Detecting Familiar Faces combining Rapid Series Visual Stimulation (RSVP) and Eye Movements

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Abstract

Traditional concealed information tests (CIT) demonstrate satisfactory performance when individuals are cooperative; however, their effectiveness can be compromised by the application of countermeasures. Techniques such as presenting critical stimuli in rapid serial visual presentation (RSVP) whilst measuring EEG or pupil dilation have been effective in countering these measures. In this study, we explored the potential of using another oculomotor measurements during RSVP, utilizing eye movement as a potential indicator. We tested 30 participants who were asked to search for a target face embedded within an RSVP task, while also presenting a familiar face, in this case one of their parents, and two control faces. Here, the familiar face constituted the 'concealed information.' On a group level, our results did not yield significant evidence of differential eye movement in response to familiar versus control faces, thus not supporting our hypothesis. Despite the participants recognizing their familiar face, no correlated eye movement was observed. This leads us to question the suitability of eye movement as a reliable measure within the CIT framework. Our findings suggest that contrary to our expectations, eye movements may not provide the robust physiological marker needed for the detection of familiar face recognition. On the other hand, our experimental setup might have been inadequate, specifically regarding presentation time and distances between stimuli and fixation points. Consequently, this underscores the need for further research in this area, potentially using AI generated faces to alleviate task difficulty and increasing the moving distances of the face stimuli.

Keywords: Concealed information detection; familiar face detection; RSVP; eye movements

Introduction

In the field of forensic psychology, a persistent challenge is the accurate detection of concealed information. Especially in situations where suspects may find it beneficial to conceal their knowledge about criminal cases. One key approach to this challenge was proposed by David Lykken (1959), who introduced the idea of a Concealed Information Test (CIT). The premise of CIT builds upon the inherent human tendency to exhibit distinctive psychophysiological reactions to various stimuli (Lykken, 1959). For instance, an increased heart rate or rapid breathing might be observed in response to stimuli that carry an emotional charge. Drawing from this observation, Lykken theorized that suspects confronted with stimuli associated with a criminal act they have committed (termed as "target stimulus") would demonstrate a stronger psychophysiological response in comparison to being exposed to neutral, irrelevant stimuli. For instance, if a stolen item was a red scarf, the suspect, upon seeing a series of neutral stimuli (such as a blue hat, a green shirt) intermixed with the target stimulus (the red scarf), would exhibit a heightened response to the red scarf, thus potentially revealing concealed information. The Concealed Information Test uses psychophysiological responses as an instrument for detecting concealed information. Continuous developments have improved the reliability and the accuracy of the CIT's (Ben-Shakhar & Elaad, 2003).

Psychophysiological differences observed in the Concealed Information Test are largely attributed to the underlying cognitive processes. Burton et al. (1999) described that repeated exposure to a specific stimulus, or an emotionally significant event, leads to accelerated recognition and enhanced memorability. This phenomenon, often referred to as "the familiarity effect", is crucial to understanding the heightened responses to certain stimuli that could detect deception (Ben-Shakhar, 2012; Bradley & Janisse, 1981; Peth et al., 2016). Concealed information test therefore employs electrodermal, cardiovascular, and pupillometry measurements to provide a robust method for detecting heightened physiological responses to specific stimuli. Detecting these familiarities has been consistently revealed as an accurate and reliable detector of deception (Ben-Shakhar, 2012), substantiating the claim that psychophysiological responses can be effectively utilized for CIT. Hence, it is the intricate relationship between familiarity and psychophysiological responses that grounds the efficacy of the Concealed Information Test in forensic settings.

On the other hand, a pivotal concern for Concealed Information Testing (CIT) is the concept of countermeasures. These refer to strategies employed by individuals aimed at actively modifying their responses to stimuli, thus making the detection of concealed information more challenging. Countermeasures have proven to be quite effective, particularly when they involve amplifying responses to all neutral stimuli (Ben-Shakhar, 2012; Peth et al., 2016). An illuminating example comes from Rosenfeld et al. (2004), where participants were instructed to strengthen their responses to neutral, irrelevant stimuli. This tactical response shift precipitated a steep decline in the accuracy of the CIT, decreasing significantly from 82% to just 18% for the detection of deception using EEG and fMRI. For instance, a participant might intentionally heighten their physiological responses to neutral stimuli, like deliberately focusing on a blue hat in the earlier example, to diminish the relative response to the actual target stimulus, the red scarf. Countermeasures have also been found to be highly effective across other measures used in CIT, such as skin conductance and cardiovascular responses. These findings reveal the susceptibility of Concealed information to countermeasures. Methodologies that can robustly counteract these strategies are necessary to maintain Cit’s efficacy in deception detection.

The technique of Rapid Series Visual Presentation (RSVP) has been introduced to counter these countermeasures. This technique involves a rapid sequence of visual stimuli presented at a high rate, displaying multiple stimuli within a second. The hypothesis behind RSVP is that by decreasing the presentation time of stimuli, it becomes more difficult for an individual to employ countermeasures effectively (Bowman et al., 2013; Broadbent & Broadbent, 1987). Under these conditions, continuous psychophysiological responses can be measured, and differences between neutral and targeted stimuli become more discernible. Bowman et al. (2013) demonstrated that rapid series visual stimulation is successful in countering countermeasures. RSVP's effectiveness in detecting concealed information has been linked to the P300 method, which identifies a voltage spike in the EEG, signifying recognition of a salient stimulus. Since the introduction of RSVP, several measures, including EEG, fMRI, skin conductance, and pupillometry, have been incorporated into the methodology. These integrated approaches have all shown promising results in enhancing deception detection.

Progress in the study of face familiarity offers another instrumentalization of targeted stimuli in Concealed Information Testing. The P300 method has been instrumental in identifying activity in the temporal lobe that corresponds to the recognition of familiar or famous faces (Alsufyani et al., 2019). These insights were employed in concealed information testing, where EEG measurements were used to detect concealed information (Alsufyani et al., 2019). Other psychophysiological measures including skin conductance, pupillometry, and cardiovascular metrics have been successfully employed to recognize familiar faces before (Bowman et al., 2013; Nahari et al., 2019). Extending this understanding, Bainbridge et al. (2013) emphasized the particular significance of these measures for faces, which seemingly carry high valence and are easily committed to memory, even with minimal exposure. Therefore, given the strong linkage between face familiarity and observable psychophysiological responses, this domain provides an optimally suited avenue for advancing concealed information testing methodologies.

Nevertheless, certain considerations must be accounted for when choosing the appropriate measures. While EEG provides comprehensive information, it is associated with high cost, time intensity, and the necessity for specialized equipment and personnel. Thus, for more efficient and practical application of CIT in the forensic setting, pupillometry emerges as a particularly attractive option. This psychophysiological measure is less resource-intensive, while still promising effective deception detection, especially when integrated with RSVP.

The ease of use, cost-efficiency, and time-effectiveness of oculomotor measures, such as pupillometry, make them particularly suitable for application within the Concealed Information Testing (CIT) setting. Chen et al. (2023) demonstrated their effectiveness in a study involving various pupillometry measures in a familiar face CIT framework. In their study, the participants were seated in front of a screen while their oculomotor responses were recorded. Initially, they focused on a fixation point in the middle of the screen. After a period of 1000ms, a stream of face images was presented in style of a Rapid Series Visual Presentation (RSVP), presentation times working on the fringe of awareness for each image. The participants were exposed to either a target, familiar, or control face and the task was to identify the target face within the stream of distractor faces. They knew that sometimes no target face might appear (which was defined as a control face). However, the participants were not told that in some RSVP streams they will be exposed to the familiar face and no target face. The complete experiment involved several blocks, each containing multiple RSVP streams. For analysis, pupillometry measures were compared between the familiar face and the control face. The concept of familiarity led to the hypothesis that pupillometry measures could distinguish between a familiar and a control face. The results of the study indicated that pupil dilation serves as a robust detector of familiarity in this context. However, the most effective detection was achieved when multiple oculomotor measures were combined. Other studies utilized pupillometry measures in different CIT settings. For instance, eye movements and fixation times were shown to be effective detectors of object recognition (Bainbridge et al., 2013; Nahari et al., 2019). In these experiments participants were exposed to multiple images at the same time, of which one was a representation of a familiar object. Visit times, the number of times a participant switched their gaze from one image to another, were combined with pupil fixations, the specific locations on the image that is observed, to compare the stimuli familiarity. These measurements were effective in distinguishing between familiar and random visual presentations (Nahari et al., 2019). However, these studies did not incorporate the RSVP method.

Based on the previously stated research results, the unexplored CIT setting involving face images, rapid series visual presentation stream, and eye movements as the physiological measure to detect familiarity emerges. Exposure to a familiar face in a stream of otherwise neutral face stimuli would be hypothesized to elicit a different physiological response. In this instance, eye movements can be compared between familiar and neutral faces, where familiar faces should drag eye fixations on them, whereas this response should not be observed for neutral faces. Hence, eye movements would be observed in the direction of moving familiar faces and not in the direction of moving neutral faces. If this response difference is present, this would provide evidence for the efficacy of this specific concealed information detection setting.

Method

Participants

Initially, the study involved 33 participants. Three participants have been excluded due to insufficient concentration (fell asleep) or technical problems throughout the experiment. The remaining 30 participants (21 females, 9 males) were first-year psychology students at the University of Groningen, in the Netherlands. They were between the ages of 18 and 24, with a mean age of 20.23. The recruitment of participants took place through the

SONA participant pool used by the Psychology Department of the University of Groningen. All participants signed up voluntarily and written consent was obtained before the experiment began, from both the participants and their parents. Participation was compensated through the assignment of SONA credits, which the participants needed to fulfil their study program's requirements. All participants indicated having no vision problems, though vision abilities were not assessed. They were asked to not wear mascara or any other eye makeups and have a good sleep the night before.

Apparatus and Stimuli

The study was conducted in the eye track laboratory of the Heymans Institute. The lab is dimly lit, sound-attenuated and has no windows, not allowing for any external distractions. The participants were sitting about 60cm away from the monitor with the head held steady on a chin and forehead rest. This stable position was adjusted to each participant's liking, ensuring no discomfort throughout the experiment. The study interface was displayed on a 27inch LCD Iiyama PL2773H monitor, with resolution set to 1920x1080 pixels and a 60 Hz refresh rate. The 9-point calibration procedure from the EyeLink system was used to calibrate each participant's eye position.

The face stimuli used in this study were sourced from the 10K Faces Dataset (Bainbridge et al., 2013), and Chicago face database (Ma et al., 2015). In the 10K Faces Dataset, to select the stimuli, we utilized the "Face Database Surfer" tool provided in the dataset, allowing us to apply specific criteria to choose 2,222 faces out of the total 10,000. From this selection, we further narrowed down the choices to non-celebrity faces that were looking directly at the camera, with a smiley or neutral facial expression. No other demographic factors were considered for exclusion. In the Chicago face database, we selected faces with only slight smiley or neutral expression. To standardize the chosen faces, each face was cropped using an elliptic shape of equal size (height = 100 pixels, width = 70 pixels), converted to grayscale, and adjusted to a mean intensity of 128, which corresponds to the midpoint of the grayscale range (0-255). Following standardization, we visually inspected the images and removed any faces that displayed noticeable artifacts, such as visible frames around the ellipse, head tilts, or closed eyes. The resulting set of faces was then divided into six final subsets based on age and gender: 1. Distractors Male (Age: 20 – 60 years), 2. Distractors Female (Age: 20 – 60 years), 3. Target Faces Young Male (Age: 30 years or less), 4. Target Faces Young Female (Age: 30 years or less), 5. Target Faces Old Male (Age: 45 years or more), 6. Target Faces Old Female (Age: 45 years or more). Each subset consisted of distinct face stimuli. For the familiar face condition, participants were asked to provide a photograph of either their mother's or father's face. To ensure uniform resolution across all stimuli, the parental face pictures were down sampled to 200 x 256 pixels, matching the resolution of the images from the 10K Faces Dataset and Chicago face database. Apart from the initial down-sampling, the familiar face underwent the same standardization process as the other face stimuli.

Trials and data collection were managed with Open Sesame (Mathôt et al., 2012) on the Windows 10 operating system. The Face Stimuli were displayed in a rapid serial visual presentation (RSVP) format against a light grey background (RGB 64, 64, 64; 207 cd/m2). All faces were centrally presented on the screen. During the trials, a fixation dot was consistently displayed in the same color (RGB 190, 190, 190) and font (18 pt) and the response dot was displayed in green (0, 190, 0) for a positive and in red (190, 0, 0) for a negative response, both in font (36 pt).

Procedure

During the experimental procedure, participants were exposed to a series of trial events in a rapid serial visual presentation (RSVP) format. The four different subsets of faces, familiar face, target faces, control faces and distractor faces varied according to gender. In total, there were 420 male and 418 female faces. Distractor faces were randomly selected from this pool and the two control faces were randomly selected from the remaining pool. There were 52 old, and 52 young target faces of each gender. If the familiar face, was the participants mother, the face stimuli used in the complete study were female, apart from the target face which was male. If the familiar face was the participants father, the face stimuli used in the complete study were male, apart from the target face which was female. This pattern led to the task of detecting faces that are of the opposite biological gender than the provided familiar face.

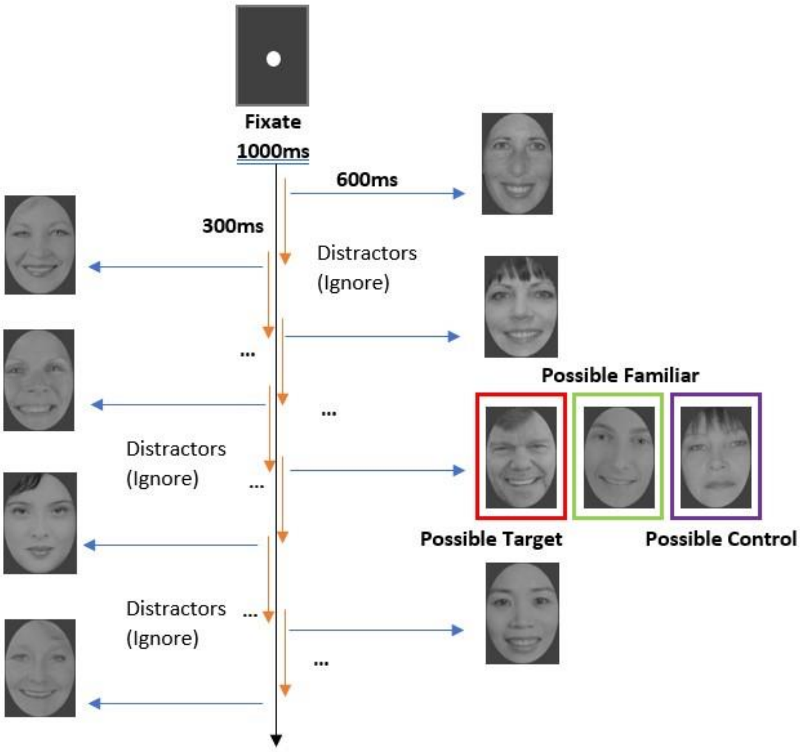
The study of practice trials (n=24) and experimental trials (n=192). The practice trials were supposed to accommodate the participants to the nature of the experiment and ensure their ability to complete the study sufficiently. Data was collected during the experimental trials.

Practice Trials

To prepare the participant for the data collection phase, 22 practice trials were administered. First, a trial commenced with a fixation dot displayed for 1000ms, serving as a preparatory period without any accompanying pictures. Subsequently, the face stimuli appeared behind the fixation point and moved 150 pixels horizontally, subsequently to the left or to the right. The movement speed of 0.25pixels per millisecond. Each face stimulus was presented for a duration of 600ms before fading, however, the following face appeared behind the fixation point after 300ms, moving into the opposite direction. The RSVP stream ended with another presentation of the fixation dot for another 2000ms. The participants were asked to focus on the fixation point until they see the target face.

Figure 1

Visual Representation of the Experimental Procedure



Note. The figure portrays a possible experimental procedure given the familiar face is female. After the fixation point has been presented, the RSVP streams start with face images appearing behind the fixation point. Between the 5th and the 8th position one of the critical faces appears, the target face indicated by red, the familiar face by the green and one of the two control faces by the purple quadrant.

The RSVP stream consisted of a total of 13 stimuli, encompassing one critical face and 12 irrelevant distractor faces. During the practice trials, the critical face was either a target face (n=8) or a control face (n=8) or another control face (n=8), randomized between RSVP streams. This allowed participants to become familiar with identifying the target face among the distractors. The primary task assigned to the participants was to follow the target face within the RSVP stream until it disappears. The response to the target face was recorded by monitoring participants' eye movements during its presentation. A green or red dot positioned on top of the fixation point provided immediate feedback, indicating whether the response was correct or incorrect, respectively. To proceed to the experimental stage, participants were required to maintain a minimum correct response rate of 70%, otherwise they had to repeat the practice trials. This criterion ensured that participants demonstrated a satisfactory level of accuracy in identifying the target face before progressing to the subsequent experimental trials.

Experimental Trials

The experimental trials had minor adaptations in comparison to the practice trials. They were divided into 12 blocks, containing 16 RSVP streams each. The critical faces were either the familiar face (n=48), the target faces (n=48), control face 1 (n=48) or control face 2 (n=48). The frequency of the familiar and control face was 48, whereas the frequency of the target faces was 1. Again, the responses were recorded by measuring the eye movement in accordance with the presentation of a critical face. However, there was no immediate feedback incorporated in these trials. Instead, after the participants completed a third of the study, they were shown their accuracy in the completed third. Also, participants were allowed to take breaks between two blocks.

Questionnaire

The last part of the study consisted of a small questionnaire, in which the participants indicated face recognition. They were asked how many times they have seen different a particular face, either 0, 12, 24, 36 or 48 times, throughout the complete experiment. They were asked about the target face, the familiar face, one control face, 3 random distractor faces and 3 unused faces. This part of the experiment was used to ensure recognition of the familiar face. If a participant would indicate to not have seen the familiar face, the data of this participant would not have been used in the following analysis.

Analysis

Data Processing

An EyeLink eye tracker from SR Research was used to monitor and generate the corresponding eye movement data during the experiment, which encompassed a total of 5741trials. The data was pre-processed with the library ‘eyelinkparser’, which allowed for further analysis of the generated data. To streamline the data, down-sampling was used, computing an average fixation point every 10ms, effectively reducing the total number of eye fixations. The analyzed eye movements were then locked to the presentation onset of the critical faces. Given the random appearance of these critical faces between the 5th and 8th position throughout the RSVP, realignment was necessary to create overlapping exposure to critical faces. Consequently, the data were divided into eight subsets, the determining factors being the category of the critical face (target, familiar, control 1, and control 2), and the direction of the image's movement (to the left or right). The eye movement in these eight conditions was averaged across participants and related to the time throughout each RSVP.

For further analysis, the eye movement under each of the eight conditions has been additionally coded as a dummy variable. A criterion of a distance of at least 50 pixels between the fixation point and eye fixations defined general eye movement. Using this definition, eye movement in the same direction as the moving critical face was assigned a value: -1 for leftward movement and +1 for rightward movement. This data processing procedure laid the groundwork for the subsequent analysis.

Results

During the experiment, participants demonstrated an ability to correctly identify the target face with an average accuracy of 79%, a rate significantly higher than what would be expected by chance alone, which stands at 33.3%. This substantial accuracy rate suggests that participants were actively engaging with the task, successfully identifying the target face approximately 4 out of every 5 attempts.

Supporting evidence for the efficacy of the experimental setup can be found in the responses given by participants in the post-experiment questionnaire. Participants reported recognizing the familiar face with a frequency closely approximating the actual frequency with which the familiar face was presented during the experiment. However, this trend did not extend to the other critical faces.

Table1

Average of the reported frequency of face images

Conditions	Target	Familiar	Control 1	Control 2	Distractor	Unused
Actual Frequency	1	48	48	48	6	0
Reported Frequency	11.8	35.2	19.6	17.6	17.4	11.2

Note. The table depicts the average of the reported frequencies the participants indicated at the end of the experiment. The questionnaire allowed participants to select the either of the values 0, 12, 24, 36, and 48. It shows that the participants did recognize the familiar face and reported to have been exposed to it 35.2 times throughout the experiment on average.

The data represented in Table 1 validates that the experimental design was effective at eliciting recognition of familiar faces, even within an RSVP context featuring moving stimuli. On average, participants reported recognizing the familiar face (35.2 occurrences) nearly twice as often as the control faces (control 1 = 19.6 occurrences, control 2 = 17.6 occurrences), even though the exposure frequency to familiar and control faces was equal, at 48 instances each. Interestingly, the frequency of reported recognition for distractor faces (17.4 occurrences) was nearly identical to that of the control faces, suggesting no perceived difference in exposure frequency between control and distractor faces. This data supports the notion that recognition of familiar faces was indeed occurring during the experiment.

To investigate the potential detection of face familiarity, eye movement data has been analyzed in relation to exposure of the different critical faces. The complete collection of trials was subdivided into eight distinct conditions, based on the category of the critical face and the direction in which it moved. For each of these conditions, a graph was constructed, depicting the temporal progression of eye fixations throughout the RSVP trial. In these graphical representations, the x-axis denotes time, while the y-axis corresponds to the horizontal pixel position of the average eye fixation, beginning from pixel 0 and the middle point of the screen indicated by pixel 960, where the fixation point was displayed. The moment of exposure to the critical face is denoted by a vertical, dotted black line.

Our initial hypothesis proposed that eye movements would exhibit a propensity to follow the direction of movement of both the target and familiar faces. Should this be the case, it would suggest that involuntary eye movements could serve as a reliable means of identifying familiar face recognition. To validate this hypothesis, we would expect to observe a notable shift in the average eye position towards the direction of the critical face movement shortly after its presentation. This shift in eye movement is compared to the initial fixation point, located at the center of the screen. For instance, if the familiar face moves towards the left, we would anticipate the average eye fixation to also trend leftwards, a shift which would be graphically represented as a downward movement, a lower count of horizontal pixels. Conversely, if the familiar face was moving towards the right, we would expect an upward shift in the graph, signifying an increase in horizontal pixels. The accompanying visual representations display the group-level analysis of eye movement.

Figure 2

Eye Fixation Points for the Eight Conditions

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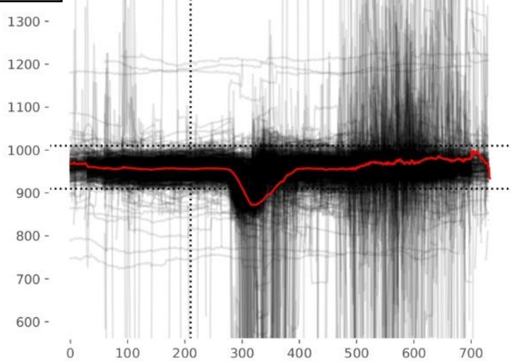
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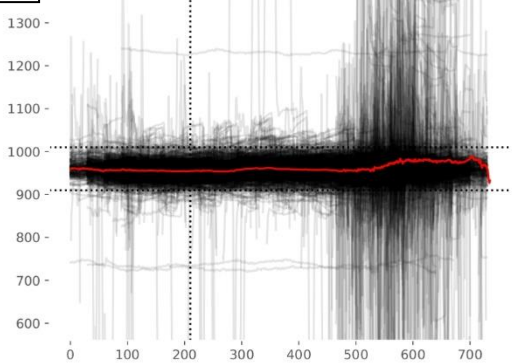
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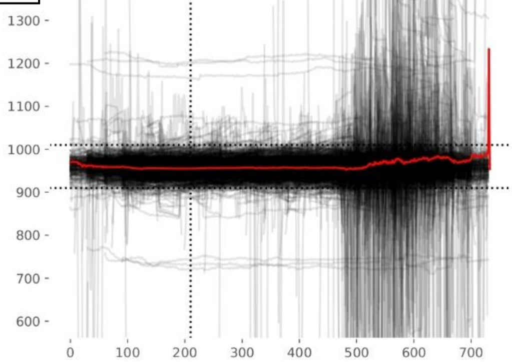
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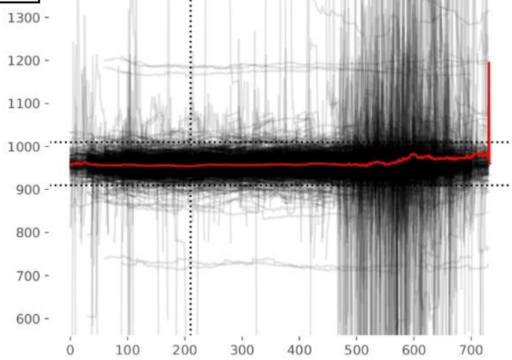
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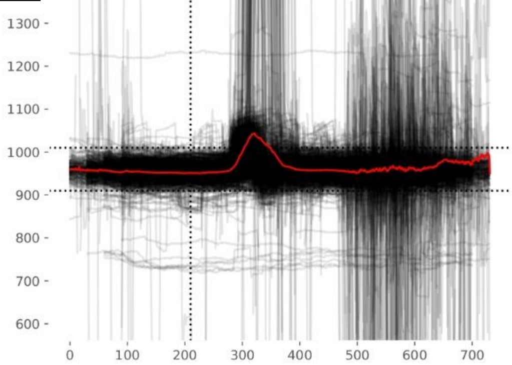
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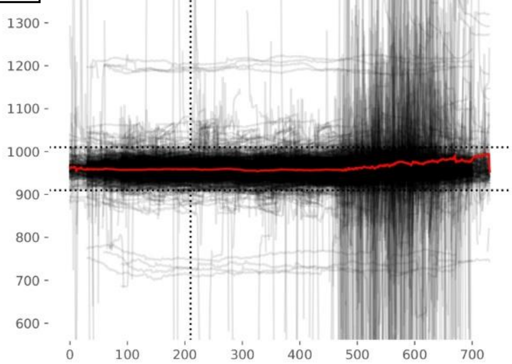
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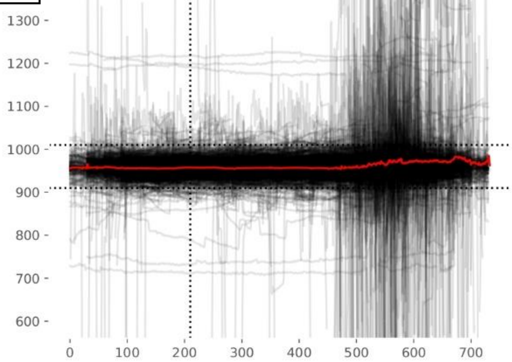
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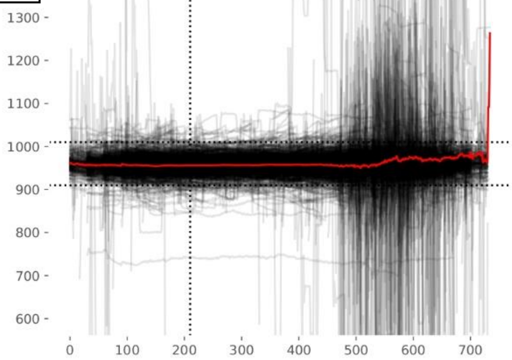
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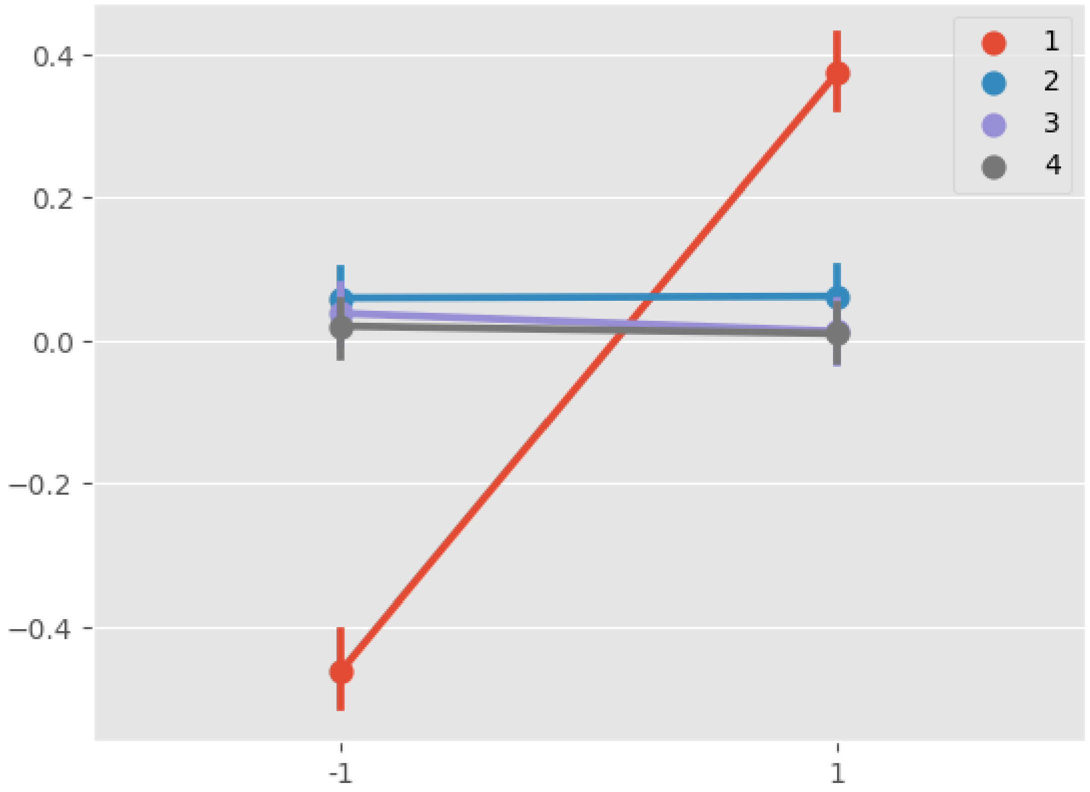
Note. The figures portray the average positions of the eye fixations across participants. The coding of the picture indicates the condition of the trial, the first number the condition of the critical face: 1 target face, 2 familiar face, 3 control face 1 and 4 control face 2; and the second number the condition of the movement direction of the critical face: -1 to the left and 1 to the right. The x-axis represents the time after the start of the RSVP in 10ms and the y-axis represents the position on the screen in pixels. The black lines represent individual eye fixations, the red line is the mean eye fixation, and the dotted vertical line depicts the moment of the critical face presentation. The significant part of the figures are the mean eye fixations (red lines) shortly after the exposure to the critical face (vertical dotted line). In Figure 2.1 and 2.5 the eye fixations show a clear shift in the direction of the target face movement. The trials with familiar faces shown in Figures 2.2 and 2.6 do not depict a shift in eye movements towards their moving direction, which is also portrayed in Figures 2.3, 2.7, 2.4 and 2.8, in which the trials for both control faces are presented.

The visual representations presented above do not support the hypothesis. While the exposure to the critical faces did indeed induce changes in eye fixations when the target faces were in motion, these alterations were not observed for other critical faces. Analyzing the data at the group-level, we found that exposure to familiar faces did not precipitate any discernible changes in eye fixations shortly thereafter. More significantly, the pattern of eye fixations in response to the familiar face mirrored those of the two control groups, rendering the familiar face indistinguishable from the control groups based solely on eye movements. Thus, within the context of this experiment, eye movements of participants were unable to provide a reliable means of identifying familiar face recognition.

The general eye movements for each trial have been coded with the help of a dummy variable. General eye movements towards the left are indicated by a -1, whereas general eye movements towards the right are indicated by a +1. These values have been added and divided by the total amount of trials for each of the eight conditions. Resulting number close to either -1 or 1 would indicate the presence of general eye movements towards the direction of the moving critical face. The figure below displays the results.

Figure 10

General eye movements when exposed to critical faces



Note. The general eye movements are plotted for each of the eight conditions. The dummy variable for the eye movements can take either the value of -1 or +1 and is represented on the x-axis. The general eye movements for each condition have been added and divided by the total amount of trials for each condition, the resulting numbers can take values between -1 and 1, represented by the y-axis. Hence, the x-axis displays the direction of the critical face and the y-axis the corresponding average eye movements of the participants. It shows that general eye movements towards the moving direction of the target face are present, whereas none are detected for the other three critical face categories.

Figure 10 shows the presence of general eye movements in the direction of the moving target faces but does not indicate any general eye movements towards the familiar face. Further, the general eye movements when exposed to the control faces resemble the general eye movements when exposed to the familiar face. The graph provides further evidence against the initial hypothesis, suggesting that eye movements do not allow for detection of familiar face recognition.

While the questionnaire results highlighted a noticeable degree of familiar face recognition, no similar findings emerged from the eye movement analyses. This presents a marked discrepancy between reported recognition of familiar faces and the absence of distinctive eye movements in their direction. Consequently, the data collected from this experiment do not lend support to our initial hypothesis that eye movements could serve as a reliable indicator of familiar face recognition. This unforeseen result underscores the complex interplay of factors involved in facial recognition and points to the need for further scrutiny of the methodology and variables that might have influenced our findings. Thus, while this study contributes valuable insights to the ongoing research in this field, the question of whether eye movements can be effectively used to detect face familiarity remains open for further exploration.

Discussion

Investigating the association between eye movements and familiar face detection, we were unable to discern a marked reaction to the presentation of a familiar face. The eye movement responses elicited by the exposure to the familiar face closely mirrored those generated by the control faces, revealing a substantial overlap in eye movement patterns for both familiar and control face stimuli. In contrast, when it came to the target face, a starkly distinct pattern of eye movements emerged. The eye movements in this instance showed a significant bias towards the direction of the target face. This distinction indicates that the eye's voluntary movement mechanism was engaged during the presentation of the target face, whereas the involuntary movements were not present during exposure to the familiar face. Combining the involuntary eye movement detection methods by Rosenzweig and Bonnet

(2019) and the familiar face recognition RSVP by Chen et al. (2023) did not elicit the hypothesized effect. The anticipation that eye movements could serve as a reliable tool for the detection of familiar faces was not realized in our study.

The complexity inherent to object recognition can affect one's ability to identify certain structures, face recognition being the most complex of all. This complexity of facial recognition draws on specific areas of the occipital cortex, and even minor damages to the occipital V4 areas can lead to prosopagnosia, or the inability to recognize faces (Bisley, 2011; Sorger et al., 2007). Consequently, an RSVP setup involving facial recognition for detecting familiarity might be so challenging as to produce no observable effect, particularly when operating at a subliminal level where general recognition is a fundamental prerequisite. The combination of rapid, fleeting exposure and image movement further exacerbates this difficulty (Vera et al., 2022). Another factor that could have influenced this inability is the quality of the standardized familiar faces. Poor quality impedes possible recognition in general. Further, if an experiment is deemed excessively difficult, participants may adapt their recognition patterns to complete the study. For instance, participants may rely on overt gender markers, such as the presence of a beard, to distinguish between male and female faces, thereby neglecting more nuanced facial characteristics. Such shifts in recognition strategy could have contributed to our observed results and the apparent inability to detect familiar face recognition (Broadbent & Broadbent, 1987; Nahari et al., 2019). In essence, the task assigned to participants might have been overly challenging and might have led to the detection of explicit gender markers.

Another explanation for the inability to detect familiar face recognition is that the methodology was inadequate in revealing in effect. Familiar face detection could occur without the necessity of eliciting significant eye movement. Thus, it may well be that our experimental setup did not provoke the eye movement required for familiar face detection, resulting in an absence of the anticipated effect.

The complexity of integrating eye movement and familiarity within experimental setups necessitates adequate calibrations to elicit tangible measurements. Crucial parameters such as stimuli presentation time, spatial distances between stimuli, image quality, and participant engagement significantly influence the study outcomes. Presentation time directly influences recognition capacity, while spatial distances can determine eye movement velocity and extent (Vera et al., 2022). Moreover, image quality significantly impacts face detection, and the level of participant involvement is essential for the generation of reliable data. Each element considerably weighs upon the study's results, thereby emphasizing the intricacy of this investigation, especially when the results diverge from initial expectations.

The role of presentation time in P300 and RSVP studies, particularly in relation to the "fringe of awareness", is a fundamental consideration. Typically, these methodologies present faces for durations ranging from 100ms to 250ms. However, this range is not absolute and depends on specific study designs. For instance, Chen et al. (2023) used presentation times of 110ms or 130ms in their study involving familiar faces. These short durations, however, were found to be too rapid for participants to successfully complete experimental trials. Consequently, the duration was increased to 600ms in the present study, where a new face appeared every 300ms. This adjustment, however, may have inadvertently created a different problem. The longer presentation time may have allowed more conscious processing and less reflexive responses from the participants. Participants may have deduced they had ample time to contemplate their eye movements (Peth et al., 2016), focusing exclusively on the target face. Such conscious control over responses could have considerably influenced the study's results.

The presentation of stimuli is also significantly influenced by factors such as the distances between stimuli and their movement speed. The importance of distances lies in their relevance to visual acuity and consequent recognition of faces during RSVP. When presented with a familiar face, a participant's gaze will only deviate if the face cannot be perceived while focusing on the fixation point. However, if the familiar face remains within the field of visual acuity while the participant is fixated on the center of the screen, eye movements are not essential. The distance between the fixation point and the point of stimulus fade-out in this study may have been too short to prompt a noticeable effect. Considering the 2-degree angle of visual acuity and the participant-screen distance of 50cm, the resultant visual acuity field might be estimated at 70 pixels. Moreover, stimulus speed has a notable impact on object recognition capabilities, with a negative correlation demonstrated between speed and recognition ability (Vera et al., 2022). While the moving nature of target stimuli can indeed make detection and recognition more challenging, the chosen distance and movement speed in this study might have permitted the recognition of familiar faces without necessitating eye movement.

The three methodological factors previously discussed, stimuli presentation time, stimuli distance, and stimuli movement speed, shaped the outcomes of this study. The interplay between these factors suggests that familiar face detection might have been achievable without the necessity of eye movement. The extended presentation time, small distances between the fixation point and the stimulus fade-out point, coupled with a low stimuli movement speed, could have allowed for the detection of familiar faces with minimal eye movement. This situation could explain the lack of significant eye movement observed in response to familiar face exposure. The reported frequencies in Table 1 provide evidence for this reasoning, since they suggest that participants generally recognized the familiar face throughout the experiment most of the time.

Finally, the results could have emerged because eye movements may not serve as an effective measure for detecting familiar face recognition within the construct of our experimental setup. The design of our study may not have adequately fostered an environment conducive to capturing the nuanced involuntary physiological responses required for the Concealed Information Test (CIT). The hypothesis was predicated on the assumption that these involuntary responses could be accurately and reliably detected and measured through eye movements, an assumption that is not supported by the results. Therefore, it might be better to use other oculomotor measures, for instance, pupil dilation, as utilized in the study by Chen et al. (2023) to detect familiar face recognition. They seem to offer a more sensitive and responsive measure for this purpose.

Future Research

Future research should explore utilizing artificial intelligence (AI) generated faces to ease experimental difficulty. Additionally, modifying stimuli presentation parameters, increasing the movement distances of the face stimuli, and reducing their presentation time, may elicit the hypothesized eye movements following the exposure to the familiar face. However, if these alterations do not yield the expected results, it would suggest that eye movements might not serve as a reliable physiological measure for detecting familiar face recognition in rapid serial visual presentation tasks. Such investigations not only augment our understanding of face recognition processes, but also advance methodologies used in deception detection.

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