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ANALYSIS OF ANSWER TIMES IN RECOGNITION OF FACIAL IMAGES

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Abstract: *In visual interaction between people, faces are the element that most attracts observers, so facial images are also an important element of communication between people. The aspect of observing and memorizing facial images has often been the subject of research. When observing facial images, there are two important parameters: the dimensions of the facial images and the observation time. Both of them have a great influence on recognition performance. In our research, we set three different dimensions of face images (small, medium, and large) and four observation times for the observation test (1, 2, 4, and 8 seconds). Since the results of face image recognition success in terms of these parameters have already been reported in other studies, we focused on the observation times for face images in the recognition process. We hypothesized that when participants looked the facial image quickly (short answer times), they were more likely to be convinced of the correctness of the answer and, consequently, fewer false recognitions would occur. In contrast, when participants looked at the face image for a longer time during the recognition process, they hesitated more, and the rate of incorrect recognition was higher because they were not completely sure of their answer. We found that in all 12 cases, the average duration of correct answers was shorter than that of incorrect answers. According to the time distribution of the duration of all answers, we set two limits (2 and 3 seconds) and analyzed the wrong answers according to these time limits. We found that with longer answer times, the proportion of incorrect recognition increased strongly. This is particularly noticeable in the tests where participants observed the facial images for a longer time (8 seconds) and could therefore memorize them better.*

Key words: facial images, observation test, recognition test, incorrect recognition, eye tracking

1. INTRODUCTION

Two parameters are important for memorizing and recognizing face images: observation time and the dimensions of the facial images. These are all controlled conditions for observing facial images. However, the question is how well we remember these faces and how well we recognize them. Memory and recognition tests are performed according to the well-established method of memory tests (YES / NO tests) (Gillund & Shiffrin, 1984; Snodgrass & Corwin, 1998). These are essentially tests that consist of two parts: an observation test and a recognition test. The observation tests contain a series of facial images that participants view under controlled conditions (the display time of the facial images is fixed). In the recognition test, new facial images are added to the facial images and the observation test, the number of which must be equal to that of the observation test. Thus, in the recognition there are twice as many images as in the observation. In the recognition process, participants had free control over the recognition responses. The success of facial image recognition can be measured by the correctness of the participants' answers to the question whether the face they see in the recognition test was also shown in the observation test (i.e. answers YES / NO).

We were interested in the time of the answers and whether we could establish a relationship between the times of the answers and their correctness (basically incorrect answers). We assumed that a participant who is sure of his answer will give it quickly. If a participant takes longer to give his answer, it means that he is not sure of his correctness and therefore makes more incorrect recognitions. This would be useful in identifying criminals in various crimes (robberies, burglaries, murders, traffic accidents) (Senior & Bolle, 2002).

Since we wanted to find out the influence of the two above-mentioned parameters on the recognition success, we determined four different presentation times of facial images (1 second, 2 seconds, 4 seconds, 8 seconds) and three different dimensions of the images ("small", "medium" and "large"). Thus, we obtained 12 different tests. So, we measured the percentage of incorrect answers for all 12 tests.

2. METHODS

2.1 Participants

As mentioned above, we conducted 12 tests. Every test was done for 6 participants, so all together we recruited 72 participants (26 male and 46 female). They were our students and had normal vision. Average age was 20,6 years (SD = 1,02).

2.2 Stimuli

We took the images from the Minear and Park Face Database (Minear & Park, 2000). We prepared them in three different dimensions ("small" (320 px × 240 px), "medium" (640 px × 480 px), and "large" (1280 px × 960 px)). Thus, the size has increased by a factor of 2.

2.3 Apparatus

All tests were carried out in the Laboratory of Visual Perception and Colorimetry at the Department of Textile, Graphic and Design of the Faculty of Natural Sciences and Engineering at the University of Ljubljana. Setting up the environmental and testing system was based on the standards and recommendations (Pernice & Nielsen, 2009).
We performed the test with the Tobii X-120 eye tracking system. The distance between the test subjects and the screen with the facial images was 60 cm. Analysis were done in Tobii Studio 3.4.8 software. The defaults setting for definition of fixation was 100 ms for 30 px area. That means if eyes stayed in the area 30 pixel for at least 100 ms it was concerned as one fixation (Tobii Studio, 2016).

2.4 Procedure

We have conducted a memory test according to the previously mentioned YES/NO principle. We performed two tests, an observation test, and a recognition test. The procedure observation test is shown in Figure 1.

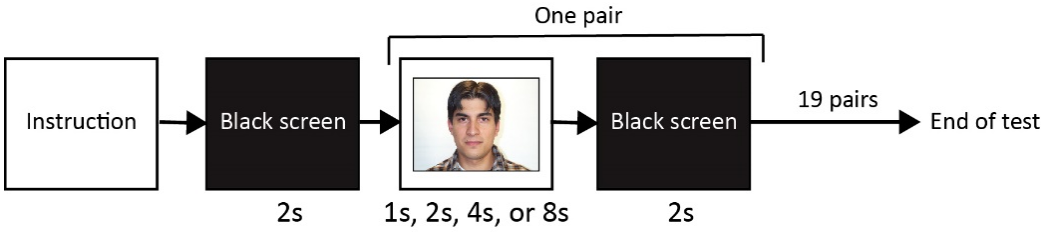

Figure 1: Procedure of the observation test

The observation test included 20 facial images (10 male and 10 female). According to the procedure in Figure 1, the tests lasted 1 minute (Test1s), 1 minute 20 seconds (Test2s), 2 minutes (Test4s), and 3 minutes 20 seconds (Test8s). The observation test was followed by the recognition test (Figure 2).

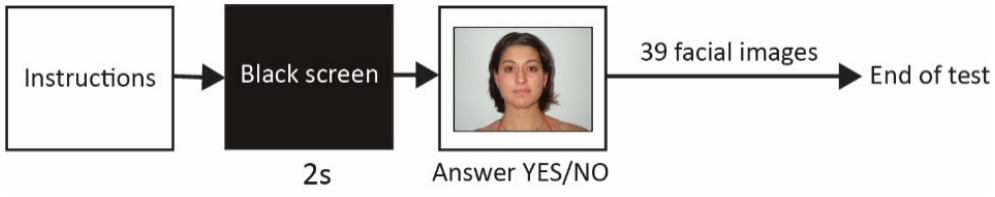

Figure 2: Procedure of the recognition test

Here we have added 20 new facial images to the original 20 facial images of the observation test. For each facial image displayed on the screen, participants were asked to indicate whether they had seen it in the observation test. We recorded their responses as correct or incorrect. Correct responses were those in which the participant answered correctly that the face image was included in the observation test or answered correctly that it was not included in the observation test. Incorrect responses were those in

which the facial image was not present in the observation test but in recognition test, participant said it was, and vice versa (the facial image was present in the observation test, but the participant did not confirm this in the recognition test).

2.5 Analysis of results

The first part of the study provided us with the results of the average time of correct answers (CA) and incorrect answers (IA) answers for each of the 12 tests. Here we wanted to confirm the assumption that the times for correct answers are shorter than the times for incorrect answers.
In the second part of the study, we were interested in the percentage of incorrect answers in relation to the duration of the answer. We assumed that for answers that took longer than a certain amount of time, the percentage of incorrect answers would be greater than the percentage of incorrect answers for all answers. To determine the time limit for the responses, we first distributed all answers according to their time duration. Figure 3 shows the time intervals, the number of responses in each time interval and distribution of the number of responses according to time intervals.

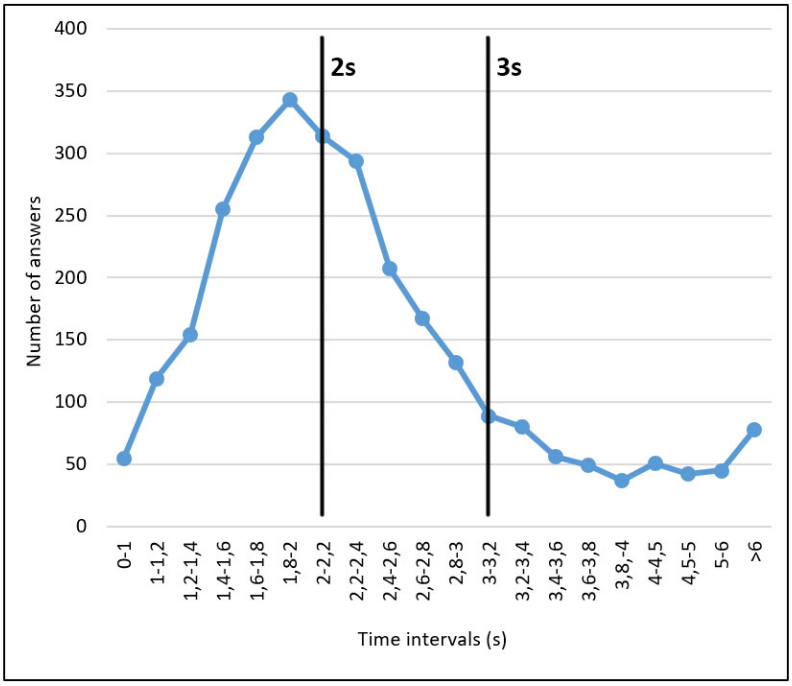

Figure 3: Time intervals, number of answers and distribution of the number of responses according to time intervals

The time intervals were set according to the duration of the answers. Where there were a lot of answers (answers duration between one and four seconds), the time interval was 0.2 seconds. For answers that lasted between four and five seconds, there were two intervals of 0.5 seconds, while for the other answers the interval was one second. Finally, all answers that lasted longer than six seconds were grouped together. In total, there were 2880 answers (72 participants, each had 40 answers).
Based on this distribution, we wanted to set two time limits for the duration of answers, for which we calculated the percentage of incorrect answers. Based on this distribution and the earlier finding that incorrect answers take longer than correct ones, we set these two time limits (two and three seconds). Thus, for each test, we were interested in the percentage of incorrect answers if they lasted longer than two seconds or longer than three seconds.

3. RESULTS

The results of the first part of our research are shown in Table 1. The average times of correct and incorrect answers for all 12 tests are given.

Table 1: Time of correct answers (CA) and incorrect answers (IA).

Average time of answers [s]			Time of observation tests			
			1s	2s	4s	8s
Dimensions of facial images	small	CA	2,27	2,49	2,56	2,35
		IA	2,54	3,09	3,06	4,02
	medium	CA	2,66	2,39	2,29	2,02
		IA	3,38	3,38	4,16	3,14
	large	CA	1,93	2,29	2,59	2,19
		IA	2,52	3,79	4,42	3,90

As mentioned earlier the second part of the study, we were interested in the percentage of incorrect answers in relation to the duration of the answer. Figure 4-7 shows the percentage of incorrect answers for three categories: all answers, answers lasting longer than 2 seconds, and answers lasting longer than 3 seconds. The graphs are shown for different presentation times of the facial image in the observation test (1s, 2s, 4s, and 8s).

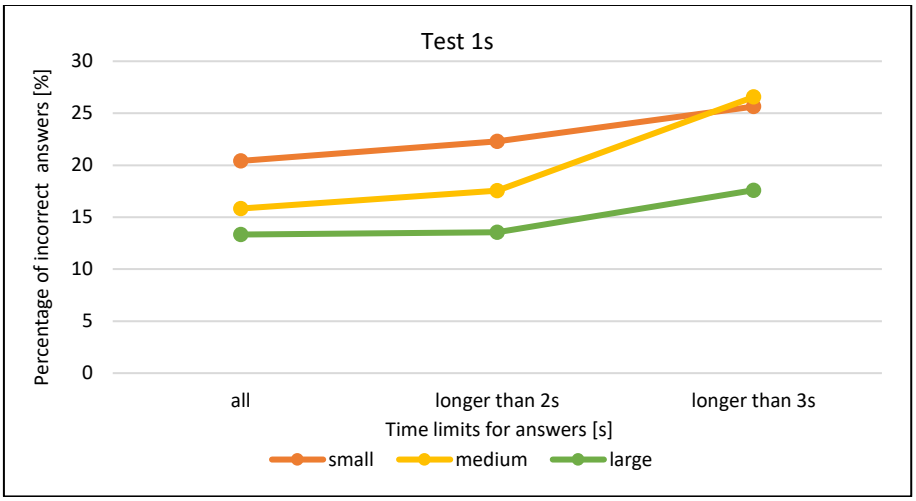

Figure 4: Incorrect recognition for all answers and two time limits for 1 second observation test

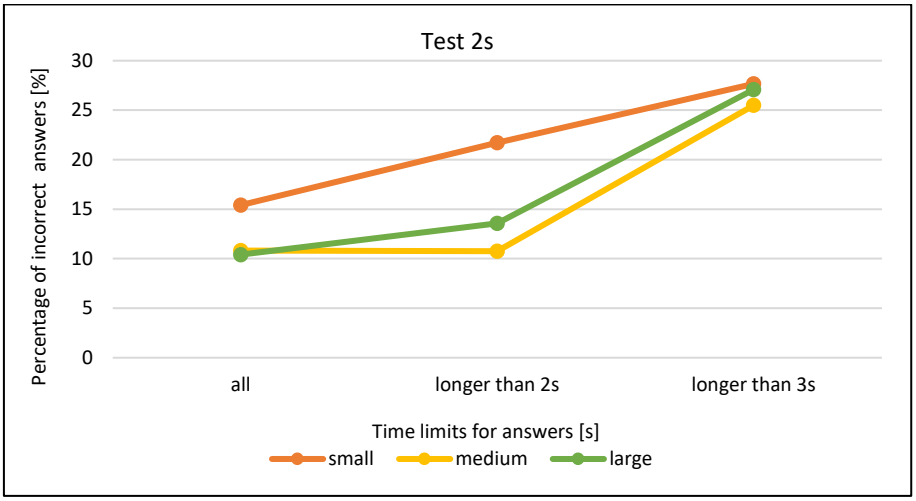

Figure 5: Incorrect recognition for all answers and two time limits for 2 second observation test

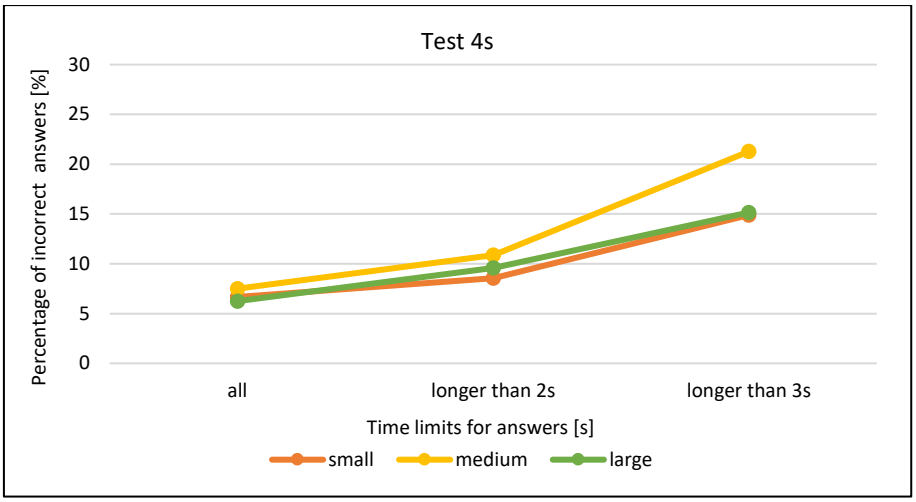

Figure 6: Incorrect recognition for all answers and two time limits for 4 second observation test

Figure 7: Incorrect recognition for all answers and two time limits for 8 second observation test

4. DISCUSSION

As we assumed, all tests confirmed that responses took longer with incorrect recognition than with correct recognition, which was also found out in the study by Liu and Chaudhuri (Liu & Chaudhuri, 2002). The difference between the times for correct and incorrect answers is greatest for the 4s and 8s tests. Thus, the times for correct answers were very short (2.02 to 2.59 seconds) when participants had enough time to look at the facial image in the observation test and consequently remembered it better, whereas for incorrect answers they usually hesitated a lot and the times were much longer (3.06 to 4.42 seconds). During the tests themselves, we found that participants made more incorrect recognitions if they hesitated to answer (which, of course, meant a longer response time). When they were confident of the correctness of their recognition response, response times were generally short.

In all the different time tests, we find that the percentage of incorrect answers is higher for longer answer times. This is due to our observations where we found that the participant answered quickly when he was sure of the answer. The longer he thought, the more often he recognized incorrectly. The differences between the percentages of incorrect answers as a function of answer time are largest for the 8-second test, where the percentage of incorrect answers among all answers is very low, regardless of the dimension of the facial images. It is also relatively low for all answers longer than two seconds. However, it increases rapidly for answers longer than three seconds (for medium-sized images, there are as many as 22.2% incorrect responses for responses longer than three seconds answers compared to 3.8% incorrect answers among all answers). The smallest increase in this trend is, of course, in the 1-second observation test, where the percentage of incorrect answers among all answers is quite high regardless of

the size of the face images (small 20.4%, medium 15.8%, and large 13.3%). Again, the percentage of incorrect answers increases with increasing response time (answers longer than three seconds: small 25.6%, medium 26.6%, and large 17.6%), but to much less than in other tests. All these numbers support the assumption that a longer answer time significantly increases the probability of incorrect facial recognition. The reason for this, in our opinion, is the uncertainty of the participants about the correctness of the answer.

5. CONCLUSIONS

In our study, we wanted to find out the relationship between the duration of answers and their correctness in recognizing facial images. We used the well-established method of the memory test. Since we wanted to cover a broader aspect of the test, we included images in three different dimensions and used four different presentation times of facial images (1, 2, 4, and 8 seconds) in the observation test. For all tests, the average times for correct answers were shorter than the average times for incorrect answers. In addition, the percentage of incorrect responses as a function of duration of answers was determined even more precisely. Here, for all 12 tests, the percentage of all incorrect answers, the percentage of incorrect answers lasting longer than 2 seconds, and the percentage of incorrect answers lasting longer than 3 seconds were determined. Again, for the 4s and 8s tests, it is very clear that for answers that take longer than 3 seconds, this percentage increased significantly compared to all answers (from about 5% to 15-20%), indicating very clearly that participants answered incorrectly in the recognition test much more often when they hesitated than when they answered quickly.

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