = 7$, $p<0.01$. For this main effect, a Tukey HSD test revealed that response times were significantly faster on the whole face and the external features than the internal features, $p<0.05$. The same analysis performed on the response times for distracter faces revealed no significant differences between experimental conditions, $F(2,16) = 3.5$, $p>0.05$. The same analysis performed on the accuracy data for the target faces revealed a significant main effect of part of face, $F(2,16) = 23$, $p<0.01$. For this main effect, a Tukey HSD test revealed that accuracy on the whole face and the external features was significantly higher than on the internal features, $p<0.01$. The same analysis performed on the accuracy data for the distracter faces revealed no significant differences between experimental conditions, $F(2,16) <1$.

11-year-olds

A one-way ANOVA was performed on the response time data for target faces with part of face as the within factor. This revealed a main effect of part of face, $F(2,18) = 18$, $p<0.01$. For this main effect, a Tukey HSD test revealed that response times were significantly faster on the whole face and the external features than the internal features, $p<0.01$. The same analysis performed on the response times for distracter faces revealed no significant differences between experimental conditions, $F(2,18) = 2.3$, $p>0.05$. The same analysis performed on the accuracy data for the target faces revealed a significant main effect of part of face, $F(2,18) = 13$, $p<0.01$. For this main effect, a Tukey HSD test revealed that accuracy on the whole face and the external features was significantly higher than on the internal features, $p<0.01$. The same analysis performed on the accuracy data for the distracter faces revealed no significant differences between experimental conditions, $F(2,18) = 2.5$, $p>0.05$.

Adults

A one-way ANOVA was performed on the response time data for target faces with part of face as the within factor. This revealed a main effect of part of face, $F(2,22) = 6.5$, $p<0.01$. For this main effect, a Tukey HSD test revealed that response times were significantly faster on the whole face and the external features than the internal features, $p<0.05$. The same analysis performed on the response times for distracter faces revealed a significant effect of part of face, $F(2,22) = 4.5$, $p<0.05$. For this main effect, a Tukey HSD test revealed that response times were faster on the whole face than the internal features, $p<0.05$. The same analysis performed on the accuracy data for the target faces revealed a significant main effect of part of face, $F(2,22) = 12.6$, $p<0.01$. For this main effect, a Tukey HSD test revealed that accuracy on the whole face and the external features was significantly higher than on the internal features, $p<0.01$. The same analysis performed on the accuracy data for the distracter faces revealed no significant differences between experimental conditions, $F(2,22) = 2.7$, $p>0.05$.

Discussion

The aim of Experiment 10 was to explore some of the factors involved in face learning. Previous research has shown that different information is important for familiar and unfamiliar face processing. The internal features of familiar faces are more useful for recognition whereas when recognising unfamiliar faces, the external features are more useful or the external and internal features are equally useful. When faces are highly familiar, it is easier to recall their names than other semantic information whereas this pattern is reversed for unfamiliar faces and faces that are less familiar. The present experiment explored whether some of these differences could be identified when children were familiarised with a set of unfamiliar faces. They were trained on a set of six faces, belonging to two families and learned to associate the name and number of siblings to each face.

The overall analysis on the recall of names and siblings revealed similar responses in children and adults and indicated that performance improved with age. Response times steadily decreased and accuracy on this task increased with age. There was some evidence that the names of these familiarised faces were harder to remember than the sibling information that was learned with them as on false trials, accuracy was lower on name decisions than on sibling decisions. However, there were some indications of differences between the 8-year-olds and the 11-year-olds and adults in the separate analyses conducted on the individual age groups. Both the 11-year-olds and the adults showed the same pattern as the overall analysis indicated whereby accuracy was lower on names than siblings on false trials. Although the 8-year-olds' data shows the same pattern, this difference was not significant. Further, the 8-year-olds were significantly faster on the name decisions than the sibling decisions whereas there were no differences in response times on name and sibling trials for the older children and the adults. These results suggest that younger children, in contrast to older children and adults, may respond faster to the names of newly learned faces than other information that they have learned about these people and may indicate a genuine age difference in face processing.

However, an alternative explanation of these results is that they may reflect the ease or difficulty of the semantic decision (siblings). Abdel Rahman et al (2004) have shown that both children and adults respond faster on name trials than semantic decisions when the semantic decisions are made more difficult than the name decision. The 8-year-olds who took part in Experiment 5 found it difficult to remember sibling information about their classmates and responded at just above chance level. The 8-year-olds in Experiment 10 may therefore have experienced similar difficulties when trying to learn the siblings of unfamiliar people and this may have caused them to respond faster to the names than the sibling trials. Further, the 8-year-olds in Experiment 9 experienced the same difficulties with name recall as did adults with faces that they studied for a short period of time. It is therefore unlikely that the present results reflect a genuine difference between younger children and adults in their recall of the names of briefly familiarised faces. Rather, the present results most likely reflect the difficulty the 8-year-olds experienced with the sibling decisions. Further experiments of this kind will be required to establish whether there is a genuine difference in the information that adults and children remember about familiarised faces.

The recognition test showed the same pattern in 8 and 11-year-olds and adults when recognising the familiarised faces. Accuracy was higher on the whole face and the external features than the internal features and response times were faster on the whole face and the external features than the internal features of the familiarised faces. In contrast, there was no difference in recognition performance of the unfamiliar faces from the external and internal features. This is consistent with the results from Experiment 8. Taken together, these results indicate that the brief familiarisation period in this experiment was sufficient to improve performance on the external features, but not the internal features. This is also consistent with the results from Newcombe & Lie (1995) who report that 5-year-olds and adults were more accurate on a matching task with the external than the internal features of familiarised faces. Thus, from Newcombe & Lie's experiment and the current experiment, there is evidence that in the early stages of the familiarisation process, both children and adults encode the external features more efficiently than the internal features. It is evident that improvement on the internal features requires a much longer period of familiarisation, perhaps a substantial amount of learning over several days as in the Bonner et al study (2003). The results of the current experiment are therefore limited to the start of the familiarisation process, but are useful in extending previous results to include older children.

4.11 General Discussion

The purpose of this thesis is to determine whether there is anything qualitatively different between child and adult face processing. The first section of this thesis (Chapter 2) examined children's ability to match the internal and external features of familiar and unfamiliar faces. Like adults, 7-11-year-old children were more accurate when matching the internal features of familiar faces. Children also showed the same pattern as adults when matching unfamiliar faces. Seven-eight-year-olds were just as accurate when matching the internal and external features of unfamiliar faces and 10-11-year-olds were more accurate when matching the external features. Both of these patterns have been reported in adult studies (Bruce et al, 1999; Young et al, 1985b).

Experiment 8 extended this research by comparing children's recognition of unfamiliar faces from the external and internal features. The results showed that 8 and 11-year-old children and adults all recognised the internal and external features of unfamiliar faces equally well. This is consistent with previous research with adults (Ellis et al, 1979) and 9-year-old children (Want et al, 2003). Want et al carried out a very similar study as Experiment 8 and reported that 5 and 7-year-olds were more accurate when recognising the external features than the internal features of unfamiliar faces and that 9-year-olds and adults were just as accurate when recognising the external and internal features of unfamiliar faces. Want et al also found that 5-9-year-olds and adults were faster when recognising the external features than the internal features of unfamiliar faces. There was some evidence in Experiment 8 that adults and children were slower on the external features than the whole face, indicating that it may have been more difficult to recognise the faces from the external features. The most likely explanation for this difference lies in methodological differences between the Want et al study and Experiment 8. Participants were instructed to respond as quickly as they could in the Want et al experiment whereas they were told they could take as long as they wanted to respond in Experiment 8. This may have led to the participants (especially the adults) in Experiment 8 taking longer to respond on the external trials because the external features of the target and distracter faces used in this experiment were so similar. Further replication of this experiment with distracters that are less similar to the target faces will help to resolve this issue. The important finding from Experiment 8 is that even when the external feature decisions were more difficult than in other studies, accuracy on the internal and external features was equivalent. If participants had been instructed to respond as quickly as they could and less similar distracter faces had been used, performance on the external features may have been better than performance on the internal features like in the Want et al study.

The purpose of Experiment 9 was to extend the research on name recall to include children. Several studies have shown that adults find it harder to remember the names of unfamiliar people than other information about them such as their occupation. This effect was replicated with adults in Experiment 9 and it was also shown that 8 and 11-year-old children recall occupations more often than the names of unfamiliar faces. There was no evidence of children finding it easier to learn the names of new people than their occupations. This reiterates the findings from Experiment 3 where children took longer to verify a familiar person's name than their occupation and suggests that the same processes are involved in children's and adults face naming. When a face is unfamiliar, they find it harder to remember the person's name and this difficulty persists even when a face is reasonably well known. It is only when someone is highly familiar that both children and adults find it easier to remember someone's name. Future research on face learning should examine when this transition takes place and investigate any factors that can influence it.

Experiment 10 brought these two strands of research together and investigated whether familiarised faces would be recognised better from the internal features or whether names of familiarised faces would be easier to recall than other semantic information. Participants were trained to associate a name and the number of siblings each person had to six initially unfamiliar faces. There was some evidence of names being harder to learn as accuracy on the false sibling decisions was higher than that on the false name decisions. However, 8-year-olds were faster overall on the name than the sibling decisions. This may reflect a developmental difference in face learning or may reflect the younger children's difficulty with the sibling task. Abdel Rahman et al (2004) have shown that a harder semantic task can produce a temporal advantage for the names of faces children and adults have learned. Future work with an easier semantic task will help to determine conclusively whether younger children find it easier to remember the names of familiarised faces.

Recognition of the familiarised faces in Experiment 10 was more accurate and faster from the external features than the internal features whereas responses to the unfamiliar faces showed no difference in accuracy or response times between the external and internal features. This extends the work of Newcombe & Lie (1995) who reported that 5-year-olds and adults were more accurate when matching the external features of familiarised faces than the internal features. Thus, in the early stages of familiarisation, faces are recognised better from the external features and names are harder to recall. Future work in this area could use a longer period of familiarisation with children to track any changes that are taking place and could investigate whether factors such as motion can influence children's learning of new faces. Recent work with adults has investigated whether faces are learned better from moving than from static images (Bonner et al, 2003; Lander & Bruce, 2003) and future work could examine whether motion benefits children's learning of new faces.

It is well established in the adult literature that there are differences between familiar and unfamiliar face processing. This thesis has established that the same differences exist for children and that previous work suggesting developmental differences in familiar face processing may have been the result of using famous faces as stimuli. Very little work has been carried out to investigate the changes that take place as unfamiliar faces become familiar with adults and even less work has been carried out with children. However, the results from Experiment 10 suggest that the same processes are involved in face learning in children and adults, and future work will help to establish exactly what changes take place during familiarisation.

Current models of face and person recognition focus on faces that are familiar, and therefore need to be modified to account for the changes that take place as faces become familiar. Burton (1994) proposed an extension to the IAC model of face recognition (Burton, Bruce & Johnston, 1990) to explain how the features of a new face are linked to a new Face Recognition Unit (FRU). Learning of a new face is said to take place through the strengthening of the links between new combinations of feature units and the new FRU. However, this account does not offer any explanation of the processes involved in integrating the new FRU to a new PIN and to the corresponding SIUs that are associated with the new person. Much more research is required on the face learning process and this new information will help to inform and develop current models of familiar face recognition to include an account of how new faces are learned. It is argued here that the same processes are involved in child and adult face learning and that new theoretical developments will apply equally to children and adults.

The results of the current experiments extend the literature on name retrieval difficulties to include children, but do not help to explain why names should be so difficult to learn. Several theories have been proposed, but other researchers have often refuted these explanations. For example, Burton & Bruce (1992) argued that names are harder to learn because they are usually unique to one individual whereas many people share semantic information, such as occupation. However, Carson et al, (2000) found that names were recalled less often than other unique information (unusual pets). Cohen (1990) proposed that names are harder to learn because they are less meaningful than other information known about a person and are consequently less well integrated in the semantic system. She showed that it was possible to reverse the name retrieval disadvantage when faces were learned with a meaningful name and a meaningless occupation (e.g. this is Mr Baker, he's a ryman).

This is similar to the findings of Abdel Rahman et al (2004) who found a name advantage in children and adults when the semantic task was made harder. However, none of the current accounts of name retrieval difficulties can explain why it is harder to remember that someone is called Mr Baker than it is to remember that someone is a baker as the same word is used as a name and an occupation (Burton et al, 2002; McWeeny et al, 1987). The search for a comprehensive account of naming difficulties, which can now be extended to include children, therefore continues.

Chapter 5 Summary, Evaluations and Further Research

The research carried out in this thesis has investigated the nature of children's improvement in face processing with the specific aim of determining whether such improvement can be attributed to quantitative or qualitative change. Support for development as quantitative change would be indicated by the same pattern of performance in children and adults with adults performing the tasks more efficiently, whilst support for development as qualitative change would be indicated by different patterns of performance in adults and children. Particular face processing skills were targeted in this thesis as previous research had suggested that there might be differences in the ways that adults and children perform these tasks.

Chapter 2 began by examining whether children show an advantage for recognising familiar faces from the internal features as do adults (Ellis et al, 1979; Young et al, 1985b). Previous work (Campbell & Tuck, 1995; Campbell et al, 1995; 1999) had indicated that, in contrast to adults, children show an advantage for recognising familiar faces from the external features. However, using a matching task, Newcombe & Lie (1995) found that 5-year-olds were just as good at matching the internal and external features of familiar faces. Experiment 1 therefore used a matching task with older children (7-8-year-olds and 10-11-year-olds). The stimuli were famous faces and the results obtained were unexpected. Overall there was no benefit for matching familiar faces and the internal features of both familiar and unfamiliar faces were matched more accurately than the external features, but on same trials only. An internal advantage for matching unfamiliar faces has never been reported before for adults or children and was therefore unexpected. It was concluded that these results reflect difficulties on the part of both children and adults in matching the external features of the same person. The results have most likely been distorted by the particular stimuli selected, as not all children will know the same famous faces to the same extent. Similar problems with famous faces have been encountered in previous research. For example, Campbell & Tuck (1995) and Campbell et al (1999) obtained a different pattern of results with the same age group (9-10 year-olds) with different famous faces used in each study and the results for the youngest group in Campbell & Tuck's study depended on which famous faces were included in the analysis. It was therefore concluded that famous faces are an unsuitable and unreliable stimulus source to investigate familiar face processing in children.

Previous experiments have used personally familiar faces and have also reported evidence of an external advantage in younger children (Campbell et al, 1995; 1999). However, the particular stimuli used in these studies may have biased responses towards an external advantage as in one study, (Campbell et al, 1995), clothing was visible in the external condition which may perhaps have improved accuracy in this condition, and in the other (Campbell et al, 1999), the faces may not have been all that familiar to the control children tested. For these reasons, it was felt necessary to examine whether children would show an external advantage as in previous studies for *highly* familiar faces, or whether the stimuli in these previous studies had perhaps underestimated children's performance on the internal features.

Experiments 2a-2c therefore employed personally familiar faces that were highly familiar in a matching task with children from two schools recruited for each age group. Each child matched familiar faces (their classmates) and unfamiliar faces (the children from the different school). In this way, each face was familiar to half of the participants and unfamiliar to the remaining participants. This controlled for the possibility that the internal or external features of particular faces could be easier or harder to match because of a distinctive feature, thereby skewing the results in a particular condition as in Experiment 1. After the matching task, children also carried out a recognition task.

Experiment 2a found that 10-11-year-olds were more accurate when matching the internal than the external features of familiar faces, and that they recognised more classmates from the internal than the external features. This is in line with previous studies using famous faces (Campbell & Tuck, 1995) and personally familiar faces (Campbell et al, 1995), but is in contrast to one study using famous faces that reported an external advantage in this age group (Campbell et al, 1999). Experiment 2b showed, for the first time, an internal advantage for matching and recognising familiar faces in 7-8-year-olds. Previous studies have either found an external advantage in this age group (Campbell et al, 1999) or no difference in recognition accuracy from the internal and external features (Campbell & Tuck, 1995, Campbell et al, 1995). Experiment 2c showed that there was a trend towards an external advantage when matching and recognising familiar faces in 3-5-year-olds, consistent with previous work (Campbell et al, 1995). However, this was only the case for different decisions in the matching task and may reflect a response bias in the younger children rather than differences in face processing between younger and older children.

It is clear from the findings from Chapter 2 that children from the age of 7 years show the adult internal advantage for familiar face recognition. Thus, there is good evidence for quantitative improvements on face processing tasks, consistent with recent work on the development of *person* recognition. Seitz (2003) found that children aged 4, 6, 8 and 10 years showed the same pattern as adults on an array task when the target person was presented in a different pose or change of clothing in the array photograph from the study photograph. Performance improved steadily with age in both the clothing and posture conditions and there was no indication of any qualitative difference between children and adults. All age groups showed no recognition detriment with a change of posture, but recognition performance was impaired in all age groups when there was a change of clothing.

Further work with children aged 3-6 years is required to clarify the pattern of development in younger children regarding the internal features and to determine whether there is a developmental shift that would have to take place much earlier than suggested by Campbell and colleagues. There are some indications that children aged 3-5 years may show an external advantage for familiar faces (Experiment 2c; Campbell et al, 1995). Age 5-6 years, when children start primary school in the U.K., may be a transitional stage. Newcombe & Lie (1995) found no difference in accuracy for matching the internal and external features of personally familiar faces in this age group. However, these were American children attending pre-school and there is no indication of how long the children have known each other. The problem of determining exactly when a developmental shift may occur is confounded by the length of time children have known the classmates who are used as stimuli. Perhaps younger children do not show an internal advantage because they have not known their classmates as long as the older children with whom their performance is compared.

One way of extending our knowledge of this developmental period is to measure 5-6-year-olds' performance on their classmates' faces at the start and at the end of their first school year. This data would give an indication of whether younger children show an internal advantage for familiar people, but only when they have known their classmates for at least a school year. Measuring children's reaction times on the matching task would also provide useful information regarding younger children's abilities. For example, the children from Newcombe & Lie's matching study may have responded faster on internal or external trials, despite being equally accurate on both types of trials.

Another way of extending this research is to compare children of different ages on the faces of people that they have known for equal amounts of time. It would be extremely difficult to find enough stimuli for this kind of study, but one way may be to compare children at secondary school on faces that they have only known for one or two years with children from primary school who have known their classmates for an equal amount of time. These kinds of experiments would contribute towards understanding whether older children show an internal advantage for all familiar faces, whether they have been known for a few months or many years, and whether children younger than 7 years do not show an internal advantage because they have not known their classmates long enough.

Thus, the findings from Chapter 2 suggest that if there are developmental differences in the recognition of familiar faces from the internal features that these differences are present only in children younger than 7 years. From the age of 7, quantitative improvements were observed on both the matching and recognition tasks. There were only slight differences in the response patterns of the 7-8-year-olds and the 10-11-year-olds. The older children were equally accurate when matching the whole face and the internal features of familiar faces than the external features while the younger children were most accurate on the whole face, then the internal and then the external features. These differences may be due to the fact that the older children have known their classmates longer than the younger children or could be taken as evidence of quantitative improvement between 7 and 10 years in the ability to match the internal features of familiar faces. The two groups also differed slightly on unfamiliar faces with the older children more accurate on the whole face and the external features than the internal features and the younger children more accurate on the whole face only than the internal features. Both of these patterns have been obtained in previous research with adults (Bruce et al, 1999; Young et al, 1985b) and are perhaps due to the fact that both groups matched different unfamiliar faces. These slight differences between the two groups do not detract from the main findings that when matching and recognising familiar faces, both 7-8-year-olds and 10-11-year-olds, like adults, are more accurate on the internal than the external features. In summary, the findings from Chapter 2 suggest that there is no indication of a qualitative difference between children over the age of 7 and adults, but that there may be qualitative differences at a much younger age. Future work should be devoted to determining whether different patterns in 3-6-year-olds are due to the shorter amount of time that these children have known their classmates or whether there is a qualitative shift in face processing at this younger age.

Chapter 3 investigated the possibility of a difference between the ways that adults and children store information about familiar people. Scanlan & Johnston (1997) reported that, in contrast to adults, children were faster to verify someone's name upon presentation of their face than their nationality or occupation. However, this study also used famous faces and following the unexpected results from Experiment 1 with famous faces, it was necessary to try to replicate Scanlan & Johnston's findings in Experiment 3. Experiment 3, however, found the opposite pattern to the original study and showed that children, like adults, were slower when verifying someone's name than their occupation. Thus, once again, different results were obtained with children of the same age when using famous faces.

Experiment 4 was designed to rule out the possibility that the results from Experiment 3 were due to the name task being more difficult than the occupation task as any name could follow a face in Experiment 3 whereas one of only four occupations could follow a face. In Experiment 4, participants performed a classification task on only four faces that were shown repeatedly. The results showed no RT advantage for classifying these faces by name, ruling out the possibility that the results from Experiment 3 were due to the name task being harder than the occupation task. It was therefore concluded that the results from Experiment 3 show that children find it harder to retrieve the names of famous people than other semantic information. However, this may not be a reliable result as Scanlan & Johnston found the opposite pattern. These conflicting results are most likely explained by the use of famous faces with such a wide age range. Not all children will know the same famous faces, nor will they know them to the same extent, therefore the level of familiarity that each individual child has with the particular famous faces selected will influence their results. Experiment 5 therefore used personally familiar faces to investigate face naming to ensure that all children were familiar with the faces used.

In Experiment 5, children saw a photograph of someone in their class followed by their name or the number of siblings the person had. Both groups of children (aged 8 and 11 years) were faster when verifying the person's name. Accuracy on the sibling task was lower than the name task, especially for the younger children. Experiment 6 therefore used an easier semantic task in order to verify whether the names of personally familiar people are easier to retrieve than other semantic information. In Experiment 6, a different group of children saw photographs of their classmates and had to either name the person or say yes if that person was in their maths work group or no if they were not in the same maths work group. Accuracy on both tasks this time was very high, but response times to names were still faster than to the semantic decision. These experiments were then carried out with adults and it was found in Experiment 7a that adults were faster to verify someone's name than their occupation and in Experiment 7b that adults were faster to say someone's name than their nationality. Thus, it was concluded that when faces are highly familiar, both children and adults are faster when recalling names than other types of semantic information. It is argued that this is the case for faces that are highly familiar to us, whether they are personally familiar or famous faces that we know extremely well. This could be explored in future work by carrying out a similar kind of experiment using famous faces from a particular film or television programme and recruiting participants who are fans of that film or programme to ensure that the participants are highly familiar with the famous faces. In contrast to highly familiar faces, it takes longer to recall the names of people that we do not know well (both famous and personally familiar). Thus, it is concluded that the results of these kinds of experiments will depend on the level of familiarity participants have with the stimulus faces used, and, for this reason cannot be taken as reliable evidence of developmental differences in name retrieval.

The findings from Chapter 3 reiterate the problems from Chapter 2 using famous faces with children to investigate the processes of *familiar* face recognition. Despite these problems, there was no evidence of developmental differences in the retrieval of information about known people. In a series of naming experiments, 8 and 11-year-old children showed the same pattern as adults with slower naming of famous faces and faster naming of highly familiar faces. In each experiment, development was marked by quantitative change as accuracy increased and response times decreased with increasing age. In Experiment 3, the adult group and the 11-year-olds were both faster and more accurate than the 8-year-olds, indicative of quantitative gains with increasing age. In Experiment 4, adults were faster than both the 8 and 11-year-olds with no differences in accuracy, which was at ceiling in each age group. The 11-year-olds responded more accurately and faster than the 8-year-olds in Experiment 5 and were faster than the 8-year-olds in Experiment 6 with accuracy again at ceiling in both groups. The adult data from Experiments 7a and 7b shows that they in turn are faster than the 11-year-olds on an equivalent task. Thus, there is no indication of qualitative differences between children and adults on these naming tasks and development is marked by increased accuracy and faster response times with increasing age. Future work with both adults and children should seek to obtain a name retrieval advantage for famous faces that are highly familiar and if this pattern of results is obtained, then models of familiar face recognition will require modification to allow faster retrieval of names of highly familiar people.

Chapter 4 then brought these two strands of research together and investigated how unfamiliar faces are remembered and the changes that take place, as a face becomes more familiar. Experiment 8 showed that children and adults remembered the external and internal features of unfamiliar faces equally well and Experiment 9 showed that children and adults remembered the occupations of unfamiliar people more often than the names of these people. The findings of Experiment 9 therefore support the conclusions of Chapter 3, whereby children and adults find it more difficult to recall the names of people they do not know that well than other semantic information. Experiment 10 then investigated how representations of unfamiliar people may change, as they become more familiar. Participants were familiarised with a set of unfamiliar faces and then performed the name verification task and a recognition task. Older children and adults were less accurate on false trials when verifying someone's name than their siblings, but younger children showed a trend towards faster verification of names, suggesting there may be a difference between children and adults. However, the younger children in Experiment 5 found the sibling task difficult even for people they knew well, therefore it would be necessary to replicate this experiment with an easier semantic task to determine whether younger children still respond more quickly on the name trials. Abdel Rahman et al (2004) found that the pattern of responses obtained in these sorts of tasks is influenced by the difficulty of the semantic decision. Thus, when a hard semantic decision is used, it has been shown that adults recall names faster than semantic information. This may explain the different results found here between the younger children and the older children and adults. Finally, all groups recognised the external features of these familiarised faces more easily than the internal features, indicating that it takes a lot longer to develop a representation of an unfamiliar face based on the internal features than this experiment permitted. The learning stimuli used in Experiment 10 consisted of different still photographs of the target faces taken from different viewpoints and with different facial expressions. Future work could examine whether learning of the internal features in children can be improved by using images with different expressions or by using video clips of non-rigid motion.

Chapter 4 therefore found that children and adults recognise and remember the same types of information about unfamiliar people and found no evidence of developmental differences. Rather, development was marked by quantitative gains as accuracy and response times improved with increasing age. Experiment 8 showed that, when recognising unfamiliar faces, adults were more accurate than 8-year-olds and that they were faster than 11-year-olds, who were in turn faster than 8-year-olds. In Experiment 9, adults recalled more ambiguous information than both 8 and 11-year-olds, and adults recalled more unambiguous information than 11-year-olds who in turn recalled more unambiguous information than 8-year-olds. In Experiment 10, adults were faster than both 8 and 11-year-olds and were more accurate than the 8-year-olds when recalling the names and siblings of familiarised faces. There was some indication of a difference between adults and children on this task as the 8-year-olds verified the names of the familiarised faces faster than the siblings whereas the 11-year-olds and adults showed a disadvantage for retrieving names as they were less accurate when verifying someone's name than their siblings on false decisions. As indicated earlier, this possible developmental difference should be followed up in future work to determine whether the difficulty of the semantic task has influenced the results in some way (e.g. Abdel Rahman et al, 2004).

In Experiment 10, the recognition data showed that adults and 11-year-olds were faster on target faces than the 8-year-olds with no age differences in response times on the distracter faces. On distracter faces, the 11-year-olds were less accurate than adults, with no age differences in accuracy on target faces. This result could perhaps indicate a dip in performance, which is sometimes reported on face processing tasks around the age of 11-12-years. There could be further evidence of a dip in performance in Experiment 9 where the recall scores on the ambiguous words are lower (but not significantly) in the 11-year-old group than the 8-year-old group. However, there is clear improvement on the unambiguous words and on all other tasks in this thesis between 8 and 11 years. As the research concerning a decline in face processing around 11-12 years of age is equivocal, it is possible that the results from Experiments 9 and 10 could be due to other factors such as lack of motivation or concentration in the older children. There was no evidence of a decline in any of the other experiments carried out in this thesis, therefore, it is concluded here that these effects provide little support for the theory that there is a dip in performance in face processing around 11-12 years of age.

Overall, there is evidence for the same types of processes in young children and adults in each of the face processing skills measured in this thesis. In a series of ten experiments, there were only two results that suggest there may be qualitative differences in face processing. These are Experiment 2c, which found a trend towards the external features of familiar faces in 3-5-year-olds and Experiment 10 where 8-year-olds showed evidence of faster name than sibling retrieval while adults and 11-year-olds were more accurate on siblings than names on false trials. Further work is required with 3-6-year-olds to determine whether there are developmental differences in this younger age group concerning the internal advantage for familiar faces. The results of Experiment 10 may be explained by the level of difficulty each age group experienced with this particular task. As Abdel Rahman et al (2004) have shown, the pattern of results on these kinds of naming tasks can depend on the difficulty of the semantic task. It may be the case that the 8-year-olds found the sibling decision harder than the name decision and that this is the explanation of their results rather than a difference in terms of how semantic information is stored for familiar people. Indeed, the 8-year-olds experienced particular difficulty with the sibling decisions of their classmates in Experiment 5. For these reasons, it is concluded here that, without further replication, the results of Experiment 10 reflect differences in the level of difficulty of the sibling decision or differences in the strategies employed by younger children to deal with this difficulty rather than a difference in the way younger children and adults organise semantic information for known people.

Thus the research carried out in this thesis supports the proposal that the same processes operate in children and adults, and that children become more efficient face processors with increasing age. In the current experiments, development is quantitative rather than qualitative in nature. Improvement on these face processing tasks is best accounted for by Chung & Thomson's (1995) proposal that children encode the same type of information from faces as do adults, but become better at encoding faces as they get older. This is supported by the increase in accuracy and improved response times with increasing age in the experiments carried out in this thesis. There is a growing body of literature which suggests that improvement on face processing tasks with increasing age is due to the development of configural processing skills (Carey & Diamond, 1994; Donnelly & Hadwin, 2003; Mondloch et al, 2002; 2003) rather than featural processing skills. Although these skills have not been directly manipulated in this thesis, the current findings support this explanation of development. On tasks involving unfamiliar faces (Experiments 2a, 2b, 8 and 10), the external features were better remembered than the internal features or both were remembered equally well. It is assumed here that the external features can be processed featurally whereas the internal features represent a configuration, which must be discriminated from other similar configurations. The current findings from the experiments with unfamiliar faces therefore support previous findings that configural processing takes longer to develop than featural processing. One way of extending this research is to examine the development of configural and featural processing using familiar faces. The stimuli could be altered so that configural and featural information was disrupted, for example by increasing the distance between the eyes or by substituting the eyes from one face with the eyes from another. Previous work with unfamiliar faces (e.g. Baenninger, 1994; Freire & Lee, 2001; Mondloch et al, 2002) has shown that children find it easier to detect changes made to the features than the configuration, however, they may be equally good at detecting both kinds of changes made to familiar faces or even better at detecting configural changes. Measuring reaction times in future experiments would also provide an insightful indicator of possible developmental differences. This research would provide useful information regarding whether children are using the same types of facial information as adults in their recognition of familiar faces. For example, although 7-11-year-olds show an internal advantage in Experiments 2a and 2b, they may not be using the configural information contained within the internal features as well as adults. Research investigating configural processing in familiar faces in these ways would therefore extend our knowledge of how children process faces. This type of work would require the use of highly familiar faces, whether they are famous or personally familiar, to ensure that the results obtained are reliable.

In conclusion, the experiments carried out in this thesis provide evidence against the proposals that there are qualitative shifts in children's face processing. Some further work is required with 3-6-year-olds before the possibility of a qualitative shift in the internal feature advantage for familiar faces can be ruled out. It is concluded from the research carried out here that if this shift does take place, that it does not occur any later than the age of 6-7 years. Further, the research carried out here has found no evidence to suggest that children and adults represent knowledge for familiar people differently. Rather, the speed at which different types of semantic information are retrieved is influenced by how well a particular person is known and the level of difficulty experienced with the particular semantic category. Finally, it has been shown that children and adults remember the same types of information about unfamiliar faces and that their representations of unfamiliar faces most likely change in the same kind of ways.

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