

A comparative analysis of black - white and colored numerical concepts organization in the short-term memory of the brain system

Lotfali Massoumi Moghadam¹, Masoud Ganji², Fatema Seidalai³, Masoomeh Dadkhah³, Maryam Alipoor³

¹. Department of Biology, Mohaghegh Ardabili University, Ardabil, Iran

². Department of Statistics, Mohaghegh Ardabili University, Ardabil, Iran

³. Department of Animal Science, Mohaghegh Ardabili University, Ardabil, Iran

lotfi.massoumi@gmail.com

Abstract: For the human to understand his nature, he receives some of its understandable information in the form of memory and remembers it. Information resides in neurons as molecular and ionic events and thus different types of memory are created. The aim of this study was to determine the effect of light waves of different frequencies on human short-term or long-term memory. The software programming for this study was based on previewing numbers in the brain hemispheres. The numbers that emerge in parts of a triple screen are sufficiently low contrast that the eye can put a spin on them so that the yellow spots do not have any number image, and the images resulting from the emergences are only previewable in one brain hemisphere; this is based on the temporal and nasal neural structure of the visual areas. Thus, the numbers only become possible pictures in both hemispheres when they appear in the central part of the triple screen. In series A the reaction time difference between the first and second groups was significant and equal to 17.09 milliseconds. In series B the reaction time difference between the first and second groups was also significant and equal to 8.1 milliseconds. This study has tried to compare colored and black-white memory formation in humans.

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1. Introduction

For the human to understand his nature, he receives some of its understandable information in the form of memory and remembers it (1). Information is neither matter nor energy, but resides in neurons as molecular and ionic events and forms short-term or long-term memory (6). Other animals besides humans also use different subjective information memory, gained from their environment (6). For example, studies have shown that chimpanzees' short-term memory is stronger than human short-term memory, but human long-term memory capacity, unlike short-term, is unlimited, and it is always ready to accept a host of information (1). Different regions of the brain are involved in different records in a way that indicates five different types of brain, and creates different kinds of disorders in human memories (4).

In recent years, many studies in the field of memories that are stored in different parts of the human brain system have been conducted, but the complexity of the brain prevents full access to functional brain information (10). Among these researches are studies about the effect of various factors in visual memories and, in recent research, the effect of light waves of different frequencies has been discussed.

2. Material and Methods

The software programming of this Reaction Time Test (RTT) study was conducted according to the following algorithm. The software was based on previewing numbers in the brain hemispheres (1). The numbers displayed in parts of the triple screen are sufficiently low contrast that the eye can put a spin on it so that the yellow spots do not have any number image, and the images emerging are only previewable in one brain hemisphere; this is based on the temporal and nasal neural structure of the visual areas (4). Thus, the numbers only become possible pictures in both hemispheres when they appear in the central part of the triple screen.

At the central part of the triple screen three double-digit (11-99) numbers appear as efficiency. Each of the two-digit numbers is displayed for 250 milliseconds. The interval between the numbers appearing is 100 milliseconds. The fourth number, the target number, appears after a period of one second for the same duration (250 milliseconds). This number may be one of the numbers that appears in the box or not one of them. After the appearance of this number, the test entrant has 750 milliseconds in which to answer. If the desired number is one of the three drop numbers, the test entrant should activate the key within the specified time to enable the

reaction time to be recorded, but if the desired number is not one of the three drop numbers, the test entrant should not activate the key, or else this will be considered an incorrect answer. If the experiment does not produce any form of response, it will be considered abandoned (9).

The numbers of correct, incorrect and abandoned answers (without testing limits) are calculated separately. The desired number could be in any one of the positions - right, middle, or left. The fourth number may also appear in any one of the right, center, or left situations. Thus, a total of 9 modes (cycle) is possible. With the appearance on screen of the fourth number, this number can also appear in the right, left or both hemispheres of the brain. When the target number and one of the three numbers appear in the middle part of the triple screen, a shorter reaction time often occurs. When the image of the above numbers appears in both hemispheres, because of the presence of the information in both hemispheres, the reaction time is faster compared to other states; it may show a marked reduction. In other cases, the image of the displayed numbers appears in only one hemisphere and because of the lack of symmetrical brain hemispheres, the information is initially transferred to the other hemisphere for decision-making and only after processing will it appear as a response. The colored software algorithm is similar to the black - white algorithm but in some cases there is little change regarding the coordinated colors and according to general physiological principles (9).

In this software, like the black - white software program, first three two-digit numbers (with the intervals listed in the general algorithm) appear in parts of the triple monitor screen and then each of the numbers in the context will appear in the three main colors. Numbers and colors appear at the same time intervals as in the overall defined algorithm. The appearance of three colors in places as well, is the second functional control based on the overall defined algorithm. In this stage, the drop-test numbers appear first in the black - white background and then in the colored one, with the same numbers as they combined to mind file. After the specified interval, the desired number (fourth number) will appear. If this number is one of the three drop-test numbers, the test entrant should activate the test key. The answer will be correct when the desired number, including its background color is indicated; otherwise, the reaction time will be calculated as an incorrect answer.

This study was conducted at the Research Physiology Lab in the Faculty of Science in the University of Mohaghegh Ardabili and continued for about a year and a half. A calm environment was the

main focus to increase the power of the candidates to continue testing. Stages of this work were as follows:

- Announcement inviting volunteers to attend
- Determine the date and time of volunteer groups
- Testing developed on the program before noon and volunteers made aware of the project
- Two or three participants normally took part in testing daily
- After each volunteer attended the laboratory, he was first given a protocol to read and information about how the test was to be conducted
- After completing the protocol, volunteers practiced the software needed for the required skills. This stage often took a long time because most respondents were unfamiliar with the test systems or software
- When instructed, the test subjects prepared for the first designed programs
- After the first series, volunteers began to practice with the other software programs.

3. Results

In this study, the results of tests using 178 volunteers from various universities of the Ardabil province were evaluated. Results from 48 persons were abandoned with regard to the content or additional instructions and in addition the results from 40 volunteers were deleted based on the quantity or quality of responses provided. Thus the results of only 80 out of the 178 volunteers participating were evaluated in the statistical analysis. The results of these 80 students were in the form of two series (Series A and Series B). Each series consisted of two groups (Group I and Group II), and each group included twenty subjects who were tested in two phases in related experiments. Thus, each series consisted of 40 volunteers.

The interval between the numbers appearing is 100 milliseconds. The fourth number, the desired number, appears after a period of one second, displayed for the same duration (250 milliseconds). This number may be one of the numbers that appears in the box or not. After the appearance of this number, the test entrant has only 750 milliseconds to answer. If the desired number is one of the three drop numbers, the test entrant should activate the key before the specified time limit to enable the reaction time to be recorded; if the desired number is not one of the three drop numbers, the test entrant should not activate the key or else the answer is considered incorrect. If the experiment does not produce any form of response, it will be considered abandoned. The respondents were divided between two series of experiments, because of the long duration of the testing at each stage and the possibility of this influencing the next step. First, series A did the black

- white software program and then, after appropriate training, tested the colored program. Given that the colored software program seemed more difficult than the black – white one, which might lead to volunteer fatigue or decreased concentration, the series B volunteers tested the colored software first and only in the second stage tested the black - white software. Thus, the results of both series reflect the same activity level.

3.1. Series A

In this series two groups of 20 people each were tested.

3.1.1. First group

The group in the first stage, after studying and completing the relevant protocol, began to gain

enough skill to practice the tests and then continued their preparation. This first stage of getting ready for the test varies in different people, based on their neural structure, concentration, mental state and various environmental factors. According to the recorded information, acquiring the skills for these tests takes different amounts of time and this is why the volunteers were not required to gain the skills in a limited time, but only when they felt they had mastered the task and also obtained the necessary speed to continue. The volunteers in both groups in this series performed their experiments in two stages. First they tested the black - white software and then the colored software program.

Table 1. Reaction time and averages, using black - white software program in the first group (first stage)

A G1 –bw	1	2	3	4	5	6	7	8	9	Average
Prac-1	609	601	651	580	527	726	560	466	629	594.3
Prac-2	562	499	593	619	440	568	555	422	508	529.5
Prac-3	559	550	671	548	629	550	540	496	523	562.8
Prac-4	478	472	491	543	410	520	485	405	522	480.6
Prac-5	481	390	379	403	345	468	398	357	390	401.2
Prac-6	609	528	546	580	488	445	528	474	581	531.0
Prac-7	621	589	580	618	549	544	505	491	562	562.1
Prac-8	550	622	646	608	482	562	555	395	515	548.3
Prac-9	437	350	415	355	319	405	296	313	447	370.7
Prac-10	485	401	420	477	408	421	435	399	450	432.8
Prac-11	606	549	635	598	510	587	525	456	524	554.4
Prac-12	412	409	427	367	468	410	392	443	444	419.1
Prac-13	616	450	608	633	474	549	525	455	534	538.2
Prac-14	521	465	457	476	558	562	483	405	473	488.8
Prac-15	468	416	523	468	423	431	505	430	462	458.4
Prac-16	398	428	437	491	431	525	499	465	565	471.0
Prac-17	383	450	421	574	515	483	515	593	479	490.3
Prac-18	650	577	624	569	492	632	579	518	609	583.3
Prac-19	549	431	534	585	511	536	466	428	440	497.7
Prac-20	484	468	484	450	518	489	588	417	546	493.7
Average	526.1	485.6	520.4	529.8	474.1	523.0	495.4	441.4	509.3	500.6

In this study, because of its method of computer analysis, the data gathered and listed in the tables was too long for presentation here. For this reason, Tables 1 and 2 show samples of the results obtained, while in the remaining cases we present only parts of the statistical results. It should be remembered that each of the numbers listed in the table (other than the section averages) is itself the average of 180 numbers. Each part numbers mean as well about 1620 averages, and the overall average of each table, shown at the bottom right, is the mean of 14580 reaction times in milliseconds.

Average reaction time in the black - white stage was 500.6 milliseconds and in the second stage (colored program) was 478.5 ms, which shows a 22.1

millisecond reduction compared to the first stage. A review of the tables for the test subjects' reaction time in the first and second stages of this group, using a paired sample t-test, identified a significant difference between the averages of the black – white and colored tests.

The results of paired sample t-test are proof of the difference in the test subjects' average reaction time in the first and second stages of this first Series A group, and from the fact that a significant level of the two ranges for this hypothesis is 0%, and this alpha value is less than significant level 5%, one can conclude that there is a significant difference between the mean of these two steps. These concepts are shown in Figure 1.

Table 2. Reaction time and averages, using colored software program in the first group (second stage)

A GI -co	1	2	3	4	5	6	7	8	9	Average
Prac-1	429	484	457	399	445	500	445	376	444	442.1
Prac-2	538	577	603	543	504	597	562	425	519	540.8
Prac-3	603	587	509	601	625	656	582	515	601	586.5
Prac-4	430	475	460	480	451	460	490	402	485	459.2
Prac-5	427	435	505	424	415	505	430	365	538	449.3
Prac-6	526	561	573	555	402	499	596	570	583	540.5
Prac-7	582	534	594	570	511	521	582	534	530	550.8
Prac-8	536	546	645	512	413	507	493	395	466	501.4
Prac-9	441	370	473	390	364	440	483	392	437	421.1
Prac-10	421	403	435	458	418	403	432	394	348	412.4
Prac-11	520	524	616	525	476	543	486	468	437	510.5
Prac-12	432	434	456	398	388	414	647	409	384	421.2
Prac-13	718	628	645	582	508	590	506	325	635	592.7
Prac-14	515	565	595	539	477	590	516	447	476	524.4
Prac-15	372	417	541	504	491	484	521	487	484	466.7
Prac-16	506	512	489	584	484	485	703	595	562	546.6
Prac-17	361	390	375	334	431	411	90	476	452	393.4
Prac-18	562	541	551	571	511	528	484	476	540	529.3
Prac-19	394	459	667	576	452	489	450	345	450	464.6
Prac-20	470	402	395	470	403	430	450	380	483	431.4
Average	492.7	443.7	494.9	502.6	458.4	500.7	497.4	438.8	489.1	478.5

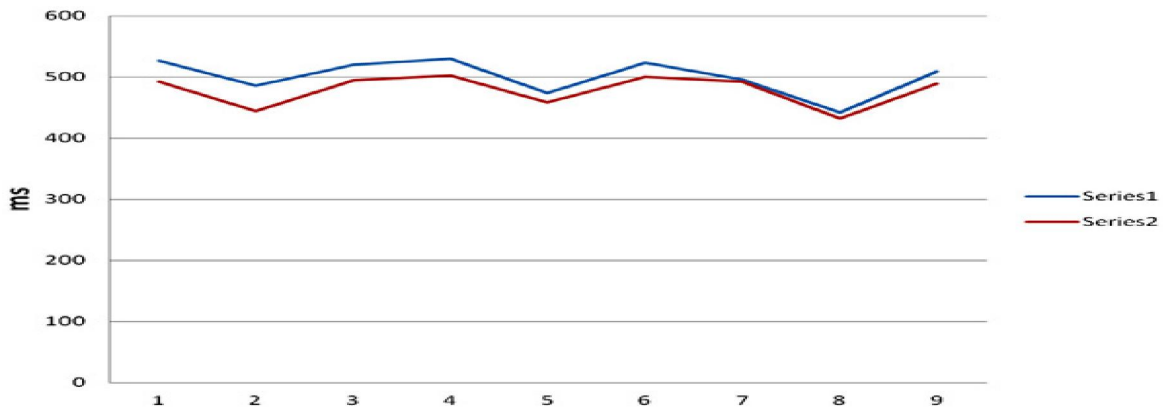


Figure 1. The significant difference between the mean of the two stages in the first Series A group.

Table 3. Analysis of reaction times in the first and second stage of this group using paired sample t-test to prove difference of means in using black – white and colored software

Significant level	Degrees of freedom	T value	Difference of average	Number	Reaction time average	Applications
0%	8	5.09	22.1	9	500.6056	Black-white
					478.5167	Colored

Table 4. Analysis of reaction times in the first and second stage of the second Series A group using paired sample t-test to prove difference of means in using black–white and colored software

Significant level	Degrees of freedom	T value	Difference of average	Number	Reaction time average	Applications
1%	8	-3.36	19.39	9	473.6222	Black-white
					493.0167	Colored

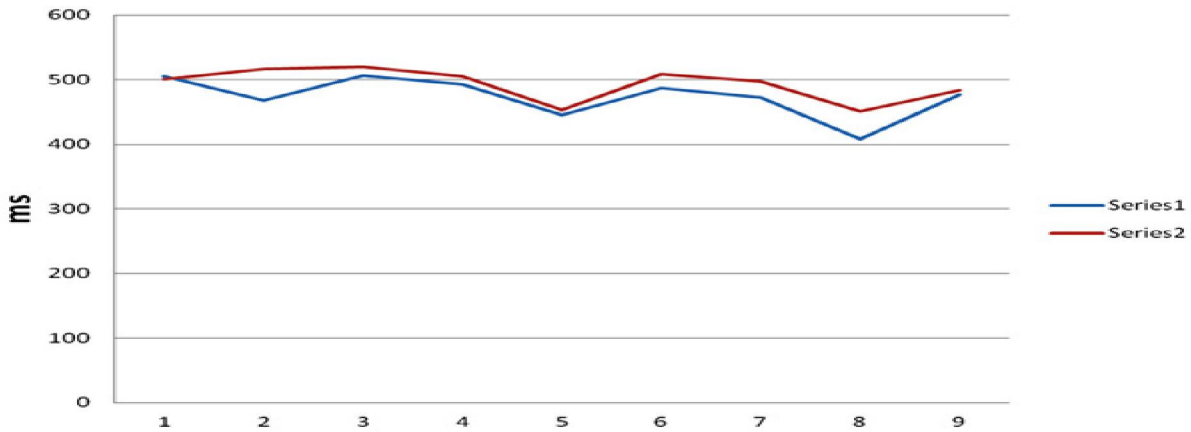


Figure 2. The significant difference between the mean of the two stages in the second Series A group.

3.1.2. Second group

The second group of Series A, just like the first group, performed the tests in two stages. The main reason for repeating the test with other volunteers was the problem of results that were not identical in different individuals. A larger number in a group allows elimination of some individual differences in the test subjects, but in smaller groups it is possible to compare results grouped in a series of multiple stages, providing more accurate conclusions. In this group 20 subjects again participated in the first stage and tested their reaction times in the black-white software program. Then this second group of Series A continued to the second stage with the colored software program. The volunteers' average reaction time in the first stage was 473.6 milliseconds and in the second stage 493.35 milliseconds, showing a 19.39 milliseconds increase compared with the first Series A group. A review of the tables of test subjects' reaction times in the first and second stages of this second group using a paired sample t-test, identified a significant difference between the averages for the black – white and colored tests.

The results of the paired sample t-test are proof of the difference in the test subjects' average reaction time in the first and second stages of this second Series A group, and from the fact that the significant level of the two ranges for this hypothesis is 1%, and this alpha value is less than significant level of 5%, one can conclude that there is a significant difference between the mean of these two steps.

3.2. Series B

In this series two groups of 20 persons took part in similar experiments, except that the volunteers tested the colored software program in the first stage and then tested the black-white software program in the

second stage. Study of the Series A protocols of the test respondents made it clear that all volunteers noted that working with the colored software application was more difficult than the black-white one, and actually getting ready to work with the program took a longer time. We had predicted this was likely from the early stages of our development proposals, which was why it was decided that the Series B test should use the colored software as its first stage to prevent unwanted changes.

3.2.1. First group

This group, after studying and completing the relevant protocol, began to gain enough skill to practice the tests and continue their preparation. They did the first stage of the test with the colored software application. As stated above, getting ready to work with this program was quite difficult for the volunteers and they all wanted to prepare for a considerable duration. After completing the first stage of testing with colored software, the test subjects started to practice the skills needed to continue testing in the second stage, and after a little time, they announced they were ready to begin the second phase of tests. A review of the reaction time changes in the first stage of the test by this group of respondents in Series B shows a mean reaction time of 493.46 milliseconds.

In the second phase of this series, it was 510.22 milliseconds, a difference of 76.16 milliseconds. A review of the tables of the test subjects' reaction time in the first and second stages of this group, using a paired sample t-test, identified a significant difference between the averages of the black-white and colored tests. Data for the two classifications are listed in Table 5.

Table 5. Analysis of reaction times in the first (colored software) and second (black-white software) stages of the first Series B group, using paired sample t-test.

Significant level	Degrees of freedom	T value	Difference of average	Number	Reaction time average	Applications
0%	8	3.96	-16.76	9	493.4611	Colored
					510.2222	Black- white

Table 6. Average reaction time analysis in the first and second stages of the second Series B group, using paired sample t-test.

Significant level	Degrees of freedom	T value	Difference of average	Number	Reaction time average	Applications
0%	8	-0.26	-8.66	9	477.6611	Colored
					486.3222	Black-white

Table 7. Changes in reaction time to black - white and colored software programs in the first and second series.

Significant level	Degrees of freedom	T value	Difference of average	number	Reaction time average	Applications
0%	8	5.36	4.51	9	492.7	Black-white
					485.6	Colored

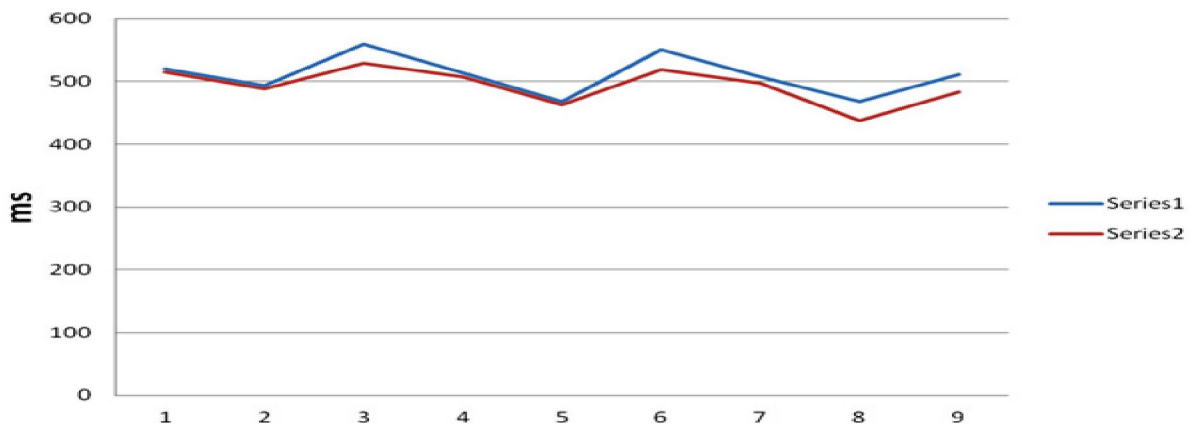


Figure 3. Based on the volunteers' average reaction time, this shows the significant difference between the mean of these two stages in the first Series B group.

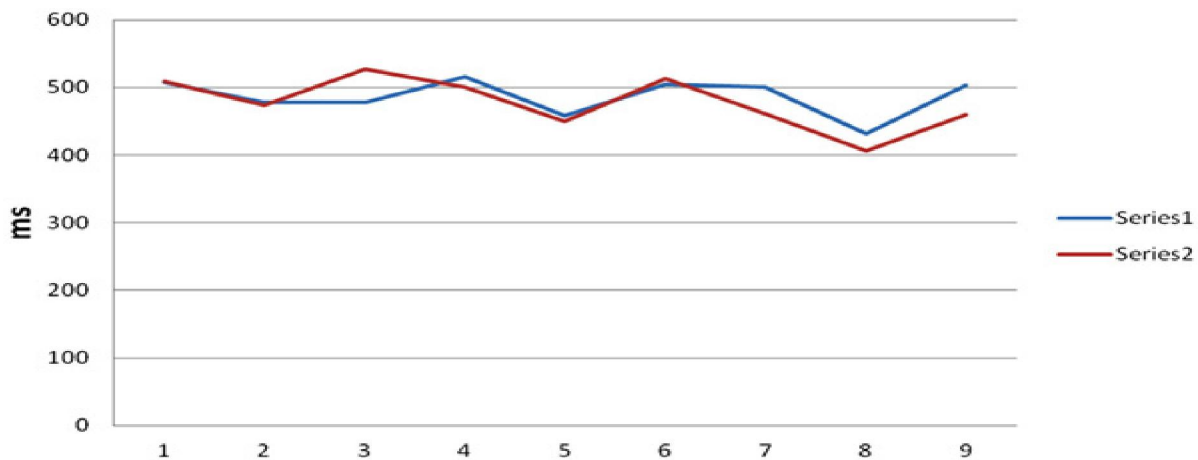


Figure 4. This shows the significant difference between the mean of these two steps.

The results of the paired sample t-test are proof of the difference in the test subjects' average reaction time in the first and second stages of this first Series B series, and from the fact that the significant level of the two ranges for this hypothesis is 0% and this alpha value is less than significant level 5%, one can conclude that there is a significant difference between the mean of these two steps. These concepts are shown in Figure 3.

3.2.2 Second group

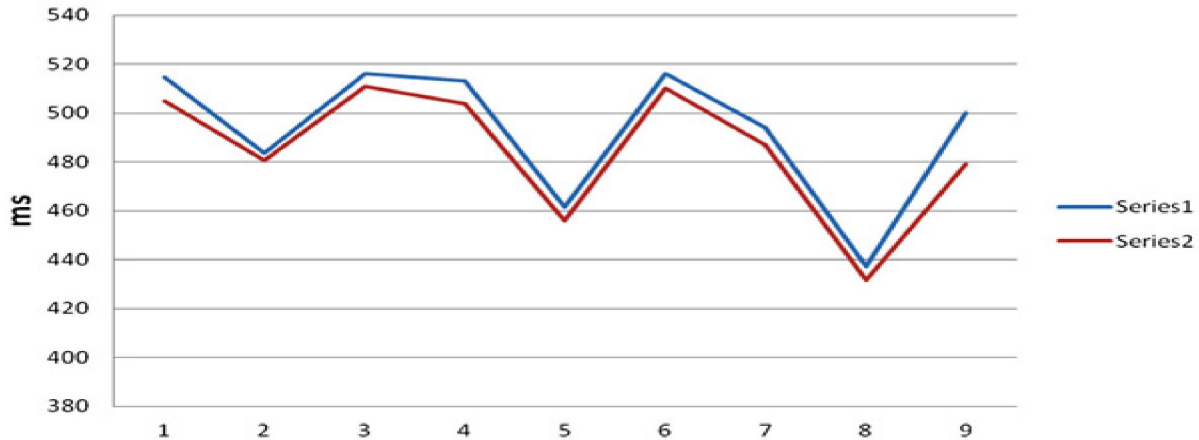


Figure 5. In this figure, reducing reaction time and thus speeding up of the formation of colored memory are seen.

A review of the tables of the test subjects' reaction time in the first and second stages of this second Series B group, using a paired sample t-test, identified a significant difference between the averages of the black – white and colored tests. The results of the paired sample t-test are proof of the difference in the test subjects' average reaction time in the first and second stages of the second Series B group, and from the fact that the significant level of the two ranges for this hypothesis is 0% and this alpha value is less than the significant level 5%, one can conclude that there is a significant difference between the mean of these two steps. These concepts are shown in Figure 4. Comparison of all the results shows that only in one of the eight steps – with the second Series A group - was the volunteers' reaction time slower working with the color software program than with the black–white. Generally, the participants' colored memory formation occurred faster with the colored than with the black–white test program, which meant their response was enhanced.

The results of the t-test with paired samples are proof of the difference in the test subjects' average reaction time in both stages of the first and second series (A & B), and from the fact that the significant level of the two ranges for this hypothesis is 0%, and this alpha value is less than the significant

This group, after studying and completing the relevant protocol, began to gain enough skill to practice the tests and continued their preparation, they did the first stage of test with the colored software application and then the second stage of testing with the black - white program. The average reaction time of the volunteers after testing with colored software was 477.66 milliseconds and in the experiment with black - white software it was calculated as 486.32 milliseconds, showing a 8.66 milliseconds increase compared with the colored software.

level, one can conclude that there is significant difference between the mean of these two steps. Studying the reaction time of all participants in the black - white and color software programs, we identified a significant difference (7.1 milliseconds) between the reaction time for these two categories. This difference indicates that colored short-term memory formation takes place faster than black - white memory formation.

4. Discussions

Abundant and diverse opinions about the types of brain memory have been presented by different researchers (3). This study has tried to compare colored and black – white memory formation in humans. Comparisons between 80 volunteers showed that the reaction times for all colored short-term memory formation are almost always faster than the reaction times for black - white short-term memory formation (2). This result can be attributed to the interest of children, adolescents and even those of higher ages in colored paintings, colored films, colored television, colored newspapers, etc. (7).

Although the overall result was repeated several times, when volunteers were divided into two series (A&B) and each of these further divided into

two sub-groups, the results did not apply equally to all the participants in the test (3). In other words the effects of software are different in different people (5). For example, the reaction times for short-term memory formation in the black-white test participants in the two groups are longer than the reaction times for formation of their colored short-term memory (8), but in all other general respects the results are repeated.

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Corresponding Author:

Lotfali Massoumi Moghadam
Department of Biology,
Mohaghegh Ardabili University, Ardabil, Iran.
Email: lotfi.massoumi@gmail.com

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