To explore how familiarity can mediate or lessen a decrement in identification caused by inconsistent camera angle.

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Abstract.

Previous studies of face identification and recognition have shown that recognition for familiar faces is highly accurate, and recognition for unfamiliar faces is highly error prone. In this study, a face memory task was used to investigate the influence of familiarity and camera angle on face identification. The study found that familiarity is influenced by camera angle but is most accurate at a camera angle of 85.7 inches. The study also found that camera angle influences identification of unfamiliar faces, with poor accuracy results being produced. Sensitivity is also affected by familiarity as individuals are able to discriminate between familiar and unfamiliar faces. Bias was found to have a low threshold for the medium camera angle, indicating that, more positive responses are made when targets are viewed from the medium camera angle. The results on familiarity are consistent with precious research that unfamiliar face matching is error prone across different viewing conditions. However, the findings of camera angle were not as predicted, and differ from previous findings.

KEY WORDS: FACE IDENTIFICATION, FACE RECOGNITION, FACE MEMORY, FAMILIAIRTY, UNFAMIARITY AND CAMERA ANGLE.

Introduction

The aim of present study is to explore the influence of CCTV camera angle on facial identification and whether this can be mediated by familiarity. There are various ways in which facial identification can be studied. One of the ways it can be studied is using a face matching task, which involves participants being shown images, videos or the live culprit simultaneously at the same time as matching the target (Megreya & Burton, 2008). Another way in which facial identification can be studied is by using an eyewitness memory task. In an eyewitness memory task, participants are shown the individual in a video, image or live in person. After the participant has been shown the target, they will be shown a line-up, which can appear simultaneously or sequentially (Megreya & Burton, 2008).

Familiarity can affect performance on facial identification tasks and is a key aspect to the identification process. Identification of familiar faces is highly accurate even when viewed in poor viewing conditions (Bruce, Henderson, Greenwood, Hancock, Burton & Miller, 1999; Bruce, Henderson, Newman & Burton, 2001). On the contrary, unfamiliar face identification is highly error prone, even under optimal viewing conditions (Hill & Bruce, 1996; Bruce et al., 1999; Henderson, Bruce & Burton, 2001). Unfamiliar faces are processed using visually derived semantic codes (Bruce & Young, 1986), which therefore indicates that changes in viewing conditions can influence an individuals' ability to identity a face.

The viewing conditions used in the face identification process can either mediate or decrement the identification. There is a lack of research into the issues of the positioning of CCTV camera angles and their influence on face identification. Therefore, the current study used three different CCTV camera angles, to determine the camera angle that mediates facial identification, which can aid in the identification of criminals.

This research is important because there is a lack of research into how inconsistent camera angles can cause a decrement in identification, and how familiarity might mediate this. By understanding the correct installation height of CCTV camera angles, it will contribute to higher levels of identification of criminals.

Literature Review

Familiarity

Familiarity with a face is a key factor in the identification process. Individuals are highly accurate at identifying familiar faces, even when there are changes to the face in relation lighting and view-point. This is due to familiar faces having a strong portrayal in memory due being confronted in the different viewing conditions, indicating that they are processed abstractly (Bruce and Valentine, 1985; Chapman, Hawkins-Elder and Susilo, 2018). Being familiar with an individual includes knowing the individuals' internal facial features, which an individual who is unfamiliar with the target is unable to identify. Unfamiliar face identification is highly error prone, even when optimum viewing conditions are used (Bruce et al., 1999; Henderson et al., 2001; Megreya & Burton, 2007, 2008). Unfamiliar face representations are based on low level image processing (Hancock, Bruce & Burton, 2001). Therefore, being familiar with a face increases the chance of an accurate identification, and an unfamiliar face decreases the chance of an accurate identification (Bruce et al., 2001). The reason being that within-person variability is the reason a face becomes familiar, but it also makes unfamiliar face matching difficult (Matthews & Moncloch, 2018).

Theory

The Bruce and Young (1986) model is the most influential model of face processing. The Bruce and Young (1986) model of face recognition differentiates the different ways familiar and unfamiliar faces are recognised. The model states that there are eight distinct forms of information that can be obtained from a face. The model suggests that familiar face recognition involves structural codes, which then creates a symbolic memory representation for each familiar face (Bruce & Young, 1986). The model indicates that the recognition of a familiar face involves a match between the current structural encoding and the structural codes have been encoded previously (Bruce & Young, 1986), which allow the correct identifications to be made. Familiar faces are recognised differently from unfamiliar faces, using more abstract codes which facilitates familiar face recognition (Bruce & Young, 1986). Unfamiliar face recognition uses visually derived semantic codes (Bruce & Young, 1986). Which is therefore why unfamiliar faces cannot account for variability in the appearance of the face, which negatively impacts recognition of unfamiliar faces (Johnston & Edmonds, 2009).

The model suggests that differences in viewing conditions such as camera angle and viewpoint does not affect an individuals' ability to recognise a familiar face, whereas unfamiliar face processing is massively influenced by change in viewing conditions (Davis & Valentine, 2009). Hill and Bruce (1996) conducted a face matching task and found that individuals' ability to face match unfamiliar faces was worse when factors such as viewpoint or lighting changed. The reason as to why change of view impacts unfamiliar face recognition is due to unfamiliar faces being recognised using pictorial codes. The individual sees the face image from one viewing condition only, and therefore finds it hard to identify the same individual, if they are shown from a different viewing condition. Which is evidence for the Bruce and Young (1986) model which suggested that pictorial coding process cannot account for changes in expression or lighting, because more abstract and structural processes are required. Therefore, unfamiliar face recognition does not account for variability.

Prosopagnosia studies can be used to show the differences in processing of familiar and unfamiliar faces and provide evidence that different processes are used for

each. A prosopagnosia study conducted by Bauer (1982) found that patients were unable to recognise a face which was familiar to them, but they were able to match an unfamiliar face. This suggests recognition is different for familiar and unfamiliar faces. Patients who were able to recognise familiar faces had bilateral occipitotemporal damage, which therefore impairs familiar face recognition. Bechara, Tranel, Damasio, Adolphs, Rockland and Damasio (1995) also found that bilateral ventromedial damage diminished recognition. Therefore, it can be concluded that recognition of familiar and unfamiliar faces is dissimilar, and different recognition processes are used for each.

Evidence for difference in familiar and unfamiliar face recognition

There is a large amount of evidence indicating that familiar faces are identified more accurately than unfamiliar faces. Burton, Wilson, Cowan and Bruce (1999) investigated individuals' ability to recognise faces from poor-quality video footage. The first experiment investigated the effects of familiarity, and whether being familiar with an individual effected their ability to recognise the face images from video footage. Twenty psychology lecturing staff were recorded for the memory identification task. The sample included twenty students from the Psychology Department from the University of Glasgow, twenty students were recruited from other departments within the university and another 20 participants were police officers who were attending a training course. Participants took part in a memory identification task, which involved being shown video clips, then a sequential line up. The study found that being familiar with a target produced high levels of identification accuracy and being unfamiliar with the target produced poor levels of identification. The researchers assumed that students who did not study psychology would be unfamiliar with the lecturers used as targets. However, participants could have still had some level of familiarity with the targets from seeing them around the university campus, which is not an absolute representation of unfamiliarity. Participants were also shown the video clips twice, which creates a learning process and allows the participants to become familiar with the target, therefore making it easier for them to identify that they were present in the image line-up.

Similar findings were found by Bruce et al. (2001). The first experiment used in the study used a single-item confirmation task of matching a video image to a photograph, with half of the participants being familiar with the targets and the other half being unfamiliar with the targets. The study used an actual CCTV video camera, which best replicates the footage produced by the CCTV cameras used by the police in the identification process. Participants were allowed to pause and replay the CCTV footage as many times as they wanted. This would create a learning process for the unfamiliar participants, which could therefore make them learn the target face. The study found that correct response rates were higher for familiar faces (92%) than unfamiliar faces (70%) when shown CCTV footage of a low quality. This is further evidence for the Bruce and Young (1986) model. However, the researchers did not match the appearance of the foil images to the target shown in the CCTV footage, which could have therefore made the identification process easier for the participants.

Henderson et al. (2001) investigated individuals' ability to face match robbers who were unfamiliar to them who were recruited from a film-extra agency. In the first experiment researchers carried out a matching task and used a mock bank raid recording. All images used in the line-up were similar to the target and had equivalent viewpoint and lightening conditions. If participants responded incorrectly, they were asked to choose which foil (distractor image) looked most like the target from the CCTV image of the robber. Due to combining both first and second choices, it does not reflect a true representation of participants own and initial choice, as they were prompted to choose a target which replicated the robber the most. The study found that only 1 in 5 participants correctly identified the target in their first choice. The study also used a more ecologically valid method compared to other studies, as it depicted a real crime scene. In experiments 2 and 3 it was made clear that even under the best conditions, unfamiliar face matching is highly error prone. The findings are in support of the Bruce and Young (1986) model that unfamiliar face processing is based on pictorial coding, and that even with optimal viewing conditions unfamiliar face recognition is highly error prone.

Another study which investigated unfamiliar face matching was conducted by Kemp, Towell and Pike (1997). The study investigated a cashiers' ability to determine whether the image on the credit card is the person they are serving, which is therefore unfamiliar face matching. The study was conducted in a real supermarket with trained employees and used real credit used, which creates ecological validity. In half of the trials the shoppers presented a credit card which had a foil image which, did not match to the shopper. The cashiers were told in a lot of detail that they should always check the credit cards. This can therefore influence the results as the cashiers may have been looking out for the fraudulent credit cards. The researchers noted this as a possible explanation for the results at the end of the study. The results found that overall 67% of cashiers' choice to accept or reject a credit card was correct. However, the study also found that the cashiers falsely accepted over 50% of the counterfeit credit cards. The findings suggest that even in optimised conditions and when the target is live in person, unfamiliar face matching is highly error prone, which is further support of the Bruce and Young (1986) model, that unfamiliar face processing cannot account for variability in images, and therefore even in optimal conditions, unfamiliar face matching is still difficult.

Closed-Circuit-Television (CCTV)

When used in a forensic setting, CCTV is mainly used by CCTV specialists such as the police, detectives and employees in the forensic field of work (Keval & Sasse, 2008). CCTV evidence can be used in criminal court (Lee et al., 2009; Lim & Wilcox, 2017). CCTV footage if often of poor viewing conditions, with low resolution and poor lighting making it harder to identify unfamiliar faces (Bruce et al., 1999; Burton et al., 1999). Unlike static images, CCTV footage has movement, which can give the eyewitness a larger perspective to the individual, making identification easier (O'Toole, Roark and Abdi, 2002). The Bruce and Young (1986) model indicated that a familiar representation of a face is not negatively influenced by differences in viewing perspective, which would therefore indicate that CCTV footage would either benefit or mediate familiar face recognition. However, the opposite would be said for unfamiliar face recognition, as differences in viewing perspective does not increase the level of identification due to the face not being familiar to them, and therefore not

processed abstractly in different perspectives and environments. Pike, Kemp, Towell and Phillips (1997) found that there is a benefit for faces being learned if they are viewed in motion rather than when inactive picture succession is used. The researchers believed that the reason for this was due to the participants seeing the face from multiple views which aids face recognition.

CCTV camera angles

Errors produced by CCTV footage in face identification is often due to the positioning and arrangement of the CCTV cameras, which is frequently above head height (Davies & Thasen, 2000; Thompson, Grattan, Rawding & Buchholz, 2010). Faces are determined by their shape and exposure but also by the angle from which they are observed (Favelle, Hill & Claes, 2017). Changes such as rotation and lightening can change the appearance of a face (Valentine & Davis, 2015) as can the angle from which the face is perceived. The view from which a face is perceived is harmful in the recognition of an unfamiliar face but less so for familiar face recognition (Johnstone and Edmonds, 2009). Bruce (1982) found that performance in face identification of unfamiliar faces dropped to 61% when the viewpoint and expression of the face changed, which is in support of the Bruce and Young (1986) model, that any change in viewing conditions of an unfamiliar face has a detrimental effect on face processing. However, a study conducted by Greene and Fraser (2002) found that participants were able to recognise celebrity familiar faces from distances as large as 200ft. However, presenting famous faces as familiar targets is unrealistic, as participants are not personally familiar with them, and therefore are unable to recognise them from different variational views.

A study conducted by Davies and Thasen (2000) investigated how effective CCTV was in identifying an individual. The study investigated the difference between identifying suspects from whole body views in experiment one, and in experiment two the study used close up images for facial identification. The study used surveillance footage. The study used a CCTV camera which was installed 6 metres above ground level. The study found that recognition accuracy was at 30% when participants had to make the identification from memory, which is substantially low in comparison to other face recognition studies by Bruce et al., (1999) and Kemp et al.,

(1997). The study also found a false alarm rate of 65%. However, the researchers argued that the low recognition level was explained by the height and viewing angle, which was 6 metres high. Therefore, the height of the camera can have a detrimental effect on face matching ability and can lessen an individuals' ability to identify a face when the viewing height of the CCTV footage is too high. Another study conducted by Walker and Tough (2015) investigated facial comparisons made my members of a jury. Within the experiment, participants were shown CCTV footage from an acted crime scene. The study found that 42% of participants made correct identifications, 26% of participants made incorrect identifications and 32% stated that there was insufficient detail, indicating they could not make an identification. However, the CCTV cameras were positioned at heights on 12ft and 20ft, indicating that the cameras could have been too high for the participants to identify the criminal, suggesting that camera height can lessen an individuals' ability to face match. However, the study did not measure the difference in accuracy for the two height conditions, so it is unknown whether the height of the camera disadvantaged the face identification process. Therefore, the height of the camera angles may have influenced identification and that CCTV cameras being placed too high can decrement facial identification. However, there is a lack of evidence and research on the influence of camera angle on face identification, which has prompted the current research

Line-Ups

Within line-ups, the target is either absent or present, and participants have to make an identification of who the correct target is. Having to identify an unfamiliar face in a target absent line up is a difficult task, as the participants have to remember the face from memory, rather than knowing the face abstractly. Bruce et al. (1999) investigated unfamiliar face matching, and found that even under optimum viewing conditions, participants still choose a target when the target was absent on 30% of the trials. However, the images were taken of different cameras, which could be the reason for the high false identification rate, because unfamiliar face identification is difficult when there is within-subject variability. Megreya and Burton (2007) investigated subjects identification ability when shown images simultaneously using unfamiliar face identification. They found that individuals who misidentified the

targets when they were present in the line-up, were more likely to choose the wrong face is the target-absent line up. The reason for this is due to the difficulties of unfamiliar face matching, and even when the target is present, it still remains a difficult task.

Research Questions

The study will explore whether an individuals' familiarity with an individual can affect whether or not they are able to make an identification. The second research question is to determine whether or not the camera angle used in the CCTV footage is a contributing factor that affects an individuals' ability to make an identification. The third research question is to determine whether familiarity and camera angle interact to affect individuals' ability to make a face identification. Previous research has suggested that familiar faces are identified better than unfamiliar faces, due to being processed more abstractly and structurally. There is a lack of research into whether camera angle can influence face identification.

Hypotheses

Based on the literature above, the following hypotheses are proposed:

1. Being familiar with a target will produce more correct responses in a face memory identification task.
2. The medium camera angle, which is 85.7 inches above ground level and captures the full face and body of the participants from above head height, will produce more correct response on the face memory identification task.
3. Being familiar with a target will interact with the medium camera angle to produce correct responses.
4. Familiarity with a target will affect sensitivity. Therefore, participants are able discriminate between a familiar and unfamiliar face.

Methods

Design

A 2 (familiar/unfamiliar) x 3 (high camera angle/medium camera angle/low camera angle) x 2 (target present/target absent) design was used in this study. The study consisted of 24 trials in total and was completed via an online survey using Qualtrics. The independent variables of the study were familiarity, camera angle and target presence/absence. The dependent variables were the possible responses in target present trials and the possible responses in target absent trials. The possible response for target present trials were hits, misses and incorrect responses. A hit is a correct identification. A miss response is when the target is present, but the participant has indicated no match. Incorrect response is when the target is present, but the participant has chosen a foil image instead of the correct target. A foil image is an image of another individual used as a distractor. The possible responses for target absent trials are correct rejection and false identification. A correct rejection is when the participant knows that the participant is absent in the line-up and has stated the no match option. False identification response is when the target is absent, but the participant believes that the target is present and identifies the target as a foil. A separate analysis of variance will be used to explore each.

Participants

The total number of participants recruited for this study was 43. The inclusion criteria for the participants to take part in the study is that they have to be familiar with half of the targets they will be presented with in the study. Therefore, participants have to be undergraduate student at Edinburgh Napier University, who study Psychology or Psychology with Sociology. Participants have to be 18 years old or over to take part. In order to complete the study participants must have normal to corrected vision to allow them to complete the face matching process. Participants were also recruited through the Psychology Participant Pool at Edinburgh Napier University. Finally, participants were recruited by being told about the study at their lectures and tutorials, by being provided with an information sheet and a link to the Qualtrics experiment, along with being indicated that they can sign up via the Psychology Participant Pool.

Materials

Materials and procedure used for building CCTV footage and target face set

There was a total of 24 targets recruited to be recorded from three camera angles and have their photo taken to build a stimuli-set. Half of the targets were deemed as familiar targets, who were lecturers in the Psychology and Sociology department at Edinburgh Napier University. The other half of the targets were unfamiliar and were family members and friends of the researcher. Familiar and unfamiliar targets were matched as closely as possible for age and gender. The recording of the targets took place in the Psychology laboratories at Edinburgh Napier, Sighthill Campus. Three GoPro Hero4 cameras were installed in cases on the back wall of the laboratory using doubled sided sticky tape. The low camera was 65.7 inches high, the middle camera was 85.7 inches high and the top camera was 99.7 inches above ground level. Targets were shown a pilot recording of what their movements will involve while being recorded. Targets were asked to walk towards the table which was in the top centre of the room, which was 1ft in distance away from the backwall which the cameras were installed on. Once targets got to the table they were asked to look through a book which was on the table. Targets then walked around the right-hand side of the table towards the chair and the cameras, against the back wall. On the back of the chair was a jacket. Targets were asked to take then jacket from the chair and exit the room. When the targets reached the centre of the room, they were asked to look back towards the three cameras on the back wall. All targets were asked to act suspiciously within their movements. White tape was used to mark out the positioning of the chair and table so that the environment in which the recordings took place was consistent. After the camera footage had been recorded, two photographic images were captured on a Sony Handycam FDR-AX33 4K Ultra HD Camcorder. In one of the photographic images, targets had the same appearance as in the video footage. The other image involved the participant changing their appearance, which varied from changing their hairstyle, to wearing glasses which is shown in figure 1. In all of the photographic images, participants will have a neutral

emotion and expression. After the images had been taken, targets were thanked for their contribution.

Figure 1. Example of targets change of appearance. The first image is the exact appearance of the target in the CCTV footage. The second image is the target changing their appearance so that they look different from their appearance in the CCTV footage. A mix of both images were used throughout the line-ups.

CCTV footage

There was a total of 72 clips recorded in total. The video footage recorded was cut down in length using Quick Time Player. Each video clip lasted no longer than 30 seconds. The CCTV footage was then cropped in size by using iMovie. The videos resolution had to be compressed to 540p and had a medium quality in order for the footage to be uploaded into Qualtrics. Figure 2. shows an example of the CCTV footage from a high, medium and low camera angle.

A B C

Figure 2. Example of camera angles captured on CCTV footage

(A) low camera angle (B) medium camera angle (C) high camera angle. Each video image shows the target looking through the book from the 3 different camera heights.

Line-up images

The photographic images were edited on Adobe Creative Cloud Photoshop CC 2018 Version 19.0. The pictures were cropped, and then were cropped further on Qualtrics to 200 pixels in width and 270 pixels in height. Images were retrieved from two other databases: Psychological Image Collection at University of Stirling (pics.stir.ac.uk) and the Karolinska Directed Emotional Faces (Lundgyist, Flykt and Öhman, 1998). The select images used from the database sets were also cropped in size and edited to have a white background on Adobe Photoshop. The line-up images were matched in gender and appearance for each target to. Figure 3. shows an example of a line-up used on Qualtrics.

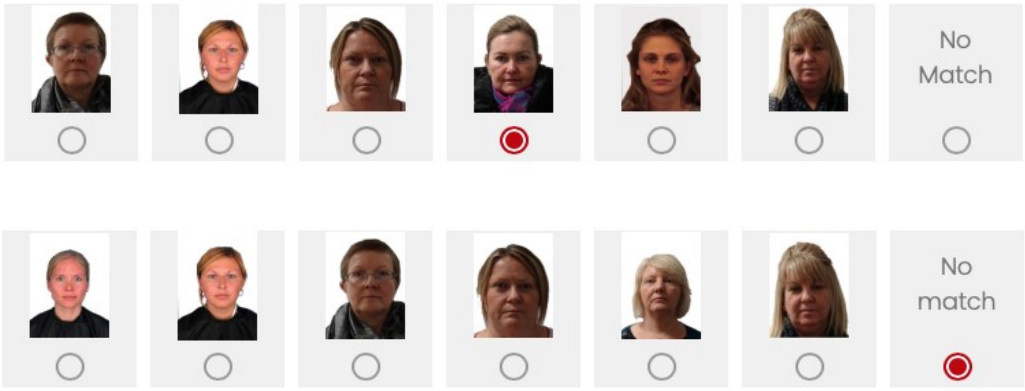

Figure 3. Example of line-up images used on Qualtrics. The first image is a target present line-up, with the correct target being selected which is shown in the top image. The second image is a target absent line-up with foil images matched on appearance and gender. The no match option has been selected on the second image to indicate a no match. All images were edited to have a white background, so no discrepancies could be made between the images from the databases and the images taken by the researcher.

The experiment

All 72 CCTV footage clips were loaded into Qualtrics. Each line-up set was uploaded for each target. Each target had two line-ups: one with the target present and one with the target absent, which are shown in figure 3. Each line-up was made up of a total of 6 images, with a 7th option being available which indicated no match present. All images were re-used for all 24 targets if they looked similar in gender and appearance. On Qualtrics, all of the trials were randomised. Therefore, participants only viewed each target once, and viewed each camera angle a total of 8 times. The process was randomised so no two participants' experiment flowed the same.

Procedure

The experiment was online based. Participants could access the experiment through the Qualtrics link provided or through the Psychology Participant Pool which sent through email to students. Once participants had opened the experiment on Qualtrics, the first page they were greeted with was the information sheet. Once participants clicked that they wish to continue, they were taken to the layered privacy

notice. Once participants had read the layered privacy notice they pressed next and were taken to the consent form. Participants then had to provide consent in order to continue with the experiment. At this point of the study participants were told that the experiment had to take place on a computer or laptop. If they did not want to continue with the study, they selected do not consent and they were taken off the study. Once participants confirmed their consent to taking part in the experiment, they were given the instructions of the experiment. Participants were shown a video which lasted approximately 30 seconds. The participants clicked the video to indicate that they had watched it before continuing. Once participants had watched the video they were presented with a question asking whether they were familiar with the individual in the CCTV footage. Participants indicated either yes or no. After the participants had answered the question, they were shown a 6-person line-up from which they identified the target in the CCTV footage to an image on the line-up. The target was either be present or absent. The same process was repeated for each 24 trials. If the target was absent from the line-up, participants either selected no match because the target was absent or selected a foil image due to thinking the target was another person. Once the participant finished the experiment, they were shown the debrief form. Participants were then asked to give secondary consent, which meant that after that point participants could not withdraw from the study. Participants were thanked for their contribution to the study, and if they had any questions they were to contact the researcher.

Ethics

There were no known ethical issues of the study. All participants were made aware that all their information would be kept anonymised. Participants did not require to give their name when taking part in the study. The data output produced gave participants reference numbers so nobody could be identified. Participants were made aware in the debrief form that after they gave secondary consent, their data could not be withdrawn.

Data Analysis

Once the data was collected and scored, it was entered into SPSS version 23. A 3 (high camera angle/medium camera angle/low camera angle) x 2 (familiar and unfamiliar) analysis of variance (ANOVA) was used to analyse the target present trials and the target absent trials. Three separate ANOVA's will be used to analyse target present trials for hit responses, misses and incorrect response. A fourth ANOVA will be used to analyse target absent trials, by analysing correct rejection responses. A total of 4 ANOVA's will be used for each dependent variable (hit/miss/incorrect/correct rejection).

Signal detection analysis was then used to determine the sensitivity and bias to familiarity and the different camera angles. Sensitivity and bias was calculated using the hit rates and false alarms (false identifications). Once the data was calculated for sensitivity and bias, two 3 x 2 ANOVA's were used to analyse the sensitivity and bias.

Results

The data was gathered using participants responses to the experiment on Qualtrics, which produced an excel sheet of participants responses. The data was collated into participants responses across target present (hits; misses; incorrect responses) and absent trials (correct rejections & false identifications) for familiarity and camera angle. The data produced had missing values due to some participants not experiencing all trials. The cells with missing values were replaced using the series mean method. Therefore, the descriptive statistics and the inferential statistics tests have been explored using the data sheet with replaced value, so that the signal detection analysis could be completed. A total of 4 repeated measures ANOVA's were explored: 3 for target present trials on hits, misses and incorrect responses and 1 for the target absent trials for correct rejections. Signal detection analysis was used with target present hit rates and target absent false alarm rates to determine whether the responses were driven by sensitivity to familiar faces, or a more liberal responses bias to make inaccurate identifications.

Descriptive Statistics

Target Present Trials

Across all target present trials, hits were scored highest. Hits were highest for familiarity and the medium camera angle and were lowest for unfamiliarity and the low camera angle. Miss responses were highest in the unfamiliar condition across camera angles, with the low camera angle producing the highest number of misses for both familiarity and unfamiliarity. Incorrect responses were highest for the unfamiliar conditions, but the medium camera angle produced the highest number of incorrect responses (see table 1).

Target Absent Trials

Correct rejections were highest for familiarity, especially in the low camera angle conditions. False identifications were made on unfamiliar targets, with most false identifications being made on the low camera angle (see table 1).

Table 1. The means and standard deviations of target present and target absent trials for familiarity and camera angle

Conditions	Familiarity	*M*	*SD*
High CA[a]			
Target Present		94.76	13.34
Hits	Familiar	86.53	23.21
	Unfamiliar	3.10	9.52
Miss	Familiar	9.96	19.71
	Unfamiliar	4.86	16.90
Incorrect	Familiar	5.98	19.71
	Unfamiliar		
Target Absent		95.15	12.22
CR[b]	Familiar	75.33	30.85
	Unfamiliar	7.57	18.81
FID[c]	Familiar	26.47	32.87
	Unfamiliar		
Medium			
Target Present		100.0	.000
Hit	Familiar	73.33	30.42
	Unfamiliar		
Miss	Familiar	.000	.000
	Unfamiliar	15.64	24.82
Incorrect	Familiar	3.45	14.98
	Unfamiliar	13.25	26.78
Target Absent			
CR	Familiar	93.52	18.43
	Unfamiliar	80.24	25.66
FID	Familiar	9.01	23.18
	Unfamiliar	21.72	28.38

Low

Target Present	Familiar	91.93	18.46
Hit	Unfamiliar	71.33	36.19
	Familiar	4.95	11.77
Miss	Unfamiliar	19.83	28.96
	Familiar	6.06	20.90
Incorrect	Unfamiliar	11.06	23.62
Target Absent			
CR	Familiar	98.48	7.51
	Unfamiliar	68.05	34.29
FID	Familiar	4.41	16.59
	Unfamiliar	35.57	35.79

Note Means and standard deviations are reported in percentages

[a] Camera Angle [a] Correct Rejection [b] False Identification

3.2 Inferential Statistics

Target Present Trials

3.2.1 Hits

A hit response is a correct identification of a target on target present trials. A 3 x 2 Analysis of Variance (ANOVA) was used to explore the accuracy of hits for familiarity (familiar; unfamiliar) and camera angle (high; medium; low). The ANOVA showed a significant main effect of familiarity with hits for identifying the target in target present trials, F (1, 43) = 43.77, p = < 001, η^2_p = .504. A significant main effect was also found for the camera angle with hits made by participants, F (2, 86) = 3.55, p = .033, η^2_p = .076. A significant interaction was found between familiarity and camera angle for hit responses, F (1.76, 75.49) = 3.79, p = .032, η^2_p = .083, with the means being highest for the interaction between familiarity and the medium camera angle (M = 100, *SD* = .000). The interaction can be shown in figure 4. Due to the interaction

being found between familiarity and camera angle for correct identification rate, paired samples t-tests were used to determine the difference between the means.

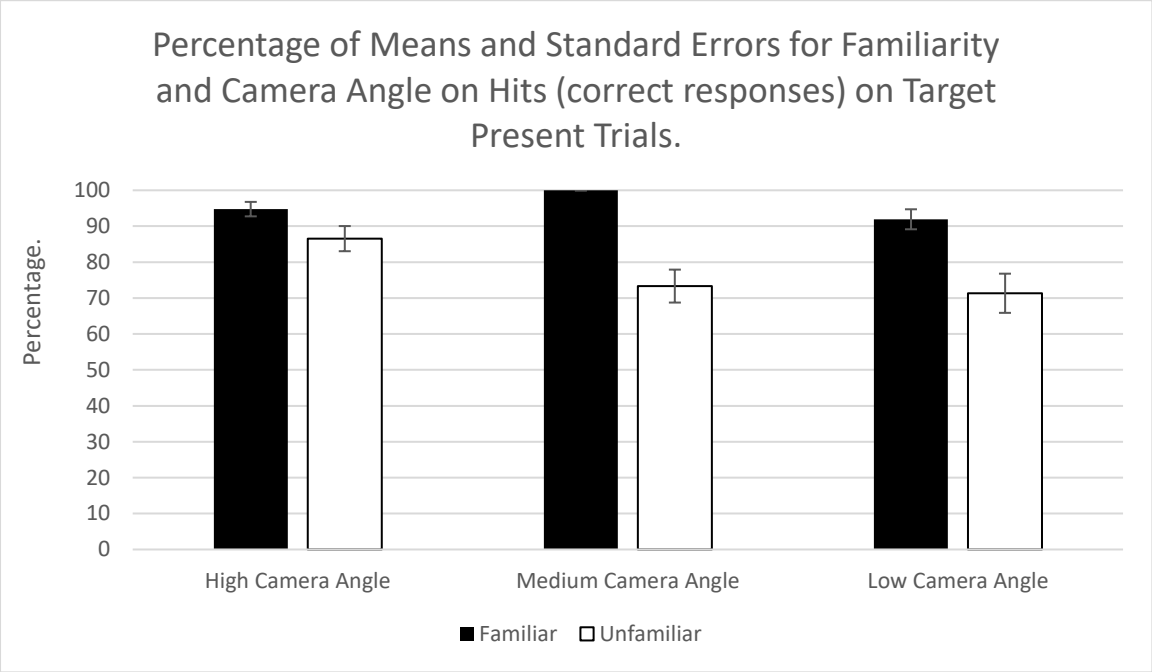

Figure 4. Percentage of means and standard errors for familiarity and camera angle on hits (correct responses) on target present trials. The data shows that faces are best identified on the familiar and medium camera angle, with no errors being made. The low camera angle on unfamiliar conditions produces lower correct identification rates with more standard errors.

Paired samples t-tests for hit responses for familiar and unfamiliar conditions at each camera angle.

There was a significant difference in the scores for the unfamiliar low angle hits (M = 71.33, *SD* = 36.19) and the familiar low angle hits (M = 91.93, *SD* = 18.46) conditions, $t(43) = -3.60$, $p < .001$. Participants who were familiar with the targets and viewed the target from the low camera angle were better at correctly identifying the target than those who were unfamiliar with the target. There was a significant difference in the scores for unfamiliar medium angle hits (M = 73.33, *SD* = 30.42) and the familiar medium angle hits (M = 100, *SD* = .000), $t(43) = -5.82$, $p < .001$. Familiarity and the medium camera angle interact to produce better correct identifications for familiar targets. A significant difference was also found for high

camera angle hit responses between familiar (M = 94.76, *SD* = 13.34) and unfamiliar (M = 86.54, *SD* = 23.09) scores, *t*(43) = -2.03, *p* = .048). The results indicate that being familiar with the target gives better at hits the high camera angle as opposed to being unfamiliar with a target.

Paired sample t-test to determine the differences between the camera angles for unfamiliarity and difference between the three camera angles

A significant difference was found between the unfamiliar low camera angle on hits (M = 71.33, *SD* = 36.19) and unfamiliar high camera angle on hits (M = 86.54, *SD* = 23.20), *t*(43) = -2.51, *p* = .016. Indicating that participants were better at identifying an unfamiliar target from the high camera angle. A significant difference between the means of unfamiliarity and the medium camera angle (M = 73.33, *SD* = 30.42) and the means of unfamiliar targets viewed from the high camera angle (M = 86.54, *SD* = 23.21), *t*(43) = -2.58, *p* = .013. The results indicate that for unfamiliar targets, the high camera angle allows more hits to be made compared to the medium camera angle. Therefore, the low camera angle is the poorest angle for unfamiliar face recognition and the high camera angle produces the best results for unfamiliar face recognition. This is further evidence for Bruce and Young's (1986) model.

A significant difference was found between the means for low angle on hit identifications (M = 91.93, *SD* = 18.46) and medium angle hit identifications (M = 100, *SD* = .000), *t*(43) = -2.90, *p* = .006. Correctly identifying a familiar target produces higher hits when the target is viewed from the medium camera angle as opposed to the low camera angle. A significant difference was found between the means of the medium camera angle for hits (M = 100.00, *SD* = .000) and the high camera angle for hits (M = 96.76, *SD* = 13.34), *t*(43) = 2.61, *p* = .013. Participants were better at identifying a face they were familiar with when they viewed the target from the medium camera angle. Therefore, the medium camera angle is the most effective condition for familiar face recognition.

Miss

A miss is a response made by a participant on target present trials. The response indicates that the participant has responded that there is no match present, even though the target is present. A 3 x 2 ANOVA was used to measure the accuracy for the number of misses made by participants on the target present trials for familiarity and camera angle. A significant main effect was found for familiarity on miss responses, F (1, 43) = 26.20, p = .000, η^2_p = .379. There was a significant mean difference between familiar (M = 2.68) and unfamiliar trials (M = 15.14). There was also a significant main effect of camera angle on miss responses, F (1.723, 74.08) = 3.308, p = .041, η^2_p = .071. No significant interaction effect was found for familiarity and camera angle on miss responses, p = .202. No significant interaction effect was found for familiarity and camera angle on miss responses, p = .202.The results indicate that more miss responses are made when participants are unfamiliar with a face, and less misses were made when they were familiar with the target. The means by familiarity and camera angle for miss responses are shown in figure 5.

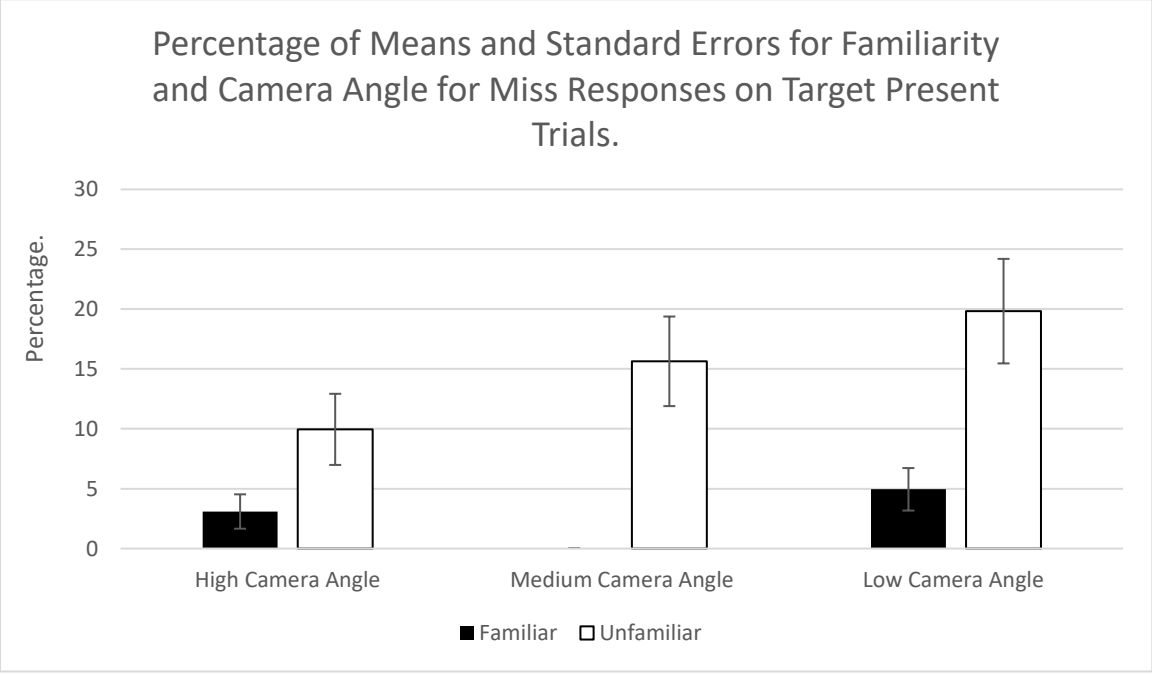

Figure 5. Percentage of means and standard errors for familiarity and camera Angle for miss responses on target present trials. Means were highest for unfamiliarity and

the low camera conditions. No misses were found on the medium camera angle for familiarity.

Incorrect Responses

An incorrect response on a target present trial is when the participant identifies the target as another distractor target. A 3 x 2 ANOVA was used to measure the accuracy for the incorrect responses made by participants for familiarity and camera angle. A significant main effect was found for familiarity of incorrect responses, $F(1, 43) = 8.66$, $p = .005$, $\eta^2_p = .168$. There was no main effect of camera angle on incorrect responses, $p = .210$. There was also no significant interaction found between familiarity and camera for incorrect responses, $p = .188$. The interaction between familiarity and camera angle means are shown in figure 6. Therefore, more incorrect responses are made on the medium camera angle when participants are unfamiliar with the target.

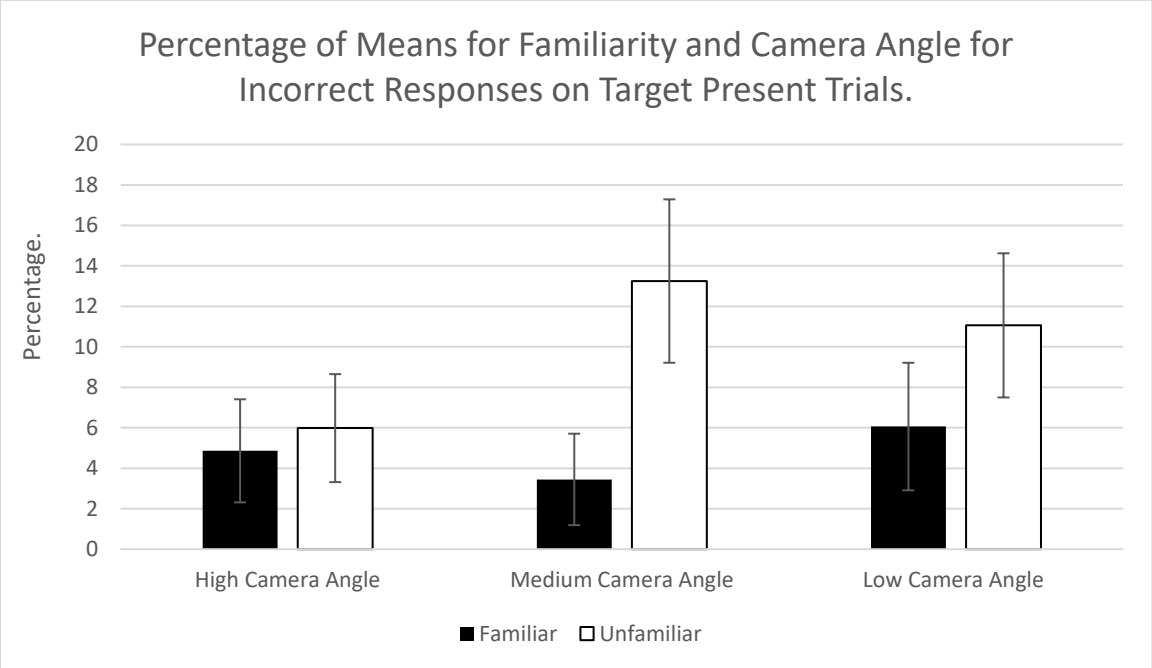

Figure 6. Percentage of means and standard errors for familiarity and camera angle for incorrect responses on target present trials. Highest percentage of incorrect responses made on medium camera angle for unfamiliarity. The least amount of errors were made on the medium angle for familiarity with the lowest percentage.

Target Absent Trials

Correct Rejections

In target absent trials, a correct rejection response was when a participant is aware that the target is not present and selected no match. A 3 x 2 ANOVA was used to measure the accuracy for the correct rejections made by participants for familiarity and camera angle. There was a significant main effect of familiarity, F (1, 43) = 250.11, $p < .001$, $\eta^2_p = .503$. No significant main effect was found for camera angle, $p = .585$. A significant interaction was found between familiarity and camera angle, F (2, 86) = 3.03, $p = .053$, $\eta^2_p = .066$. There was a significant difference between the percentage means of familiarity (M = 95.71) and unfamiliarity (M = 74.54), indicating that participants were able to correctly reject a distractor image if they were familiar with the target they viewed in the CCTV footage, which is shown in figure 7. The results show that individuals who were familiar with the target face were able to correctly reject that they knew the target was not present. Unfamiliarity decreased the number of correct rejection responses especially on the low camera angle.

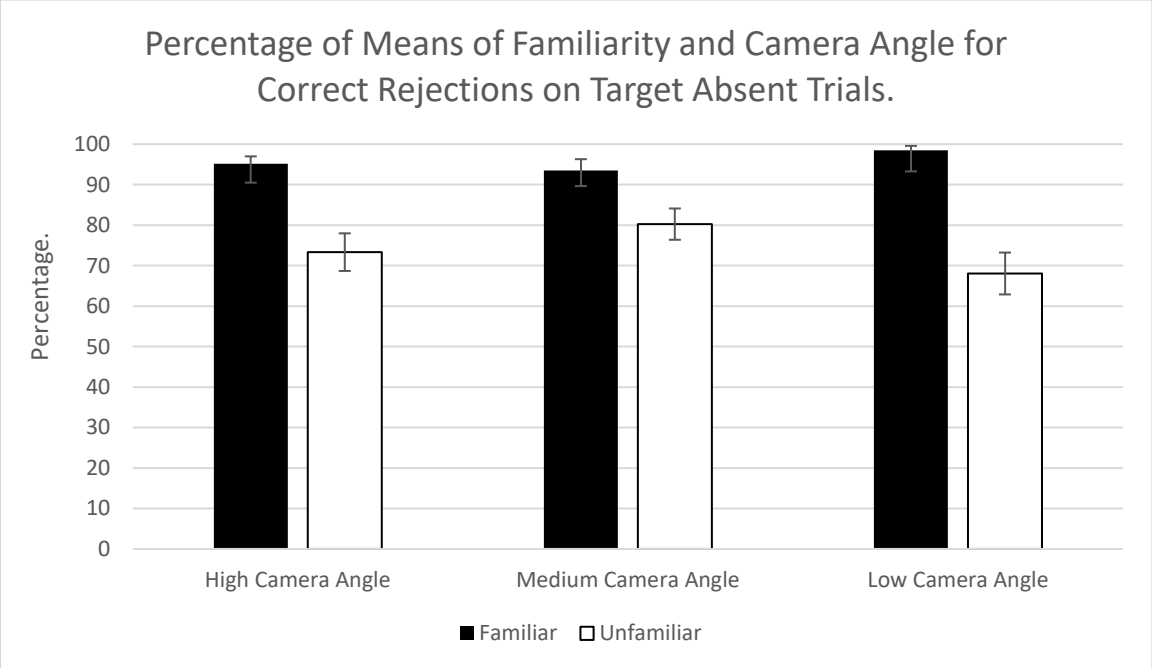

Figure 7. Percentage of means for familiarity and camera angle for correct rejections on target absent trials. Percentage scores were highest for familiarity across all camera angle conditions. The low camera angle and unfamiliarity interact to produce a low percentage of correct rejections.

Signal Detection Analysis

Background

Signal detection theory is used to measure the ability to detect when a target is present (hits) and when a target is mistaken for noise signals, also known as distractors (false alarms) (Green & Swets, 1966). Hits were collated from target present trials and false alarms were obtained from target absent trials. In the present study, sensitivity (*d'*) is the participants ability to distinguish whether the target is present or absent. Bias (*c'*) are used to show participants tendency to state that the target is present or absent. Hits and false alarms were combined to produce sensitivity (discriminability) and bias (criterion) for the experiment.

Sensitivity

Sensitivity to a target was affected by familiarity, F (1, 43) = 84.92, p = < .001, η^2_p = .664. Estimated means were significantly different between familiarity (d' = 5.01) than unfamiliarity (*d'* = 2.713), indicating that discrimination was significantly better for familiar targets than the unfamiliar targets and that participants were able to discriminate between the different conditions. The camera angle which participants viewed the CCTV footage had a marginal main effect on sensitivity, p = .067. The interaction between familiarity and camera angle had no significant main effect on participants sensitivity, p = .124. The interaction between familiarity and camera angle for sensitivity are shown in figure 8. Therefore, participants response is driven by sensitivity to familiar faces, indicating that they are able to discriminate between familiar and unfamiliar faces. However, responses were not driven by sensitivity for camera angle.

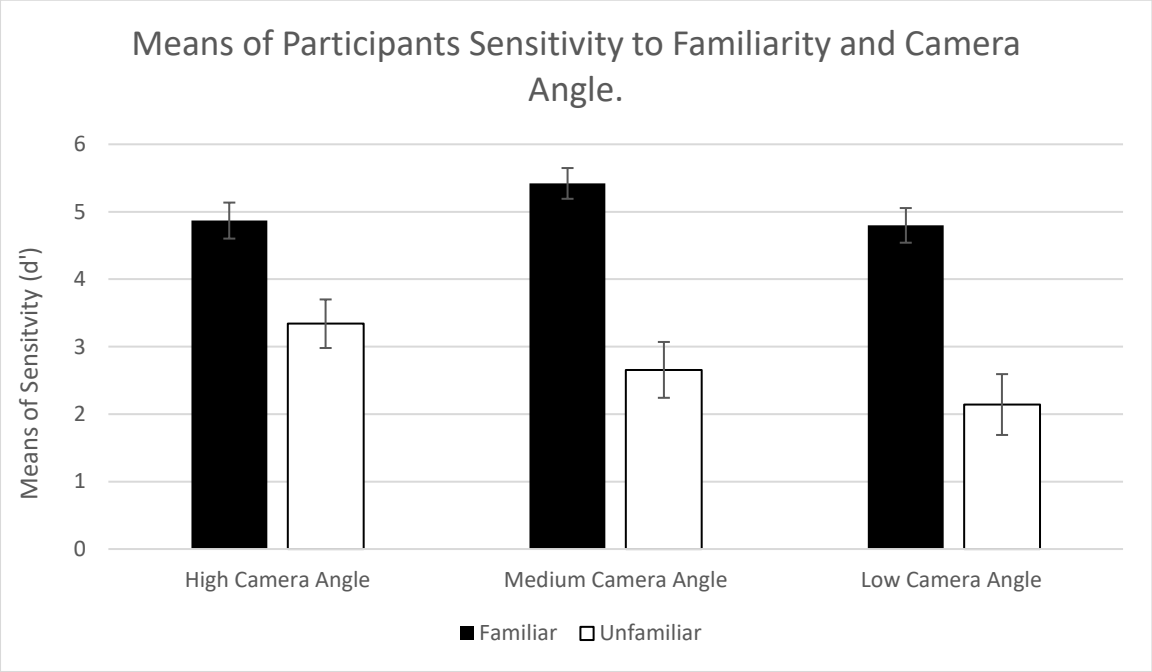

Figure 8. Means of participants sensitivity to familiarity and camera angle.

Bias

Familiarity with a target did not significantly affect an individuals' bias, p = .873, with the means not being significant different between familiarity (c' = -.10) and unfamiliarity (c' = -.12), suggesting that familiarity with a target did not bias the participants response. There was no main effect found for the camera angle on bias, p = .352. The interaction between familiarity and camera angle had a significant main effect of participants bias, F (2, 86) = 5.226, p = .007, η^2_p = .108. In order to compare the differences in means, paired samples t-tests explored the differences in means between the interaction of familiarity and camera angle for response bias.

A significant difference was found between familiar trials and camera angles which affected participants bias. There was a significant difference between the low camera angle (M = .168, *SD* = .865) and the medium camera angle (M = -.381, *SD* = .758) for participants criterion, $t(43) = 3.748$, $p < .001$. The results show that participants are more bias to familiar targets when viewed from the medium camera angle. Participants have a lower threshold on the medium camera angle and have more willingness to make a positive response on the medium camera angle.

A significant difference was found between the medium camera angle (M = -.3811, *SD* = .758) and the high camera angle (M = -.085, *SD* = .725), *t*(43) = -2.052, *p* = .046. The results indicate that participants have a higher threshold to the high camera angle than the medium camera angle, suggesting that participants are more indecisive in their identifications when they are shown the familiar target from the high camera angle compared to the medium camera angle.

Discussion

The discussion will start by an interpretation of the results which will be split into sections on: familiarity, camera angle, familiarity and camera angle interaction, familiarity and sensitivity. The limitations of the study will then be explored, as well as the implications and future research.

Interpretation of results

Familiarity

The first hypothesis was that familiar faces will be identified more accurately and correctly than unfamiliar faces. This hypothesis was supported, as the current study found a significant main effect for familiarity for hit responses on target present trials. Familiar targets were better identified at all camera angles. This is in support of the Bruce and Young (1986) model as it indicates that familiar faces are recognised using structural coding, and familiar face recognition is subject variability. Research by Bruce et al. (2001) found similar results to the present study. They found that correct identifications were highest when participants were familiar with the target (92%) compared to when participants were unfamiliar with the target (70%). The slight differences could be explained by the differences in methodology which was a single verification task. However, the current research found a high accuracy rate for familiar face identification compared to other studies. Burton et al. (1999) used a recognition memory task in their first experiment. The study found that only 73% of the participants correctly identified a target. This accuracy rate is relatively low for familiar face recognition. The reason for such differences could be due to the time period between being shown the CCTV footage and the phase of being asked to identify the target. Participants were shown all videos first, and then shown the 20 images one at a time. Participants may have forgotten in that time period the faces which were shown in the video footage.

The results for miss responses also show support for the first hypothesis, as unfamiliar faces had a higher percentage of miss responses than familiar faces, with the unfamiliar mean percentage being 15%. Therefore, unfamiliar faces are harder to detect in a target present line-up, and participants choose a no match option, indicating that they believed that the target was not present. The results are

supported by previous research as Bruce et al. (2001) found a mean percentage of miss responses in target present trials for unfamiliar faces being 18%. The present study also found participants who were familiar with a target were able to correctly reject the target as not being present in a target absent line-up more than those who were unfamiliar with the target, with a 96% accuracy rate. The correct rejection percentage for unfamiliar targets was 75%, indicating that individuals who are unfamiliar with a target are still able to identify to some extent that the target is absent in the line-up. The results found in the present study are supported by previous research conducted by Bruce et al. (1999) who investigated how matching images to a selection of face photo arrays was influenced by changes in viewing conditions. Participants looked through 40 target array arrangements. After looking at each array participants were asked what number of the face matched the target. The study found that the mean percentage of participants being able to correctly reject an unfamiliar target, which they were shown on images captured from videos was at 70%. The reason for this result could be due to participants having no time limit when inspecting the arrays, which could have created a familiarisation process. Conversely, in the current study participants were indicated to watch the video footage one time only.

Camera angle

The present study found that the camera angle that the participants viewed the target from affected their ability to identify them in the line-up. The effect of the camera angle on face identification differed between familiar and unfamiliar faces. Unfamiliar face identification performance was best at the high camera angle, and familiar face identification performance was better at the high and medium angle. Therefore, the findings show that correct identifications on target present line-ups are more accurate when the CCTV footage is displayed from a camera height that is approximately 99.7 inches, with a hit accuracy of 91%. Consequently, the second hypothesis of the study is rejected, which was that the medium camera angle would produce more correct identifications. Davies and Thasen (2000) explored differences in colour and monochrome viewing conditions and what effect they had on participants identification which were made from either memory or view. In their first experiment the study used a CCTV camera which was installed 6 metres (236.22

inches) above ground level. The study found an overall correct identification rate of 20% from memory and a false alarm rate which was just over 60%. However, the camera height used by Davies and Thasen (2000) was installed 136.52 inches higher than the high camera used in the present study. Therefore, this evidence suggests that having a CCTV camera installed higher than 99.7 inches can be detrimental to an individuals' ability to identify a face, with the current findings producing a 91% hit accuracy rate when the camera angle was placed under 100 inches.

Familiarity and camera angle interaction

The third hypothesis of the study was that familiarity and the medium camera angle would interact to produce a high percentage of correct responses. The hypothesis was accepted due to the interaction of familiarity and the medium camera angle having a 100% mean accuracy rate. The present study also found significant differences between familiarity and camera angle. The study found that familiar face identification was highly accurate in both the medium and high camera angles. The study also found that unfamiliar face identification was best in the high CCTV camera angle (87%), and poorest in the low camera. Lee et al. (2009) found that when the CCTV camera was position at ceiling height, which was similar to the high angle in the current study, accuracy was 67% for correct identifications. However, higher accuracy was found in the current study, which could be due to the better quality of the footage produced by the CCTV cameras

Familiarity and sensitivity

The fourth hypothesis of the study was that participants would be more sensitive to familiar faces than unfamiliar faces. This hypothesis was supported, with the means being highest for the familiar conditions than the unfamiliar conditions, and a significant finding being found. Which indicates that participants are able to discriminate between familiar and unfamiliar faces. Bruce et al. (2001) also found that familiarity affected sensitivity. A study conducted by Pike et al. (1997) found a sensitivity mean for dynamic unfamiliar faces of 2.49, which is similar to the findings of the current study. Therefore, being familiar with a target makes individuals better

at being able to discriminate when a target is familiar with them and when a target is unfamiliar with them, and their response is driven by sensitivity to familiar faces.

Familiarity, camera angle and bias

The study also found a significant interaction between bias responses for familiarity and camera angle. The study found that participants are more likely to make a positive response on medium camera angle conditions. A higher threshold was found for the high camera angle, indicating that participants are more liberal in their responses.

Limitations

The first limitation of the study is the sample size. The sample size used in the study would be considered small (N = 43). Due to this, there is a lack of power within the findings to produce a significant result. Another limitation of the study is that the age and gender of the participants was not recorded. This should be done for future research, as previous research has found differences across the two domains (Sun, Gao & Han, 2010) which could have given further insight into the present study. Another limitation of the line-up images is that some of the images were used more than once, this can create a learning process for the participants, and they can become more familiar with the individuals if they see them more than once, making it easier for them to differentiate between the target and the distractors (Bindemann & Johnston, 2017). A further limitation of the design of the experiment was that participants could watch the CCTV footage as many times as they wanted to, regardless of being instructed to only watch the video once. This creates a learning and familiarisation process, where individuals can learn the face from the video, and can match them more easily in the line-up, despite being unfamiliar with them. This was found by Clutterbuck and Johnston (2005), who found that unfamiliar faces can become familiar with repeated exposure, creating a process of familiarisation. Another limitation of the experiment is that the number of target present and absent trials presented to participants was not balanced for example, some participants saw 9 target present trials and 15 target absent trials, rather than an equal number of target present and absent trials (12 target present trials and 12 target absent trials).

Due to this not being evenly controlled, it causes limitations of the present study, as individuals may be better at correctly rejecting a face (target absent trial) than correctly matching the face (target present trials). Due to the limitations of the study, the recommendations provided are tentative and further research is needed.

Implications

The findings of the current study are important in relation to the council, courts and police investigation. The findings indicate that familiar face identification is very accurate, while unfamiliar face matching is not as accurate. The findings also gave further evidence that change in viewing conditions, such as the low camera angle, cam have a detrimental influence on unfamiliar face identification, while familiar face identification was not influenced by changes in viewing conditions. Which gives rise to the conclusion that unfamiliar identification of criminals should not be used within the criminal justice system, due to its low accuracy. The findings also give evidence which could be used by the council in relation to the installation of camera heights, and that having a camera height of 99.7 inches provides near enough accurate identification for familiar and unfamiliar faces. In the real world, the camera height for familiar face recognition does not influence face identification, due to high accuracy rates being found across all angles. However, unfamiliar face recognition is influenced by changes in camera angle, with poor accuracy rates being produced. This therefore indicates that unfamiliar face identification should not be used in practice due to being error prone, which could lead to an innocent individual being convicted. Therefore, that camera height could be used in shops, cafes and even outdoors, to aid an increased accuracy of familiar face identification, aiding the process of identifying a criminal of a moderate to serious crime, and giving people justice.

Future Research

For the future research in relation to the current study, researchers need to make sure that the experiment has a more controlled design. Therefore, a sample size twice the amount of the current study is required. Due to Qualtrics being online based, participants can become affected by other factors such as background noise

and distractions, which would not occur if the experiment was done one-to-one with the participant and experimenter on E-Prime as it is a controlled environment. Future research should also consider making the experiment more ecologically valid, by recording the CCTV footage in a real-life setting from one location but using different cameras. A further consideration is using CCTV footage which can rotated, to give a wider view of the target from differing variations from the one camera angle. Another consideration is increasing the ecological validity of the experiment further and recording the CCTV footage in a real-life setting such as a café. This would contribute to a wider understanding of face recognition in a real-life environment.

Conclusion

This research has provided additional insight into familiar face identification and the influence of differing camera angles. It has supported the existing literature which highlights the differences in accuracy for familiar and unfamiliar face matching and recognition, with unfamiliar face matching being more prone to incorrect responses, misses and false identifications. The research found that a camera angle installed above head height does improve the accuracy of unfamiliar face matching, but the difference was not significant. The study found that the combination of both familiarity and camera angle produced the most correct identifications. Sensitivity towards a target was influenced by familiarity, but the camera angle was not. Therefore, being familiar with a target allows participants to discriminate between the familiar target and other foil targets shown in the line-up, while being unfamiliar with the target makes it harder to discriminate the target from the foils present in the line-up. Familiarity influenced by sensitivity but not bias. The accuracy for unfamiliar face identification was highest on the high camera angle conditions but was still error prone. The accuracy for familiar face recognition was best from the high camera angle, but recognition accuracy remained high across all three camera angles. Therefore, the camera angle does not influence familiar face identification. However, it does influence unfamiliar identification. Therefore, caution should be applied when using unfamiliar eyewitnesses in the identification process, and familiar face identification should be prioritised by the police, as highly accurate results were produced.

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