International Journal of Japan Academic Society of Hospitality Management
Vol. 8 No. 1
【Article】

The Effect of Background Music on Relaxation and Work Efficiency: An Analysis Based on Survey Data from University Students

Chiaki MORITA[a], Kokoro SHIRAHAMA[a]

Hisao ATARASHI[b], Yuji MIZUKAMI[a]

[a] *Nihon University, 1-2-1 Izumi-cho, Narashino, Chiba 275-8575, Japan*

[b] *Elsys Japan Ltd., 2-5-8 Hiratsuka, Shinagawa, Tokyo 142-0051, Japan*

Abstract

Music is sometimes played in the waiting rooms and examination rooms of medical institutions such as dental clinics, usually a genre intended for relaxation, such as nature sounds and instrumental music. Such soothing sounds are assumed to have positive effects on patients' mental health, easing their fears and tensions. However, relaxing music may also impact negatively on employees' efficiency. This study examines the effects of music on relaxation and work efficiency, and which types of music are best for fostering both relaxation and work efficiency. This experiment tested the effects of music on relaxation and work efficiency measuring amylase in saliva, using the results to estimate stress values, and by measuring oxygen saturation and heart rate with a pulse oximeter.

***Keywords*:** healing music, amylase, stress, work efficiency

1. Introduction

Otsuji and Sato (2017) note that music is used in our daily lives to elicit various responses. As typical examples, they cite "the effect of improving purchase awareness in supermarkets," "the effect of controlling emotions in video works," and "the effect of creating an atmosphere in restaurants."

Another common instance is the music played in medical institutions, such as dental clinics, which is typically relaxing—nature sounds and instrumental songs. It is believed that these musical genres can help maintain patients' mental health, easing their fears and tensions (Bando, 2008).

However, Gassho and Mizuno (2010) hold that, in a learning environment (considered as a working environment in this study), it is preferable that music not be played. If this is so, then the efficiency of employees working in dental clinics may be compromised due to the effects of music.

This study examines the effects of music on relaxation and work efficiency, and which types of music are best for fostering both relaxation and work efficiency. The experiment tested the effects of music on relaxation and work efficiency measuring amylase in saliva, using the results to estimate stress values, and by measuring oxygen saturation and heart rate with a pulse oximeter.

Received: December 15, 2021

Accepted: February 14, 2022

2. Studies on the Relaxing Effect of Music

Bando (2008) found that background music (BGM) in the medical field is used to enhance relaxation and reduce stress. By examining the relationship between the listener's mental health status, situation, and preference for BGM, they concluded that background music is effective in reducing depressive tendencies.

Nagoya and Tokura (2004) found that playing background music to patients waiting for their hospital checkups reduced their anxiety. Yoshida and Yoshinaga (2004) investigated the effect of listening to background music on the mood of patients in a pharmacy waiting room and found that they felt less tired when background music was played than when it was not played. This suggests that background music positively affects patients' fatigue even in pharmacies, where patients stay for shorter periods than in hospitals, where they cannot actively listen to background music.

Gassho and Mizuno (2010) examined the effects of music on work efficiency and found that no music fostered a more effective learning environment. When music that students liked was played, they lost concentration and paid more attention to the songs. This research examines the impact of music on relaxation as it relates to employees' work efficiency.

Taniguchi (1997) states that, when people are listening to music, they enter a state that goes beyond the merely perceptual and rises to a cognitive level. Consequently, listening to music with lyrics while performing tasks that require deliberate thought can interfere with the required thought processes because the brain pays attention to the lyrics. This study tests whether listening to music with lyrics reduces work efficiency.

In examining the relationship between musical tempo and work efficiency, Abe and Aragaki (2010) found that, for tasks with high cognitive load, the tempos of background music had no effect while, for moderately challenging tasks, the type of task determined the appropriate tempo. However, for simple tasks, music increase helped increase work efficiency. This study hypothesized that fast (but not extremely so) tempo background music would tend to increase efficiency.

3. Studies that Define and Measure Stress

The word "stress" was originally used in the fields of physics and engineering to describe an object's distortion by an external force. Selye (1936), who conducted research in physiology and medicine, published his stress theory, which helped popularize stress research. Selye's stress theory defines stress as "a nonspecific reaction of the organism to external demands," the stimulus that causes the reaction as a stressor, and the state of distortion caused by the stimulus as stress. Since then, stress has been studied in many fields such as medicine, ergonomics, psychology, and business administration, accumulating a great deal of knowledge. Stress indicators can be broadly classified into subjective indicators and physiological indicators.

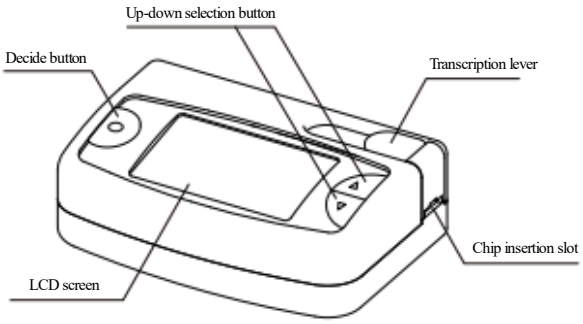
Subjective evaluation methods (subjective indicators) measure stress by directly asking the subject what they are seeing and feeling. Representative examples of subjective evaluation methods include the NASA Task Load Index (NASA-TLX) method (Hart and Staveland, 1988; Haga and Mizukami, 1996), the Profile of Mood State method (McNair, Lorr and Droppleman, 1971), and the Semantic Differential method (Osgood, Suci and Tannenbaum, 1957).

Meanwhile, physiological evaluation methods (physiological indicators) measure stress using the subject's biological responses. Furthermore, bioindicators can be categorized into methods that measure the endocrine system and methods that measure the activity of the autonomic nervous system. In measuring the endocrine system, the expression of stress response involves the hypothalamic–pituitary–adrenal (HPA) system and the sympathetic–adrenal–medullary (SAM) system of the hypothalamus–sympathetic–adrenal–medullary (Ezawa et. al. 2007). These endocrine systems are analyzed to measure the stress response.

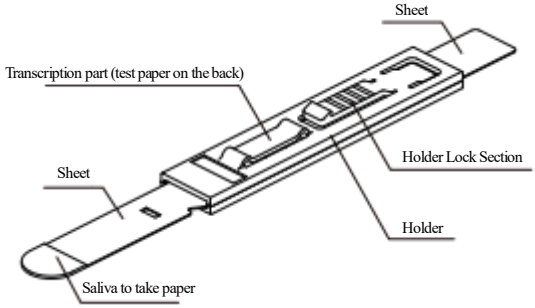
3.1. Measurement of Amylase in Saliva

We used the Salivary Amylase Monitor, a contact-type enzyme analyzer from Nipro Corporation, as the measurement system on which to base the effectiveness verification of stress level (Nipro Corporation, 2017). Figure 1 shows the Salivary Amylase Monitor.

In the measurement, a special tip is first inserted under the sublingual area, soaking it with saliva and collecting the sample. Next, a chip is inserted into the main unit, and in about 60 seconds, the amylase activity in the sample is displayed. To continue measurement, the subject rinses their mouth with purified water after saliva collection and prepares for the next measurement. For other measurement methods, detailed operating instructions were provided in the instruction manual of the device. Note that the special tips are disposable, so one must purchase new ones in advance depending on the number of measurements (Yamaguchi, Hanawa and Yoshida, 2007).



(a) Main body of the measuring instrument



(b) Saliva collection chip

Figure 1: Salivary amylase monitor
(Nipro Corporation, 2017)

3.2. Measurement of Heart Rate and Oxygen Saturation

We used a pulse oximeter to measure heart rate and oxygen saturation. Matsumoto et al. (2010) focused on heart rate variability to analyze autonomic nervous system stress and quantitatively evaluated whether a significant difference exists between the results of stress and resting states.

Iha and Suetsugu (2020) examined the effects of the presence or absence of nurses' verbal communication during stretcher transfer on the passenger's psychological aspects based on mood assessment, eye movement, pulse rate, and arterial blood oxygen saturation.

4. Purpose of the Study

According to Otsuji and Sato (2017), background music is used in the medical field to alleviate patients' fear and tension. By contrast, examining the impact of music on employees, Gosho and Mizuno (2010) found that an environment without music is better for improving work efficiency. They also noted that music that employees like tends to reduce concentration. Taniguchi (1997) also found that listening to music with lyrics interferes with intellectual work. Thus, background music lowers work efficiency. This study sets out to clarify the background music environment that enables both relaxation effects and improves work efficiency.

Although this research opens by referring to music in medical institutions, the author did not have the wherewithal to conduct a survey in such a setting

The research question addressed here is "What kind of music enables both relaxation effect and improvement of work efficiency for young people such as college students?"

4.1. Hypothesis

The following three hypotheses will be used to answer the research question.

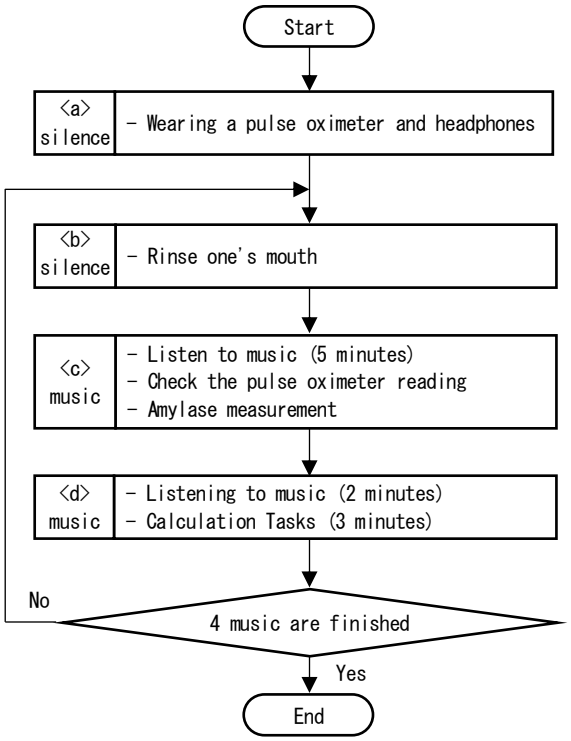


Figure 2: Experimental sequence

H1: Music with lyrics reduces concentration and work efficiency.

H2: Piano sounds and music box sounds have a relaxing effect and slow down our thinking.

H3: Fast tunes will increase work efficiency.

In defining these hypotheses, we first defined the H1 hypothesis based on Taniguchi's (1997) assertion that "listening to music with lyrics while performing intellectual work interferes with intellectual work. The H1 hypothesis was defined as follows. Next, I defined hypothesis H2 based on Gassho and Mizuno's (2010) assertion that "music for relaxation purposes lowers the work efficiency of employees. We defined hypothesis H2. Finally, I defined hypothesis H3 based on Abe and Aragaki's (2010) assertion that "if not extreme, fast-paced background music tends to increase efficiency.

5. Research Process

Figure 2 shows the experimental sequence. The subject wears a pulse oximeter and headphones at Step <a>. Then, in Step <b>, they rinse their mouth with water. In Step <c>, the subject first listens to a piece of music for 5 minutes, then their oxygen saturation, heart rate, and stress values are measured with a pulse oximeter, amylase, and mental checker while the music is still playing. Then, in Step <d>, the subject listens to the music for 2 minutes, then working on 100 calculations (addition) for 3 minutes with the music playing. The music is then stopped. This sequence repeats Steps <c> to <d> until four different songs are finished. This process takes 45 minutes for one subject to complete.

Table 1 shows the four types of music used in the experiment and the items that test the hypothesis. The first type of music used was 1 POPS (piano), which has no lyrics and a slow tempo. The next test piece was 2 Nihon University School Song and Cheering Song, which has lyrics and an upbeat tempo. The third selection was 1 POPS (piano) with lyrics and an upbeat tempo and 2 minimal music, which has no lyrics and a rapid tempo. 3 Minimal music is music that repeats a patterned sound pattern. Finally, we used POPS, which has lyrics and a peaceful timbre.

The pulse oximeter is worn on the index finger of the subject's non-dominant hand for measurement. Oxygen saturation and pulse values are measured. In addition, for the amylase measurement, the subject's saliva is collected

Table 1: 4 types of music used in the experiment and the hypothesized empirical items

Song number	Contents	Lyrics	Tune	Hypothesis		
				H1	H2	H3
1	POPS (Piano)	No	Slow	○	○	
2	Nihon Univ. Anthem	Yes	Fast			○
3	Minimal music	No	Fast			○
4	POPS	Yes	Slow	○		

and placed on the measuring instrument. A higher concentration of amylase indicates greater stress. Task performance is measured by the subject doing computational problems with a light to moderate cognitive load, with the number of answers and the percentage of correct answers used to determine performance level.

5.1. Addressing Selection Bias

In general, when considering selection bias during experiments, test cases are randomly selected to avoid the influence between test cases. However, while this method eliminates such influence, that of the previous test case remains, and the effect of the variability of the test results persists. This study avoids the influence of the previous test case by lengthening the music playing time relative to the salivary amylase reaction time. The order of the test cases is fixed, for this reason, considering that there is no need to adhere to a random selection of test cases.

Furthermore, before subjects participate in an experiment, their stress levels should be as stable and aligned as possible. In this experiment, therefore, the participants received a full-body massage in a massage chair for 10 minutes before the experiment.

6. Analysis of Results

The subjects were 31 students (19–23 years old, 15 males and 16 females) from the Department of Industrial Engineering, Nihon University. Testing and data collection took place from October 19 to October 27 (10:00 to 20:00). The analysis draws on data from 21 out of 31 subjects' data, excluding those who showed no change in stress values by amylase measurement and those who showed abnormal values.

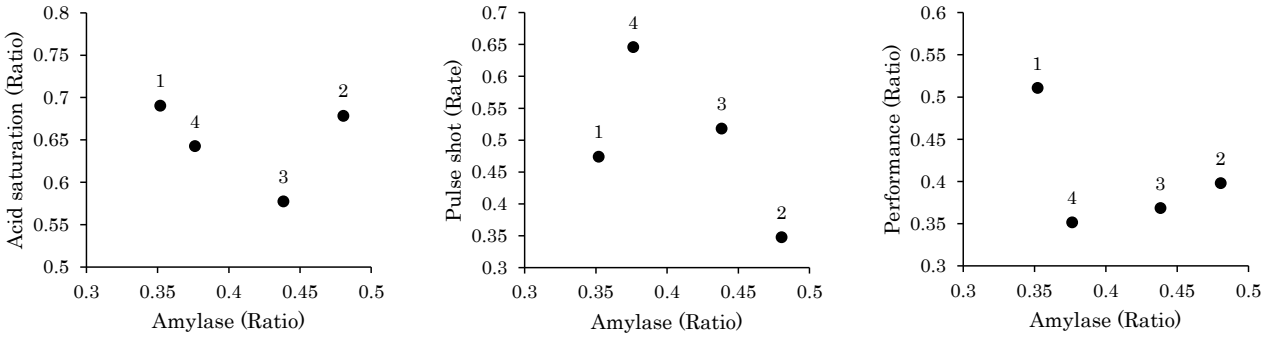
Equation 1 shows the formula for determining the tolerance d of the measured value.

$$d = r\sqrt{\frac{p-(1-p)}{n}} \qquad \text{Equation 1}$$

The response ratio p is 50.0%, and the sample size n is 31. The confidence level r of 95.0% is generally used, but this study set the confidence level to 80.0% because of the small number of samples. A z-value of 0.842 was used for the calculation. Based on these assumptions, the acceptable range d was 7.6%.

This study measured amylase, pulse rate, oxygen saturation, and performance to assess the subjects' overall condition. Figure 3 shows the results of the amylase measurement and the ratios of performance ability, pulse rate, and oxygen saturation.

Amylase is a stress response due to tension in the sympathetic nervous system, and it indicates stress levels by measuring the concentration of salivary amylase. The higher the concentration, the higher the person's stress. Pulse rate indicates the extent of an individual's tension and excitement. The higher the subject's pulse rate, the stronger the tension and excitement they feel. Oxygen saturation shows a person's state of breathing as a stress response of the autonomic nervous system. The lower the oxygen



(a) Amylase measurement and Oxygen saturation (b) Amylase measurement and pulse (c) Amylase measurement and Performance capacity values

Figure 3: Results of amylase measurement and ratio of performance capacity, pulse rate, and oxygen saturation

Table 2: 4 types of music and their analysis results

Song number	Contents	Lyrics	Tune	Amylase (Stress)	Pulse rate (Tension, Excitement)	Oxygen saturation (State of breathing)	Performance (Concentration)
1	POPS (Piano)	No	Slow	0.352 (Lowest)	0.474 (Low)	0.690 (High)	0.511 (Highest)
2	Nihon Univ. Anthem	Yes	Fast	0.480 (Highest)	0.348 (Lowest)	0.679 (High)	0.398 (High)
3	Minimal music	No	Fast	0.438 (High)	0.518 (High)	0.577 (Lowest)	0.369 (Low)
4	POPS	Yes	Slow	0.376 (Low)	0.646 (Highest)	0.643 (Low)	0.352 (Lowest)

Figures indicate the average of the relative ratios with values between 0.000 and 1.000.

saturation, the higher the stress level. In other words, low amylase, low pulse rate, and high oxygen saturation constitute a relaxed state. Meanwhile, performance indicates the state of a subject's concentration; the higher their performance, the higher their concentration and therefore their work efficiency.

Comparing the results of the pulse oximeter, the highest average reading for oxygen saturation was for the song in 1, while the lowest was for the song in 3. The highest average for pulse rate was found in song 4, and the lowest for song 2. Comparing the results of amylase measurement, the highest stress value was found in song 2, the lowest in song 1.

Since the number of answers to the 100-square calculation increases with practice, this effect was corrected through weighting. The total number of answers and the percentage of correct ones were used to calculate and compare the level of performance for each subject.

The next step involved checking correlations between oxygen saturation, heart rate, and performance levels with the stress value for each piece of music. Figure 3 shows the correlation between the stress value and each measured value. In song 1, the pulse rate was moderate, the oxygen saturation was high, and the amylase was low, suggesting that the subject was relaxed. The performance level here was in the highest tier. Song 4, which had the lowest performance level, correlated with the highest pulse rate and relatively low oxygen saturation and amylase. Songs 2 and 3 had the highest amylase and the lowest performance results.

7. Examination

In this study, "relaxed state" is measured by low amylase, low pulse, and high oxygen saturation. Also, "work efficiency" is defined by high performance. Table 2 shows the four types of music and the analysis. The fact that the music in 1 correlated with a medium pulse rate and a high oxygen saturation value can be attributed to the relaxing effect of the massage chair before the experiment. In addition, the stress value of amylase while listening to the music was low, indicating that this song was the most relaxing. Although the stress value of amylase is highest for song 2, it is not categorized as relaxing because the performance is moderate; nevertheless, it is a song that allowed concentration. The music in 3 correlated with a low oxygen saturation level. This may be because the tempo was faster than the other songs and made the participants feel breathless due to discomfort and impatience. The stress value of amylase was also the second highest, making this song non-relaxing. The participants' low computation scores showed that the song lowered concentration. Song 4 drew the second-lowest stress value of amylase, so was not considered stressful. Nonetheless, the subjects' performance was the lowest for this song. In sum, the songs with the most relaxing effects were 1 and 4, while song 1 had the highest correlation with concentration.

H1: Music with lyrics reduces concentration and work efficiency.

H1 was verified. Songs 1 and 4 have a relaxing effect, but song 1 without lyrics correlates with the highest

performance while song 4 with lyrics has the lowest. This result is consistent with Taniguchi's (1997) statement that "listening to music with lyrics interferes with intellectual work.

H2: Piano sounds and music box sounds have a relaxing effect and slow down our thinking.

H2 was not proven. Although the music in 1 is relaxing, it correlated with the highest performance scores, so lower cognitive affect is not applicable. This result contradicts Gassho and Mizuno's (2010) finding that "music for relaxation purposes lowers the work efficiency of employees."

H3: Fast tunes will increase work efficiency.

H3 was not proven. The songs with fast tempo 2 and 3 correlated with low performance. This result differs from Abe and Aragaki's (2010) finding that "if not extreme, fast-paced background music tends to increase efficiency."

8. Discussion

The purpose of this research is to demonstrate the effects of music on human emotions and work efficiency. The effects of music on relaxation and work efficiency were demonstrated by measuring amylase in saliva and calculating stress values, oxygen saturation, and heart rate using a pulse oximeter.

One characteristic observed in the study results is a continuous decline in work efficiency, shown in Figure 4.

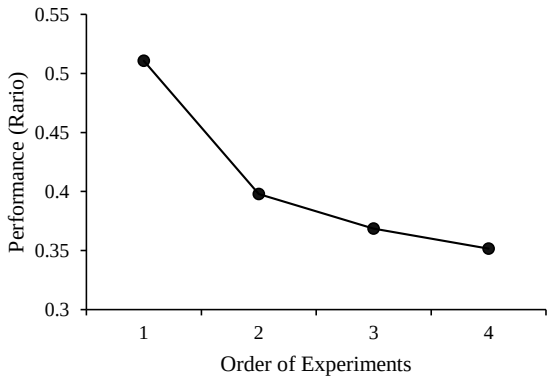


Figure 4: Continued decline in work efficiency

This figure shows that as the experiment progressed, the subjects' average work efficiency decreased to 0.511, 0.398, 0.369, and 0.352. One factor that may have contributed to this phenomenon may be the effect of fatigue on the subjects.

To avoid selection bias, this study increased the time between test cases so that the subjects were not influenced by the previous test case. The sequence of the test cases was then fixed. However, although this method is expected to reduce data variation, it does not consider the effect of subject fatigue. In addition, because of subject fatigue, hypothesis 2, "Piano sounds and music box sounds have a relaxing effect and slow down our thinking," and hypothesis 3, "Fast tunes will increase work efficiency," may not have been significant.

To effectively avoid subject fatigue, the subjects may randomly select the order of the test cases after implementing the current measures. This will be a future issue.

9. Conclusion

As a result of the analysis, it was found that instrumental music without lyrics was most effective in fostering, as per the research question, relaxation while also improving work efficiency.

These findings are also applicable to the kind of background music used in medical institutions such as dental clinics. Instrumental music will have a relaxing effect and can contribute to improving both the mental care of patients and the work efficiency of employees.

However, the experiment did not demonstrate that "the sound of a piano or a music box has a relaxing effect that slows down thinking" and "fast-paced music increases work efficiency." Further research is needed on these issues.

One limitation of this study would be the possibility of sampling bias between the assumed population and the subjects. Thus, a future research direction may involve conducting a survey that addresses this point.

Our university does not require a review of research ethics for the on-campus research activities of undergraduate students. Therefore, the subjects are assumed to be on-campus students. Meanwhile, their personal information is managed following the university's guidelines for research involving human subjects.

Acknowledgments

This research is a project of the Interdisciplinary Innovation Research Group, School of Industrial Technology and Science, Nihon University.

References

Otsuji, M., & Sato, N. (2017), "Relationship between Listeners' Mental Health and Music Preference," Psychosomatic Medicine, Vol.57, No.2, pp.160–172

Bando, H. (2008), "Current Status of Music Therapy," Japanese Journal of Complementary and Alternative Medicine, Vol.5, No.1, pp.27–36

Gassho, K., & Mizuno, Y. (2010), "Influence of 'Preferred' Background Music on Work Efficiency," Journal of the Human and Environmental Studies Association, Vol.13, No.2, p.30

Nagoya, T., & Tokura, A. (2004), "Changes in Students' Perceptions of Children's Responses: An Analysis of Vital Signs Measurement Situations," Proceedings of the Japan Nursing Association, Vol.35, pp.145–147

Yoshida, T., & Yoshinaga, M. (2004), "The Effect of BGM on Patients' Mood Change while Staying in a Pharmacy's Lounge," The Pharmaceutical Society of Japan, Vol.134, No.8, pp.901–908

Taniguchi, H. (1997), "A Study of the Effects and Problems of Background Music: Focusing on Intellectual Work," Journal of the Suzuki Seminar, No.8, pp.61–119

Abe, M., & Arakaki, N. (2010), "The Effect of the Tempo of Background Music on Work Efficiency," Proceedings of the 27th Annual Meeting of Cognitive Science Society, pp.330–336

Selye, H. (1939), "The effect of testosterone on the kidney," Journal of Urology, Vol. 42, pp. 637–641

Hart, S. G., & Staveland, L.E. (1988), "Development of NASA-TLX (Task Load Index): Results of Empirical and Theoretical Research," Advances in Psychology, Vol.52, pp.139–183

Haga, S., & Mizukami, N. (1996), "Japanese Version of NASA Task Load Index: Sensitivity of its Workload Score to Difficulty of Three Different Laboratory Tasks," The Japanese Journal of Ergonomics, Vol.32, No.2, pp.71–79

McNair, D. M., Lorr, M., & Droppleman, L. F. (1971), "Profiles of Mood States," Educational and Industrial Testing Service

Osgood C. E., Suci, G. H., & Tannenbaum, P. H. (1957), "The Measurement of Meaning," University of Illinois Press

Ezawa, S., Shirotsuki, K., Sugaya, N., Ogawa, N., Suzuki, K., & Nomura, S. (2007), "The Application of Saliva to an Assessment of Stress: Procedures for Collecting and Analyzing Saliva and Characteristics of Salivary Substances," Japanese Journal of Complementary and Alternative Medicine, Vol.4, No.3, pp.91–101

Nipro Corporation Salivary Amylase Monitor Instructions (2017) J_27B1X00045000110_AA_02

Yamaguchi, M., Hanawa, N., & Yoshida, H. (2007), "Evaluation of a Novel Monitor for the Sympathetic Nervous System using Salivary Amylase Activity," Transactions of Japanese Society for Medical and Biological Engineering, Vol.45, pp.161–168

Matsumoto, Y., Mori, N., Mitajiri, R., & Jiang, Z. (2010), "Study of Mental Stress Evaluation based on Analysis of Heart Rate Variability," Journal of Life Support Engineering, Vol.22, No.3, pp.105–111

Iha, A., & Suetsugu, N. (2020), "Effects of Nurse's Communication in Transport by Stretcher," The South Kyusyu Journal of Nursing, Vol.18, No.1, pp.11–18