Measuring Pupil Dilation in a Concealed Information Test Using Rapid Serial Visual Presentation

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Abstract

Rapid serial visual presentation (RSVP) has been proven to be an effective measurement device in concealed information testing (CIT). RSVP presents stimuli at the fringe of awareness, leading to a low susceptibility to countermeasures. Previous studies successfully measured concealed information based on brain potentials through electroencephalography (EEG). However, the use of pupillometry as measurement during RSVP was proposed due to its cost-effectiveness and easier application into practice. Generally, pupils dilate when being presented with a salient stimulus. This is why we propose pupillary responses to be uninhibited reactions in an RSVP setting and that pupillometry is an effective measurement in detecting concealed identity information. 36 participants were instructed to take on a fake name or keep their real name and search for it in RSVP streams of names. Pupil size was recorded during those streams. We found that pupils were more dilated when participants were presented with their real or fake names compared to control names, yet, the evidence was not significant in the beforehand chosen time window. In the exploratory analysis, however, significant evidence was found in a reduced time window leading to a positive effect for pupillometry use in CIT. Further investigation and development in that field is needed to create a reliable detector of concealed information.

Keywords: CIT, concealed information test, concealed identity information, pupillometry, RSVP, rapid serial visual presentation

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Crime is a reoccurring societal problem. To reassure safety, reparation and fairness for all members of a society, a lot of energy is put into the detection of criminals. Criminals most often do not intend to be caught, presumably engage in lying, or try to disguise their identity. Others purposefully give wrong information in order to mislead investigation. Concealed information is a memory or knowledge one hides in mind, sometimes containing crucial details for crime-solving. This is why the improvement of interrogation techniques and concealed information testing is an ongoing process in forensic science (Lykken, 1959; Kleiner, 2002; Ben-Shakhar, 2011; Bowman et al., 2013). There are multiple tests to facilitate the detection of concealed crime-related information. The concealed information test (CIT), for example, aims to detect hidden information through involuntary physiological reactions to stimuli (Lykken, 1959). The CIT assumes that guilty participants show specific bodily reactions when presented with guilty knowledge (Ellson et al., 1952; Lykken, 1959). So far, different methods of measuring responses to the CIT have been developed. Initially polygraphs were used to observe bodily reactions such as the sweating of palms, increased heart rate, and other autonomic-nervous-system responses (Kleiner, 2002). Those reactions were said to differ significantly from reactions to neutral information. However, high physiological reactions do not exclusively expose the guilty. They can simply indicate several emotions any suspect is likely to feel during an interrogation (Podlesny & Raskin, 1978). For example, feelings such as fear, the feeling of being accused, and stress in an unknown situation. Even the possession of crime-related information is not solely found in the guilty. Innocent subjects could have been exposed to it before the interrogation, for example through media and other clues, or be witnesses without having been part of the crime (Lykken, 1974). Besides the mentioned structural flaws, previous measurement techniques of CIT were shown to be insufficient because countermeasures can impede the process of finding evidence (Ben-Shakhar, 2011). For example, participants could inflict themselves pain or distract themselves with topic-opposing thoughts to impede measurements. Thus, the general reliability and validity was questioned (Ben-Shakhar, 2011; Peth et al., 2016).

Scientists are working on new ways to detect concealed information and to improve the CIT. In order to counteract the various downsides and countermeasures in concealed identity detection, Bowman et al., (2013) used a method called rapid serial visual presentation (RSVP). RSVP presents the participant a series of stimuli that are each visible for a short time (Broadbent & Broadbent, 1987). The quick presentation of stimuli is described to be at the “fringe of awareness”. Therefore, the triggered reactions to the presentation of „guilty knowledge“ might be more uninhibited and is hypothesized as more robust to countermeasures (Bowman et al., 2013). RSVP was proven to be an effective measurement device for CIT (Bowman et al., 2014). In a fake-name search task, participants were instructed to use a fake name and disguise their own name (Bowman et al., 2014). Then they were instructed to search for the fake name during the RSVP streams. Despite disguising the real identity, they showed significant and unintended responses to their actual names that appeared on the screen. So far, responses were measured through electroencephalography (EEG). With the EEG, the P300 brain potential was found as a reaction to crime-related information (Meijer et al., 2014). The P300 is associated with conscious recollection of subjective memories that were made conscious (Bergström et al., 2013). However, the use of EEG is expensive and not easily applicable outside laboratory settings, which makes application to forensic settings more difficult (Furedy, 2009). That is why Chen et al., (2021) replicated the study of Bowman et al. (2014) but introduced a different approach in measuring CIT: observing pupillary responses during RSVP. Earlier, eye movements such as blinking, fixation, and pupil size had shown to be effective measurements in the forensic field (Lubow

& Fein, 1996; Peth et al., 2016; Seymour et al., 2013). Pupil dilation was proven to reflect attention allocation and cognitive processing (Wierda et al., 2012). And according to Niewenhuis et al. (2011), pupil dilation is evoked when a stimulus is salient for the participant. Chen et al. (2021) instructed participants to disguise their identity with a fake name and measured their pupil response when presented with the real name, the fake name, or randomly selected control names. She assumed to find a larger pupil size when presented with the critical names. And indeed, increased pupil dilation was found when presented with the real name compared to the control name. So, even if the participants hid their identity, their real name did elicit more pupil dilation. Nonetheless, this finding was only applicable on a group level and not significant during individual analysis.

In the current study, we aim to replicate the experiment of Chen et al. (2021) in order to support improvement in forensic concealed information detection with pupillometry. This study is used to test whether pupillometry would be a more efficient measurement technique than EEG. The focus lies on involuntary variation of pupil size during stimulus presentation with RSVP. We as well will present participants with a range of names through RSVP and measure and record their pupil size throughout the whole process. We will compare pupil sizes of the participants when being presented with their real or fake name and compare it with the pupil size when presented with a control name. Since every name will be presented for only a short time it is made very hard to counteract or inhibit any pupillary response (Bowman, et al., 2013). Our goal is to observe pupil dilation when participants are presented with the familiar fake and real names. Chen et al. (2021) instructed participants to do 180 trials but mentioned the possibility of a learning effect to decrease the reliable difference between the real and control condition. Bowman et al. (20) found that pupil size decreases over time due to fatigue. To avoid that from happening we reduced the number of trials to 96 for each participant.

In order to investigate whether pupillometry in combination with RSVP is an efficient measurement in CIT we developed two hypotheses. The first hypothesis assumes that participants have a significantly larger pupil size whenever their fake name appears on screen compared to control names. The second hypothesis is that participants have a significantly larger pupil size whenever their real name comes up compared to control names. We expect to measure different pupillary responses to familiar names than to unfamiliar names.

Method

Participants

The study consisted of a sample of 36 participants, which were all first-year Psychology students at the University of Groningen. Prior to the experiment, every participant gave informed consent. All participants had normal or corrected to normal vision. The average age of all 36 participants (9 male, 27 female) was 20.2 (*SD* = 1.4). Participants received study points for participation, which is part of the requirements to pass a course. One participant was excluded due to their glasses hindering calibration and one was excluded due to the experiment software malfunctioning. Four participants were not present.

Apparatus and stimuli

The experiment took place in a lab located in the Social and Behavioural Sciences faculty building of the University of Groningen. The lab consisted of a desk with a 27” LCD Iiyama PL2773H monitor where an EyeLink 1000 eye-tracker using Pygaze was placed in front (Dalmaijer et al., 2014). Pupil size was recorded at 1,000 Hz and downsampled to 50 Hz offline. The eye-tracker was set at a distance of approximately 60 cm to the participant, measuring the pupil size throughout the whole procedure. Participants sat behind the monitor with their heads placed comfortably on a chin rest pointed towards the middle of the screen. On the monitor, each participant was presented with 96 trials of a randomly selected series of names through RSVP. All names started with a capital letter and had the same monospaced font (Courrier), size (21 pixels) and luminance. The names on the screen were shown sequentially in the centre of the screen with the same length. The difference in name lengths was evened out using hashtags and plus signs randomly before and after the names to ensure that every string consisted of eleven characters. As a result, the visual angle for each stimulus was 0.61°, whereas the whole screen consisted of a rectangle of 52.97° by 31.31°. The experiment was designed and carried out using Open Sesame 3.2.8 running on Windows 10 Enterprise.

We used the same set of names as Chen et al. (2021), consisting of 533 names, 281 of which are female and 252 of which are male. Those names were taken from the database by the Meertens Institute for Dutch language and culture research. Chen et al. (2021) first selected the first 100 top Dutch names of each year between 1975 and 2014 and then selected all names that are 10 characters or shorter. From that set of names, several subsets of 15 names were randomly selected to be presented to the participant in each trial. The fake name was picked by the participant from one of these subsets of unfamiliar names. The remaining distractor names to put before and after the fake, real and control names were selected randomly from the set of 533 names. Control names are randomly picked names from the name pool of Chen et al. (2021). Names with more than two identical consecutive letters were not allowed to be next to each other in one trial.

Procedure

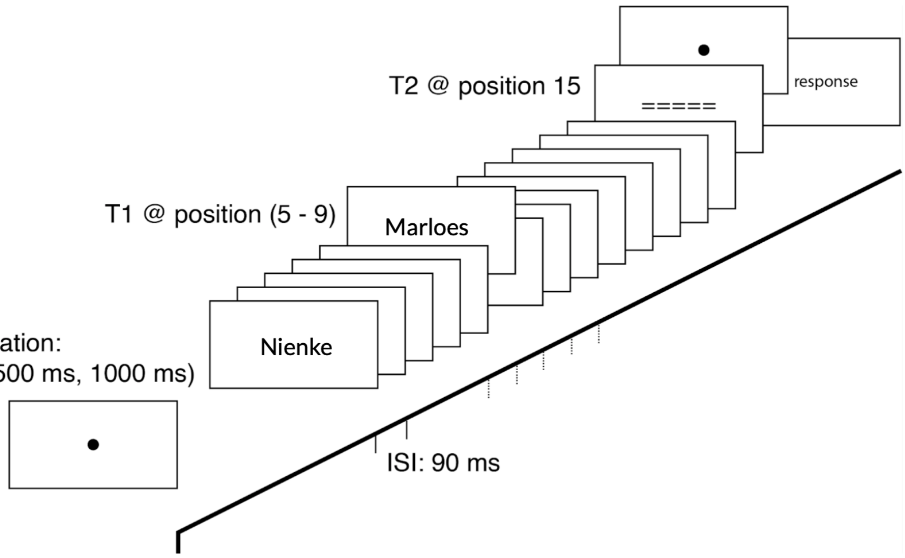
First, the eye-tracking camera was calibrated and the chin rest was adjusted. Then, the program asked for demographic details such as age, dominant hand, and real name. Prior to the first trial, half of the participants were asked to select an unknown fake name out of a randomly selected subset with 15 names of their indicated sex. In each trial sequence, the participants were presented with 15 randomly selected names that appeared for 100 milliseconds each in the middle of the screen. Depending on the condition, in each stream, the participant is presented with either the real name, fake name or control name. Those three options of names are called *critical names*. In each trial, the critical name could be shown at one of the positions between positions 5 to 9 (see Figure 1). The names in positions prior and after functioned as distractors. After the names, dashes or equal signs were shown for 100ms and the participants had to indicate which one they saw to assure they paid attention up to the end of the RSVP. Participants were asked to indicate whether they saw their target name by pressing “M” on a QWERTY keyboard when they did not see the target and “C” when they did see it. The order of the response keys was counterbalanced between participants. When responses to the first question were correct participants would earn 5 points or lose 5 points when the answer was wrong. For the response whether the participants saw the critical name 10 points were added when correct or subtracted when incorrect, meaning responses to the critical name were emphasised. The eye-tracker measured and recorded the participants’ pupil sizes throughout every trial. Every trial started with a one-point drift-correction procedure.

Design

The participants started with 10 practice trials to get familiar with the procedure. In total, the experiment consisted of 96 trials. Even participants were told to look for their real name (Truth condition). Uneven participants were instructed to search for the fake name they had to choose prior to the trials (Lie condition). For this study, an experiment with a 4 x 2 design was used. There were four conditions (T1) for the Lie and Truth conditions respectively: Target, Secret Target, Control and No Target. Participants had to indicate whether they saw the target, the chosen fake name, in the Lie condition while in the Truth condition they searched for their real name. In the Lie-Secret Target condition, the real name was shown and in the Lie-Control condition, the reaction to a randomly chosen distractor name that was the same for every control trial was recorded. Finally, in the Lie-No Target condition, a different randomly chosen distractor was shown. For the Truth-Target condition, the real name was shown, while in the Truth-Secret Target and Truth-Control condition the same randomly chosen distractor was presented. For both Truth and Lie conditions, each trial a different name was chosen for the No Target condition. An example of one trial in the Lie-Secret Target condition is shown in Figure 1.

Figure 1

Example of one trial in the Lie-Secret Target Condition



Note. In this trial, random names are shown before and after position 6. T1 is presented at position 6 and it is the participant's real name Marloes. T2 consists of equal signs and is presented at position 15. After another fixation point, participants responded to the questions regarding T1 and T2.

Data Processing and Analysis

All data and analysis scripts are publicly accessible in the Open Science Framework (https://osf.io/aq8pm/). Raw data is accessible on reasonable request.

For data analysis R was used with lme4 (v1.1-26; Bates et al., 2015). First, we analysed how accurate participants responded to questions one and two. Question one *(Did* *you see ------ or ====?)* indicates how well participants maintained their attention on the screen during the RSVP trials. Question two *(Did you see your (fake) name?)* was used to assess how well participants were able to detect their (fake) name and to get an indication of task difficulty.

Regarding our hypotheses, we did the analysis solely on the data of participants that were in the Lie condition. The first hypothesis of our experiment is that participants in the Lie condition had a significantly larger pupil size whenever their fake name (Target) appeared on screen compared to control names that changed with every trial (No Target). Our second hypothesis is that participants who were in the Lie condition would have a significantly larger pupil whenever their real name (Secret Target) came up compared to only control names that changed with every trial (No Target). Mean pupil sizes within the window of 320-1120ms were calculated for each trial. Pupil size was then time-locked and baselined by subtracting mean pupil size during a period of 300ms leading up to the presentation of T1 from the rest of the pupil trace.

To test these hypotheses, we estimated linear mixed-effects regression (LMER) models on a group level to investigate the difference in pupil size between the No Target reference conditions and the Secret Target, Target and Control conditions respectively. With the LMER we test if the variance between mean pupil sizes can be explained by the T1 conditions. Next, we used Bayes Factors to find evidence for or against the absence of the effect the T1 condition has on pupil size. Pupil size was used as a dependent continuous variable, and T1 was considered a categorical independent variable. Participant was used as a random factor. After that, we did a post-hoc contrasts analysis. This included a Tukey correction for multiple comparisons. Only No Target and Target were compared, as well as No Target and Secret Target. Lastly, we did an exploratory analysis where we visualised a linear mixed-effects regression on each time point to find out the critical time points at which

Target Secret was significantly larger than No Target. In other words, we are looking for a time window when the p-value for pairwise comparison of Secret Target vs No Target is smaller than .05 and thus significant.

Result

Task Performance

Participants responded to the attention question, whether they saw -------- or ======, with an accuracy of 97.34% and to the T1 response question with 94.56% (see Table 1). This implies that the participants were able to detect their fake names during the RSVP trials and maintained attention up to the end of the trials.

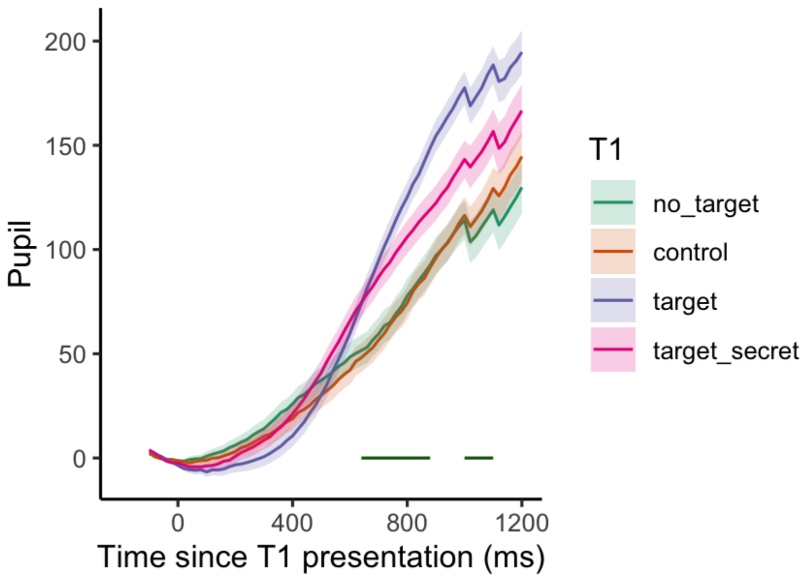
Pupil Data

Chen et al. (2021) mentioned in the discussion that setting a fixed time window for pupil variation observation would be advisable. Their results showed a range (from 320ms to 1120ms) in which the pupil size was significantly larger when presented with their real name than with a random control name. Our hypotheses, that in the Lie condition pupil size would be significantly larger in the Target and Secret Target condition than in the No Target condition in the range of 320ms to 1120ms, was not confirmed by our data. For that, we plotted the mean pupil size traces (see Figure 2a).

Figure 2a and 2b

2a) *Mean Pupil Size Traces for all T1-Lie Conditions*

2b) *Green Line that indicates the time point in which the pairwise comparison of Secret Target and No Target is significant*

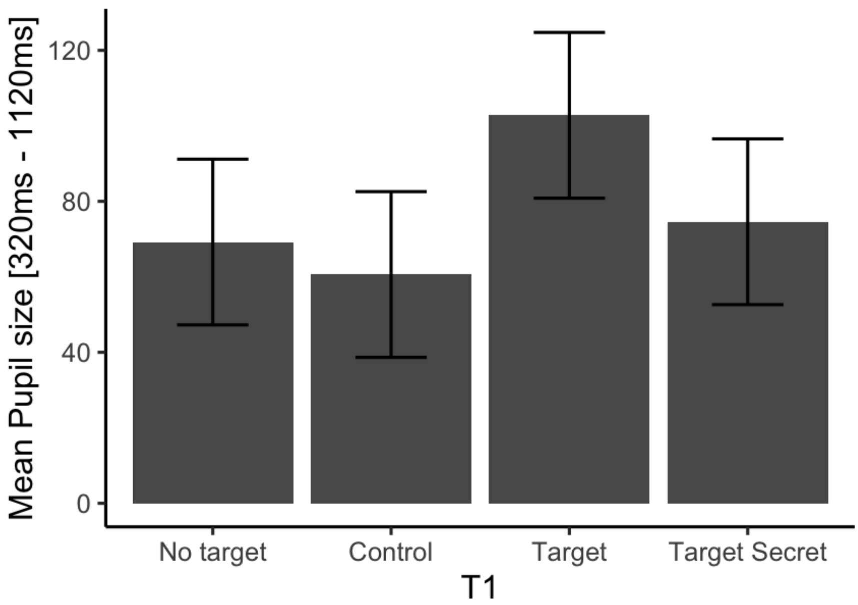


Note. This plot shows the pupil size for each condition in the time window -100 – 1200ms as well as the corresponding standard errors. The green line indicates the time frames for which the p-value for pairwise comparison of Secret Target vs No Target is smaller than .05, thus indicating a significant difference between Secret Target and No Target.

The average pupil size in the Lie condition is between 320ms and 1120ms since T1 presentation was calculated (see Figure 3 and Table 2a). The average pupil size in the Target condition is 91.4 (*SE* = 15.8), Secret Target condition: 82.4 (*SE* =15.8), Control is 63.3 (*SE* =15.8), and for the No Target condition 65.8 (*SE* =15.8).

Figure 3

Bar Graph of the Mean Pupil Sizes of all T1-Lie Conditions Including Their Standard Error for Time Points Between 320ms and 1120ms



We used a linear mixed-effects regression analysis to test whether the variance between mean pupil sizes between 320ms and 1120ms since T1 presentation can be explained by the T1 condition. Mean pupil sizes within that window were calculated for each trial and were used as dependent variables. Bayes Factor (*BF*) was estimated by comparing a model with the T1 condition as a dependent categorical variable with a model without that variable using Bayes Information Criterion ($BF > 1000$) (BIC, Wagemakers, 2007). Next, we did a post-hoc comparison. Post-hoc comparisons revealed that both the differences between No Target - Target ($p = .088$, $z = -2.83$) and No Target - Secret Target ($p = .594$, $z = -1.84$) were not significant at a 5% significance level (see Table 3). From that information, we can conclude there is no significant evidence for or against either of the two hypotheses in the time window 320 - 1120 ms.

Finally, we did an exploratory analysis and plotted a linear effects regression on each time point to find the time points at which the differences between the T1 conditions are not equal to 0 (see Figure 2a (or 2b) & Table 4). In our data, we observe *p*-values lower than .05 in the time frame between 640ms to 920ms and 1000ms to 1100ms since the T1 presentation.

This means that we found a time window that shows a significant difference between the Secret Target and No Target conditions. When comparing *p*-values of the No Target and Target condition we observe values lower than the 5% significance level for the whole time frame -200 - 1200.

Discussion

The results show that concealed information can be detected through RSVP and pupillometry. There is evidence for a positive effect between pupil size and the concealed identity information of names. Pupil size was bigger when presented with the real name than with a control name, even though they hid their identity through a fake name. This shows that a concealed name can be detected through pupil observation in interrogation. However, the evidence found was not significant. There was no significant difference between pupil sizes of real and fake names compared to control names. Bowman et al. (2013) advised choosing a set time window prior to analysis. In their discussion, Chen et al., (2021) pointed out a time window (from 320ms to 1120ms) in which the pupil size was significantly larger when presented with their real name than with a random control name. We decided to use that specific time window to observe the pupillary responses. However, we could not find a significant difference. During the exploratory analysis, however, we found a time window (640ms to 920ms and 1000ms to 1100ms) in which the difference in pupil size in response to the real name compared to the control name is significant. This means that we found evidence for larger pupil dilation when the participants, who were instructed to hide the identity, saw their own actual name during the stream. That finding indicates support for the RSVP and pupillometry approach in CIT. The gap between 920ms and 1000ms is due to the fact that not every trial captured the same amount of pupil size data. Pupil measurement started with the onset of stimuli presentation, thus, the first critical name. But depending on the condition, the trial ended already before the last position, resulting in noise in the data (see Table 2a). Data after 1000ms is therefore not important for analysis. Choosing an even smaller time window, for example from 320ms to 1000ms, can therefore be proposed.

The percentage of task performance with regard to answering the two questions during the trials was relatively high, which can be a sign for the task being too easy. Even if we prevented a learning effect through decreasing the trial numbers from 180 like Chen et al. (2021) to 96 per participant, the overall task difficulty in future studies could be increased. However, to achieve less noise in data, more trials have to be recorded. We chose 96 trials for each participant to counter learning effects. In future studies, trial size could be decreased to 120.

There are multiple reasons why there were participants that showed a qualitative effect towards our predicted direction and why they were participants that did not.There were participants who had difficulties with blinking during trials. Some were unable to see without glasses or had irritated eyes due to removing eye makeup right before the trials. If more data would be collected, disturbed trials and inconsistent results could be more easily excluded and detected. Also, the participants were instructed to choose the fake name out of a list of Dutch names. However, not all students were dutch which, in general, could disturb the ability to react to the names fully. Familiar names would naturally stand out more in between names one has never heard of. Generally, pupillary responses can also be caused by other names a person is actively trying to hide and/or is simply familiar with. To investigate this in future studies, an extra condition could be implemented in which participants are instructed to exclude all familiar names. For example, those names could be the name of a friend or a family member. However, that would be very time consuming, thus, inefficient.

If pupillometry and RSVP would be used in the future, ways have to be found to expand the CIT further than only using words. Thus far (with regard to personal knowledge) there are no other studies with pupillometry that extended the experiment with using different stimuli. Zimmermann et al., (2019), for example, showed participants pictures of familiar celebrity faces in between neural unfamiliar faces. Significant differences in P300 potential for the faces of the celebrities were found. However, this was found through EEG measurements. Research with pupillometry could expand through experiments with faces investigating pupillary responses to familiar faces. When using pictures, experimenters should keep in mind that the brightness and colours that a pupil can receive have to be kept consistent. Even little differences in luminance can cause a pupillary response. Further propositions would be using different words than names up to sentences. So far, pupillometry seems promising as a measure in CIT that can be implemented in concealed information detection. Besides the evidence, pupillometry is more affordable and practical, which makes it a valid measurement technique next to EEG.

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Table 1

Mean Traces of all T1 Conditions for Questions One and Two

T1	T1 correct	T2 correct
Target	0.8900463	0.9537037
Target secret	0.9664352	0.9756944
Control	0.9606481	0.9849537
No target	0.9652778	0.9791667

Table 2

Estimate, Standard Error, Degree of Freedom and Upper and Lower Confidence Interval Bounds for Each T1 Condition

T1	Estimate	*SE*	df	95% CI	
				LL	UL
No Target - Lie	65.77509	15.81492	Inf	34.77842	96.77177
Control - Lie	63.29287	15.82414	Inf	32.27813	94.30762
Target - Lie	91.40178	15.81802	Inf	60.39903	122.40454
Secret Target - Lie	82.42912	15.82102	Inf	51.42050	113.43774
No Target - Truth	72.65481	15.85974	Inf	41.57029	103.73934
Control - Truth	57.93543	15.85585	Inf	26.85854	89.01233
Target - Truth	114.18350	15.86591	Inf	83.08689	145.28012
Secret Target - Truth	66.74712	15.86279	Inf	35.65662	97.83762

Note. CI = confidence interval; LL = lower limit; UL = upper limit

Table 3

Contrast Table

Contrast	Estimate	*SE*	df	*z*-ratio	*p*
No target lie – control lie	2.482	9.07	Inf	0.274	1.0000
No target lie – target lie	-25.627	9.06	Inf	-2.829	0.0879
No target lie – target secret lie	16.654	9.06	Inf	-1.837	0.5943
No target lie – no target truth	-6.880	22.40	Inf	-0.307	1.0000
No target lie – control truth	7.840	22.39	Inf	0.350	1.0000
No target lie – target truth	-48.408	22.40	Inf	2.161	0.3757
No target lie – target secret truth	0.972	22.40	Inf	-0.043	1.0000
Control lie – target lie	-28.109	9.07	Inf	-3.097	0.0410
Control lie - target secret lie	19.136	9.08	Inf	-2.108	0.4098
Control lie – no target truth	-9.362	22.40	Inf	-0.418	0.9999

Contrast	Estimate	*SE*	df	*z*-ratio	*p*
Control lie – control truth	5.357	22.40	Inf	0.239	1.0000
Control lie – target truth	-50.891	22.41	Inf	2.271	0.3097
Control lie – target secret truth	3.454	22.41	Inf	-0.154	1.0000
Target lie – target secret lie	8.973	9.07	Inf	0.989	0.9761
Target lie – no target truth	18.747	22.40	Inf	0.837	0.9910
Target lie – control truth	33.466	22.40	Inf	1.494	0.8109
Target lie – target truth	-22.782	22.40	Inf	1.017	0.9721
Target lie – target secret truth	24.655	22.40	Inf	1.101	0.9569
Target secret lie – no target truth	9.774	22.40	Inf	0.436	0.9999
Target secret lie – control truth	24.494	22.40	Inf	1.094	0.9584
Target secret lie – target truth	31.754	22.41	Inf	-1.417	0.8496
Target secret lie – target secret truth	15.682	22.40	Inf	0.700	0.9970

Contrast	Estimate	*SE*	df	*z*-ratio	*p*
No target truth – control truth	14.719	9.20	Inf	1.600	0.7506
No target truth – target truth	41.529	9.22	Inf	-4.506	0.0002
No target truth – target secret truth	5.908	9.21	Inf	0.641	0.9983
Control truth – target truth	-56.248	9.21	Inf	-6.106	<.0001
Control truth – target secret truth	8.812	9.20	Inf	-0.957	0.9802
Targe truth – target secret truth	47.436	9.22	Inf	5.144	<.0001

Note. Degrees-of-freedom method = asymptotic; number of contrasts = 28; 4 x 2 Design; *p*-value adjustment: Tukey method for comparing a family of 8 estimates

Table 4

P-Values for 71 Observations for Every 20ms comparing Target vs No Target and Secret Target vs No Target

Time	*p* Target vs No Target	*p* Secret Target vs No Target
-200	3.838940e-01*	0.27352378
-180	4.368272e-01*	0.36356238
-160	3.249122e-01*	0.12886363

Time	*p* Target vs No Target	*p* Secret Target vs No Target
-140	5.016298e-01*	0.27772775
-120	3.973150e-01*	0.31737751
-100	4.319924e-01*	0.24659622
-80	4.698054e-01*	0.27729985
-60	1.147252e-01*	0.93621303
-40	9.817355e-01*	0.20933405
-20	2.906907e-01*	0.14699469
0	1.614969e-01*	0.68620829
20	8.370765e-02*	0.52409019
40	4.193294e-02*	0.17391582
60	5.584579e-02*	0.22061577
80	1.235786e-01*	0.29385822
100	3.463594e-02*	0.24452132
120	6.522067e-02*	0.20847705
140	5.687859e-02*	0.26423483
160	6.665998e-02*	0.37210655
180	7.441697e-02*	0.27971378
200	8.866641e-02*	0.41828556
220	7.156204e-02*	0.49275426
240	7.164052e-02*	0.53393724

Tim e	*p* Target vs No Target	*p* Secret Target vs No Target
260	5.212664e-02*	0.46786465
280	4.710359e-02*	0.48850944
300	4.744431e-02*	0.55262912
320	3.783173e-02*	0.46107308
340	3.494375e-02*	0.50331084
360	2.864253e-02*	0.46341853
380	5.414441e-02*	0.63238500
400	5.530946e-02*	0.70428743
420	7.282703e-02*	0.75500556
440	1.496689e-01*	0.93217098
460	2.559438e-01*	0.99292074
480	3.507858e-01*	0.99290545
500	5.964229e-01*	0.91514767
520	8.585372e-01*	0.67756676
540	9.999829e-01*	0.49819413
560	9.089053e-01*	0.36823574
580	6.198141e-01*	0.19335405
600	3.800130e-01*	0.12648286
620	1.330275e-01*	0.06447917
640	3.207157e-02*	0.03351090*

Time	*p* Target vs No Target	*p* Secret Target vs No Target
660	6.228228e-03*	0.01900985*
680	2.975364e-03*	0.02205828*
700	7.749382e-04*	0.01439293*
720	3.167835e-04*	0.01530493*
740	7.208315e-05*	0.01144135*
760	3.114908e-05*	0.01127933*
780	1.466264e-05*	0.01190484*
800	2.255088e-05*	0.01862819*
820	6.863212e-06*	0.02110851*
840	5.646435e-06*	0.02310384*
860	2.385124e-06*	0.02849537*
880	1.195626e-06*	0.03818725*
900	8.944168e-07*	0.05757398
920	6.826870e-07*	0.04767915*
940	5.233383e-07*	0.05598409
960	5.737148e-07*	0.05353320
980	4.368729e-07*	0.05094060
1000	3.326033e-07*	0.03967117*
1020	3.176216e-06*	0.01855278*
1040	2.654440e-06*	0.01654581*

Time	*p* Target vs No Target	*p* Secret Target vs No Target
1060	4.017606e-06*	0.02091431*
1080	2.117450e-06*	0.01902652*
1100	1.515462e-06*	0.01612155*
1120	6.242735e-05*	0.05905138
1140	1.363861e-04*	0.07153397
1160	1.237123e-04*	0.06144384
1180	1.706553e-04*	0.06149453
1200	2.247243e-04*	0.06107930

*$p < .05$.