

Relationship between Mental Health Stress Levels and Cognitive Function

Kazue Sawami^{*}, Mitsuo Kimura¹, Himeyo Nakagawa¹, Tetsuro Kitamura¹ and Chizuko Suishu²

¹Nara Medical University, Kashihara, Nara, Japan.

²Shubun University, Ichinomiya, Aichi, Japan.

*Correspondence:

Kazue Sawami, Nara Medical University, Kashihara, Nara, Japan,
E-mail: sawami@naramed-u.ac.jp.

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ABSTRACT

Introduction: As to addiction, it is evident that high palatability (addictive) substances, such as drinking alcohol or smoking, all occur due to emptiness, psychologically the same mechanism, with emotional and mental factors playing a big role. Therefore, we have, focused on mental soundness, and researched the relationships between mental health level/stress and cognition/judgement. Furthermore, through a brain training game employing rhythmical exercises and touching, we have clarified whether this will mitigate mental stress and affect cognitive functions, too.

Methods: Subject: We recruited 100 people living in the area by public information in Kashihara City. It was a three month intervention, comparing the results with controls and interventions. The evaluation scale is as follows.

Measurement of cognitive function: The Montreal Cognitive Assessment (MoCA-test). Measurement of emotional states: Japanese version General Health Questionnaire 12 (GHQ-12).

Measurement of negative stress: Measuring salivary α -amylase concentration.

Results of the MoCA test and saliva α -amylase: In the t-test after the intervention (implementation), positive increases in areas such as recalling animal names (reproducing ability), repetition tests (memory), digit span tasks both sequential and reverse, sustained attention, calculation (concentration, attention and memory) have been statistically significantly recognized (p/t, 5% level). As for saliva amylase that reflects mental stress in comfort / discomfort, the measured value before the intervention was 46.3 KU/L; that after the control period was 45.5 KU/L, with no major changes seen. After the intervention, on the other hand, the value was lowered to 33.4 KU/L with the statistically significant decrease of mental stress recognized (p/t, 1% level).

Results of the GHQ-12: There were correlation between GHQ score and Alternating Trail Making, Attention, Abstraction, Delayed recall, Orientation, and total score, while cognitive function was high when mentality state was also healthiness.

Conclusion: The cognitive training employing rhythmical exercises and touching not only improved cognitive functions but also reduced stress. With the correlation between amylase in saliva that reflects stress and cognitive functions, and that between GHQ-12 that indicates mental health level and cognitive abilities made clear, it is obvious that the reduction of stress is imperative for sound thought or judgement.

Introduction

As to addiction, it is evident that high palatability (addictive) substances, such as drinking alcohol or smoking, all occur due to emptiness, psychologically the same mechanism, with emotional and mental factors playing a big role. While smoking is the cause

for death most preventable in the world, it will entail a very strong mental dependence with it much worse than heroin's / cocaine's [1]. As for drinking, habitual drinking will make the atrophy of brain progress faster than the age suggests [2]. As the characteristics for such people, psychological stress is high [3], and physically the

aging in blood vessel age [4] or brain age [5] has been hastened.

For this psychological state, majority of non-drug treatments are methods to promote pleasant mood, such as music and horticultural therapies [6-8]. Effect of these activities differs between documents, but the relationship between memory and emotion are being clarified. The emotional states can selectively influence cognition-related neural activity in lateral prefrontal cortex (PFC), as evidence for an integration of emotion and cognition [9,10]. But it is not clear how much feelings affect memory although its effect is being reported [11].

Therefore, we have, focused on mental soundness, and researched the relationships between mental health level/stress and cognition/judgement. Furthermore, through a brain training game employing rhythmical exercises and touching, we have clarified whether this will mitigate mental stress and affect cognitive functions, too.

Method

Subject: We recruited 100 people living in the area by public information in Kashihara City and 118 people registered for project participation.

Time frame: April - July 2016

Measurement of cognitive function

The Montreal Cognitive Assessment (MoCA-test) [12,13]: This is a cognitive screening instrument developed to detect mild cognitive impairment (MCI). It assesses different cognitive domains: attention and concentration, executive functions, memory, language, visuoconstructional skills, conceptual thinking, calculations, and orientation. The time taken to administer the MoCA-test is approximately 10 minutes. The total possible score is 30 points; a score of 26 or above is considered normal. (Source: Translation of the MoCA-Japanese version; Hiroyuki Suzuki, Supervision; Yoshinori Fujiwara. Tokyo Metropolitan Institute of Gerontology). Regarding the use of this scale, I am licensed by the developer Doctor. Ziad Nasreddine.

Measurement of emotional states

Japanese version General Health Questionnaire 12 (GHQ-12) [14-17]: The General Health Questionnaire is a measure of current mental health. This instrument was initially designed by Goldberg. This measurement consisted of 12 items, each one assessing the severity of a mental problem over the past few weeks using a 4-point Likert-type scale (from 0 to 3). The score was used to generate a total score ranging from 0 to 36. High scores indicated worse mental health.

Measurement of negative stress

Positive and negative mood was measured by collecting sublingual saliva and measuring salivary α -amylase concentration (NIPRO; catalog number, 34549000). This was measured before intervention. Salivary α -amylase reflects sympathetic nervous activity. It rises following a negative stimulus, and reduces following a positive one [17]. The reference values of salivary α -amylase by NIPRO, the

manufacturer of the measurement device, is as follows: Table 1.

0-30 KU/L	There is no negative stress.
31-45 KU/L	There is slight negative stress.
46-60 KU/L	There is negative stress.
61 KU/L	There is a high amount of negative stress.

Table 1: The reference values of salivary α -amylase.

The methods of intervention and evaluation

Round 1: Evaluation of each point has been made before the intervention.

Round 2: Evaluation has been made after the 3-month non-intervention / control period.

Round 3: Evaluation has been made after the 3-month intervention.

The test of statistical difference has been conducted on the results of the experiments above.

Analysis

A paired t-test was used to compare the variables before and after the intervention. The relationship between MoCA scores and GHQ-12 scores analyzed using Spearman's rank correlation coefficient. Correlations of MoCA scores with salivary α -amylase were computed using Pearson product-moment correlation coefficients.

Ethical considerations

The outline of the research, voluntary nature of participation, anonymity, and agreement regarding the publication of the document were explained to prospective participants both in writing and verbally, and their consent was subsequently obtained. The study protocol was approved by the ethical review board of Nara Medical University.

Results

Results of the MoCA test and saliva α -amylase

There were 104 participants (16 male and 88 female), with an average age of 74.4 ± 8.3 years. The comparison before and after intervention in score of MoCA test and saliva α -amylase were as shown in Table 2.

The average of the total score in MoCA test before the intervention was 24.8, not having reached the cut-off value (26); that measured after the control period was 26.1, having reached it. As to this result, only the delayed reproducing test showed the improvement of the score by 1.2 on average, which also boosted the total score, with no other aspects improved.

In the t-test after the intervention (implementation), positive increases in areas such as recalling animal names (reproducing ability), repetition tests (memory), digit span tasks both sequential and reverse, sustained attention, calculation (concentration, attention and memory) have been statistically significantly recognized (p/t, 5% level).

As for saliva amylase that reflects mental stress in comfort/

discomfort, the measured value before the intervention was 46.3 KU/L; that after the control period was 45.5 KU/L, with no major changes seen. After the intervention, on the other hand, the value was lowered to 33.4 KU/L with the statistically significant decrease of mental stress recognized (p/t, 1% level).

MoCA test component	Description of the test component (maximum score)	Mean scores		
		Before-intervention	After-control	After-intervention
Trail Making	Subject alternates between connecting numbers and connecting letters, in the ascending order "1→A→2→B..." [1]	0.90	0.85	0.91
Visuo-constructural (Cube)	The participant is asked to accurately replicate a drawing of a cube [1].	0.85	0.77	0.74
Verbal Fluency	Participant is asked to list as many words as possible that begin with a designated letter of alphabet [1].	0.48	0.53	0.49
Repetition	The participant is read a sentence and asked to repeat it back exactly [2].	0.75	0.81	1.02*
Abstract thinking	The participant is required to describe what characteristic 2 words have in common [2].	1.63	1.68	1.70
Naming	The participant is shown pictures of animals and asked to correctly name them [3].	2.92	2.91	3.00*
Visuo-constructural (Clock-task)	The participant is asked to draw a clock in a specified period of time [3].	2.67	2.66	2.81
Short-Term Memory Recall	The participant must recall a list of 5 words [5].	3.44	4.57**	4.83**
Attention, concentration, other	Repeat, reciprocal number, target detection, subtraction task [6].	5.46	5.49	5.83**
Orientation	Participant is asked to give precisely the current date as well as their present location [6].	5.71	5.72	5.79
TOTAL SCORE	The total possible score is 30 points. A score of 26 or above is considered normal.	24.79	26.06**	27.06**
Salivary α-amylase	α- amylase reflects sympathetic nervous activity.It rises following a negative stimulus, reduced positive one.	46.3 KU/L	45.5 KU/L	33.4 KU/L**

Table 2: Comparison of before and after intervention in MoCA test and salivary α-amylase Corresponding t-test: N=104. * Significant at 5% level ** Significant at 1% level.

Average score of GHQ-12 is given in table 3. Scores 0 and 1 are good and slightly good, scores 2 and 3 are slightly bad and bad. The items that received scores over 1 were concentration, sleep time, stress, unsolved difficulty, self-doubt, and loss of self-worth. The item that received the worst score was self-doubt.

Results of the GHQ-12

Contents of the GHQ-12	Mean values
Concentration	1.18 ± 1.15
Sleep time	1.11 ± 1.06
Efficiency	0.84 ± 0.87
Decision making	0.98 ± 0.84
Stress	1.16 ± 1.01
Unsolved difficulty	1.04 ± 0.95
Enjoyable routine	0.57 ± 0.68
Aggression toward problems	0.95 ± 0.86
Despondency	0.95 ± 0.90
Self-doubt	1.25 ± 1.05
Loss of self-worth	1.21 ± 1.07
Euphoria	0.80 ± 0.82
Total score	12.04 ± 7.42

Table 3: Mean scores on the GHQ-12; N=104.

Next, by setting the total score of GHQ-12 which shows the mentality state as objective variable and MoCA test which shows the cognitive function as explanatory variable, the correlation coefficient is given in table 4. Only items which showed correlation is showed.

There were correlation between GHQ score and Alternating Trail Making, Attention, Abstraction, Delayed recall, Orientation, and total score, while cognitive function was high when mentality state was also healthiness.

MOCA test items	Correlation coefficients and p values	
Alternating Trail Making	<i>rs</i>	-.300*
	<i>p</i>	.028
Attention	<i>rs</i>	-.322*
	<i>p</i>	.017
Abstraction	<i>rs</i>	-.285*
	<i>p</i>	.037
Delayed recall	<i>rs</i>	-.310*
	<i>p</i>	.022
Orientation	<i>rs</i>	-.320*
	<i>p</i>	.018
Total score	<i>rs</i>	-.318*
	<i>p</i>	.019

Table 4: The relationship between MoCA scores and GHQ-12 scores. Spearman's rank correlation coefficient. Only items which showed correlation is showed.

Next, in the correlation between psychological stress and cognitive abilities, the correlation as shown in figure 1 has been observed; the higher saliva amylase that reflects mental stress was, the lower the cognitive ability was (Pearson's product-moment correlation coefficient, $r = -0.25$).

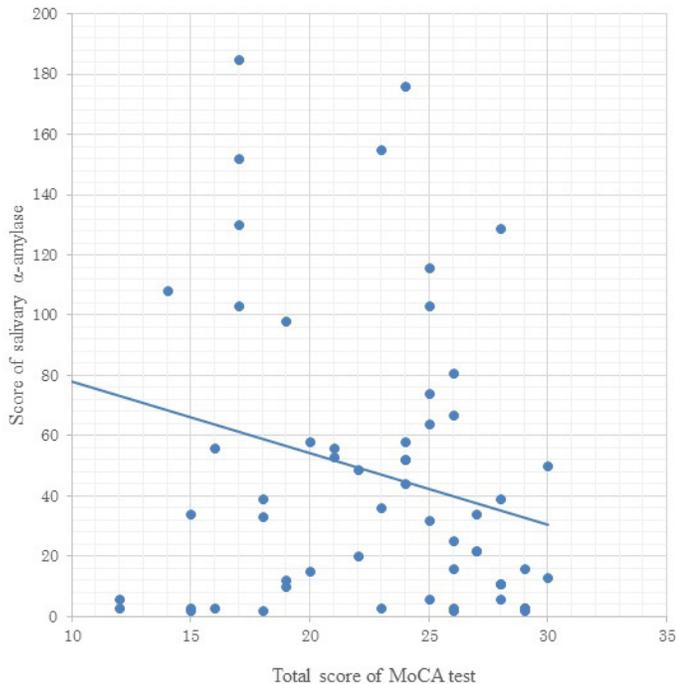


Figure 1: Correlation between MoCA test and salivary α -amylase.

Discussion

The non-pharmacological treatments for addiction nowadays have been well-developed, which have to be further developed for the coming stress society. The time we have focused on people living in the local society; some individuals have personally embraced stress, with us not able to definitely conclude they have nothing to do with addiction.

What we can worthy of special mention in the endeavor this time is that rhythmical exercises and touching introduced to the group intervention for cognitive training have reduced psychological stress. Comfortable emotions will activate the intra-brain reward system area (A10 nervous system) to motivate activities. Moreover, a research comparing the influence of the affirmative emotions and that of the negative ones based on the state of neutrality has revealed that the affirmative ones have expanded the scope of attention, thought, and activity; the negative one have shrunk instead [18]. In this research, too, the result that confirms these has been obtained by showing that there is a correlation between the measured vale of saliva amylase that indicates stress and the result of the MoCA test that indicates cognitive functions; the lower the stress is, the higher the cognitive/thinking abilities are.

Furthermore, the intervention has reduced stress so that as to cognitive functions, memory, reproducing ability, concentration

and attention has been statistically robustly improved. For this result, provided that the lowered stress has enabled cognitive abilities, to lower stress can be a beneficial goal. It can be deemed that in the near future this will be applicable in various fields, as we are planning the introduction of it to institutions for elderly people. Short-term memory and working memory decline with increasing age. Currently, a significant effort is being made to develop methods of maintaining these cognitive functions in aging patients.

Majority of non-drug therapies of mental care are intervention to work on emotion, like the music therapy and horticultural therapy. Also in this study, the results affirmed this: There was a correlation between multiple memory tasks and mentality state. With the total GHQ-12 score as a purpose variable, a correlation was found between alternating trail making, attention, abstraction, delayed recall, orientation, and total score in memory tasks. In conclusion, as mentality state became higher, memory became better. In the prior study on cognition and emotion, it has been reported that dysphoria lowers working memory [19] and that positive affect improves working memory [20]. In fact, increase of endorphin by music therapy [21] and so on and decrease in plasma cortisol levels [22] have been reported, thus these physiological reactions are considered to be factors to improve brain functions.

Consequently, in the brain training, it was suggested that effectiveness against cognitive function is higher if the emotion at intervention is comfortable. Out intervention is one that introduced rhythmical exercises and touching to the group intervention for cognitive training, which will activate serotonin and is intended to eliminate stress.

In addition, the combination of exercise and brain training, the dual-task is considered to be more effective than doing the single task. Previous studies utilizing brain training have reported cortical activation during dual-task interference [23] and increased activation of the prefrontal cortex (PFC) [24,25]. In addition, dual-task had wider effective range compared to single-task. Higher scores in attention, verbal fluency & understanding, and similarities were found in the dual-task group than in the single-task group at post-intervention [26].

Reason for this, several neuroimaging studies has revealed increased brain activity in the prefrontal cortex during dual-task activity [27,28]. Prefrontal cortex plays cognitive and execution functions, such as working memory, planning, and reasoning. In addition, it is part for higher-order affective-motivational functions and for controlling decision-making process and social behavior based on it. For this reason, the benefits of dual-tasks, where body and brain are simultaneously used, are greater than those of single tasks where only the body or brain is trained.

Chronicle stress will induce the aging of cells [29] to become a contributing factor for the lowered mental and physical functions called functional somatic syndrome [30]. The result of this research has clarified the negative correlation between cognitive functions

and stress and revealed that to reduce stress is imperative for sound cognition. When we think of addiction, the countermeasures against stress for sound thinking and judgement are very meaningful. In the future, we will make further researches to make the methods of intervention to reduce stress more precise to accumulate effective programs.

Conclusion

The cognitive training employing rhythmical exercises and touching not only improved cognitive functions but also reduced stress. With the correlation between amylase in saliva that reflects stress and cognitive functions, and that between GHQ-12 that indicates mental health level and cognitive abilities made clear, it is obvious that the reduction of stress is imperative for sound thought or judgement. For this, the promotion of the intervention that can at the same time improve the cognitive functions and reduce stress is very meaningful; the further development of this program is the coming task.

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