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The effect of laughter measured by scoring facial expressions: observation study

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Abstract

Background: Laughter is a universal expression of emotion for humans, and it has been linked with health and well-being. The purpose of this study is to clarify the physical and psychological effect of laughter by scoring procedure of facial expression. Method: During a period of a month, a total of three interventions to induce laughter were conducted for 22 adults. During the interventions, data on facial expression and vital signs were collected for future analysis, and psychological examinations were conducted. Measures related to quality of life, including scores on the Medical Outcomes Study 36-Item Short-Form Health Survey version 2, did not show signs of improvement between the measures before or after interventions for mean participants. Results: Those participants who laughed more heartily, showed significant reductions in their scores for Tension-Anxiety, and Pain. The male group, as a whole, had significantly lower scores for happiness according to the data for facial expression. Conclusion: This study suggests that laughter may not bring positive changes to total quality of life. However, it does appear that the effects of laughter may be more easily demonstrated for participants who are not habituated to its effects, which would depend on the specific intervention used and the context in which the laughter takes place.

Key words : laughter, facial expression, comedy, positive emotional effect, habituation, adaption

Introduction

Laughter is a generally amicable, trustworthy, playful signal promoting an approach to other people that does not involve any danger[1-4]. It is also considered to be a universal human expression that is important as it enhances well-being and health[5]. Like the Japanese saying, "good fortune and happiness come to those who laugh", laughter gives people a positive image[6,7]. Japan has a culture of viewing comedic performances and laughing or smiling. During such comedic performances, the comedian creates a situation that makes the participants laugh. This may be because it is difficult to evaluate facial expressions. While Facial Action Coding System (FACS)[8,9] may be used as a means of evaluating facial expressions (smiling) during laughter, it cannot be appropriately used by anyone as it requires training and budget considerations[10]. Specialized knowledge is also required to interpret the results of FACS evaluation. In this study, we defined laughing as "the comedian creating a situation that would make the participant laugh and actually making the participant laugh." We then scored smiling in numerical values to investigate smiling and changes in physical and mental indices. If our clarification of the changes brought about by laughing on physical and mental state based on the scoring of expressions during laughter reveals improved physical and mental state, our ultimate aim is to construct a laughter intervention model and offer it as preventive medicine.

Methods

Participants

The need for participants in this study was pub-

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licized through Kindai University Public Relations Department, Yoshimoto Creative Agency, OMRON Corporation, and Nippon Telegraph and Telephone West Corporation. The participants were recruited through the website of the Internal Medicine Laboratory at the Department of Psychosomatic Medicine of the Kindai University School of Medicine. The eligibility criteria were being healthy and older than 20 years. Being healthy was defined as being in "a state that does not require hospitalization at present." Exclusion criteria were having a psychiatric disorder, visual impairment, hearing impairment, or anticipated difficulty participating in the full program of the study. Psychiatric disorders, visual impairments, and hearing disorders were self-disclosed by the participants in questionnaires. The number of recruits was 22 from the equipment and seat problems that can be prepared. The sex ratio of participants were recruited without consideration. There were 22 participants in all (average age 35.22 ± SD 3.17 years old; 14 males, 8 females), out of which eight were students at Kindai University, three were university staff, and 11 were employed by the three cooperating companies.

Design

This trial was conducted for one month, beginning on February 15, 2017. The study design has three noteworthy features. The first feature was the use of *manzai*, *rakugo*, and *conte* as stimulants to laughter. These forms of humorous art are as follows.

Manzai is a storytelling art form where comedians usually perform as a pair. In *rakugo*, the storyteller plays all of the roles and tells the story through physical gestures alone. *Conte* involves several comedians performing on a stage, playing different roles. Personnel and locations for the *manzai*, *rakugo*, and *conte* exhibitions were provided by Yoshimoto Creative Agency.

The second feature was the use of the "Human Vision Components B 5 T–007001" (HVC) (OMRON Corporation, Kyoto) to measure participants' facial expressions. This software measures facial expressions and creates datasets from them (Fig. 1A) [11]. This piece of equipment was rented from Omron Corporation for the study.

The third feature was the use of a DC6M-4JN3000 (SHARP Corporation, Osaka) to measure the participants' vital data. This device was used to measure the heart rates and respiration of the participants (Fig. 1B) [12] and was borrowed from Nippon Telegraph and Telephone West Corporation.

This study and its design were approved by the Kindai University School of Medicine Ethics Committee (28-153). The subjects agreed to par-

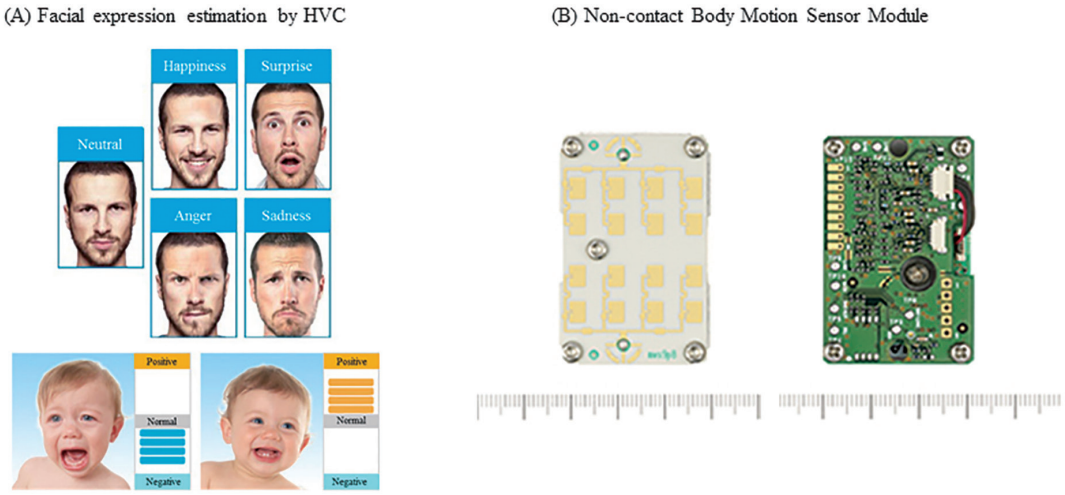

Fig.1 Features about HVC and DC6M4JN3000.
(A)The facial expression (surprise, happiness,…) data that can be gathered using HVC (Omron Corporation, 2014). HVC scores the facial expressions of the target group, and it guesses five facial expressions (surprise/happiness, anger, sadness, and neutral). This study used the three facial expressions of happiness, surprise, and neutral.
(B)(1) Measures without contact using the Doppler effect.(2) The module can be embedded in products as sensing is possible through obstructions (except in cases where the obstructions are metal or metal plated).(3) Enables stable measurement without being affected by factors such as temperature, direct sunlight, or reflector color.

ticipate on the condition that they would be able to enjoy *manzai* (Fig. 2) , *rakugo* (Fig. 3), and *conte* (Fig. 4) for free at the theater. All participants provided written informed consent.

Fig.2 Manzai.

Fig.3 Rakugo.

Fig.4 Conte.

Procedures

The 22 participants were divided into a morning group and an afternoon group. They watched 150 minutes of *manzai*, *rakugo*, and *conte* thrice at two-week intervals: the first (Day 1), second (Day 15), and third intervention (Day 29). In total, there were 50 minutes of *manzai* and *rakugo* for each session, along with 100 minutes of *conte*. Before and after observing *manzai*, *rakugo*, and *conte*, the participants were asked to complete a psychological examination and a survey. Using the HVC and DC6M4JN3000, facial expression data and vital data were measured and collected (Table 1) during the viewing (Fig. 5).

The main evaluation item was improvement to health-related quality of life. To measure this, the Medical Outcomes Study 36-Item Short-Form

Table 1
Study procedure and time points for actions and evaluations

	pre-test (D1)	test (D1)	test (D15)	test (D29)	post-test (D29)
SF-36	○	—	—	—	○
WHO-QOL26	○	—	—	—	○
POMS	○	—	—	—	○
ESAS-r-J	○	—	—	—	○
LSI-K	○	—	—	—	○
Questionnaire about laughter	○	—	—	—	○
Facial expression data	—	○	○	○	—
Vital data	—	○	○	○	—

SF-36, Medical Outcomes Study 36-Item Short-Form Health Survey version 2, Japanese version; WHO-QOL26, WHO Quality of Life 26; POMS, Profile of Mood States, Japanese version; ESAS-r-J, Edmonton Symptom Assessment System, revised Japanese version; LSI-K, Life Satisfaction Index K.

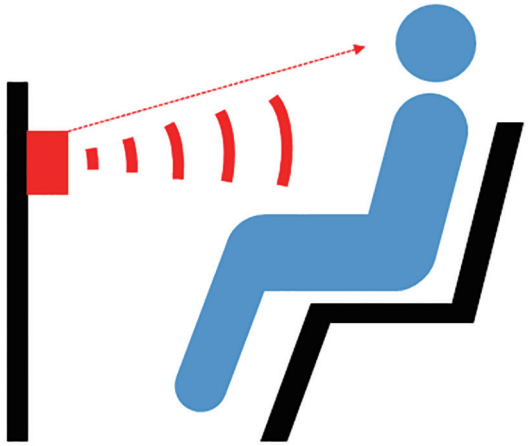

Fig.5 Measurement method of expression data and vital data. Method for measuring facial expression and vital data. The HVC and DC6M4JN3000 were set-up in front of the target group. Data was measured continuously while they were experiencing the manzai, rakugo, and conte set.

Health Survey version 2 (Japanese version) (SF-36) [13,14] was used. The following were also measured as secondary evaluators: changes in mood and emotions; rates of improvement in subjective physical and mental symptoms; and improvement rates in life satisfaction. The following were used to measure these evaluators: the WHO Quality of Life 26 (WHO-QOL26) [15], the Profile of Mood States (Japanese version) (POMS) [16-18], the Edmonton Symptom Assessment System (revised Japanese version) (ESAS-r-J) [19], the Life Satisfaction Index K(LSI-K) [20]; questionnaires regarding laughter; facial expression data from the HVC; and breathing/heart rate data collected using the DC6M4JN3000. The free setting item in the ESAS-r-J was "addiction on alcohol, tabacco, gambling". The questionnaire on laughter consists of the following questions: How are you laughing during the study? (not laughing heartily < 0 > to laughing heartily < 100 >). Responses to these questions were evaluated using a visual analog scale (VAS). The data collection schedule is summarized below.

Data analysis

Analysis was carried out on three groups, which were divided in the following ways: 1) all participants; 2) groups divided by sex; and 3) VAS: whether the participants' VAS score had decreased or increased between Day 1 and Day 29. The division by sex was made because women and men have different neurological responses to laughter [21]. The reason for creating groups divided by VAS score was to examine the differences between the expression score measured by the electronic device and the feelings participants actually experienced.

The level of statistical significance was set at 5%, and, before and after the intervention (Day 1 and Day 29); the main and secondary evaluation items were analyzed using the Wilcoxon Signed-Rank test. The expression data and vital data (from Days 1, 15, and 29) were analyzed using the Friedman test. For statistical analysis, the IBM SPSS software (version 19.0; SPSS Japan Inc, Tokyo) was used.

For the analysis of HVC data, the number of instances of expressions of happiness and surprise were counted. Expressionless faces and expressions of negative emotions, such as anger or sadness, were not counted in this study.

In the analysis of the data of DC6M4JN300 using clinical definitions [22], heart rates of 100 beats or more per minute were defined as tachycardia, and heart rates of 60 beats or less per minute were defined as bradycardia. Likewise, respiratory rates of 25 breaths or more per minute were defined as polypnea, and nine breaths or less per minute were defined as bradypnea [23].

The HVC and DC6M4JN3000 gathered a very large amount of data; therefore, the authors hired a graduate student from the Information Science Department of Kindai University to assist in analyzing the data. This student was paid at a unit price of 1000 yen × 100 hours = 100,000 yen, and the data were organized using Python (version 2.7; Python Software Foundation, Wilmington).

Results

Background

Of the 22 participants, 21 fulfilled the eligibility criteria (1 was absent for one of the sessions), and one person's data could not be measured due to an equipment malfunction. Therefore, the facial expressions and vital data of 20 participants were analyzed (Fig. 6).

Results of psychological tests and questionnaires

The analysis showed no significant change in the scores for the SF-36 in any group. Psychological health ($p = 0.020$) and overall score ($p = 0.019$) were significantly decreased in the WHO-QOL 26 scores for the male group.

All participants showed a significant decrease in Tension–Anxiety ($p = 0.006$), Anger–Hostility ($p = 0.003$), and Fatigue ($p = 0.016$) on the POMS. In the male group, the psychological health ($p = 0.020$) and overall scores ($p = 0.019$) on the WHO-QOL 26 showed significant decreases. Tension–Anxiety ($p = 0.023$) and Anger–Hostility ($p = 0.050$) on the POMS also significantly decreased in the male group. In the female group, a significant decrease was seen in Confusion ($p = 0.017$).

Among participants whose VAS scores increased, the following factors showed a significant decrease: Tension–Anxiety ($p = 0.041$), Depression ($p = 0.028$), and Anger–Hostility ($p = 0.011$) on the POMS; Pain ($p = 0.047$) on the ESAS-r-J; and KIII (Acceptance of aging) on the LSI-K.

Among participants whose VAS scores decreased, a significant decrease was found in psychological health ($p = 0.048$) and overall score ($p = 0.018$) on the WHO-QOL26. A significant in-

crease was also found in well-being (p = 0.018) on the ESAS-r-J in the same group (Table 2).

Facial expression data and vital data

"Happiness" scores did not show a significant decrease in the female group, the group with increased VAS scores, or the group with decreased VAS scores. "Surprise" scores decreased significantly in all the groups. In the female group, and in the group with increased VAS scores, a significant decrease in the number of instances of tachycardia was observed (Table 3).

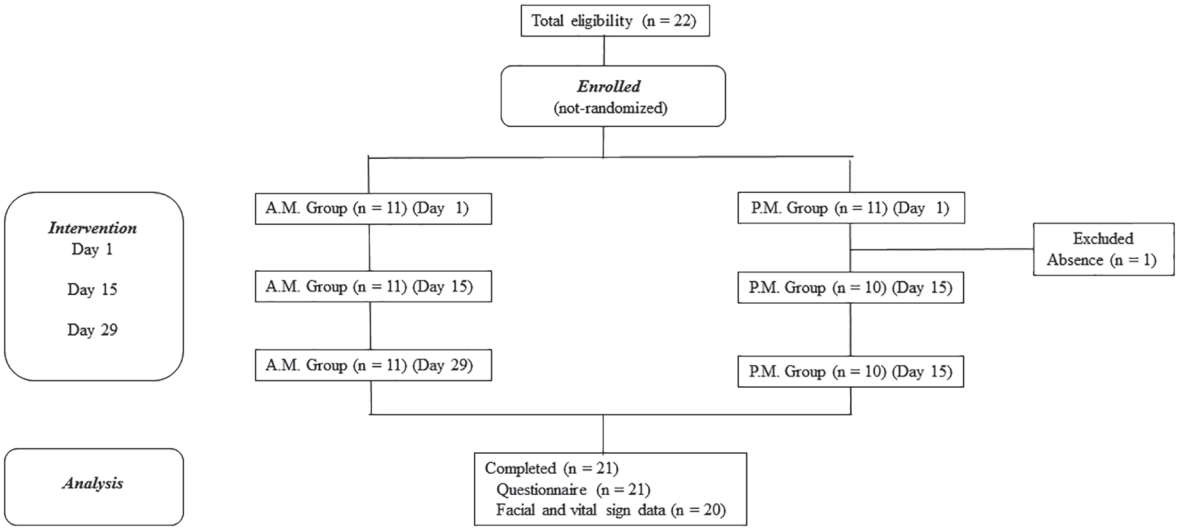

Fig.6 Participation flow chart.
The 22 participants were asked in advance whether they would like to participate in the morning or afternoon examination, and were accordingly distributed to the morning group or the afternoon group. One member of the afternoon group was excluded because they were absent on Day 15. Questionnaires and psychometric tests were collected from a total of 21 participants on Days 1 and 29. Additionally, due to a malfunction of one machine in the morning group on Day 1, it was not possible to collect expression data and vital data from this participant. Thus, data was collected from 20 people on Days 1, 15, and 29.

Table 2 Comparison of Psychological questionnaire at Day 1 and Day 29.

Variables	All participants (N=21)		P-value	Male group (N=13)		P-value	Female group (N=8)		P-value	VAS up group (N=14)		P-value	VAS down group (N=7)		P-value
	Day 1	Day 29		Day 1	Day 29		Day 1	Day 29		Day 1	Day 29		Day 1	Day 29	
SF-36															
Physical function	91.90±12.40	91.67±12.08	0.715	95.77±4.94	96.15±4.16	1	85.63±18.02	84.38±17.00	0.785	91.07±13.33	92.14±12.67	0.558	93.57±11.07	90.71±11.70	0.854
Role physical	86.02±18.32	88.71±14.86	0.304	90.39±12.91	90.88±11.86	0.887	78.93±24.07	85.18±19.16	0.194	87.51±19.15	88.85±17.18	0.799	83.06±17.56	88.41±9.83	0.223
Bodily pain	65.71±18.69	73.48±16.05	0.082	69.38±18.01	78.69±12.78	0.18	59.75±19.38	65.00±17.98	0.157	65.36±18.40	74.43±17.19	0.052	66.43±20.72	71.57±14.56	0.673
General health	64.18±19.83	66.05±20.94	0.43	65.54±16.34	63.85±19.79	0.579	61.98±25.62	69.63±23.63	0.058	64.84±19.97	65.36±19.24	0.925	62.86±21.07	67.43±25.62	0.167
Vitality	59.54±14.06	57.46±18.92	0.917	59.631±14.5	57.23±19.74	0.539	59.39±14.17	57.84±18.82	0.528	63.86±11.53	62.96±16.35	0.812	50.90±15.50	46.46±20.05	0.734
Social functioning	81.07±18.60	80.95±20.01	0.858	82.69±12.01	82.69±18.07	0.874	78.44±26.99	78.13±23.86	1	81.43±19.78	83.04±15.20	0.589	80.36±17.47	76.79±28.35	0.68
Role emotional	80.56±19.95	84.52±20.80	0.503	81.41±18.69	83.33±23.58	1	79.18±23.14	86.45±16.63	0.109	83.94±17.12	89.88±13.55	0.172	73.80±24.74	73.80±29.04	0.684
Mental health	65.24±11.99	69.29±15.76	0.11	65.38±12.66	69.23±16.94	0.268	65.00±11.65	69.38±14.75	0.102	67.86±12.04	72.50±11.22	0.128	60.00±10.80	62.86±21.96	0.527
WHO-QOL26															
Psychological health	3.41±.799	3.25±.754	0.202	3.65±.756	3.30±.842	.020*	3.00±.734	3.19±.632	0.547	3.37±.667	3.41±.568	0.813	3.48±.1.07	2.95±1.02	.048*
Overall score	3.52±.501	3.35±.540	0.082	3.62±.538	3.29±.606	.019*	3.35±.410	3.45±.433	0.933	3.53±.446	3.49±.435	0.675	3.49±.637	3.08±.656	.018*
POMS															
Tention-Anxiety	52.62±10.47	46.52±9.957	.006*	53.85±8.41	47.54±11.00	.023*	50.63±13.60	44.88±8.39	0.062	48.64±8.93	44.07±7.74	.041*	60.57±9.05	51.43±12.57	0.063
Depression	54.43±13.12	51.05±12.12	0.102	52.85±10.72	51.69±13.33	0.529	57.00±16.80	50.00±10.65	0.075	51.57±11.58	47.29±8.63	.028*	60.14±15.03	58.57±15.14	0.917
Anger-Hostility	53.62±10.49	47.57±9.53	.003*	52.69±11.95	46.46±10.83	.005*	55.13±8.06	49.38±7.23	0.141	50.29±7.98	44.14±4.22	.011*	60.29±12.28	54.43±13.48	0.108
Fatigue	52.86±10.11	48.48±9.64	0.016	50.92±8.82	48.31±10.79	..114	56.00±11.86	48.75±8.10	0.075	50.43±8.66	45.07±6.55	.005*	57.71±11.70	55.29±11.64	0.686
Confusion	52.29±11.04	49.62±11.43	0.064	49.77±8.24	49.85±12.55	0.665	56.37±14.18	49.25±10.14	.017*	48.57±8.07	46.07±7.89	0.054	59.71±12.98	56.71±14.57	0.498
ESAS-r-J															
Pain	2.10±2.45	1.81±2.16	0.411	1.62±1.71	1.62±1.90	1	2.88±3.31	2.13±2.64	0.059	2.57±2.68	1.93±2.10	.047*	1.14±1.68	1.57±2.44	0.785
Wellbeing	3.19±2.14	4.38±2.67	0.109	3.15±2.08	4.54±2.99	0.164	3.25±2.38	4.13±2.23	0.399	3.29±2.02	3.07±2.02	0.465	3.00±2.52	7.00±1.73	.018*
LSI-K															
K Ⅲ	1.14±.478	1.05±.498	0.414	1.15±.376	1.15±.376	1	1.13±.641	.880±.641	0.317	1.93±1.44	1.00±.555	.046*	.860±.378	1.14±.378	0.157

Data represent the means ± standard deviation. P-values represent differences observed before and after administration of this study intervention.
P-values represent differences observed before and after administration of this study intervention. *p<.05

Table 3 Comparison of HVC and DC6M4JN3000 at Day 1 , Day 15 and Day 29

Variables	All participants (N=20)			P-value	Male group (N=12)			P-value	Female group (N=8)			P-value
	Day 1	Day15	Day 29		Day 1	Day15	Day 29		Day 1	Day15	Day 29	
HVC												
Happiness	372.70±208.13	469.25±286.42	305.25±122.38	.041*	479.58±206.25	596.17±231.43	332.33±123.17	.001*	212.38±42.08	278.88±263.58	264.63±116.90	0.882
Surprise	481.05±247.12	534.70±292.97	292.45±125.79	.001*	538.25±260.51	581.75±301.99	311.42±101.29	.028*	395.25±212.32	464.13±283.14	264.00±159.02	.021*
DC6M4JN3000												
Tachycardia	97.95±33.87	111.05±38.06	71.25±43.98	0.202	94.23±49.03	115.08±41.90	82.15±.41.93	0.113	91.75±17.14	101.50±29.52	49.25±40.37	.030*

Variables	VAS up group (N=13)			P-value	VAS down group (N=7)			P-value
	Day 1	Day15	Day 29		Day 1	Day15	Day 29	
HVC								
Happiness	383.69±212.52	462.31±289.57	291.92±126.63	0.292	352.29±214.71	482.14±302.97	330.00±119.40	0.102
Surprise	506.69±234.81	546.08±293.49	302.62±120.46	.012*	433.43±281.14	513.57±314.21	273.57±142.97	0.05
DC6M4JN3000								
Tachycardia	109.38±33.09	121.77±36.66	73.92±42.65	.010*	76.71±25.18	91.14±34.48	66.29±49.42	0.368

Data represent the means ± standard deviation. P-values represent differences observed before and after administration of this study intervention. *p<.05

Discussion

To the best of our knowledge, this is the first study to quantify smiling expressions and explore the effects of laughter, with the findings as follows:

1) Laughter appears not to improve total quality of life significantly. No group showed a significant difference from one another in the items of the SF-36. In fact, the results for the WHO-QOL 26 for the male group and for the group in which VAS (sincere laughter) scores decreased, psychological health and overall score were significantly worse. Psychological health and overall score were significantly worse. This suggests a decrease in quality of life. This result, combined with the findings of other research finding that participation in laughing sessions over several weeks had no positive psychological effect over the long term [24], leads to the conclusion that to improve people's total quality of life through laughter, it may not be enough to simply grant opportunities to laugh. Other kinds of intervention may be necessary. In addition, the grounds for this result are uncertain, and we think that investigation of factors leading to this result is also necessary in the future.
2) Using the method of intervention exhibited in this study, laughing reduced Anxiety– Tension, Anger–Hostility, and Fatigue scores. Similarly, in another intervention, laughter led to reduced anxiety scores [25]. These results show that there may be differences in the way emotions are affected by different methods of intervention used to induce laughter.
3) The factors that might improve emotional scores through laughter are different for men and women. Reductions were found in the scores for Tension–Anxiety and Hostility–Anger in the male group, while within the female group, the Confusion score was reduced. Research suggests that men and women interpret humor differently [26]. Our results lead to the supposition that the intervention presented here may have produced different results because the interpretation of humor differs between the sexes.
4) Participants who laughed more heartily showed decreased short-term emotions of anger and hostility as well as lower scores for Pain and Acceptance of aging. By contrast, those who laughed less heartily showed lower scores for well-being.

These results, when taken together with studies that have found that the brain does not distinguish between self-induced laughter and laughter induced by external stimuli [27], suggest that the effects of laughter are mediated by the extent to which people can laugh heartily.

5) In the female group and among participants whose VAS scores increased, no significant decrease was found in happiness scores, and tachycardia was significantly reduced. This means that the participants continued to enjoy the laughter stimulus multiple times without being bored and that for women and those who laughed heartily, enjoyment is possible even in the absence of intense stimulation. This result is different from the results of research suggesting that people are programmed to adapt in response to subjective feelings [28]. An alternative explanation would be that it is easier to enjoy things when one is part of a

group, and the threshold of enjoyment is also lowered. Similarly, it appears that those who laugh more heartily have a lower enjoyment threshold.

In terms of these five points, the total quality of life did not improve by the laughter stimulus. However, on the one hand, improvements were seen in the scores measured by the various psychological tests, and on the other hand, gender-based differences and individual differences depending on whether the laughter was sincere were found. Therefore, this suggests that sincere laughter might be possible if the laughter intervention method was tailored to suit each participant and if participants can experience a beneficial effect without getting habituated to the laughter stimulus. The participant group whose VAS scores increased and who experienced a beneficial change comprised a particularly large proportion of ordinary workers (i.e., not students or academics), 12 out of 14 people. Future studies should increase the number of laughter interventions focusing on these ordinary members of society while also shortening the length of the interval period and observing the effects of laughter in relation to the content of laughter stimulus (e.g., watching laughter video software).

This study had the following limitations. First, the content of the comedy performances viewed by the participants was slightly different at each of the three instances. Entirely identical conditions were simply not achievable. Actors can be replaced, or the same actor may make a subtle change to his or her performance. The performances (*manzai*, *rakugo*, and *conte*) were nevertheless the same, so far as that was possible, and the length of the performances was set to 150 minutes, so changes may not have greatly affected the value of the research. Second, clinical examination data were not used. Previous studies have examined links that laughter has to natural killer cells [29,30] and immunoglobulin E [31]. However, because it has been found that laughter exerts no consistent influence on the activity of natural killer cells [32], such indicators were not measured in this study. Third, the sample size was small. Previous studies on laughter have reported small sample sizes [33,34] and it is difficult to make predictions from a small sample. This study was also limited by the amount of equipment that could be obtained. Nevertheless, this study was, to our knowledge, the first to quantify expressions of laughter and clarify its effects; as such, it remains valuable as a pilot study. Fourth, there was an issue with the geographical region of participants. Only the participants who lived in the Kansai region were subjects of this study. People in the Kansai region use some of the same techniques as the manzai comedian for everyday conversation [34]. Especially the Osaka people have affinity for laughter [35]. Therefore, participants may have specific affinity with the intervention method used in this study. Fifth, the influence of cognitive bias may be significant. Laughter's links to health have been extensively reported on in the media, such that public expectations of the effects of laughter may exceed the actual effects [36,37]. The participants may have been affected by this bias. The five factors mentioned above in the limitations are difficult to control, and additional research into the subject of laughter should take these considerations into account. Although our study has several limitations, there may be positive effects (e.g., relief from anxiety, pain, tension, and acceptance of aging) gained from sincere laughter, where getting habituated is less likely. Future studies should increase the number of laughter interventions focusing on ordinary members of society while also shortening the length of the interval period and observing the effects of laughter in relation to the content of laughter stimulus (e.g., watching laughter video software). Alongside exploring intervention methods for use with the general public, the researcher plans to develop further intervention models that have positive effects and can be provided as preventative medical care.

Conclusions

This study suggests that, depending on the methods used to induce it and the context in which it takes place, a way may exist to demonstrate the effects of laughter without habituating the participants.

Acknowledgments

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Competing interests

The authors declare that they have no competing interests.

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Author Correction:

Preventing development of cow's milk allergies in infants with atopic dermatitis through intake of cow's milk formula before weaning: A cross-sectional study

Megumi Nagai, Yutaka Takemura, Tomoyuki Arima, Hiroki Masumi, Koji Yamasaki, Hitomi Nishi, Norihiro Inoue, Tsukasa Takemura

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In the version of this article initially published, table numbers were mistakenly described in the text. The correct description is as follows.

On page 59, column 2, the last line, "Table 1" should have been "Table 2" .
On page 61, column 2, the last line, "Table 2" should have been "Table 3" .
On page 62, column 1, line 5, "Table 3" should have been "Table 4" .
On page 62, column 2, line 1, "Table 4" should have been "Table 5" .
On page 59, column 2, the last line, "Table 5" should have been "Table 6" .

The error has been corrected in the PDF version of the article.