Appendix A: Methodological considerations

In this appendix, more detail is given on further methodological considerations, which are briefly summarised in the Methodology chapter of the thesis.

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Face recognition ability

It is generally thought that human face recognition ability falls on a spectrum with some individuals being very good and others being very poor (Davis et al., 2016, Russell et al., 2009, Yovel et al., 2014, Wilmer et al., 2010, Wang et al., 2012). It is thought that those within the 'normal' face recognition ability spectrum (between poor and good), however, show qualitative differences in the processing of both familiar and unfamiliar faces (Megreya and Burton, 2006). However, it is thought that there are some individuals that sit outside of that 'normal' spectrum and one such condition that demonstrates this is Prosopagnosia, otherwise known as face blindness (Jiang et al., 2011). This can either be acquired through injury, normally in the occipital cortex, which appears to prevent holistic processing of faces. Or individuals can be born with developmental prosopagnosia. It can be so severe that sufferers are unable to recognise family members (Hole and Bourne, 2010). Prosopagnosics have been shown to adopt a more piecemeal type of processing, focusing on featural shape information, in order to try and encode and recognise faces (Marotta et al., 2001, Ramon et al., 2010). On the opposite end of the face recognition spectrum are the super-recognisers who demonstrate superior face recognition abilities that allows them to, for example, recognise a person whom they encountered once, many years ago (Davis et al., 2016, Bobak et al., 2016, Russell et al., 2009). Bobak et al. (2016) found super-recognisers to have enhanced domain specific face recognition skills and memory as well as heightened holistic processing abilities. However, it is not yet known if these super-recognisers are simply just exceptional at face recognition on the ‘normal’ spectrum or if they sit outside of this due to differences in the structure of the face processing parts of the brain. For the current study, no participants were excluded based on their face recognition abilities. This was because only trials where veridical images were correctly recognised were used for analysis, so any difficulties in recognising faces, for various reasons, would not be picked up within the trials that were used for analysis. Including all levels of face processing, also yields a result that is more representative of the general population.

Development of face recognition

New-born infants very quickly develop face perception and recognition skills, albeit primitive ones, that help them discriminate between faces (Morton and Johnson, 1991) and because of the requirement for this skill infants are highly drawn to looking at faces (Simion et al., 2007). It is thought that one of the first areas of the face that we process are the eyes, or rather the contrast of pupil/iris against the white sclera (Otsuka et al., 2013). Most close face-to-face-contact between babies and another face is during breastfeeding where the child can see their mothers face up close. As a child develops, so does their ability to recognise faces and research has shown that children focus more on the external parts of the face such as hair as well as blemishes and adornments such as piercings (McKone et al., 2012, Campbell et al., 1995). For example, when a father shaves off his beard, the child may find it difficult to recognise them. The switch from external feature preference to internal features is thought to occur around the age of nine years (Campbell, 1999). It has also been shown that children use featural cues before they go on to develop configural processing and, as such, do not develop holistic processing (a combination of both) until later (Mondloch et al., 2002, Carey and Diamond, 1977, Campbell, 1999, Carey, 1992). Using a same/different task, Mondloch et al. (2006) disrupted configural information in a comparative child/adult (human/monkey stimuli) study and found that configural processing improved after the age of eight and suggest that the improvements found may be related to a more general development of perceptual skills. Contrary to this, Baenninger (1994) found no qualitative differences in reliance on either configural versus featural information for children in comparison to adults in a target present/target absent study where faces had their features either moved or removed, to test both processing techniques in isolation. Results did, however, find that face recognition abilities, overall, increased incrementally in line with an increase in age. Additionally, Pedelty et al. (1985) used a similarity ratings task to assess how many features were used in children's judgements of these faces and found an improvement in simultaneous use of multiple features after the age of ten. Other studies that support the qualitative differences in featural versus configural processing for children have shown that the switch to holistic processing can be seen in children as young as six years of age by using the parts/whole task to show an advantage for whole faces (Pellicano and Rhodes, 2003, Tanaka et al., 1998). Children will start to develop a way of encoding more robust representations of faces using the 'gestalt' method mentioned and moving towards the pattern of adult face recognition (see (Taylor et al., 2004) for a more detailed review on the development of face processing in children). From this, there is clear evidence that there are differences in face recognition abilities between adults and children, albeit contentious as to what those differences are. Therefore, this study will focus solely on adult face recognition using only adult participants. An adult participant pool is also more accessible through university systems.

Expression

Bruce and Young's (1986) model of face recognition (see Bruce and Young's model of face recognition in the main thesis for an overview) suggests that expression is processed in parallel to identity and is highly variable, so potentially less useful for identity judgements. However, they do note that characteristic facial expressions (those that are uniquely specific to that person) can aid in face recognition and there is more recent empirical evidence to support this (Kaufmann and Schweinberger, 2004) where familiar faces with characteristic expressions displayed, were recognised faster. The present study will use target images with a neutral expression to avoid any unique characteristic facial expressions that may provide a cue as to identity, so that only shape changes are being tested. This will also facilitate the compositing process, as compositing expressive features onto an expressive face is notoriously problematic.

Face images in psychology

When testing face images in a recognition task paradigm, there are some limitations and considerations that need to be taken with regards to using them in a laboratory setting:

The use of synthetic faces vs real face photographs: The current study's aim was to create unique composites (stimuli) that were matched with a target face for swapping features. The composites needed to pass as images of real people to therefore engage normal face processing mechanisms. The compositing process involved sampling facial features from existing face photograph databases and compositing them to form a new face (unique composite). It could be argued that based on the context of this study, that it may have been more appropriate to generate synthetic faces that do not require the same ethical considerations and also side-step the issue of finding appropriate face image databases. This method could have potentially eliminated the process of manual compositing for the creation of the unknown unique composite faces by using one of the automated face synthesis systems. However, these systems may not support the level of control needed for swapping specific features between unknown and known faces (Blanz and Vetter, 1999, Akimoto et al., 1993). Synthesised faces have been used in previous face perception research (Loffler et al., 2005, Leopold et al., 2001, Oosterhof and Todorov, 2009) and have used processes such as Principal Components analysis to generate a 'face-space' where faces can be adjusted mathematically (Gao and Wilson, 2013). However, synthetic faces do not necessarily pass as images of real people, even if they do still engage normal face processing mechanisms that would be observed for face photographs (Wilson et al., 2002, Burton, 2013). With high quality convincing synthetic faces there remains the issue of synthetic image noise that may provide a cue that the face is not of a real person. Therefore, it was advantageous to use photographs, to form composites, which eliminated the possibility that participants may not view the image as that of a real person, as all facial detail such as texture and luminance as well as photographic image quality, that is normally associated with photographing real people, was maintained. Using photos of natural faces was also more ecologically valid (Abudarham and Yovel, 2016) and kept the methodology in line with the materials likely to be available to the institutions that may adopt this technique (e.g. investigating bodies, forensic artists, CGI artists etc.). Following on from this, the compositing technique, therefore, needed to be robust enough so as not to be detectable, and Pilot study 2 (see Appendix F Pilot studies) was used to asses each unique composite for this.

Viewpoint: Research has shown that the viewpoint of a face has a dramatic effect on face recognition, even with veridical faces (Troje and Bülthoff, 1996, Troje and Kersten, 1999, Hill et al., 1997). In general the recognition performance level is lowest for a profile view, with the next best frontal and the optimum view, three-quarter: it is thought that the most shape from shading information is available in the three-quarter view, yielding higher recognition rates (Hill et al., 1997, Favelle et al., 2011, Nakato and Nagata, 2002, O'Toole et al., 1998, Troje and Kersten, 1999, Bruce et al., 1987). It is worth noting that some of these studies testing the effects of viewpoint use familiarisation of one viewpoint and test participants' ability to generalise to a novel view. This tells us how much information is available in the learnt view (encoding) and which is optimum from which to estimate how a face will look in a novel view. It may also inadvertently test how much pictorial information can be generalised over to a novel view. However, this only describes which view provides the most information for familiarisation and creating a stored face memory structure. Some of the studies mentioned above also tested viewpoint dependency for recognition of already familiar faces to test which view provides the most cues for extracting the face memory and found a similar effect.

There were two main considerations with regards to the face viewpoint presentation in the current study;

1. First, the availability of viewpoints of the target faces (both celebrities and lecturers). As mentioned earlier, the optimum viewpoint is a three-quarter view, however, sourcing images at exactly the same three-quarter view across a whole stimulus set may have been difficult to achieve. Most celebrity images are candid paparazzi photography from various heights and angles. One constant viewpoint taken of celebrities within the paparazzi's range of viewpoints, however, is a full frontal image (this consideration was not relevant to lecturer images as they were directly photographed by the Experimenter).
2. Second, the act of compositing becomes much more difficult using three-quarter view images. As mentioned before, sourcing congruent three-quarter views

would have been difficult and compositing three-quarter features that do not exactly align in viewpoint could made for an image that is prone to perceptually incongruent viewpoint errors that would undoubtedly be detectable by participants.

Therefore, using full frontal face images in the study eliminated both these practical issues, at the cost of perhaps slightly reduced recognition rates.

Colour: According to Kemp et al. (1996) and Bruce and Young (1998), removing colour pigmentation does not drastically alter recognition rates of known faces. The researchers argue that colour does not affect shape-from-shading information processing because it does not require 'colour'. Additionally, with respect to the current study, and from a technical point of view, compositing different skin-tones in colour is notoriously problematic and time-consuming, supporting the decision to use grey-scale images over colour for the experimental stimuli.

Online testing methods

In more recent years, researchers have adopted the use of online data collection platforms, in particular for psychological studies relating to face recognition and face perception in general (Hahn et al., 2016, Wang et al., 2016). The main advantage of using this method is reaching a larger target audience (Rhodes et al., 2003) as well as ease of recruitment, access to the experiment for the participant and an increase in participant's willingness to take part if the study can be completed within their own time-frame (Rosenfeld and Penrod, 2011). However, there are differences in the amount of experimental control between online and laboratory based studies: online participants have the freedom to choose the device they conduct the experiment on, the environment may contain distracting and contaminating images (e.g. faces), presentation delays and inconsistencies due to internet connection, the freedom to move around and take breaks from the experiment as and when, and distractions from other people. Do these differences affect the results of the studies? Jones et al. (2007) conducted a face perception study on men's face preferences in relation to their own sensation seeking interests repeating it in both online and one-to-one testing paradigms and found that the data showed a similar pattern of results for both formats. Metzger et al. (2003) also compared online and laboratory testing formats, but for a face recognition study. Participants were required to study (familiarise) a set of faces, half distinctive and half average, followed by a subsequent recognition task for those faces learned. The results, again, showed no significant difference between recognition rates for the two formats of data collection and no interaction between face type and data collection format.

Given the large numbers of participants that were needed for the multiple experiments in the current study and due to *most* of the recruitment advertised via email rather than through a designated participant pool, such as those found in psychology departments, online testing provided the large network and access required to generate high participant numbers (only some UCLan participants will be recruited via a participation system). However, there were some disadvantages to this method that may impact on the results:

- no control over viewing distance and angle in relation to the face image across participants
- no control over the device that will be used to complete the experiment (although it will be stated, as a recommendation, that participants use a laptop/PC)
- no control over duration (participants will be instructed to not take breaks, however they may decide to leave and return during the experiment)
- participants may potentially be distracted by their surroundings
- the risk that participants might not answer questionnaires honestly

However, some of these disadvantages still occur in a laboratory setting, such as distraction and concentration issues. The main considerations in this study concerned the variability of face image viewing distance between participants caused by differences in the device used for participation and the duration of the experiment. Reaction time measurements were recorded for one reason: the times will indicate any 'breaks' in the experimental process so that any participants carrying out the experiment with large breaks, could be evaluated more closely. More specific reaction times for stimuli response durations were not a reliable indicator of processing speed due to the differences in the type of device used and internet connection.

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