Analysis of Effect by Duration of Cryotherapy in the Posterior region of Neck for College Students

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Abstract Attention is a fundamental aspect in the cognitive process of human. Cognitive system of human body requires to focus on selected information among a vast amount of information from sensory organs. It has widely studied that various environmental factors affected the level of attention; however, few researches have aimed to the effect of direct cryotherapy. In this research, level of attention was studied comparing sub-indexes of FAIR test between groups with different duration of direct cryotheapy to the back of neck. FAIR test is a evaluation tool for visual attention consisting of three sub-indexes. Selective attention, accuracy of attention, and persistence of attention can be independently analyzed by FAIR test. In the analysis of selective attention, cryotherapy for 5 to 20 minutes showed higher result than cryotherapy for 40 minutes. In the analysis of persistence of attention, cryotherapy for 5 to 15 minutes showed higher result than cryotherapy for 40 minutes. Overall, selective attention and persistence of attention turns out to be maximized between 5 to 20 minutes of cryotherapy and tends to decrease afterwards. However, accuracy of attention does not seem to be affected by the duration of cryotherapy. Correlation between selective attention and the skin temperature by cryotherapy tends to be negative supporting the findings by ANOVA and post-hoc test. Correlation between persistence of attention and the skin temperature showed similar results.

Key Words : FAIR, cryotherapy, selective attention, accuracy of attention, persistence of attention

1. Introduction

Attention is usually defined as an ability to concentrate one's awareness on a particular information or phenomenon among mixed stimuli from human sensory system [1]. Inattentional blindness, an unintentional ignorance to a unexpected event among mixed visual stimuli, is thoroughly examined. It is noticeable that significant amount of participants did not notice the unexpected events while they were told to pay attention to the basketball players' specific movement counting them in silence. Also, inattentional blindness level is related with the difficulty of the task to which the participant was told to pay attention [2]. From these findings, it is possible to say that attention is a psychological process recruiting available one's mental resources in order to deal with confronting problems.

There are a few important characteristics of attention to understand its mechanism. First, It is widely accepted that attention is based on the limited capacity of human cognitive ability; however, it should be considered as essential rather than lack of capacity because one can process far less information than given information from the environment. Second, because of the fist characteristic of attention, selection is systematically inevitable.

Simultaneous stimuli are obtained from multiple sensory organs and one must choose target information in order to achieve the goal of the following action. In the next process, accurate decision should be made with speed. In this procedure, information should be modulated. Finally the modulated information should be effective sustaining it over a prolonged period of time. This characteristic of attention is called vigilance. Also, attention can be categorized into external attention and internal attention [3].

It has been widely studied that attention might be affected many different factors. Students in a off-line class showed higher level of academic motivation and concentration than students in a on-line class [4]. Brain education results advanced achievements in attention level among elementary school students [5]. Indoor air quality was compared varying ventilation condition in order to identify the difference of cognitive functions among elementary school children [6].

A few temperature-related researches derived interesting finding as well. Controlled room temperature yielded difference in participants' attention ability after they are exposed to reading and study [7]. Similar result was obtained from the study on the electroencephalogram(ECG) analysis [8]. Cryotherapy is widely used among athletes after training sports activities [9]. Also, it is natural to massage the back of the neck with one's own hand in order to release tension during stressful activities such as study. In order to determine the relevance of such phenomenon, drect cryotherapy to the neck showed higher level of attention after the participants were exposed to study activity [10].

However, the sustainability of direct cryotherapy has not examined from previous researches.

The purpose of this study is to verify the relationship between attention level and reduced skin temperature of the anterior region of neck in order to examine sustainability of cryotherapical effect on attention for college students.

2. Research Methodology

2.1 Attention Level Evaluation

45 college students were participated in this study. All participants were available to read and understand the instruction as well as to complete Frankfrute Aufmerksamkeits Inventar (FAIR) test. All participants have no visual disability and the history of known cognitive dysfunction.

Every participant was required to wear a cooling pad on one's posterior region of neck. They were instructed to fit the cooling pad to one's neck with no gap between the neck and the pad. The cooling pad provided 6 individual blocks and each block is filled with refrigerant liquid with 14℃ and 20℃ of solidification point. Those temperatures were empirically set by the manufacturer in order to minimize the discomfort due to the chill; however, related data was not revealed. The cooling pad itself is flexible and thus equipped with a plastic frame for exact fitting.

The participants were divided into 9 groups and each group contains of 5 participants. Attention level was examined every 5 minutes group by group in accordance with the cryotherapy duration after wearing the cooling pad. Duration increment was compromised

because of two reasons. First, available number of participants were limited. Second, due to the nature of FAIR test, participants must read and understand the instruction prior to the test yielding different prep time among participants. Maximum duration was set up to 40 minutes since 20 minutes of exposure condition was studied in prior research [10]. Skin temperature of the neck was measured using a infra-red thermometer along with the duration of cryotherapy.

Table 1. Evaluation Protocol and mean neck temperature

Group	No. of Participants	Cryotherapy Duration (min)	Mean neck temperature (℃)
A	5	0	33.77*
B	5	5	22.70
C	5	10	22.15
D	5	15	21.87
E	5	20	22.42
F	5	25	23.63
G	5	30	23.75
H	5	35	23.58
I	5	40	24.10

* measured before cryotherapy

Attention level was examined by Frankfrute Aufmerksamkeits Inventar (FAIR) test, a self-marking evaluation tool. Participants are required to read the instruction and complete two evaluation forms within 3 minutes for each in accordance with the instruction. There was no time limitation reading the instruction; however most participants required no more than 10 minutes for reading the instruction. Every participant has a enough time to read the instruction before the cryotherapy. Skin temperature on the posterior region of the neck was measured along with the beginning of marking in FAIR test form. However, the first group (group A) was measured before they started marking.

One-way analysis of variance (ANOVA) was performed to identify the difference in attention level between cryotherapy duration. More specifically, three sub-indexes of FAIR, performance index (P), quality index(Q), and continuity index(C) were separately examined. Due to the central limit principle, sample size larger than 30 can be considered as following normal distribution, therefore ANOVA was available [11]. A post-hoc test was used at 0.05 of the significance level. Also correlation analysis was performed between mean value of sub-indexes and the mean value of skin temperature in the posterior region of the neck.

2.2 FAIR Test

FAIR test was developed to evaluate visual attention in 1995. It was locally normalized to use in Korea, 2002. Attention is a complex function in the human cognitive science. There are various theories for attention; however, there is an agreement that attention includes various sub-aspects. FAIR test is based on three sub-indexes, performance index (P), quality index(Q), and continuity index(C) [12].

Performance index (P) is decided by the total numbers of item completed in time limitation. P index indicates the selective attention of the participant. Q index refers to the accuracy of attention dictated by the amount of correct answers among all answers. C index refers to the persistence of attention avoiding mistakes [12].

FAIR test consists of a instruction sheet and two test sheets. The participant is required to read the instruction sheet and to complete each test sheet as much as one can within 3 minutes. The evaluator informs the participant the beginning and end of the marking and provides answers if there is any within the scope of written instruction.

Each test sheet contains 320 items. Each item is combined with 2 or 3 dots and shapes. Item shapes were either concentric circle(◎) or circle in a square(◉). Dots are printed in the shape with two patterns (⁚ or ⁖ for two dots, ∴ or ⋰ for three dots). Therefore there are 8 different types of items; however they are categorized into 4 kinds. The participant is required to only check 3-dot-concentric-circle (◎ ◎) and 2-dot-square-in-circle (◉ ◉) as much as one can within time limitation. Those items are printed in random manner in order to disperse participant's attention.

3. Results

As described in Research Methodology, the participants were divided into 9 groups based on the duration of cryotherapy. FAIR test was executed with increment of 5 minutes for the cryotherapy duration. Table 2 shows means and standard deviations of each index for every group. Table 3 represents that result of analysis of variance among groups for the indexes. Performance index and continuity index showed significant difference between groups at α=0.05.

Table 2. Mean and standard deviation of sub-indexes within group (P for Performance, Q for Quality, and C for Continuity)

Gro ups	P		Q		C	
	M	SD	M	SD	M	SD
A	419.6	55.1	0.942	0.027	395.2	53.3
B	508.0	64.0	0.943	0.046	478.7	61.5
C	515.4	62.5	0.954	0.015	477.3	49.9
D	504.2	45.6	0.946	0.018	491.5	55.4
E	484.4	56.0	0.934	0.015	453.1	57.9
F	422.0	44.2	0.955	0.025	403.7	49.8
G	451.2	38.1	0.919	0.034	415.2	45.4
H	403.2	53.0	0.918	0.019	370.8	55.0
I	372.0	59.5	0.917	0.063	343.2	72.5

Group A to I : characterized by cryotherapy duration from 0 min to 40 min with increment of 5 min from A to I

Table 3. Results of ANOVA on sub-indexes of FAIR (P for Performance, Q for Quality, and C for Continuity)

	P	Q	C
Sum of Square	108230	0.0093	109494
Mean Square	13528.75	0.0011	13686.75
F-ratio	4.68	1.08	4.34
P-value	0.01*	0.39	0.01*

* $p<0.05$

Results of post-hoc test on performance index and continuity index are shown in Table 4 and 5, respectively. Performance index of group A indicates no significant difference with any other group. Performance index of group B indicates a significant difference with only group I. Performance index of group C indicates significant differences with groups H and I. Performance indexes of groups D and E showed significant differences with group I. From these finding, it is possible to say that selective attention with a 5-minute cryothearpy (group B) is higher than selective attention with a 40-minute cryotherapy (group I). Selective attention with a 10-minute cryothearpy (group C) is higher than selective attention with a 35-minute and a 40-minute cryotherapy (groups H and I, respectively). Selective attention with a 15-minute (group D) and a 20-minute cryothearpy (group E) is higher than selective attention with a 40-minute cryotherapy. Overall, level of selective attention with 5-minute to 20-minute tend to be higher than level of selective attention with prolonged cryotherapy indicating effectiveness of cryotherapy between 5 to 20 minutes.

Table 4. Result of post-hoc test between groups on Performance index

	A	B	C	D	E	F	G	H
B	0.22							
C	0.15	0.99						
D	0.27	0.99	0.99					
E	0.61	0.99	0.99	0.99				
F	0.99	0.25	0.17	0.31	0.66			
G	0.99	0.76	0.63	0.82	0.99	0.99		
H	0.99	0.08	0.05*	0.11	0.32	0.99	0.89	
I	0.89	0.01*	0.01*	0.01*	0.05*	0.86	0.35	0.99

* p<0.05

Table 5. Result of post-hoc test between groups on Continuity index

	A	B	C	D	E	F	G	H
B	0.34							
C	0.36	0.99						
D	0.18	0.99	0.99					
E	0.78	0.99	0.99	0.97				
F	0.99	0.48	0.51	0.28	0.89			
G	0.99	0.69	0.71	0.46	0.98	0.99		
H	0.99	0.09	0.10	0.04*	0.36	0.99	0.94	
I	0.86	0.01*	0.01*	0.01*	0.08	0.74	0.53	0.99

* p<0.05

Table 6. Result of correlation analysis

	P Index	Q Index	C Index
Neck Skin Temp	−0.426	−0.007	−0.405

* p<0.05

While quality index does not show significant differences between groups, continuity index showed significant differences between a few groups. Continuity index of group H showed a significant difference with Group D. Continuity index of group I indicates significant difference with groups B, C, and D. Results of post-hoc test on the continuity index yield similar to the result of post-hoc test on the performance index. Persistence of attention can be advanced with cryotherapy from 5 minutes to 15 minutes compared to cryotherapy for 40 minutes indicating effectiveness of cryotherapy between 5 to 15 minutes.

A correlation analysis was performed between mean skin temperature of posterior region of neck and mean sub-indexes of FAIR test (Table 6). Selective attention indicated by the P index showed negative correlation (-0.426) with skin temperature yielding that the level of selective attention tends to decrease as the skin temperature rises. Similar correlation (-0.405) occurred between the persistence of attention and skin temperature. Accuracy of attention does not show correlation with skin temperature indicating correlation efficient of -0.007. However, none of these correlation coefficient showed statistical significance.

4. Conclusion

In this study, the level of visual attention was compared between various duration of cryotherapy in order to identify the effectiveness of the cryotherapy duration. Also the correlation between the skin temperature of the posterior region of neck and sub-indexes of attention. Cryotherapy between 5 and 20 minutes yielded significantly higher level of selective attention compared to a 40-minute cryotherapy. Also cryotherapy between 5 and 15 minutes yielded significantly higher level of persistence of attention compared to a 40-minute cryotherapy. Overall, selective attention and persistence of attention tend to be maximized between 5 and 15~20 minutes and decreased afterwards. Results of correlation analysis back up the tendency indicating negative correlation between the skin temperature and selective attention as well as the persistence of attention.

Participants of this study is limited to college students in their 20s. The level of attention tend to vary by age, therefore it is strongly advised not to expand the result of this study to

general population. Although all measurement was placed air-conditioned indoor, outdoor weather condition was not considered. This could be another limitation of this study because our body feels temperature differently depending on the climate.

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