Catching Wanted People at the Border: Prospective Person Memory and Face Matching in Border Control Decisions

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Abstract

Border control officers may be on the lookout for wanted people while they verify that travelers match their passport photos. We developed a novel experimental paradigm to investigate whether people are more likely to report that someone is wanted if they also believe that person is using a fraudulent passport. In two experiments, undergraduate students assumed the role of a border control officer and completed multiple "shifts" of a face matching task designed to simulate a passport verification check. Before each shift participants viewed posters of wanted people and were instructed to report any sightings if a wanted person appeared in any of the images during the passport check. Participants were more likely to say an individual was wanted if they also believed the person did not match their passport image. In addition, the accuracy of wanted person sightings was reduced for trials with nonmatching passports compared to trials with matching passports. This suggests wanted people with matching passports were easier to spot because participants had an additional image to compare with their memory of the person in the wanted poster.

Keywords: prospective person memory, face matching, border security, wanted people

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Wanted people may use fraudulent passports to cross borders without getting caught. When deciding whether to admit a traveler, border control officers must ensure that the person in the passport photograph is indeed the passport holder. This process is called face matching (Bruce et al., 1999). While border control officers are checking passports, they are also required to keep an eye out for wanted people. To do so, border control officers regularly review databases containing information about people accused of terrorism or other crimes (Meurrens, 2013). Border control officers have many demands and are not able to constantly reference these databases; therefore, successful identification of wanted people is dependent on prospective person memory, which is the practice of looking out for someone while simultaneously completing other tasks (Lampinen et al., 2009). In this paper we investigate prospective person memory and face matching tasks in a mock border control situation. Research has shown that people are more likely to make a wanted sighting when they receive a reminder (Moore, 2017). Given that wanted people sometimes rely on fraudulent passports to cross borders, suspicion of a fraudulent passport may act as a reminder to keep an eye out for wanted people. Therefore, we predicted that participants would be more likely to report spotting a wanted person if they also believed that person is using a fraudulent passport.

Border control officers are primarily concerned with face matching, which involves deciding whether two faces are of the same person or of different people. Previous research indicates that face matching performance is error-prone (Bruce et al., 1999; Bruce et al., 2001; Burton et al., 2010; Kemp et al., 1997; Megreya & Burton, 2006), and even under low-stress

conditions or with professional training, mistaking two different people as the same can happen as often as 30% of the time (Susa et al., 2019; White et al., 2014a). Although border control officers may have strategies for judging passport authenticity, their professional training does not make them immune to the difficulties of face matching. In previous face matching research, border control officers performed no better than the general population (White et al., 2014a; White et al., 2021; Wirth & Carbon, 2014).

In addition, border control officers may have response biases related to their perceptions of the prevalence of mismatches that impact face matching performance. If the primary concern is public safety and fraudulent passports are perceived to be common, the officer might adopt a mismatch response bias (i.e., responding mismatch more often). A mismatch bias would increase detection of fraudulent passports but would also increase false accusations toward people with legitimate passports. By contrast, if the officer believes virtually every traveler will match their ID and they are averse to making a false accusation, they may adopt a match response bias and be inclined to admit travelers even if the picture in their ID is not a great likeness to their current appearance. Research has shown that people tend to develop a match response bias when the prevalence of mismatches is disproportionately low in comparison to the prevalence of matches (Papesh et al., 2018). Therefore, given that fraudulent passports would be much less common than genuine passports in an actual border control context, document examiners could adopt a match response bias. Although the development of a match response bias would reduce false accusations, it would also lead to increased acceptance of fraudulent passports.

One challenge for matching faces at the border is that the traveler must be matched to a photograph that was taken on a different day. In previous research, face matching performance has been substantially reduced when the photographs are taken several months apart versus on

the same day (Davis & Valentine, 2009; Megreya et al., 2013; Sandford & Ritchie, 2021). This decline in performance is problematic for border security because passports are often valid for up to 10 years and drastic variability in appearance is possible within that amount of time. Variability in faces can result from many factors including changes in expression, aging, and environmental changes such as lighting (Ritchie & Burton, 2017). This can result in innocent travelers being accused of using fraudulent passports. For example, in 2009 a 31-year-old Canadian woman named Suaad Mohamed Haji was accused of using a fraudulent passport in Kenya (Goddard, 2009). Haji was detained for months simply because she no longer resembled her passport photograph, which she attributed to losing weight, changing her glasses, and experiencing a change in skin-tone in the four years since her photograph was taken.

People often underestimate how much the appearance of unfamiliar faces can vary between encounters. Previous research has shown that people are better at face matching tasks when they are familiar with the faces in the task than when they are unfamiliar (Bruce et al., 2001; Clutterbuck & Johnston, 2002; Megreya & Burton, 2006; Ritchie & Burton, 2017). People have extensive experience with familiar faces, which provides a flexible representation of the possible variability in faces of familiar people. Ritchie and Burton (2017) found that participants performed better on a face matching task when the faces used in the task were previously learned using multiple, highly variable images as opposed to less variable images. Border control officers may become more familiar with wanted people through viewing their faces on wanted posters as part of their job. This familiarization could enhance border control officers' ability to determine whether wanted people seen previously on posters are using fraudulent passports or not.

To identify a person seen previously on a wanted poster while verifying passports, border control officers must use prospective person memory. Remembering to engage in future activities, such as going to an appointment at a later date, requires the use of prospective memory (Brandimonte et al., 1996). When on the lookout for a certain person, a specific type of event-based prospective memory, known as prospective person memory, is used. For prospective person memory to be successful in the search for wanted people, a person would need to remember to contact authorities (delayed-intention) when a wanted person is encountered (prospective memory cue) during other attention-demanding ongoing tasks (Lampinen et al., 2009; Lampinen & Moore, 2016).

In border control contexts there are unique prospective person memory considerations, particularly with respect to expectations for encountering wanted people. The identification of wanted people is not common, and this is due in part to the public having low expectations of an encounter. Wanted-person alerts are frequently televised on the news; however, most viewers usually never encounter the wanted person. Therefore, members of the public may develop low expectations for identifying wanted people in the future, especially if the crime was committed in an area that is not close in proximity (Lampinen & Moore, 2016). In comparison to the general public, border control officers are more likely to come across wanted people. For instance, in 2021, the US Customs and Border Protection arrested 1,904 non-citizen individuals with outstanding warrants when they were attempting to cross the border (U.S. Customs and Border Protection, 2022). Given that border control officers are more likely to come across wanted people during their day-to-day activities, they may have higher expectations of encountering wanted people and a higher intent to lookout for them.

Whether or not a border control officer reports a traveler as wanted could also be influenced by the perceived authenticity of their passport. If an identity document is legitimate and belongs to a wanted person, the automated border control system will likely recognize the name on the document and flag their presence (Interpol, n.d.), which could motivate wanted people to use fraudulent passports to help conceal their identity. Border control officers could anticipate this and, in turn, have the expectation that wanted people are more likely than the average traveler to be using a fraudulent passport. This expectation could be another instance of illusory correlations, in which associations are assumed for events that are actually uncorrelated or correlated to a lesser extent than assumed (Chapman, 1967). However, wanted people have been known to use fraudulent passports to evade authorities when crossing borders (Interpol, 2014), and thus the detection of a fraudulent passport could be a valid indicator that a person is wanted. Even if the passport is not actually fraudulent, the mere suspicion of fraud could lead border control officers to further suspect that a person is wanted. Sightings are more likely to occur if there is a reminder to look for wanted people, which serves to refocus attention on the prospective person memory task (Moore, 2017). Consequently, border control officers may be more likely to identify a wanted person or falsely accuse someone of being wanted if they suspect them to be using a fraudulent passport.

There are different theories about the role of reminders in prospective memory. According to the preparatory attentional model, maintaining a focused attention on the prospective memory task is necessary for successful retrieval. However, outside of basic laboratory tasks people often rely on spontaneous retrieval because it is unrealistic to maintain focused attention for extended time periods (Einstein et al., 2005). Spontaneous retrieval occurs when prospective memory does not require monitoring of the environment and is initiated by

some form of reminder (Einstein et al., 2005). In the multi-process model of prospective memory, spontaneous retrieval is more likely when (a) there is a strong association between the prospective memory cue (e.g., the wanted person) and the delayed intention (e.g., contacting authorities when a wanted person is encountered), and (b) the ongoing task uses a type of mental processing similar to that required by the prospective memory task (Lampinen et al., 2016). Applied to prospective person memory, a successful sighting would be more likely if (a) the wanted person's appearance in the alert is similar to their appearance at a subsequent encounter and (b) the individual looking for the wanted person is engaged in a task that focuses their attention on the faces of others (Lampinen et al., 2016). In the case of border control officers, their job is to examine the faces of travelers and determine whether or not they match the photograph in their passport. Thus, the primary task of a border control officer has features that increase the likelihood of spontaneous prospective person memory retrieval.

As mentioned previously, a person's appearance can vary substantially from one day to the next (Jenkins et al., 2011; Ritchie & Burton, 2017; Sweeney & Lampinen, 2012). Therefore, when a wanted person is encountered they may look considerably different from their photograph in the wanted alert, which is known to affect sighting rates (Lampinen et al., 2016). In a border control setting, however, the identity document could provide additional information about the variability in a person's appearance, which could increase the likelihood of wanted person sightings. Specifically, if a wanted person is using their own passport or a fake that depicts the wanted person' own photograph (e.g., with false identifying information), border control officers would have two sources for comparison to their memory of the wanted person: the individual in front of them and the passport they are tendering. Conversely, if the wanted person's passport depicts a photo of someone else, a correct identification of the wanted person

from the passport would not be possible, and the border control officer would only be able to make a genuine sighting by comparing their memory to the traveler.

Although the benefits of viewing multiple images that depict a person's variability in appearance has been primarily studied by showing the images at encoding (Juncu et al., 2020; Ritchie & Burton, 2017; Sweeney & Lampinen, 2012), it is possible that exposure to greater variability during testing can also improve face recognition. Sandford and Ritchie (2021) found that providing highly variable images of an individual during testing improved face matching performance on match trials. Providing multiple, variable images during testing may benefit prospective person memory performance as well, which would be the case if a wanted person uses a genuine passport or a fake passport displaying their own photograph.

The Present Research

We conducted two experiments that employed a new paradigm for investigating face matching and prospective person memory. The primary task was to determine whether two side-by-side images depicted the same person or different people (face matching). The secondary task was to keep an eye out for wanted people (prospective person memory).

Hypotheses

First, we had competing hypotheses for matching faces of wanted vs not-wanted people. For wanted people, participants matching performance might benefit from the increased familiarity from the prior viewing of their photographs on the wanted posters. Therefore, one prediction was that the increased familiarity with wanted people will increase correct match responses for wanted people compared with not-wanted people (Hypothesis 1a). Alternatively, recognizing someone as a wanted person might make participants suspicious that the person is also using a fraudulent passport (i.e., that the passport image does not match the ambient image).

Therefore, another possibility is that the increased suspicion will reduce correct match responses for wanted people compared with not-wanted people (Hypothesis 1b).

Second, in addition to increasing correct match responses, increased familiarity with wanted people could reduce incorrect match responses. Therefore, we predicted a lower incorrect match response rate for wanted people vs not-wanted people (Hypothesis 2).

Third, we anticipated that suspecting someone of using a fraudulent passport would further raise suspicion that the person is wanted. Therefore, we predicted that when participants responded mismatch (i.e., responding that the two images are of different people) they would be more likely to also report a sighting of a wanted person than when they responded match (Hypothesis 3).

Finally, having two images of the wanted person provides more representations of their face, which was predicted to increase the likelihood of a correct sighting. Therefore, we hypothesized that prospective person memory discriminability (*d'*) would be higher on match trials than on mismatch trials (Hypothesis 4).

General Method

Design

Participants simultaneously completed two tasks: The primary task was to determine whether two side-by-side images (image pairs) were of the same person or different people (face matching). The secondary task was to determine whether any wanted people were depicted within the image pairs (prospective person memory). This study employed a 2 (face matching: match or mismatch) × 2 (prospective person memory: wanted or not wanted) within-subjects design. These factors were manipulated at the trial level; therefore, each participant completed approximately 16 match and four mismatch trials per shift, and wanted people appeared in both

trial types. For dependent variables we measured face matching and prospective person memory accuracy, total number of wanted person sightings, and confidence in wanted person sightings.

Materials

Study materials were obtained from Google Images. All images were of actors from the Australian television series *City Homicide* (Banas, 2007), *Blue Heelers* (McElroy, 1994), *East West 101* (Knappman & Wyld, 2007), *Dead Lucky* (Beaumont & Proffitt, 2018), *Janet King* (Haddrick, 2014), and *Doctor Doctor* (Salmon et al., 2016), the British television series *Torchwood* (Davies, 2006), *The Missing* (Williams & Williams, 2014), and *The Paradise* (Gallagher, 2012), and the American television series *The Leftovers* (Leder, 2014).

For both tasks, all images were of White individuals. If a wanted person was of a particular ethnicity that was underrepresented within the stimuli, they may have been easier to spot. Accordingly, the use of individuals that were all the same race was intended to prevent racial identity from acting as a signal for the prospective person memory task. Half of the people depicted in the images were men and half were women. Their ages ranged from 28 to 65.

Participants played the video game "Snake" (Armanto, 1997) during scheduled breaks between blocks of trials, which were referred to as "shifts" in the instructions to the participants. The game does not involve viewing human faces.

Wanted Posters

Posters were constructed for 10 wanted people, five men and five women. Wanted posters included the "Crime Stoppers" logo at the top, a frontal headshot image of the wanted person, and a made-up first and last name in bolded font at the bottom. Having a name on each poster allowed participants to associate labels with each face, making it easier to differentiate between them.

Passport Images

Passport images were black and white headshots of 100 people (10 wanted, 90 not wanted) that were forward facing and cropped at the chest. The passports contained a headshot image as well as the individual's made-up nationality, birth date, place of birth, document number, date of issue, date of expiry, and the authority of the passport issuer. The headshot images were frontal-faced, neutral-posed, and edited onto passport templates. Names were not included on the passport because names were included on the wanted posters, and we wanted to avoid names influencing prospective person memory. All passports were Australian to reduce potential associations with North American cities, such as particular cities being associated with crime.

Ambient Images

Ambient images were natural photographs (i.e., not staged) of 100 people. Out of the 100 ambient images, 78 were of the same people used in the passport photographs (5 wanted and 73 not wanted) and 22 were of new people (5 wanted and 17 not wanted). The images were forward facing because border control officers typically see passport tenderers head on as opposed to only a profile view. These images were in colour.

Image Pairs

The face matching task included 100 image pairs, each comprising one passport image and one ambient image. Passport and ambient images appear to be taken on different days; however, because they were obtained from Google Images, we are not certain. The passport and ambient images depicted the individuals with different backgrounds, in different clothing, and with different facial expressions. The image pairs either matched (the passport image and ambient image were of the same person) or mismatched (the passport image and ambient image

were of different people). In every shift, which comprised 20 trials, approximately 4 trials were mismatches. Two shifts contained an additional 5th mismatch pair that was added in error. Overall, 22% of the trials were mismatched. There was a disproportionate number of match trials to simulate a border control scenario, where mismatches would be less common than matches. Although the prevalence of mismatches would be much lower than 22% at a real border, we decided against using such a low mismatch prevalence to avoid low cell counts on mismatch trials. To prevent participants from recognizing a wanted person by some aspect of their poster image that is unrelated to the identity (e.g., the lighting in the image), the images of wanted people for face matching were different from images in the wanted poster.

Procedure

The study was completed online using Qualtrics. Participants were instructed that they were going to be completing five shifts in the role of a border control officer. At the beginning of every shift, participants viewed posters for two wanted people (one male and one female) for 5-seconds each. All wanted people that appeared in the posters showed up within the shift they preceded; however, participants were instructed that they may or may not show up. Half of the wanted people appeared in match trials and the other half appeared in mismatch trials. For both experiments, whether each wanted person appeared in a match trial or mismatch trial was counterbalanced between participants. Typically, wanted people use fraudulent passports that depict innocent people to avoid arrest; therefore, in mismatch trials wanted people appeared only in the ambient images.

After viewing a set of two wanted posters before a shift, participants viewed 20 image pairs for that shift and decided whether each passport was genuine (matched to ambient image) or fraudulent (mismatched to ambient image). There was no filler task between viewing the

wanted posters and viewing the image pairs. For each trial, participants were asked “Do you believe these images are of the same person?”. If participants believed the images were of the same person they were to select “Yes, I believe these images are of the same person”. If they believed the images were of different people they were to select “No, I believe these images are of different people”.

Below each image pair, there was a green button. If participants believed an image depicted a wanted person, they were instructed to click on the green button. If they clicked the green button, they were then asked to rate how confident they were that they correctly identified a wanted person on a scale of 50 (“I am guessing”) to 100 (“I am certain”). After each shift participants had a 1-minute break where they played the “Snake” game. Breaks were implemented to reduce the risk of fatigue. Following the study, participants were asked to report their age, ethnicity, and gender. To check if participants had any prior exposure to the stimuli, they were also asked if they recognized any of the individuals in the study from outside of the experimental context. Participants then read a debriefing form.

Data Analysis

Face matching. A correct match response, or hit, on the face matching task is correctly responding that the two images match when they depict the same person. The correct match response rate was computed by dividing the number of correct match responses by the total number of match trials (78). An incorrect match response, or false alarm, is responding that the two images match when they actually depict different people. The incorrect match response rate was computed by dividing the total number of incorrect match responses by the total number of mismatch trials (22). For face matching, discriminability reflects accuracy in determining whether the two images depict the same person or different people, with higher discriminability

scores indicating higher accuracy, and criterion reflects bias towards responding match or mismatch, with scores below zero indicating a mismatch bias and scores above zero indicating a match bias.

To account for the possibility of rates of zero or one, which preclude computation of discrimination and criterion scores, a modified loglinear correction was applied (Stainslaw & Todorov, 1999). The experimental procedure included 3.6 times as many match trials (78) as mismatch trials (22); therefore, the loglinear correction was approximately 3.6 times greater for match trials than for mismatch trials. Specifically, for the incorrect match rate on mismatch trials, 0.05 was added to the numerator (frequency of incorrect match responses) and 0.10 was applied to the denominator (number of trials); and for the correct match rate on match trials, 0.18 was applied to the numerator (frequency of correct match responses) and 0.35 was applied to the denominator (number of trials). Discriminability was calculated using the following formula: z(Hit rate) – z (False alarm rate). To calculate criterion, the following formula was used: $-0.5 \times [z(\text{Hit rate}) + z(\text{False alarm rate})]$ (Stainslaw & Todorov, 1999).

Prospective person memory. A sighting on the prospective person memory task is reporting that an individual is a wanted person, regardless of whether the individual is wanted or not. A correct wanted sighting, or hit, on the prospective person memory task is correctly identifying a wanted person. An incorrect wanted sighting, or false alarm, is incorrectly responding that a not-wanted person is wanted. The sighting rate was computed for each participant by dividing the total number of wanted person sightings by the total number of trials.

Signal detection measures were again computed for the prospective person memory task, such that *d'* reflected discrimination between wanted and not-wanted people and *c* reflected response bias towards (negative values) or against (positive values) reporting that a person is

wanted. In calculating *d'* and *c*, we were unable to use the loglinear approach for correcting rates of zero and one (i.e., the approach applied for the face matching task) because there were only 10 trials that included wanted people, and after these trials were split by trial type and response type on the matching task, it was not feasible to compute *d'* and *c* scores for each participant. Accordingly, rather than computing scores for each participant and then aggregating the scores, we computed hit and false alarm rates at the level of the group and then used those group-level scores to compute group-level *d'* and *c* scores using the following formulas: $d' = z(\text{Hit rate}) - z(\text{False alarm rate})$; $c = -0.5 \times [z(\text{Hit rate}) + z(\text{False alarm rate})]$ (Stainslaw & Todorov, 1999). This resulted in a single *d'* and *c* score for each of the four conditions of interest, namely match and mismatch responses on match and mismatch trials. To test for differences between these conditions, we used Gourevitch and Galanter's (1967) significance test for comparing single *d'* and *c* scores (Banks, 1970; MacMillan & Creelman, 1990). This test, which has recently been applied for signal detection measures on eyewitness identification tasks (Fitzgerald & Price, 2015; Mickes, Moreland, Clark, & Wixted, 2014), requires a *d'* or *c* score and a sample size. We entered the group sample size (i.e., 324), which provides a more conservative significance test than entering the trial sample size.

Experiment 1

Participants

Undergraduate university students ($N = 331$) were recruited through a Psychology Department research participation system. They received partial course credit for their participation. For a paired sample *t*-test, power analysis indicated that a minimum sample size of 327, 54, or 23 would be necessary to achieve 95% power to detect a small ($d = 0.20$), medium ($d = 0.50$), or large effect size ($d = 0.80$), respectively. Six participants were excluded because they

did not identify any individual as wanted and one other participant was excluded because they identified someone as wanted on all 100 trials.

The final sample included 324 participants (68.6% identified as female, 31.4% as male). In terms of age, 6.2% were aged 17 or younger, 90.1% were 18-24, 2.9% were 25-34, and 0.8 % were 35-44. For ethnicity, 34.5% identified as Caucasian, 30.0% Asian, 29.6% South Asian, 2.5% mixed race, 2.0% Hispanic, 2.0% Indigenous, and 0.5% Black. Twenty participants had one trial excluded from data analysis because they reported prior familiarity with the individual pictured in that trial. Two participants had two trials excluded due to familiarity with the individuals pictured in the trials. None of the excluded trials included wanted people.

Results

Face Matching

Across the full procedure (100 trials), the average accuracy rate on the face matching task was .79 (range: .44–.95), with higher accuracy on match trials (M = .81, SD = .13) than on mismatch trials (M = .72, SD = .18). Correct and incorrect match response rates for wanted and not-wanted people are summarised in Table 1, along with discriminability (*d'*) and criterion (*c*) scores. There were five match trials that included wanted people and 73 match trials that did not include wanted people. In contrast, there were five mismatch trials that included wanted people and 17 mismatch trials that did not. As mentioned in the data analysis section, a modified loglinear correction that accounted for the inequality between trial types was applied to calculate *d'* and *c*.

Table 1

Face Matching in Experiment 1

Trial Type	Correct Match Response Rate	Incorrect Match Response Rate	*d'*	*c*

Wanted Trials	.84 (.19)	.21 (.23)	2.34 (1.25)	0.03 (0.68)
Not Wanted Trials	.81 (.14)	.30 (.19)	1.64 (0.59)	-0.19 (0.56)

Note. Values in parentheses represent standard deviations.

A paired *t*-test revealed that participants made significantly more correct match responses on trials that included wanted people (M = .84, SD = .19) than on trials that did not include wanted people (M = .81, SD = .14), $t(323) = 2.81$, $p = .005$, $d = 0.17$ [95% CI: 0.05, 0.30], which provides support for Hypothesis 1. Consistent with Hypothesis 2, a paired *t*-test revealed that there was a significantly lower rate of incorrect match responses on mismatch trials including wanted people (M = .21, SD = .23) than on mismatch trials that did not include wanted people (M = .30, SD = .19), $t(323) = 7.69$, $p < .001$, $d = 0.42$ [95% CI: 0.31, 0.54].

Prospective person memory

Participants were on the lookout for 10 wanted people, half of which were encountered during match trials and half during mismatch trials. On average, participants reported 3.54 correct and 2.38 incorrect sightings.

In line with our third hypothesis, a paired *t*-test showed that the sighting rate was significantly higher when participants made mismatch responses on the face matching task (M = .09, SD = .07) than when they made match responses (M = .05, SD = .03), $t(323) = 8.30$, $p < .001$, $d = 0.59$ [95% CI: 0.44, 0.74].

Group-level hit and false alarm rates were used to compute aggregate d' and c scores. Table 2 shows discrimination between wanted and not wanted people was higher on match trials (d' = 1.72) than on mismatch trials (d' = 1.25), $G = 2.17$, $p = .030$. This supports Hypothesis 4.

Sighting response bias was more lenient for match trials (c = 0.96) than for mismatch trials (c = 1.24). Considering that the sighting rate was significantly higher when participants made mismatch responses on the face matching task than when they made match responses, this

finding is counterintuitive. However, response bias was more lenient on match trials when participants incorrectly responded mismatch (c = 0.91) than when they correctly responded match (c = 1.09), G = .13, p = .90, which is in line with the sighting rate being higher for mismatch responses than for match responses.

Table 2

Prospective Person Memory in Experiment 1

		Hits		False Alarms		Overall		
Trial	Response	%	*N*	%	*N*	*N*	*d'*	*c*
Match	Match	42.6	1365	2.3	19184	20549	1.81	1.09
	Mismatch	50.2	255	3.4	4444	4699	1.83	0.91
	Overall	43.8	1620	2.5	23628	25248	1.72	0.96
Mismatch	Match	16.9	338	4.0	1640	1978	0.79	1.35
	Mismatch	29.8	1282	2.8	3863	5150	1.38	1.22
	Overall	27.1	1620	3.1	5508	7128	1.25	1.24

Note. *N* = Number of trials. Hits = Correct wanted sightings. False Alarms = Incorrect wanted sightings.

Further examination of the data shows that prospective person discriminability was weakest when participants were presented with a mismatch and incorrectly classified it as a match. Table 2 shows that on mismatch trials, discrimination between wanted and not wanted people was higher for mismatch responses (d' = 1.38) than for match responses (d' = 0.79), G = 2.70, p = .007. This means that when participants were presented with a mismatch trial, they were better at discriminating between wanted and not wanted people when they correctly classified the trial as mismatch than when they mistakenly classified it as match. In comparison, wanted person discrimination was unaffected by response type on match trials, G = .09, p = .92.

Exploratory analyses were conducted to examine participants' confidence in their wanted sightings. Every time participants made a wanted sighting; they were asked to rate how confident

they were in their sighting on a scale of 50 (guessing) to 100 (certain). Altogether, the 324 participants in this study made 1918 wanted sightings. Out of the 1918 wanted sightings, 30.2% (580) were made with high confidence (90-100 confidence rating), 40.1% (770) were made with medium confidence (70-89 confidence rating), and 29.6% (568) were made with low confidence (50-69 confidence rating). Of the high confidence wanted sightings, 83.3% (483) were correct identifications of wanted people. In comparison, accuracy was 57.5% (443) for sightings made with medium confidence and 39.1% (222) for sightings made with low confidence. A paired *t*-test revealed that participants were significantly more confident for correct sightings ($M = 82.4$, $SD = 14.4$) than for incorrect sightings ($M = 71.2$, $SD = 13.4$), $t(769) = 15.86$, $p < .001$, $d = 0.81$ [95% *CI*: 0.70, 0.93].

Discussion

The purpose of Experiment 1 was to investigate prospective person memory and face matching within the context of border security. Although the effect was small, we found that prior exposure to faces improved face matching performance. Participants performed better on the face matching task when the trials included wanted people, who had been studied previously, than when the trials included new, not-wanted people. This is in line with previous research that has shown that people are better at face matching tasks when they are familiar with the faces in the task than when they are unfamiliar (Bruce et al., 2001; Clutterbuck & Johnston, 2002; Megreya & Burton, 2006; Ritchie & Burton, 2017). Contrary to this previous work, which involved more extensive familiarization procedures, face matching in Experiment 1 seems to have benefited from a brief prior exposure to a single image of the faces. Another possibility is that the wanted people were sufficiently recognizable to warrant further study, which resulted in better face matching performance.

In support of our hypothesis that suspicion of a fraudulent passport would serve as a reminder to look out for known wanted people, we found that participants were more likely to say someone was wanted if they also believed the person was using someone else's passport. The mean difference was relatively small (.04). However, sightings were rare events; therefore, a small mean difference is to be expected. Although the absolute difference in sighting rate was small, the sighting rate associated with mismatch responses was almost double the rate associated with match response. We also found that when the passport did not match its holder, correctly detecting the fraudulent passport was associated with improved discrimination between wanted and not-wanted people. Together, these findings suggest that detecting a fraudulent passport can be an effective reminder to look out for known wanted people. Discriminability in identifying wanted people was also higher overall on match trials than on mismatch trials, which suggests that prospective person memory on match trials benefited from having two sources of the wanted person's appearance during the face matching task (i.e., the ambient and passport images).

Note, however, the matching decision did not necessarily precede the prospective person memory decision on each trial. The directionality of the association between these two decisions is uncertain, and it is possible that it was the sighting of a wanted person that motivated participants to say mismatch. It is also possible that some unmeasured third variable, such as poor attention or poor face recognition ability, increased the likelihood that participants would miss both the mismatch and the wanted person.

Experiment 2

In Experiment 1, we found statistically significant results that supported our hypotheses. However, the mean differences and effect sizes were relatively small. Therefore, we conducted

an additional experiment to test the robustness of the findings. In Experiment 2, we also asked a subset of the participants to report whether they noticed the wanted person before or after the passport check after each sighting.

Method

Participants

Undergraduate university students (N = 353) were recruited through a Psychology Department research participation system. They received partial course credit for their participation.

The final sample included 343 participants (66.7% identified as female, 32.1% as male, and 1.2% as non-binary). There were 10 participants who were excluded due to missing data. In terms of age, 0.6% were aged 17 or younger, 98.2% were 18-24, and 1.2% were 25-34. For ethnicity, 36.5% identified as Caucasian, 24.2% Asian, 22.5% South Asian, 5.7% Middle Eastern, 4.5% mixed race, 2.9% Hispanic, 2.0% Black, 1.2% Indigenous, and 0.4% Pacific Islander. Six participants had one trial excluded from data analysis because they reported prior familiarity with the individual pictured in that trial. The excluded trials were not wanted trials.

Design

We used the same experimental paradigm in Experiment 2, except that after a sighting half of the participants were asked a question about the order of their decisions (i.e., if the sighting was made before or after the passport check). This resulted in a 2 (face matching: match or mismatch) × 2 (prospective person memory: wanted or not wanted) × 2 (order question: included or not included) mixed design, with face matching and prospective person memory as within-subject manipulations and directionality as the between-subject manipulation. We made

no hypotheses about the order question, but we only included it for only half of the participants so that we could test for any effects of adding the question on the matching or sighting tasks.

Materials

The materials used were identical to Experiment 1, except for the following changes. Two individuals from Experiment 1 that were frequently recognized from prior exposure were replaced with different actors. The individuals were not wanted people. In Experiment 1, one wanted person was sighted 230 times. For comparison, the average number of sightings based for the other nine wanted people was 104. It could be that the wanted person who was sighted more frequently had a more distinctive face than the other wanted people. Therefore, the wanted person who was sighted significantly more in Experiment 1 was replaced in Experiment 2 to ensure that our findings are not driven purely by the sightings of one wanted person.

In Experiment 1 it is possible that some wanted individuals were easier to identify because they were the only plausible option that appeared in the shift. To prevent wanted individuals from standing out, the number of plausible matches and mismatches to each wanted person were equated in each shift, such that there was a minimum of one plausible match trial and one plausible mismatch trial for each wanted person in addition to the trial that the wanted person appeared in. The plausible individuals were selected to be similar to the wanted person in gender, age, and hair colour.

Like Experiment 1, whether a wanted person appeared in a match or mismatch trial was counterbalanced. In addition, to ensure the findings were not stimuli specific, the 22 mismatch trials from Experiment 1 were counterbalanced between-participants in Experiment 2. To do so, one version of Experiment 2 contained the original mismatch and match trials from Experiment 1. The other version contained 22 different mismatch and match trials. To create the new

mismatch trials, an original mismatch pair was broken up, such that one of the actors in the pair was used to make a new match trial and the other was mismatched with an actor from one of the existing match trials. As a result, 22 new mismatch and 22 new match trials were created using existing images from Experiment 1. Participants were randomly assigned to the different stimulus sets. Due to a counterbalancing error, 170 participants had 23 mismatch trials and 77 match trials, rather than 22 mismatch trials and 78 match trials.

To address the issue of directionality, approximately half of the participants (N = 168) were randomly assigned to a condition that required them to answer a follow-up question if they made a wanted sighting.

Procedure

The procedure was the same as Experiment 1, except for the added condition. If the participants in this condition made a wanted sighting, they were then asked to select one of five options: I noticed that the person was wanted BEFORE I noticed that the passport did not match (Option A), I noticed that the person was wanted AFTER I noticed that the passport did not match (Option B), I noticed that the person was wanted BEFORE I noticed that the passport matched (Option C), I noticed that the person was wanted AFTER I noticed that the passport matched (Option D), or I cannot remember (Option E). This question followed the confidence rating that participants were also required to provide after a wanted sighting.

Results

Face Matching

Across the full procedure (100 trials), the average accuracy rate on the face matching task was .87 (range: .56 - 1.00), with higher accuracy on match trials (M = .92, SD = .12) than on mismatch trials (M = .82, SD = .16). Correct and incorrect match response rates for wanted and

not-wanted people are summarised in Table 3, along with discriminability (*d'*) and criterion (*c*) scores. To calculate *d'* and *c,* the same modified loglinear correction from Experiment 1 was used to account for the unequal numbers of match and mismatch trials.

Table 3

Face Matching in Experiment 2

Trial Type	Correct Match Response Rate	Incorrect Match Response Rate	*d'*	*c*
Wanted Trials	0.78 (0.19)	0.23 (0.19)	1.96 (1.60)	0.06 (0.37)
Not Wanted Trials	0.93 (0.10)	0.15 (0.13)	2.84 (1.01)	-0.24 (0.33)

Note. Values in parentheses represent standard deviations.

Contrary to what was found in Experiment 1, a paired *t*-test revealed that participants made significantly more correct match responses on trials that did not include wanted people ($M = .93$, $SD = .10$) than on trials that included wanted people ($M = .78$, $SD = .19$), $t(342) = 12.86$, $p < .001$, $d = 0.99$ [95% CI: .81, 1.18]. This finding provides support for Hypothesis 1b.

A paired *t*-test also revealed that there was a significantly lower rate of incorrect match responses on mismatch trials that did not include wanted people ($M = .15$, $SD = .13$) than on mismatch trials that did include wanted people ($M = .23$, $SD = .19$), $t(342) = 5.31$, $p < .001$, $d = 0.44$ [95% CI: 0.27, 0.61]. This contradicts the support that was found for Hypothesis 2 in Experiment 1.

Prospective person memory

Participants were on the lookout for 10 wanted people, half of which were encountered during match trials and half during mismatch trials. On average, participants reported 3.39 correct and 3.50 incorrect sightings.

In line with our third hypothesis, a paired *t*-test showed that the sighting rate was significantly higher when participants made mismatch responses on the face matching task ($M =$

.11, *SD* = .10) than when they made match responses (*M* = .05, *SD* = .03), *t*(342) = 10.71 *p* < .001, *d* = 0.73 [95% CI: 0.58, 0.88].

Group-level hit and false alarm rates were used to compute aggregate *d'* and *c* scores. Table 4 shows discrimination between wanted and not-wanted people was higher on match trials (*d'* = 1.61) than on mismatch trials (*d'* = 0.90), *G* = 3.48, *p* < .001. This supports the hypothesis that discriminability would be higher on match trials than on mismatch trials (Hypothesis 4). There was no significant difference in sighting response bias between mismatch trials (*c* = 1.05) and match trials (*c* = 1.16), *G* = 1.05, *p* = .29.

Table 4

Prospective Person Memory in Experiment 2

		Hits		False Alarms		Overall		
Trial	Response	%	*N*	%	*N*	*N*	*d'*	*c*
Match	Match	41.8	1329	2.2	23097	24426	1.81	1.11
	Mismatch	16.8	386	5.3	1858	2244	0.65	1.29
	Overall	36.2	1715	2.5	24955	26670	1.61	1.16
Mismatch	Match	25.4	413	3.5	910	1323	1.15	1.24
	Mismatch	28.0	1302	7.3	5005	6307	0.87	1.02
	Overall	27.4	1715	6.7	5916	7631	0.90	1.05

Note. *N* = Number of trials. Hits = Correct wanted sightings. False Alarms = Incorrect wanted sightings.

Further examination of the data shows that discrimination between wanted and not-wanted people on mismatch trials was higher for match responses (*d'* = 1.15) than for mismatch responses (*d'* = 0.87). However, this finding was not significant, *G* = 1.44, *p* = .15. On match trials, discrimination between wanted and not-wanted people was significantly higher for match responses (*d'* = 1.81) than for mismatch responses (*d'* = 0.65), *G* = 5.35, *p* < .001.

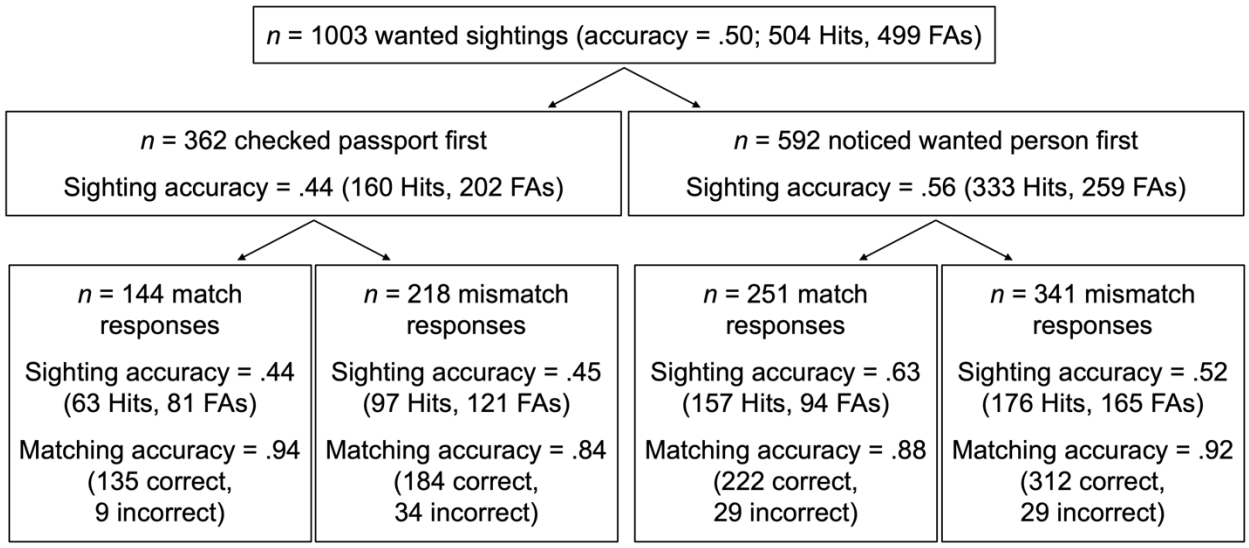
Exploratory analyses were conducted to examine participants' confidence in their wanted sightings. Altogether, the 343 participants in this study made 2100 wanted sightings. Out of the

2100 wanted sightings, 27.0% (568) were made with high confidence (90-100 confidence rating), 44.0% (925) were made with medium confidence (70-89 confidence rating), and 28.9% (607) were made with low confidence (50-69 confidence rating). Of the high confidence wanted sightings, 73.4% (417) were correct identifications of wanted people. In comparison, accuracy was 48.5% (449) for medium confidence sightings and 35.3% (214) for low confidence sightings. Like the findings from Experiment 1, a paired *t*-test revealed that participants were significantly more confident for correct sightings ($M = 81.93$, $SD = 14.02$) than for incorrect sightings ($M = 73.04$, $SD = 13.26$), $t(1009) = 14.73$ $p < .001$, $d = 0.66$ [95% *CI*: 0.57, 0.76].

Additional exploratory analyses were conducted to assess for associations with self-reports of when the wanted person was noticed. A subgroup of participants ($n = 168$) were asked whether the passport was checked before or after a total of 1003 wanted sightings (504 correct sightings; 499 incorrect sightings). Descriptive statistics for these participants are reported in Figure 1. For the majority of the wanted person sightings (59%), participants reported that they noticed the wanted person before they decided if the passport was match. By comparison, 36% of sightings were reported to have occurred after the passport decision. For the remaining 5% of sightings, participants did not remember which decision came first. Figure 1 shows that wanted sightings were more likely to be correct if the wanted person was noticed before the passport check (56%) than if they were noticed after the passport check (44%), χ^2 (1) = 21.48, $p < .001$, $OR = 1.62$ [95% *CI*: 1.25, 2.11].

Figure 1

Wanted person sightings after vs. before the passport check (Experiment 2)



Note. For forty-nine of the sightings, participants reported that they did not recall whether they noticed the wanted person before or after checking if the passport matched.

Discussion

The purpose of Experiment 2 was to test the robustness of the findings from Experiment 1. On the prospective person memory task, we replicated the finding that participants were more likely to say someone was wanted if they also believed that person was using a fraudulent passport. The finding that discriminability in the identification of wanted people was higher on match trials than on mismatch trials also replicated. However, contrary to Experiment 1, we did not find any support for improved face matching performance from prior exposure to faces.

Like Experiment 1, participants in Experiment 2 were more likely to make a wanted sighting when they also suspected a fraudulent passport. To explain this finding, we initially speculated that detecting a fraudulent passport served as reminder to look out for known wanted people. However, in the self-report measure we added in Experiment 2, participants more commonly reported that they noticed the wanted person before determining if the person matched their passport photo. If participants were able to accurately recall the temporal order of their decisions, this finding would suggest that suspecting someone of being wanted may have

cued participants to closely inspect for a fraudulent passport, rather than the reverse. In addition, participants were more accurate in their wanted sightings if they reported that they noticed the wanted person before rather than after the passport verification decision. One explanation for this finding is that if participants had a strong memory for the wanted person, they instantly recognized them as familiar before having time to evaluate the passport. This is line with previous research demonstrating that familiar faces are processed more automatically than unfamiliar faces (Yan et al., 2017).

In Experiment 1, prior exposure to wanted faces improved face matching performance; however, this finding did not replicate in Experiment 2. In a study by Clutterbuck and Johnston (2005), participants had better face matching performance when the task included familiar famous faces than when the task included faces that were recently learned through repeated, brief exposures. This suggests that extensive experience with faces and how they vary is necessary to improve face matching performance. Although participants were able to recognize and identify wanted people during the border control task, Experiment 2 provided no support for the prediction that this brief exposure to the wanted posters would be enough to improve face matching performance. Contrary to identifying wanted people, which requires memory, face matching can be completed without memory by perceptually comparing the images. Therefore, participants could have been basing their face matching decisions on the images in front of them, rather than incorporating what they learned from previous exposure to the wanted poster.

General Discussion

The two experiments reported in this manuscript used a novel experimental paradigm to investigate prospective person memory and face matching in a border control context. In both experiments, participants were more likely to make wanted sightings when they suspected a

fraudulent passport, suggesting that passport verification decisions and wanted sightings were not independent of each other. We also found that accuracy for the detection of wanted people was better for match trials than for mismatch trials. This finding indicates that wanted people who match the image on their passport are easier to detect than those who do not.

In both experiments, participants were more likely to report a wanted sighting when they also suspected that the passport was fraudulent. Identifying wanted people involves remembering a wanted person's face and remembering to contact the authorities when they encounter them (Lampinen & Moore, 2016). Previous research has shown that people are more likely to make a wanted sighting when they receive a reminder to monitor their environment (Moore, 2017). In addition to fraudulent passports being illegal, evidence suggests that wanted people use fraudulent passports to evade authorities when travelling (Interpol., 2014). Therefore, suspicion of a fraudulent passport could provide a crucial reminder to look out for and spot wanted people. To support this rationale, participants from both experiments who incorrectly judged a fraudulent passport to be genuine also tended to miss the opportunity to identify a wanted person. Therefore, if border control officers are better at detecting fraudulent passports, they may in turn be better at identifying wanted people trying to cross the border. This finding suggests that failure to detect fraudulent passports may result in the failure to detect wanted criminals or terrorists at the border, allowing them to travel and possibly carry out further crimes.

While it is logical to assume that suspicion of a fraudulent passport provides a crucial reminder to look out for wanted people, this logic is challenged by participant reports of which decision came first. For the majority of sightings (59.0%) participants reported that they noticed the wanted person before they made any decisions about the passport. It is important to note that this finding was based on self-reports from a subset of participants, and we were unable to

objectively confirm the actual order of the decisions. In cases where a wanted person is highly salient, border control officers may recognize them first and this recognition may cue them to closely inspect for a fraudulent passport. Conversely, in cases where a wanted person is not immediately recognized, border control officers may detect a fraudulent passport first, which in turn makes them suspicious that the traveler may be wanted.

Wanted sightings were also more likely to be correct when they were reported prior to passport decisions than when they were reported after. This finding suggests that the strength of memory for the wanted person affects how quickly they are recognized. A strong memory for the wanted person would increase the likelihood of immediately recognizing the traveler as wanted and the sighting being correct. This is in line with the multi-process model of prospective person memory. According to this model, spontaneous prospective person memory retrieval is more likely when the wanted person's appearance in the alert is similar to their appearance at a subsequent encounter (Lampinen et al., 2012). Therefore, if a traveler is a close match to the border control officer's memory for the wanted person, they may be more likely to be immediately recognized and correctly identified as wanted. Conversely, if the match is not that good, they would be less likely to be immediately recognized as a wanted person. Alternatively, the preparatory attentional mechanism model states that successful prospective person memory retrieval requires a focused attention (Smith, 2003). Therefore, one possibility is that participants who made sightings first maintained a focused attention on finding wanted people, which increased the likelihood of successful prospective person memory retrieval.

Exploratory analyses revealed that, in both experiments, participants were more confident for correct sightings of wanted people than for mistaken sightings of not-wanted people, suggesting that confidence is a good indicator of prospective person memory performance. This

finding is in line with previous research on metacognition and prospective memory, which suggests people have a basic awareness of their prospective memory abilities due to memory failures in their everyday lives (Meeks et al., 2007). Meeks and colleagues (2007) examined participants' ability to assess their performance on a previously completed prospective memory task and found that these assessments were strongly correlated with accuracy. In our study, participants were significantly more confident for correct sightings than incorrect sightings, providing evidence that metacognitive awareness also extends to prospective person memory. To date, this is the first study to show a confidence-accuracy relationship for prospective person memory.

In Experiment 2, face matching performance was worse on wanted trials than on not-wanted trials. Specifically, participants in Experiment 2 were more likely to misclassify genuine passports as fraudulent on wanted trials than on not-wanted trials. This finding suggests that recognizing someone as a wanted person might have made participants suspicious that the person is also using a fraudulent passport. Following this rationale, we would also expect participants to be better at detecting fraudulent passports on wanted trials than not-wanted trials. However, participants in Experiment 2 were less likely to detect fraudulent passports on wanted trials than not-wanted trials. Furthermore, the opposite results were found in Experiment 1.

In Experiment 1, we found that prior exposure to faces improved face matching performance. This is consistent with previous studies showing improved face matching performance with familiar faces (Bruce et al., 2001; Clutterbuck & Johnston, 2002; Megreya & Burton, 2006; Ritchie & Burton, 2017). Although the differences were small, participants in Experiment 1 performed better on the face matching task when the trials included wanted people, who had been studied previously, than when the trials included new, not-wanted people.

Previous research by Megreya and Burton (2006) has shown that even brief exposure to faces prior to a face matching task results in improved performance. However, participants in their experiment studied 30-second videos that showed each face from multiple different angles. In contrast, participants in our experiments studied a static image of each wanted person for 5-seconds. The failure to replicate the face matching findings in Experiment 2 calls into question whether such brief exposure to a single, invariable image is enough to familiarize participants with the potential variability of wanted faces and improve face matching performance.

In both experiments, discriminability in the identification of wanted people was higher overall on match trials than on mismatch trials. In previous research, increasing the number of images on a wanted or missing poster at encoding led to more sightings when a target appeared later in the experiment (Juncu et al., 2020; Sweeney & Lampinen, 2012). In the current study, participants viewed a single image of the wanted person during encoding, but if the passport was genuine (match trials) they had access to multiple images during testing. A person's face can vary daily (Ritchie & Burton, 2017). Therefore, how a person looks in a wanted poster could be considerably different to how they look in a passport photograph or in person. Although we did not manipulate variability, having multiple different photographs of an individual may have increased exposure to within-person variability and provided more examples of how someone can look. This could then increase the possibility that the wanted person looked similar to how they looked on their poster in at least one of the photographs, increasing the chances of prospective person memory retrieval. If replicated in future research, this finding could be supportive of a policy requiring passports to have multiple images attached. We did not compare photo IDs with a single photo attached to photo IDs with multiple photos attached, however, and future research would be necessary to support this policy change. Nonetheless, providing photo

IDs with multiple images attached has been shown to improve face matching performance (White et al., 2014b). Therefore, in addition to potentially improving the detection of wanted people, photo IDs with multiple images attached may also improve identity verification.

Limitations

Although these findings represent a promising first step in the study of prospective person memory and face matching, our study has limitations to consider. First, we administered the study online and it took less than half an hour to complete, making the temporal and spatial boundaries more constrained than they would be in real life. Previous studies show that under more realistic conditions, prospective person memory is much more difficult (e.g., Lampinen et al., 2009). Second, the passport images did not match the passport holder on 22% of trials, which could impact the generalizability of our findings. We opted for mismatches to appear relatively frequently to keep the participants motivated, but this is a much higher rate of fraudulent passports than what border control officers see in real life. Previous research on the low prevalence effect in face matching has shown that people are worse at detecting mismatches when they are infrequent (Papesh & Goldinger, 2018). Therefore, performance may be worse in real life. Likewise, a third limitation was that wanted people appeared on 10% of trials. Again, this is higher than what border control officers would see in real life. Furthermore, all wanted people appeared in the shift they preceded; therefore, by the final shift, participants' expectations of an encounter may have been higher than what expectations are for real life encounters. We opted for wanted people to appear more frequently than they would in real life to obtain sufficient data for analysis.

The low ecological validity of the experimental procedure poses additional limitations. Contrary to the devastating consequences of a miss or false alarm for real border control

decisions, there were no consequences in our study for making an error. Furthermore, participants were comparing two photographs for the matching task. In real life settings face matching typically involves the comparison of a passport photograph to a live person, which could be more difficult (Ritchie et al., 2020). The sample also consisted of undergraduate students, rather than border control professionals. Although previous research suggests that border control officers are no better than the general population at face matching tasks (White et al., 2014a; White et al., 2021), it is currently unknown whether border control officers are better at prospective person memory tasks than the general public and the findings from this study should not be generalized to the decisions made by border control officers. Lastly, we used a homogenous stimulus set composed only of White faces, which is not representative of the diversity encountered in real life and this may limit the generalizability of our findings.

Future Directions

More studies expanding on our findings are needed to gain a better understanding of the relationship between prospective person memory and face matching. We found that having two different photographs of a wanted person during testing, as opposed to one, increases the chances of a correct sighting. Future research should explore whether prospective person memory is further improved when the number of photo IDs provided by individuals is manipulated. Investigating the impact of the number of photo IDs provided could help to determine the optimal number of photo IDs for identifying wanted people when verifying ID documents.

In the current study participants viewed each wanted poster shortly before the appearance of the wanted people. In real life, it is unlikely that a wanted person would be encountered immediately after viewing their wanted poster. To improve the external validity of the experimental paradigm, different delays between viewing a wanted poster and encountering the

wanted person should be explored in future research. Another avenue for future research would be to investigate whether the communication of confidence between individuals working in pairs improves prospective person memory. Dowsett and Burton (2015) found that individuals working in pairs outperform those working alone on face matching tasks, which has been attributed to reliance on the more confident group member in their decision making (Bahrami et al., 2010). Exploratory analyses in this study revealed that confidence was related to accuracy in the identification of wanted people. Thus, the communication of confidence between two border control officers may also improve the accuracy of wanted person sightings.

Future research should also use more realistic conditions to address the limitations of this study. First, meaningful consequences should be incorporated into the study to make the task more conducive to a real-life border control situation. An example of a consequence could be a deduction from a monetary award every time a participant misses an opportunity to identify a wanted person or mistakenly identifies an innocent individual as wanted. Second, a replication of this study should be attempted using stimuli that is more ethnically diverse and representative of the population. Third, studies on professional border control officers should be conducted in an environment similar to a real border control setting (e.g., using live passport tenderers as opposed to images).

Conclusion

We studied face matching and prospective person memory together, using a novel experimental border control paradigm. By employing this paradigm with hundreds of participants, we found that border control decisions are influenced by the belief that wanted people use fraudulent passports when travelling, such that the detection of one may remind individuals to inspect for the other. Furthermore, when a traveler was wanted and their passport

did not match, participants were more likely to identify the wanted person if they also correctly detected the fraudulent passport. We also found the accuracy of a wanted person sighting is improved by increasing the number of images of the wanted person. The findings of this study will contribute to the development of better border control protocols by providing insight into the cognitive processes behind identifying wanted people and fraudulent passport holders.

Declarations

Ethics Approval

This study was approved by Simon Fraser University's Research Ethics Board (approval number: 30001634) and was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments.

Data Availability Statement

The data that support the findings of this study are openly available in [Open Science Framework] at https://doi.org/10.17605/OSF.IO/4N6C8.

References

Agresti, A. (2015). *Foundations of linear and generalized linear models.* Wiley.

Airlines and governments share responsibility to stop stolen passports being used to board planes. (2014). Retrieved 29 March 2021, from https://www.interpol.int/en/News-and-Events/News/2014/Airlines-and-governments-share-responsibility-to-stop-stolen-passports-being-used-to-board-planes

Armanto, T. (1997). Snake [Computer software]. Findland: Rumilus Design

Banas, J. (Producer). (2007). *City Homicide* [Television series]. Australia: Southern Star Group.

Banks, W. P. (1970). Signal detection theory and human memory. *Psychological Bulletin*, 74, 61–99. http://dx.doi.org/10.1037/h0029531

Beaumont, E. & Proffitt, D. (Producers). (2018). *Dead Lucky* [Television series]. Australia: Subtext Pictures

Bahrami, B., Olsen, K., Latham, P. E., Roepstorff, A., Rees, G., & Frith, C. D. (2010). Optimally Interacting Minds. *Science, 329,* 1081-1085. doi: 10.1126/science.1185718

Beckford, N. (2014). *What happens to lost and stolen passports?*. BBC News. Retrieved 2 November 2020, https://www.bbc.com/news/magazine-26783486

Brandimonte, M. A., Einstein, G. O., & McDaniel, M. A. (2016). Prospective memory: Theory and applications. Routledge.

Bruce, V., Henderson, Z., Greenwood, K., Hancock, P., Burton, A., & Miller, P. (1999). Verification of face identities from images captured on video. *Journal of Experimental Psychology: Applied*, 5(4), 339-360. https://doi.org/10.1037/1076-898x.5.4.339

Bruce, V., Henderson, Z., Newman, C., & Burton, A. M. (2001). Matching identities of familiar and unfamiliar faces caught on CCTV images. *Journal of Experimental Psychology: Applied, 7*(3), 207–218. https://doi.org/10.1037/1076-898X.7.3.207

Burton, A. M., White, D., & McNeill, A. (2010). The Glasgow face matching test. *Behavior Research Methods*, 42(1), 286-291.

Chapman, L. J. (1967). Illusory correlation in observational report. *Journal of Verbal Learning and Verbal Behavior*, *6*(1), 151–155. https://doi.org/10.1016/s0022-5371(67)80066-5

Criminal Alien Statistics Fiscal Year 2020. U.S. Customs and Border Protection. (2020). Retrieved 2 November 2020, from https://www.cbp.gov/newsroom/stats/cbp-enforcement-statistics/criminal-alien-statistics.

Davies, R., (Producer). (2006). *Torchwood* [Television series]. United Kingdom: BBC Wales.

D'Orazio, E. (2020). *Inside the FBI: Top Ten List Turns 70 | Federal Bureau of Investigation*. Federal Bureau of Investigation. Retrieved 2 November 2020, from https://www.fbi.gov/news/podcasts/inside-the-fbi-top-ten-list-turns-70-042920.

Dowsett, A., & Burton, A. (2014). Unfamiliar face matching: Pairs out-perform individuals and provide a route to training. *British Journal of Psychology*, 106(3), 433-445. https://doi.org/10.1111/bjop.12103

Einstein, G. O., McDaniel, M. A., Thomas, R., Mayfield, S., Shank, H., Morrisette, N., & Breneiser, J. (2005). Multiple processes in prospective memory retrieval: Factors determining monitoring versus spontaneous retrieval. *Journal of Experimental Psychology: General, 134*(3), 327–342. https://doi.org/10.1037/0096-3445.134.3.327

Fleck, M. S., & Mitroff, S. R. (2007). Rare targets are rarely missed in correctable search. *Psychological Science*, *18*(11), 943–947. https://doi.org/10.1111/j.1467-9280.2007.02006.x

Fitzgerald, R. J., & Price, H. L. (2015). Eyewitness identification across the life span: A meta-analysis of age differences. *Psychological Bulletin, 141*(6), 1228–1265. https://doi.org/10.1037/bul0000013

Frontline Database Access. (n.d.). Retrieved from https://www.interpol.int/en/How-we-work/Border-management/Frontline-database-access

Gallagher, B. (Producer). (2012). *The Paradise* [Television series]. United Kingdom: BBC Productions.

Givens, J. (2023). *CBP expands simplified arrival to five ports of entry in Washington State*. U.S. Customs and Border Protection. https://www.cbp.gov/newsroom/local-media-release/cbp-expands-simplified-arrival-four-ports-entry-washington-state

Glanzer, M., & Adams, J. K. (1985). The mirror effect in recognition memory. *Memory & Cognition*, *13*(1), 8–20. https://doi.org/10.3758/BF03198438

Gourevitch, V., & Galanter, E. (1967). A significance test for oneparameter isosensitivity functions. *Psychometrika, 32*, 25–33.http://dx.doi.org/10.1007/BF02289402

Haddrick, G. (Producer). (2014). *Janet King* [Television series]. Australia: Screentime.

Jenkins, R., White, D., Van Montfort, X., & Burton, A. M. (2011). Variability in photos of the same face. *Cognition, 121*(3), 313-323.

Juncu, S., Blank, H., Fitzgerald, R. J., & Hope, L. (2020). Do image variability and names in missing person appeals improve prospective person memory? *Journal of Applied*

Research in Memory and Cognition, 9(3), 410–418. https://doi.org/10.1016/j.jarmac.2020.07.001

Kemp, R., TowellL, N., & Pike, G. (1997). When Seeing should not be Believing: Photographs, Credit Cards and Fraud. *Applied Cognitive Psychology*, 11(3), 211-222. https://doi.org/10.1002/(sici)1099-0720(199706)11:3<211::aid-acp430>3.0.co;2-o

Knappman, S., & Wyld, K. (Producers). (2007). *East West 101* [Television series]. Australia: SBS One.

Lampinen, J. M., Arnal, J. D., & Hicks, J. L. (2009). Prospective person memory. In M. R. Kelley & M. R. Kelley (Eds.), *Applied memory*. (pp. 167–184). Nova Science Publishers.

Lampinen, J. M., Curry, C. R., & Erickson, W. B. (2016). Prospective person memory: The role of self-efficacy, personal interaction, and multiple images in recognition of wanted persons. *Journal of Police and Criminal Psychology*, 31(1), 59–70. https://doi.org/10.1007/s11896-015-9164-7

Lampinen, J. M., & Moore, K. N. (2016). Missing person alerts: Does repeated exposure decrease their effectiveness? *Journal of Experimental Criminology*, 12(4), 587–598. https://doi.org/10.1007/s11292-016-9263-1

Leder, M. (Director). (2014). *The Leftovers* [Television series]. New York, New York: White Rabbit Productions.

Macmillan, N. A., & Creelman, C. D. (1991). *Detection theory: A user's guide*. Cambridge, UK: Cambridge University Press.

McElroy, H. (Director). (1994). *Blue Heelers* [Television series]. Australia: Southern Star Group.

Megreya, A. M., & Burton, A. M. (2006). Unfamiliar faces are not faces: Evidence from a matching task. *Memory & Cognition*, *34*(4), 865-876.

Megreya, A. M., & Burton, A. M. (2008). Matching faces to photographs: Poor performance in eyewitness memory (without the memory). *Journal of Experimental Psychology: Applied, 14*(4), 364–372. https://doi.org/10.1037/a0013464

Megreya, A. M., White, D., & Burton, A. M. (2011). The other-race effect does not rely on memory: Evidence from a matching task. *Quarterly Journal of Experimental Psychology*, *64*(8), 1473-1483.

Meissner, C. A., Susa, K. J., & Ross, A. B. (2013). Can I see your passport please? Perceptual discrimination of own- and other-race faces. *Visual Cognition*, *21*(9–10), 1287–1305. https://doi.org/10.1080/13506285.2013.832451

Meurrens, S. (2013). The CBSA Databases – ICES, FOSS, CPIC, and NCIC – Steven Meurrens. Retrieved 7 April 2021, from https://meurrensonimmigration.com/the-cbsa-databases-ices-foss-cpic-and-ncic/

Mickes, L., Moreland, M. B., Clark, S. E., & Wixted, J. T.(2014). Missing the information need to perform ROC anal-ysis? Then compute d', not the diagnosticity ratio. *Journal of Applied Research in Memory and Cognition, 3*, 58–62. http://dx.doi.org/10.1016/j.jarmac.2014.04.007

Moore, K. N., Lampinen, J. M., & Provenzano, A. C. (2016). The role of temporal and spatial information cues in locating missing persons: Expectations and prospective person memory. *Applied Cognitive Psychology*, *30*(4), 514–525. https://doi.org/10.1002/acp.3242

Moore, K. N. (2017). *The role of attention and memory in prospective person memory* (Publication No. 10604925).[Doctoral Dissertation, University of Arkansas]. ProQuest Dissertations Publishing.

Papesh, M. H., Heisick, L. L., & Warner, K. A. (2018). The persistent low-prevalence effect in unfamiliar face-matching: The roles of feedback and criterion shifting. *Journal of Experimental Psychology: Applied*, *24*(3), 416–430. https://doi.org/10.1037/xap0000156

Ritchie, K. L., & Burton, A. M. (2017). Learning faces from variability. *Quarterly Journal of Experimental Psychology, 70*(5), 897-905. https://doi.org/10.1167/15.12.1199

Ritchie, K. L., Mireku, M. O., & Kramer, R. S. S. (2020). Face averages and multiple images in a live matching task. *British Journal of Psychology, 111*(1), 92–102. https://doi-org.proxy.lib.sfu.ca/10.1111/bjop.12388

Salmon, P., Stenders, K., & Sims, J. (Directors). (2016). *Doctor Doctor* [Television series]. Australia: Essential Media and Entertainment.

Sandford, A., & Ritchie, K. L. (2021). Unfamiliar face matching, within-person variability, and multiple-image arrays. *Visual Cognition, 29*(3), 143-157.

Smith, R. E. (2003) The cost of remembering to remember in event-based prospective memory: Investigating the capacity demands of delayed intention performance. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 29*, 347–361.

Stanislaw, H., & Todorov, N. (1999). Calculation of signal detection theory measures. *Behavior Research Methods, Instruments, & Computers*, 31(1), 137-149. https://doi.org/10.3758/bf03207704

Stephens, R. G., Semmler, C., & Sauer, J. D. (2017). The effect of the proportion of mismatching trials and task orientation on the confidence–accuracy relationship in unfamiliar face

matching. *Journal of Experimental Psychology: Applied*, *23*(3), 336–353. https://doi.org/10.1037/xap0000130

Susa, K. J., Michael, S. W., Dessenberger, S. J., & Meissner, C. A. (2019). Imposter identification in low prevalence environments. *Legal and Criminological Psychology*, *24*(1), 179–193. https://doi.org/10.1111/lcrp.12138

Sweeney, L. N., & Lampinen, J. M. (2012). The effect of presenting multiple images on prospective and retrospective person memory for missing children. *Journal of Applied Research in Memory and Cognition*, *1*(4), 235–241. https://doi-org.proxy.lib.sfu.ca/10.1016/j.jarmac.2012.08.001

Ten Most Wanted Fugitives | Federal Bureau of Investigation. (2021). Retrieved 10 April 2021, from https://www.fbi.gov/wanted/topten

Towler, A., Kemp, R. I., & White, D. (2021). Can Face Identification Ability Be Trained? In M. Bindemann (Eds.), *Forensic face matching: Research and practice*, (pp. 89-110). Oxford University press.

Valentine, T. (1991). A unified account of the effects of distinctiveness, inversion, and race in face recognition. *Quarterly Journal of Experimental Psychology, 43*(2), 161-204. https://doi.org/10.1080/14640749108400966

Valentine, T. (2001). Face-space models of face recognition. In: M.J. Wenger & J.T. Townsend (Eds.) *Computational, geometric, and process perspectives on facial cognition: Contexts and challenges* (pp. 83-113). Mahwah: LEA.

Wanted by the RCMP | Royal Canadian Mounted Police. (2020). Retrieved 10 April 2021, from https://www.rcmp-grc.gc.ca/en/wanted

White, D., Kemp, R. I., Jenkins, R., Matheson, M., & Burton, A. M. (2014). Passport officers' errors in face matching. *PLoS ONE*, *9*(8), e103510. https://doi.org/10.1371/journal.pone.0103510

White, D., Burton, A. M., Jenkins, R., & Kemp, R. I. (2014). Redesigning photo-ID to improve unfamiliar face matching performance. *Journal of Experimental Psychology: Applied*, *20*(2), 166–173. https://doi.org/10.1037/xap0000009

White, D., Towler, A., & Kemp, R.I. (2021). Understanding professional expertise in unfamiliar face matching. In M. Bindemann (Eds.), *Forensic face matching: Research and practice*, (pp. 62-88). Oxford University press.

Williams, H., & Williams, J. (Producers). (2014). *The Missing* [Television series]. United Kingdom: New Pictures.

Yan, X., Young, A. W., & Andrews, T. J. (2017). The automaticity of face perception is influenced by familiarity. *Attention, Perception, & Psychophysics*, 79(7), 2202–2211. https://doi.org/10.3758/s13414-017-1362-1

Zill, O. (2001). *Crossing Borders - How Terrorists Use Fake Passports, Visas & Other Identity Documents.* PBS. https://www.pbs.org/wgbh/pages/frontline/shows/trail/etc/fake.html.