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The Difference in Pupil Size Responding to Cognitive Load and Emotional Arousal Questions between Guilty and Innocent Groups*

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The purpose of this study is to examine the effects of emotional arousal and cognitive load on pupil diameter during a lie detection interview. The guilty group (n = 30) committed a mock crime (i.e., stealing cash) and the innocent group (n = 30) performed a mission (i.e., sending a message) in the research assistant's office. After that, their pupil size was measured using a wearable eye-tracker during the interview. The interview questions were classified with the three cognitive load, three emotional arousal, and three neutral questions. The results indicate that the main effects of group and time were not significant, but the interaction between group and time was significant. It means that when answering cognitive load questions, the guilty group showed larger increase in pupil diameter than the innocent group. The present study suggests that inducing cognitive load is more effective than inducing emotional arousal during an interview when using pupil diameter as an index of deception, and it is expected to improve the accuracy of lie detection.

Key words : lie detection, pupil diameter, eye-tracker, cognitive load, emotional arousal

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The difference in the physiological and behavioral responses of a guilty individual and an innocent individual is important for lie detection. For example, a guilty individual's physiological reactions include enlarged pupil size and increased heart rate, and behavioral reactions include looking up and down or making less eye contact (Webb, Honts, Kircher, Bernhardt, & Cook, 2009). Lie detection is especially critical in crime situations. It is not easy for experienced experts to accurately determine whether a statement is true or a lie, so attempts are being made to judge it. Currently, most lie detection scenes use polygrph measurements with Control Question Test (CQT) to determine the authenticity of suspects (Raskin & Honts, 2002; Rajan, 2019). Polygraph is a tool to detect lying by measuring physiological responses including blood pressure, heart rate, skin conduction, and breathing (National Research Council, 2003). However, when an innocent individual experiences emotional arousal including anxiety, there is a high possibility for false positives because he or she can show the physiological responses like a liar (Horowitz et al., 1997; Gawrylowicz et al., 2016).

Alternatively, pupil diameter came to the fore as an effective measurement, because it could reflect both emotional arousal and cognitive load respectively. A guilty individual not only experiences an arousal or a negative emotion, but also makes a cognitive effort to make a lie (DePaulo et al., 2003; Verschuere, Köbis, Bereby-Meyer, Rand, & Shalvi, 2018). First, a guilty individual experiences greater arousal than an innocent individual in situations where a risk is high, or where there is gain or loss (Gozna et al., 2001). A guilty individual also feels a sense of accomplishment if the lie is successful (Ekman, 1992), as well as the fear or guilt of the lie being revealed (Zuckerman et al., 1981). In addition to the physiological responses that can be measured with polygraphs, the emotional arousal experienced at this time also changes the size of the pupil of the lying person (Stern, Ray, & Quigley, 2001). The larger the arousal value, the larger the pupil size (Bradley et al., 2008; Partala & Surakka, 2003; Stern et al., 2001). Therefore, if the size of the pupil of the innocent individual increases when detecting a lie, a threatening stimulus (e.g., situational fear) may have triggered an automatic physiological response (Horowitz et al., 1997).

On the other hand, some studies claim that lie detection should be cognitively approached because emotional arousal may be different depending on personality or situation (Vrij et al., 2010). Based on the Activation-Decision-Construction Model of answering questions deceptively (Walczyk et al., 2013), a guilty individual requires more cognitive effort than an innocent individual. Because truth is automatically activated from long-term memory by questions that the liar hears or reads. Then the guilty individual usually decides to make a lie, based on the truth and social circumstances,

in order to achieve his purpose. Finally, a rational and persuasive lie is constructed which is appropriate for the situation. Like this, the guilty individual needs more cognitive effort (Gombos, 2006; Zuckerman et al., 1981). In addition, the load of cognition is increased because it is necessary to suppress the truth while making a lie (Sporer & Schwandt, 2006). Since the pupil size increases in a situation where the cognitive load is large, the pupil dilates when lying (Cook et al., 2012; Dionisio et al., 2001; Webb et al., 2009).

Based on the simultaneous occurrence of emotional arousal and cognitive load when lying, some researchers sought to improve the accuracy of lie detection through pupil response (Cook et al., 2012; Webb et al., 2009). Because the pupil reflects the autonomic nervous system response, the size automatically changes as he or she experiences emotional arousal or cognitive load (Bradley et al., 2008; Cook et al., 2012, Wang, 2011). This is a physiological response that is difficult for an individual to control, so it can be used as relatively objective standard of evidence. Webb et al. (2009) measured changes in pupil size during comparison question tests using mock crime scenarios. As a result, it was possible to distinguish the lie and the truth from the pupil size. However, when innocent individuals responded to crime-related and comparative questions, the pupils showed a difference in size, while the guilty individuals did not. In addition, they claimed the pupil dilation due to cognitive load, but they have not been able to explain whether the observed pupil response reflects emotional arousal or cognitive load. In another study (Cook et al., 2012), they compared changes in pupil size between guilty individuals and innocent individuals during lie detection after mock crime. The pupil size of the guilty group increased significantly in relation to the stimulus associated with the lie, compared to the neutral stimulus. They tried to explain pupil size differences based on cognitive factors but did not consider the possibility that emotional factors influenced the results. The findings of the lie detection through pupil size are so mixed that it is necessary to re-validate through repeated study to determine whether the pupil size is a measure capable of distinguishing between the lie and the truth and also the relative impact of emotional arousal and cognitive load on pupil size changes has not been clearly established.

Furthermore, this study uses an ecologically valid mock crime scenario to increase the possibility for generalization through the lie detection results. The threat level has been increased by setting a punishment that they will not be compensated when a guilty group's lie is detected. In order to increase the motivation for guilty and innocent groups, it has been set up to receive appropriate compensation if they are judged true. Also the two self-reported scales were used to see non-verbal behavior. State-Anxiety Inventory (Spielberger, Gorsuch, &

Lushene, 1970) measured the state anxiety after the interview to see if the actual anxiety increased after the guilty group lied. State Shame and Guilt Scale (Marschall, Sanfter, & Tangney, 1994) was also conducted to see if post-interview status shame and guilt increased. In addition, unlike the previous studies that used goggles and a video camera (Webb et al., 2009), or a head-mounted eye tracker (Cook et al., 2012) with a computer monitor, the pupil size change is measured using a wearable eye tracker in this study so that the wearable eye tracker does not limit the participant's peripheral view. Also, the time course is represented by measuring the pupil size for 6000 ms to observe the pupil changes (Lee et al., 2016), because eye movement can be measured accurately by continuously observing for a long time, rather than by measuring the reaction speed within a short time (In-Albon et al., 2010).

This study aims to examine the automatic physiological response of the guilty individual through a change in pupil size when lying and the relative influence and importance of each factor on the change of pupil size by inducing emotional arousal and cognitive load on the guilty individuals. We expect that (1) among guilty and innocent groups, the change in pupil size of guilty group would be greater. (2) The change in pupil size of the guilty group by cognitive load would be larger than the emotional arousal. (3) Pupil dilation among the time intervals, the largest change in pupil size would be from 1000 ms to 2000 ms. Because pupil dilation when performing cognitively demanding process peaks at about 1000ms to 2000ms after onset of demand (Beatty, 1982).

First, we implement mock crime scenarios with an ecological validity to increase the level of emotional arousal experienced by the participants. In the interviews, the emotional arousal questions caused more inconvenience by using the accusatory style (Vrij, Mann, & Fisher, 2006). Second, complicating the statement increased the cognitive load (Vrij, Fisher, Mann, & Leal, 2006). Cognitive load questions require participants' cognitive efforts by presenting questions in a variety of conditions (i.e., speaking in chronological order and in reverse order, and unexpected questions) in an information-gathering form. Even if they lie, without a strong motivation to look sincere, cognitive load and emotional arousal may not increase. Furthermore, considering the fact that there may be differences in the emotional response and physiological response in the lie detection situation according to individual tendency, the State-Trait Anxiety Inventory, State Shame and Guilt Scale were used to see the difference between the groups. In summary, the purpose of this study is to examine the effects of emotional arousal and cognitive load on pupil size when lying. To do this, the participants were randomly assigned to either guilty or innocent group to conduct a mock crime or a neutral task in accordance with their

group allocation. They were then measured their pupil size with the eye tracker during a lie detection interview. The hypotheses to be tested in this study are as follows. When lying, pupil size changes due to cognitive load will be larger than emotional arousal. Therefore, it is expected that the guilty group for the detection of the lie will have a larger pupil size change than the innocent group for the cognitive load question.

Method

Participants

A total of 60 participants, aged between 19 and 30, were recruited via poster and online advertisements on a university website. Participants were told to be recruited for a psychology experiments involving crimes and lies, and received $ 10 for their participation. Exclusion criteria were: wearing glasses or lenses, uncorrected visual acuity less than 0.1, and severe astigmatism. The participant were randomly assigned to either guilty (n = 30) or innocent (n = 30) group and performed each given mock crime. After that, they finished the lie detection interview and got the debriefing and reward. Of the total of 60 participants, one in each of the guilty and innocent groups was excluded due to the abnormality of the measuring device. Finally, we analyzed the results of a total of 58 participants from guilty (n = 29) and innocent (n = 29) groups. The mean age was not significantly different between groups, $t(56)$ = -1.97, *n.s.* The mean age of the guilty group was 22.07 (SD = 2.10, female 21) and the mean age of the innocent was 23.17 (SD = 2.16, female 22).

Materials

Self-report questionnaires

State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, & Lushene, 1970). In order to measure the level of anxiety among the group participants, this study used the Korean version of the State-Trait Anxiety Inventory (STAI; Kim & Shin, 1978). The questionnaire consisted of twenty items of state version (STAI-S) and twenty items of trait version (STAI-T). The STAI-S measures the current anxiety (e.g., "I feel nervous") and the STAI-T measure the anxiety of the past month (e.g., "I lack self-confidence"). This is a four-point Likert scale (one point: almost not, four points: always). Both scales range from twenty to eighty points, and the higher the score, the higher the level of anxiety. In this study, the state and trait anxiety scales were administered before the experiment and the state anxiety scale was used once again after the experiment to check the change of the participants' anxiety level. Cronbach's alpha was calculated as .70 before the experiment and .68 after the experiment for the state anxiety, and .68 for the trait anxiety.

State Shame and Guilt Scale (SSGS; Marschall, Sanfter, & Tangney, 1994). SSGS was conducted to evaluate the level of shame and guilt felt by the participants at the moment (state). In the present study, Korean version of SSGS was used (Lim, 2010). This scale includes a total of ten questions with five items that correspond to shame (e.g., "I feel humiliated, disgraced") and five items of guilt (e.g., "I cannot stop thinking about something bad I have done"). A four-point Likert scale of one (not at all) to four (strongly agree). A higher score means higher levels of shame and guilt. In this study, the scale was measured before and after the experiment to check the change of participants' shame and guilt level. The Cronbach's alpha was .73 before the experiment, and .75. after experiment.

Measures

Wearable eye tracker. An eye tracker was used to measure pupil size changes. Previous studies measuring pupil size used a monitor-type eye tracker for analysis, but there was a drawback that the eye of the participant was limited to the monitor area. Therefore, this study used the wearable eye tracker which can measure pupil size without restriction on the participant's gaze area. The apparatus used in the experiment was Tobii's Tobii Glasses 2 Pro and the pupil size (mm) was measured at a sampling frequency of 50 Hz. The pupil is sensitive to light, so it maintained a constant brightness (about 700 lux) in a windowless lab (via Inparo's RZMT-30 digital illuminometer). In addition, to minimize visual interference, the participant stared at the blank white wall and responded to the interview questions.

Interview questions. In this experiment, nine questions were used to induce cognitive load and emotional arousal in the lie detection interview. Questionnaires consisted of three cognitive load questions, emotional arousal questions, and neutral questions, respectively. Two types of questionnaires were used to control the order effect (e.g., type A, type B). The type A questionnaires were consisted of three cognitive load questions, three neutral questions, and three emotional arousal questions. Then the type B questionnaires were consist of three emotional arousal questions, three neutral questions, and three cognitive load questions. The cognitive load question used the form of an information-gathering interview style (Vrij et al., 2006) that requires participants' cognitive effort at the time of the statement. In addition, we applied the unexpected question (i.e., open question, time and space question; Vrij et al., 2009) and reverse order statement (Vrij et al., 2008) to increase cognitive load.

Increasing the liars' cognitive load by making the statement complex (e.g., reverse order statement) can make it easier to distinguish false cues (Vrij et al., 2006). Vrij et al. (2008) stated that when a person who committed a mock

crime made statements in reverse, he/she revealed more linguistic clues and vocal clues. In other words, since speaking backwards requires a cognitive effort that exceeds the inherent intellectual resources of an individual, it is more likely to fail in lying, easily revealing false cues.

The emotional arousal question consisted of accusatory interview style questions (Vrij et al., 2006) that participants could feel more discomfort. Direct questions about illicit behaviors were suggested to use to stimulate the individual emotionally (Bovard et al., 2019). Neutral questions have nothing to do with crime, and they consist of neutral questions that participants do not have to lie. Participants in each group answered the truth in neutral questions, but in the cognitive load and emotional arousal question, the guilty group lied about the mission and the innocent group responded truthfully. The interview questions are as follows. For emotional arousal questions: “Did you come to lie to me today?”, “I know cash is gone, did you take it?”, “Did you just lie to me now?”. For neutral questions: “What is your major?”, “Is your major appropriate for your aptitude?”, “Why did you choose that major?”. For cognitive load questions: “Please tell me in order what happened in the assistant room”, “Please tell me in reverse order what happened in the assistant room”, “How many people, where and what were you doing in the assistant room?”

Procedure

All laboratory procedures were approved by the Institutional Review Board (IRB). The experiment consisted of two stages: mock crime missions and lie detection interviews. First, the participants arrived at the laboratory and signed a written consent form. And they also completed the questionnaires including the State-Trait Anxiety Inventory and the State Shame and Guilt Scale. When the questionnaires were completed, the researcher brought in two envelopes containing the mission of the guilty and innocent groups, and the participant selected one of them. When the participants selected an envelope, they did not know what the mission inside was. This procedure ensured they were randomly assigned to either of the groups. The researcher explained the contents of the mission in the envelope so that the participant could clearly understand the contents of the mission, and then guided the location of the assistant to perform the mission. The mock crime missions performed by the two groups are like below.

The participant of the guilty group enters the assistant room, sits at the designated seat, opens the computer's memo program and writes “I used this seat for a while.” Then, on the bookshelf, finds the <Clinical Psychology> book and takes out the envelope with the word ‘research fund’. Takes out the cash (about $ 1,000) in the envelope, checks the amount, hides it in the bag or pocket, and puts the

envelope back in the book. Subsequently, the participant of the guilty group returns to the laboratory. On the other hand, the participant of the innocent group enters the assistant room and sits at the designated seat and opens the page 207 of the <Abnormal Psychology> book on the bookshelf and takes a picture with the mobile phone. After sending the picture to the designated phone number, they open the memo program on the computer and write “I used your seat for a while.” Finally, the participant of the innocent group leaves the assistant room and returns to the laboratory.

When the participant returned to the lab, the researcher verified that the mission was successfully completed and briefly outlined the next phase of the lie detection interview. The guilty group had to persuade the interviewer of their innocence and the researcher stressed that if the participant of the guilty group failed or said the truth, they would receive half the reward. On the contrary, the innocent group had to assert the truth, and the researcher explained that if the participant of the innocent group did not get a verdict of truth, or if they lied, they would receive half of the reward. And the participant went into the interview room.

The participant in the interview room wore the wearable eye tracker and sat in a chair that was set against an empty white wall. The interviewer sat behind the participant and calibrated. The lie detection question was presented as a computer voice to control the impact of extraneous variables (e.g., interviewer's way of speaking or voice tone) that could vary from situation to situation. The interview took about 20 minutes.

After completing all the experiments up to the second stage, participants were interviewed and then filled out a questionnaire to assess state anxiety, shame and guilt, and were debriefed. In order to increase the motivation of the lie at the interview, the conditions of the reward were different depending on the success of the verdict, but all participants received the same $ 10 reward.

Data analysis

Because each question was not presented at the same time in the questionnaire used in this study, we measured the change in pupil size for 6000 ms after the start of each response to cognitive load and emotional arousal questions (Lee et al., 2016). Because pupil size varies by individual, we calculated the change in pupil size with the pupil size as the baseline at the start of each response. In order to examine the change in measured pupil size over time, the mean value was obtained at 1000 ms intervals for cognitive load and emotional arousal questions. And we used the value obtained by subtracting the pupil size change of the emotional arousal question from the pupil size change of the cognitive load question for each time period as the dependent measure. If the

pupil size was further increased in the cognitive load question than in the emotional arousal question, the difference appears to be a positive value, which means that the participant was more affected by the cognitive load in lying.

Statistical analysis was performed using IBM SPSS Statistics 23. To determine the temporal variation of the pupil size difference between the questions in each group, we conducted a 2 (group: guilty, innocent) × 6 (time: 1000 to 6000 ms) mixed analysis of variance (ANOVA). To determine whether the difference in pupil size between groups was significant at a particular time, we also analyzed the difference in pupil size between groups at different time points using an independent sample *t*-test.

Results

Changes in pupil dilatation

To examine pupil size differences between groups by questions over time, we used the difference in pupil size variation between cognitive load and emotional arousal questions as dependent measures. A 2 (group: guilty, innocent) × 6 (time: 1000 ~ 6000 ms) mixed ANOVA was conducted. As a result of analysis, interaction between group and time was significant, F (1, 56) = 2.84, p = 0.016, η^2 = .048, which means that pupil size variation was significantly different between the two groups. The main effect of group was not significant, F (1, 56) = 2.56, p = n.s., η^2 = .044, and the main effect of time was not significant, F (1, 56) = 1.79, p = n.s., η^2 = .031. In order to confirm the interaction between group and time, we conducted one-way ANOVA for each time interval. The difference in pupil size variation

Table 1. Differences in pupil size variation (mean and standard deviation) between the cognitive load question and the emotional arousal question at each time interval by group

Time Interval	Guilty (n = 29)	Innocent (n = 29)	F	p
1000ms	.27(.48)	.06(.26)	4.177*	.046
2000ms	.21(.42)	-.01(.28)	5.533*	.022
3000ms	.07(.34)	.07(.31)	.003	.955
4000ms	.24(.38)	.10(.27)	2.362	.130
5000ms	.17(.40)	.02(.35)	2.464	.122
6000ms	.14(.37)	.19(.25)	.385	.537

*p < .05

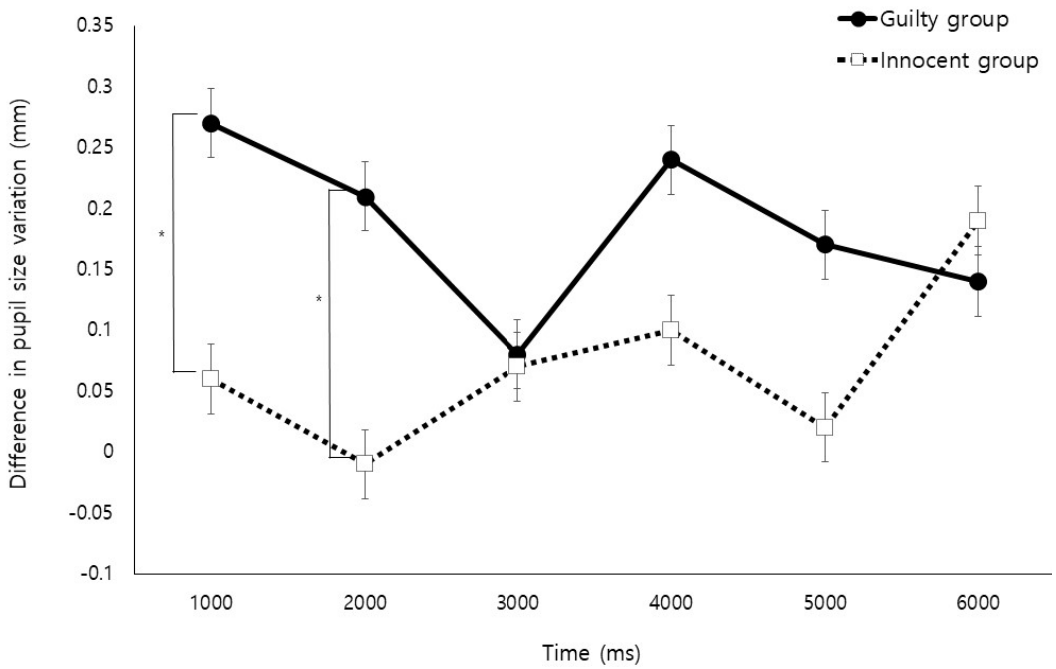

Figure 1. Group difference in pupil size variation between cognitive load questions and emotional arousal questions

Note. *p < .05

between the two question types was significant in the 1000 ms and 2000 ms intervals. This means that the pupil size of the guilty group increased more in the cognitive load question than the emotional arousal question for 2000 ms compared to the innocent group, as shown in Table 1 and Figure 1.

Demographics and self-reported scales

In the Table 1, the independent sample t-test was conducted to identify differences in age and trait anxiety, and there was no difference between the two groups. This means that the groups are well organized. As a result of the t-test for the state anxiety and shame/guilt before and after the experiment, there was no difference in the state anxiety of the two groups. However, after the experiment, the two groups showed a significant difference in shame/guilt, compared to the difference before the experiment, t (56) = 2.38, p <.05. This means that in a lie detection interview, the guilty group experienced a state of high shame and guilt when compared to the innocent group.

Table 2. Mean and standard deviation (SD) for self-reported scales

	Guilty (n=29)	Innocent (n=29)	t
STAI-T	41.62 (5.63)	41.69 (5.58)	0-.05
STAI-S (baseline)	39.28 (5.46)	40.07 (5.55)	0-.55
STAI-S (post)	36.83 (5.22)	38.07 (5.82)	0-.86
SSGS (baseline)	11.97 (2.86)	12.66 (3.74)	0-.79
SSGS (post)	14.38 (4.94)	11.86 (2.85)	00 2.38*

Note. * $p < .05$; *STAI-T: State-Trait Anxiety Inventory-Trait, STAI-S: State-Trait Anxiety Inventory-State, SSGS: State Shame and Guilt Scale.*

Discussion

The purpose of this study was to identify the variable that predominantly affects the pupil size change of the guilty individuals among cognitive and emotional factors. To do this, the participants randomly assigned to participate in guilty or innocent group to perform a mock crime, and pupil size was measured by the eye tracker during a lie detection interview. We compared changes in pupil size according to question types for guilty and innocent groups. The results of this study are summarized as follows.

The main finding was that when comparing the pupil size changes of guilty and innocent groups for cognitive load question and emotional arousal question, the difference in pupil size variation between groups was statistically significant, with a significantly larger pupil size increase in the guilty group in the cognitive load question. This means that the size of the pupil expanded to a larger extent while the guilty group lied about the cognitive load question. These results are consistent with the hypothesis that pupil size changes due to cognitive load will be larger than emotional arousal when lying, and affirms the arguments of previous studies that attempted to explain the change in the pupil size of the liar as a cognitive factor. The results of previous studies (Cook et al., 2009; Webb et al., 2009) did not explain the relative influence of cognitive load and emotional arousal, but in this study, the pupil size variation of the guilty group for the cognitive load question was larger in accordance with the hypothesis by presenting different questions to compare the influence of the cognitive load and the emotional arousal at the lie detection interview. This shows the accuracy of the detection of a lie through the pupil size, and it is possible to obtain more certain results when using the question of increasing the cognitive load during lie detection.

When we looked at the differences in pupil size changes between the two groups of cognitive load and emotional arousal questions over time, participants' answers began to appear, with a significant difference between the two groups up to 2000 ms, but not significant thereafter. According to Wang (2010), a meta-analysis of existing pupil studies, the increase in pupil size due to cognitive load and emotional arousal occurs most often after 2000 ms. This is different from the present study because we measured the pupil size from the beginning of the answer, not measured from the beginning of the question. The reasons for measuring the pupil size from the beginning of the answer in this study are the large differences in the length of each question and response. For example, the cognitive load question is a long, open question, such as “Please tell me in reverse order what happened in the assistant room”. Therefore, it takes a relatively long time to ask questions and respond. On the other hand, the emotional arousal question is a short, closed question like the question “Did you come to lie to me today?” So, a relatively short response of yes or no will be made. Thus, we measured changes over the same time period using the pupil size just before the participant started to respond.

When we look at the self-report questionnaire results of the State Shame and Guilt Scale, there is no difference in the shame and guilt of the guilty group and innocent group before the test. On the other hand, there was a significant difference in the shame and guilt of the guilty and innocent groups after the test, and the shame and guilt of the guilty group was significantly higher than that of the innocent group. This can be attributed to the fact that after the test, the guilty group experienced a shame and guilt about lying unlike the innocent group. It means that the mock crime was effective for the participants in a high-stake and real-life criminal situation.

The limitations of this study are as follows. First, we only use the pupil size as a measurement index. If additional indicators (e.g., gaze aversion; Meijer, Verschuere, Gamer, Merckelbach, & Ben-Shakhar, 2016) are used with the pupil size in a future study, more systematic and accurate results will be obtained. Second, in this study, we aimed to increase the level of anxiety of the participant through simulation crime scenarios with ecological validity and to increase the possibility of generalization of polygraph detection results. However, there was no difference in state anxiety between the guilty and the innocent before and after the test. This is because most of the participants were students, so it was relatively difficult for the assistants and labs in the school to feel anxiety and threat. Future research will need to broaden the scope of the environment, increasing the anxiety of the crime scene and lie detection interviews. Third, although we tried to assign cognitive load and emotional arousal by different

interview styles (e.g., information-gathering interview style vs. accusatory interview style), the results of this study can be seen as difference in the length of answer because of different question types (e.g., open-ended question vs. closed-ended question) rather than the result of cognition load and emotional arousal. In future study, it would be better to unify the question type into open-ended question. Fourth, since the difference in state anxiety between the two groups has not been verified, it is difficult to interpret the result as a superior role of cognitive load. It may be interpreted that the manipulation of physiological arousal and anxiety was poor.

Despite these limitations, this study is significant in that it increases the possibility of detecting a lie by confirming the relative influence of cognitive load and emotional arousal on the pupil size change of the lying person through the eye tracker. The guilty individuals' pupil size changes due to cognitive load was greater than pupil size changes due to emotional arousal. This is consistent with the Activation-Decision-Construction Model (ADCM), which requires more cognitive effort because the guilty individual goes through the extra steps of deciding and constructing a lie than the innocent individual (Walczyk et al., 2013), and because the pupil size increases in situations where the cognitive load is high (Wang, 2011), the pupils expand when lying (Cook et al., 2012; Webb et al., 2009). We confirmed that the cognitive approach is more effective in explaining the lie, and we confirmed that it is possible to increase the lie detection rate by asking questions that increase the cognitive load rather than emotional arousal at the interview. Information-gathering interview style (Vrij, Mann, & Fisher, 2006), unexpected questions (Vrij et al., 2009), and reverse order (Vrij et al., 2008) are known to increase cognitive load. Currently, there is a need to search for additional response indicators because it is difficult to distinguish the physiological response of a lie from the truth teller by emotional arousal alone. Since the eye tracker can distinguish the cognitive load and emotional arousal of a lie by changes in pupil size, we can improve lie detection technology by using specific interview methods that will increase cognitive load.

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유죄 및 무죄 집단 간 인지적 부하 및 정서적 각성 질문에 따른 동공크기의 변화의 차이

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본 연구는 거짓말 탐지 시 정서적 각성 및 인지적 부하가 동공 크기 변화에 미치는 영향을 확인했다. 총 60명 모집 후, 참가자가 자발적으로 집단을 선택했다. 유죄 집단(n = 30)은 모의 범죄(현금 훔치기)를 수행하고, 무죄 집단(n = 30)은 연구 조교 사무실에서 임무(메시지 보내기)를 수행했다. 그 후, 거짓말 탐지 면담 질문 중에 웨어러블 아이트래커를 사용하여 동공 크기를 측정했다. 면담 질문은 인지적 부하 질문 3개, 정서적 각성 질문 3개, 중립 질문 3개로 구성되었다. 실험 결과, 집단이나 시간의 주효과는 유의미하게 나타나지 않았으나, 집단과 시간의 상호작용은 유의미하게 나타났다. 즉, 동공 크기에 기반한 거짓말 탐지 시 인지적 부하 질문에 응답 할 때 유죄 집단이 무죄 집단 보다 동공 크기가 더 크게 증가했다. 이는 동공 크기를 기반한 거짓말 탐지 시 인지 부하를 유도하는 것이 정서적 각성을 유발하는 것보다 효과적임을 시사한다.

주요어 : 거짓말 탐지, 동공크기, 웨어러블 아이트래커, 인지적 부하, 정서적 각성