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Psychological and Physiological Effects of Touching on Anxiety and Stress: A Nursing Technique

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Full Paper

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1 Introduction

On a daily basis, nurses come into physical contact with patients both intentionally and unintentionally. Nurses observe closely the condition of the patients and try to reduce their feelings of worry or anxiety. This form of contact, colloquially called 'touching' or 'touch', is a useful nursing technique. On touching the skin of an individual, nurses can cause sensations of tactile contact, pressure, pain, temperature, etc. that can elicit pleasant or unpleasant affective emotions in the individual, depending on the situation, psychological state, prior experiences or exposures, and background of the individual.

Takakuwa (1988)[1] gives several examples of the common effects of touch and explains that touch can convey the following feelings: affection, trust, goodwill, warmth, comfort, intimacy, interest, empathy, shared responsibility, sexual interest (depending on the situation), and sexual desire. She also cites the following effects of touch as examples: 1) enhancement of goodwill; 2) increased cooperation (on the part of the patient); 3) Increased verbalization; 4) the causing of the patient to feel an invasion of personal space (PS).

In clinical settings, touch has been established to be capable of leading to the following favorable outcomes: emotional stability in times of confusion immediately before death,[2] deepening of the nurse-patient mutual trust for patients with mental disorders who before persistently refused nurses' efforts to provide care,[3] facilitation of insertion of gastroscope with reduction of symptoms of anxiety, tension, worry or fear,[4] as well as the reduction of presurgical anxiety.[5] Another area where touch has been found beneficial is in the field of ophthalmology. It is part of a method used to relieve the suffering involved in maintaining a persistent prostrate position.

The levels patients reported of satisfaction with the pain relief derived from this massage were the highest when compared with hot compress and talking.[6] Additionally, pain relief from touch has been shown through not only subjective impressions but also physiological measurements like the skin electric potential standard, blood pressure, and pulse[7] and visual recording[8]. Moreover, positive effects for touch have been revealed in the clinical field for rubbing the affected body part (26.5%), putting the hand casually on the shoulder (26.2%), and holding the hand of the patient (22.2%)

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for patients having 'pain or suffering with nausea' (22.1%) or 'anxiety and fear' (20.6%), where at such times of pain and suffering, touch was used to 'provide ease and relief' (21.5%), 'attenuate suffering' (16.0%), 'calm' (14.4%), and 'promote relaxation' (14.2%).[9] Additionally, another study has demonstrated that touch is frequently used to buffer pain and anxiety.[10]

The aforementioned effects are induced by touch. According to Weiss,[11] 6 factors are involved in producing effects via touch: viz., (i) touch-duration, (ii) touch-location, (iii) touch-action, (iv) touch-intensity, (v) touch-frequency, and (vi) touch-sensation. Briefly, (i) touch-duration is defined as the length of time from the moment of contact to termination of the act; (ii) touch-location refers to the part of the body of subject receiving the stimulus; (iii) action refers to the speed by which the stimulator (touching person) comes into contact with the subject (person being touched); (iv) touch-intensity refers to the degree of pressure applied as touch by the stimulator; (v) touch-frequency measures the total quantity/duration of intentional touch experienced by subject in everyday life; and (vi) touch-sensation is defined as the pleasantness or unpleasantness of the touch stimulus sensed by the subject. In another study,[12] involving touching practice by students, an additional 5 factors were identified: viz., (a) the area of the hand-touching surface of subject; (b) the distance between the person doing the touch (stimulator) and the subject receiving the touch (stimulator-subject distance); (c) non-touch non-verbal stimuli (e.g. visual line, facial expression, position of face, etc.) of stimulator; (d) stimulator-subject position; and (e) whether the stimulator performs the touch from a position within the vision field of the subject. Briefly, factor (a) describes a feeling of warmth and connection that arises when the stimulator uses the whole surfaces of fingers and hand, in contrast to feelings of uncertainty or inadequate commitment experienced by the subject when only the finger-tips or certain parts of the hand are used. As for factor (b), the PS of the subject is infringed upon by the stimulator when the latter approaches the former to provide the touch stimulus; the stimulator-subject distance is a determinant of the touch efficacy. Factor (c) depicts a scenario where the stimulator excessively adjusts his/her position with reference to subject's visual line while inducing pressure on the subject's hands, and another scenario where the stimulator adjusts his/her position outside the subject's line of sight thereby creating anxiety of the touch with respect to the touch being performed. Factor (d) implies that assuming an unnatural posture without facing the face and body of the subject can induce doubts about the touch act, i.e. a sense of uncaring. With regard to factor (e), touch executed by the stimulator outside the field of vision of the subject may surprise the subject resulting in unpleasantness or dissatisfaction.

With respect to nursing, it would be useful if each of the constituting elements mentioned above could be borne in mind by nurses while they are on duty. In certain scenarios where the need for touch is sensed and promptly provided, the outcome can be highly satisfactory if the respective factors are well understood and the appropriate constituting factors are applied when and where necessary. Furthermore, Takakuwa (1988)[1] has pointed out that the meaning and effectiveness of touch can be affected by: 1) the stimulator-subject relationship; 2) the psychological state of the subject; and 3) how the touch is combined with other communication methods. Based on the constituting elements of touch in investigating clinical outcomes, the time-length factor of touch (touch-duration) has not been documented, and is situation-dependent or varies case by case. Moreover, touching the hand, shoulder, and back (BK) tends not be experienced as a pleasant sensation when the touching is done deliberately, while rhythmical touching is likely to be perceived as a pleasant sensation.[13] The touch-sites of patients in intensive care units (ICU) are most likely to be the hand and shoulder,[14] while those of terminal cases with cancer frequently involve the hand, shoulder, BK, and upper extremities.[10] Furthermore, the results of touching the hand and shoulder have been demonstrated to reduce heart-rate (HR), indicating the effectiveness of touching both aforementioned sites, the hand appears to be more sensitive than the shoulder.[15] The component elements of touch - such as the action, intensity, frequency, and sensation - have not been documented in previous studies.

Based on the above findings, touch is a complex and multifaceted stimulus, and its definition and categorization varies according to the authors. In the present study, we define touch as an act of bodily contact that provides psychological effects with the express purpose of providing a comfortable, buffering action on the anxiety, pain/distress, and tension of the patients. Touch with the purpose of eliciting comfort has been evaluated through much research in the nursing field, and many of the results are derived from subjective evaluations of individual patients. With reference to physiological indexes, although various methods have been used to attempt to evaluate touch, a standardized and reliable method has yet to be established. Moreover, in the field of brain physiology, the emotional aspects of pleasant and unpleasant feelings of touch have not been clearly established. Nurses feel there is a need to apply touch when they sense patients are suffering from psychological and physical pain. As such, only when the intention of nurses to work on attenuating the suffering of patients converges with the actual needs of the patient receiving the touch, can the touch be effective. Hitherto, findings related to PS and a constitutive element of touch, have yet to be established.

In short, touch in the field of nursing is an important nursing intervention for buffering the anxiety and tension of patients. Although the effects of touch have been documented, the assessments are frequently based on the subjective perspectives of patients.

In nursing, touch is considered to be useful and helpful, and it is therefore very important to clarify the touch-effects in order to establish effective touch-methods as technical nursing skills. The purpose of this study was to both show the efficacy of touch using psychological and physiological indexes and to compile data for reference that can later be used for the development of effective touch methods.

2 Investigation Methods

2.1 Subjects and grouping

Subjects (n=57; female: 44) were healthy adults (age range: 18 - 32; mean: 21.5 ± 2.6yr) who participated in the study with written consent. Participants made no alterations to their normal daily routines for the experiment, and participated in the study under normal conditions. They did not wear any metallic jewelry during the study.

Grouping of participants

With regard to the present study, a state-trait anxiety inventory (STAI) of participants was taken (α = 0.92 was employed for the purposes of this study). Based on the mean scores, participants were randomized into 2 groups such that there was no bias with regard to the transient situational anxieties induced by the autonomous nervous system (ANS) under stress.

2.2 Experimental period and conditions

The experiment was conducted between July and August of 2006 in a shielded room at University A. The room was illuminated at a light intensity of 40-43 Lx and maintained at 24-26℃ with relative humidity of 40-50%.

2.3 Methods

The experiments were conducted as follows:

2.3.1 Electrode placement:

Subjects were seated on a chair with their backs (BKs) supported, and electrodes for an electrocardiogram (ECG) and an electroencephalogram (EEG) were attached.

2.3.2 Resting electroencephalogram (EEG_{Rt}) and ECG_{Rt} monitoring:

When electrodes were placed at the appropriate sites, subjects were asked to close their eyes. The measurement was started when the EEG_{Rt} stabilized (3 min) and that condition was maintained thereafter for another 3 min after touching.

2.3.3 STAI, personal space (PS), and impression assessment rating (IAR) measurements[16,17]:

STAI, PS and IAR were measured on resting subjects.

2.3.4 Loading of psychiatric stimulus

Subjects were asked to listen carefully to various previously recorded single-term words, and they were asked to imagine the actual emotions perceived. The subjects were asked to raise their right hand if the words caused uncomfortable or negative feelings. Subjects were told that they were free to terminate

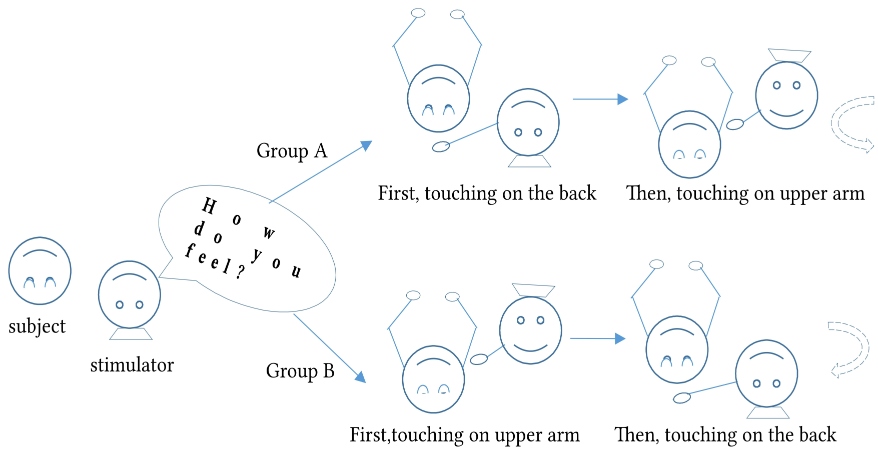

Fig. 1: Touch procedure involving the stimulator and subject in Groups A and B, where the former is seated at different location during touching.

the playing of the tape at any time.

2.3.5 Measurements of STAI and PS after stimulus loading

After psychiatric stimulus (after listening the recorded single-term words), the subjects answered the questionnaire on STAI and PS.

2.3.6 Touch procedure (Fig. 1)

During each trial, the stimulators would touch the subject's UA and BK each once. She performed the touching of each part for 50 sec. She initially seated to the right side parallel to the subject with her left hand on the subject's back, and attempted to make the subject feel relaxed by asking: 'How do you feel?' When the upper arm (UA) was to be touched, the stimulator would turn her seat to face the subjects (Fig. 1), and after touching the subject for 50 sec with the right hand, would rotate her seat to be again parallel to the subject and again place her left hand on the subject's back (Fig. 1).

The order in which the touching would occur – starting with the back or starting with the upper arm – was decided ahead of time and at random. The stimulators were notified of the order before beginning the touching.

2.3.7 EEG and ECG after touching (AT):

The subjects were asked to close their eyes 3 min after the second touch during EEG and ECG monitoring.

2.3.8 Recording the AT resting STAI, PS, and IAR:

The above-mentioned procedures were repeated: STAI, PS, and IAR were measured, and subjects were asked to complete a questionnaire related to the touch order designed by the authors.

2.4 Conditions of touch

Words designed to cause anxiety and tensions/stress were selected before touching.

Anxiety can be understood as having two components. One of them is a sense of danger that arises when physical threat is perceived or expected. The other is a sense of danger that arises when a threat to one's pride or self-respect is perceived.[18] With these considerations in mind, two-word phrases that had anxiety-inducing effects[19] were selected and recorded on tape. In designing the experimental setting, subjects listening to the recorded two-word phrases were given psychiatric load leading them to experience anxiety/tension.

2.4.1 Touch-duration

Subjects in previous studies have revealed indicated that a 3-min touch-duration was too long to efficiently complete the entire study, and therefore the touch stimulus was adjusted to 50 sec in order to effectively complete the study in the shortest possible time while still allowing for all necessary physiological data to be obtained.

2.4.2 Touch-sites

In nursing, the BK, UA, shoulders, and hands are common touch sites.[10] Touching of either the hand and shoulder reduces the HR, and is effective in buffering tension/stress, although subjective evaluations have shown the hand is a more sensitive site than the shoulder.[15] A study monitoring the EEG with touching done on the dorsal part of hand, the palm, the shoulder opposite the stimulator, the shoulder on the same sides as the stimulator thigh, or lumbar region, has revealed that the most relaxing effects were obtained with touching the shoulder on the same side as the stimulator; the next most relaxing was the dorsal part of the hand. In that study, touching the thigh and lumbar region did not yield any relaxing effect.[20] Therefore, the present study investigated hitherto undocumented sites, such as the dorsal area of the torso/back and upper arm. Furthermore, the subject was purposely placed in a naturally seated position such that the touch-sites (BK, UA) would also assume a natural position, and so as to prevent the subjects from falling asleep. In touching the BK, the stimulator was seated on the right of the subject and the BK was touched with the left hand. As for the UA, the stimulator faced the subject and touched the-right UA with the right hand.

2.4.3 Touch-gesture

In the first instance of touching, the stimulator placed her hand on her knee, and the interval required for the hand to move to the touch-site from the knee was under 1 sec, and a 6-sec interval was used to adjust the body posture for mobilizing the hand from the initial touch-site to a subsequent site.

2.4.4 Touch-sensations

The hands used in touching were always maintained at a constant temperature, and were measured at the central part of the palm on every subject using a digital thermometer (AD-5625 water-proof thermometer; A&D Co. Ltd.) The surface temperatures of the hand measured before the experiment and before touching yielded mean values of 34.7±0.83 and 34.7±0.80℃, respectively. The interval of temperature-reading was 50 sec. Furthermore, the mean temperature of the BK and UA on touching were 35.2±0.64 and 35.1±0.61℃, respectively.

2.4.5 Touch surface area

When stimulator executed the touching, the hand as a whole - not part of the hand - executed the touch in a natural state without using additional force.

2.4.6 Distance between subject and stimulator (subject-stimulator distance)

The height of stimulator was 162 cm (64 cm: from acromion to the third fingertip; and in the case where touch was executed with the arm bent, the acromion to the third fingertip was 42 cm). The subject was asked to remain still in a seated position in the chair during the experiment. The position of the rotatory chair used by the stimulator was fixed during touching; however, when the touch-site was altered, the position of the stimulator was accordingly adjusted by rotating the chair.

2.4.7 The body posture of subject

The subject was asked to assume the most comfortable posture possible after having listened to explanation of the total time required and the need to maintain the same posture throughout the experiment. Therefore, the subject maintained a position with the lumbar region deeply seated in the chair.

2.4.8 Touch-intensity

Before starting this study, the touch-intensities of stimulator were measured by the following method: viz., the left-hand touch for the BK, and the right-hand touch for the UA were placed accordingly on a piece of ultra-low pressure sheet (two-sheet type) for Fujifilm press scale (Fuji Photo Film Co. Ltd., Tokyo). The sheet was spread over a low-pressure monitoring press-scale mat (Joban Rubber Co. Ltd., Tokyo) specially designed for Fujifilm press scale use. The mat covered with the sheet was placed on the touch-sites (BK and UA) for pressure measurements. When the respective touches were placed on the ultralow pressure sheet, red marking spots appearing on the sheet could be converted visually to comparative pressure values (intensity markers) of the respective touches. As touch-intensities are difficult to convert to pressure values using the whole hand, the only sites where intensities/pressures were measured were the thenar and fingertips (0.001–0.01 Mpa, where 1 Mpa=10.2 kgf/cm[2]). The touch of stimulator was ascertained to be within the aforementioned force-range before the experiment using touch was initiated.

2.4.9 Odor during touching

The stimulator dressed with a clean nurse-coat and did not wear any perfume or cologne. Care was taken to ensure that no noticeable odors were present in the experimental room and environment.

2.4.10 Visual line of stimulator

Because the study measured physiological data of the subject, the subject was asked to close their eyes to avoid eye-contact during the experiment.

2.4.11 Subject-stimulator relationship

The subject and stimulator (nursing experience: 12 yr; height: 162 cm) met for the first time during the experiment

2.4.12 Positional relationship with stimulator

The stimulator sat to the right of the subject to execute the touching. Preliminary studies showed that it was preferable that the stimulator sit to the right of subject to shorten the approach-distance when bilateral shoulders were touched, and that approaching from the right (rather than the left) facilitated touch-acceptance.

2.5 Measurement contents

2.5.1 Basic particulars

The following particulars of the subjects were investigated: age, height, time of sleep on the night before the experiment: absence or presence (and amount) of tobacco intake, postprandial time (hr), absence or presence (and amount) of alcohol intake. In cases of female subjects, regular or irregular menstrual cycle, or number of days after last menstrual period. Additionally, the following information of the subjects was recorded: the family composition, current household environment, absence or presence of conversation and/or bodily contact with others (mean number of people) in the week prior to experimentation, and presence/absence of hospitalization history.

2.5.2 Psychological indexes

The psychological indices used in this study were derived from the items on the state-trait anxiety inventory (STAI) (www.ncbi.nlm.nih.gov/pmc/articles/PMC3879951/).

2.5.2.1 STAI (state-trait anxiety inventory)

The items on the STAI (due to excitation of the autonomous nervous system (ANS) accompanied by anxiety induced by transient emotional states) related to the status and anticipatory anxiety associated with subjective emotions and ANS activation were measured.[21] The examination items during the resting state (Rt), post-stimulus loading (PSL), and after-touch(ing) (AT) were recorded in triplicate. Scores were calculated for each event, and values between events were respectively analyzed using the Student-t test. Differences where $p<0.05$ were considered significant.

2.5.2.2 Impression assessment rating(IAR)

The Adjectives for Characteristic Rating scale is used for measuring various dimensions of personality that are strongly expressed when a person comes into physical contact with others.[20] The questionnaire comprises a total of 20 adjectives (i.e. positive vs. negative, gentle vs. narrow-minded, sociable vs.

unsociable, etc.) pairs with a 7-scale assessment. In cases involving touch, the subject-stimulator relationship is important. This scale can assess the impression of the subject toward the stimulator before an experiment, and evaluate change in impression after touch. In this study, the scale was identified as the impression-rating scale. This evaluated the impression before and after touching, and the scores for the respective items were rated. Moreover, the rating differences before and after touch were verified with the χ^2 test, followed by comparison with the Wilcoxon signed-rank test; and differences where $p<0.05$ were considered significant.

2.5.2.3 Eleven compositional elements of touch

The constitutional elements of touch, which were added freely in the comment column, were designed by the author(s) with the following elements: (1) touch-duration; (2) touch-site; (3) gesture when performing touch (touch-gesture); (4) sensation immediately after touch (touch-sensation); (5) surface area of hand on touching (touch surface area); (6) subject-stimulator distance when touched (subject-stimulator distance); (7) posture assumed when touched (posture); (8) touch-intensity; (9) odor during touching; (10) attention of stimulator; and (11) visual line of stimulator. With reference to these 11 elements, when answers on a 5-rank scale were required, unpleasant feelings were rated as 1 while pleasant feelings were rated as 5. Participants were asked to freely record in the comments column their reason(s) for the given evaluations. Frequencies of the 11 constitutional elements as for touches to the BK or UA were derived, and each constitutional element was first analyzed with the χ^2 test, followed by comparison of touches on BK and UA with the Wilcoxon signed-rank test; differences where $p<0.05$ in both tests were considered significant.

2.5.2.4 Personal space (PS)

So as to minimize the duration of the experiment and any suffering that might be endured by the subject, a so-called "imaginary projection" method was employed to monitor patient's sense of PS: viz., subjects imagined the center of a sheet of paper as representing their position in the room, then imagined an unknown stimulator was approaching them from 8 directions (front, right-front, right, right-rear, rear, left-rear, left left-front), and marked undesirable directions/positions of approach via extended radial lines on the paper.

The PS after resting (PS_{ARt}), post-stimulus loading (PS_{PSL}), and after touching (PS_{AT}), was monitored by the imaginary projection method. From the center, the distances in the left-front, front, right-front, right, right-rear, rear, left-rear, and left directions were compared with event changes. When the PS_{PSL} distance was subtracted by the PS_{ARt} distance (load less rest or L-Rt), the PS_{AT} distance was subtracted by the PS_{PSL} distance (touch less load or T-L), and the PS_{AT} distance was subtracted by the PS_{ARt} distance (touch less rest or T-Rt), the differences in distance were takes as measures of the quantitative variations of the respective PS values. These quantitative variations (i.e. L-Rt, T-L, T-Rt) were compared using the Student t-test, and differences where $p<0.05$ were considered significant.

2.5.2.5 The STAI-PS correlation

In order to determine if PS is related to anxiety status, quantitative conversions of the STAI and PS scores were verified examined using the spearman rank-correlation coefficient, and two-item differences where $p<0.05$ were considered significant.

2.5.2.6 IAR-PS relationship

The relationship between impression assessment rating (IAR) on others and PS was derived by correlating after-touch IAR (IAR_{AT}) with after-touch PS (PS_{AT}) using the spearman rank-correlation coefficient, and differences where $p<0.05$ were considered significant.

2.5.3 *Physiological indexes*

2.5.3.1 Index of central nervous system (CNS) functions: EEG

With the reference electrodes fixed bilaterally to earlobes, electrodes connected to an EEG device (Synafit2100, NEC Corp., Tokyo) were placed at Fp1, Fp2, F3, F4, C3, C4, T3, T4, P3, P4, O1, and O2 according to the International Standard Electrode Method (https://en.wikipedia.org/wiki/10-20_system_EEG) to monitor the EEG. EEG data were subjected to analog-digital conversion (Vital Tracer, Kissei Comtech Co. Ltd., Nagano) for frequency analysis at 10-sec intervals using the EEG-mapping research program ATAMAP II (Kissei Comtech Co. Ltd.,Nagano), where 3 min were allowed for resting, 50 sec for stimulus-loading (SL), 50 sec each for touching the back (BK) or upper arm (UA). Furthermore, EEG was categorized into various wavebands: viz., δ (2.0 - 4.0Hz), θ (4.0 - 8.0Hz) α1 (8.0 - 10.0Hz), α2(10.0 - 13.0Hz), β1 (13.0 - 20.0Hz), and β2 (20.0 - 30.0Hz), where the arousal level (mental activity) was evaluated by prevalence of the frequency. EEG outputs at the respective sites were analyzed by the following method

In determining arousal levels, the percentage (%) power value (frequency amplitude change) was derived. Summation of all wavebands (δ〜β2) then expressed the total power value. Considering individual differences, the ratios of various wavebands occupying the total power value were expressed as a percentage power, or %-power, value (%). From the %-power value, the prevalence rate of small and coarse waves (fast or slow waves) were determined. As for arousal levels in the brain, changes induced by events were compared as follows: changes in the respective wavebands were monitored by assessing the differences in the mean value for each event. In other words, differences between the events: i.e. differences between stimulus-loading and resting (i.e. D_{SL-Rt}), touching-BK and stimulus-loading (D_{BK-SL}), and touching the UA and stimulus-loading (D_{UA-SL}) were derived before being verified for statistical comparisons using the Student t-test, and differences where $p<0.05$ were considered significant.

2.5.3.2 Indexes of autonomic nervous system (ANS) function

Indexes of autonomic nervous system (ANS) function included heart rate (HR), high-frequency (HF) value [index for parasympathetic nervous system (PNS) activity of the heart], low-frequency/high-frequency (LF/HF) value [index for sympathetic nervous system (SNS) of the heart].

In the measurement of above-mentioned indexes, data were first subjected to analog-digital conversion using an active tracer (AC-301, GMS Col. Ltd., Tokyo) prior to being uploaded to a personal computer, followed by performing the HR variability (HRV) analysis with waveform analysis (TAWARA/WIN; Suwa Trust Co. Ltd., Tokyo), where frequencies of 0.04 – 0.15Hz and 0.15 – 0.40Hz were treated as LF and HF, respectively. HF served as an index of PNS activity; however, as LF indicated both SNS and PNS activities, the LF/HF ratio thus served as an index of SNS activity. In fashions similar to EEG analysis, data for the 3-min Rt period, 50-sec SL period, 50-sec BK-touching period, and 50-sec UA-touching period were used. For comparison of changes in each event, the HR, HF value, LF/HF value were monitored: viz., the difference in the mean value of each event. Therefore, the following differences; i.e. $D_{PSL-ARt}$, D_{BK-PSL}, and D_{UA-PSL} were calculated before being verified for statistical comparisons using the Student t-test, and differences where $p<0.05$ were considered significant.

2.6 Ethical considerations

The participants were briefed orally and in written form on the purpose, methods of the study, their rights as participants, and how the study data and their privacy would be protected, and how the study would be published. Participants were free to withdraw from the study at any time they deemed desirable even after having given their consent to participate, without affecting their academic results or imposing any disadvantage whatsoever thereafter. All investigation materials and data sheets would bear code numbers from the list of participants. The code numbers, participant lists, and study data were collected and separately stored with an electronically secure system. On completion of the study, the list of participants was thoroughly shredded and disposed of. Thus, the anonymity and privacy of participants were properly guarded and maintained. Subjects who wished to participate in the study signed their names to give written consent after having acknowledged understanding the above conditions.

Furthermore, subjects who participated in the study were expected to learn and deepen their understanding of the touch technique, and they were expected to enhance their education and gain experience as nursing students.

Note that the present study was approved by the Ethics Committees of the Yamanashi University Medical School, and the National College of Nursing.

3 Results

3.1 Subjects

Table 1. Information about the Subject

N=57 (Female 44)	Mean	SD
STAI-T	45.6	12
Age	21.5	3
Height (cm)	161.6	6
Time of sleep on the night before the experiment (hour)	6.5	2
Postprandial time (hour)	3.3	2

Of the 61 subjects who consented to participate in the study, data from 57 (effective responders: 93.5%) were used for analysis (omitted cases due to dropping-out or other reasons: n=4) (Table 1). Based on their STAI scores prior to the study, participants were randomly placed into 2 groups (originally with equal numbers): Group A had the BK as the first touch-site followed by the UA (n=30), while Group B had the touch-sites in the reverse order (n=27). When the 2 randomized groups with their final STAI scores were compared (Group A vs B: 47.2±11.7 vs 43.7±12.9), homogeneity of the groups was established without significant difference.

3.2 Evaluation of psychological indexes

3.2.1 STAI (anxiety state)

Table 2. Means of Stare Trait Anxiety Inventory after each event.

	after-resting (ARt)	post-stimulus loading (PSL)	after-touch (AT)	t test
mean (SD)	40.5 (9.7)	45.1 (10.6)	40.8 (8.0)	ARt<PSL ($p<0.001$) PSL<AT ($p<0.001$)

Measurements of STAI after-resting (ARt), post-stimulus loading (PSL), and after-touch (AT) showed that the differences in PSL (45.1±10.6) vs ARt (40.5±9.7) and PSL (45.1±10.6) vs AT (40.8±8.0) were significant ($p<0.001$ in both cases), Note that significant differences in ARt vs AT were not established, while PSL induced obvious anxiety (Table 2). Moreover, Because AT STAI scores were not significantly different with regard to the sequence of touch-sites, confirming that the sequence of touch-sites was not important.

3.2.2 Touch-induced constitutional elements

Although an 11-element assessment of touch on the BK or UA were compared, significant differences were not observed. Additionally, 'unpleasant' and 'if I had to make a choice, it's unpleasant' for unpleasant; and 'pleasant' and 'if I had to make a choice, pleasant' for pleasant. The choice for answers were divided into 3 categories: 'unpleasant', 'unsure of either', and 'pleasant'. Individual constitutional elements were then verified with the chi-squared (χ^2) test (Table 3).

Of the constitutional elements, touch-duration (Table 3, line a), touch-site (Table 3, line b), touch-gesture (Table 3, line c), touch-sensation (Table 3, line d), touch surface area (Table 3, line e), subject-stimulator distance (Table 3, line f), and touch-intensity (Table 3, line h) indicated that more subjects noted

Table 3: Assessment of 11 elements of touch on the back (BK) and upper arm (UA) were measured.

Reference	Constitutional elements	unpleasant	neither	pleasant	χ2	p
a	touch-duration	11	18	28	7.68	0.021
b	touch-site	6	17	34	19.75	<0.001
c	touch-gesture	6	23	28	13.32	<0.001
d	touch-sensation	10	11	36	22.84	<0.001
e	touch surface area	1	21	35	30.74	p=0.001
f	subject-stimulator distance	8	21	28	10.84	p=0.001
g	posture	11	24	22	5.16	p=0.076*
h	touch-intensity	4	6	47	62.00	p=0.001
i	odor during touching	0	42	15	12.79	p<0.001
j	attnetion of stimulator.	16	23	18	1	p=0.504*
k	visual line of stimulator	7	44	6	49.37	p<0.001

* *not significant*

that component-element as ‘pleasant’. In addition, odor during touching (Table 3, line i) and visual line of stimulator (Table 3, line k) were ranked as ‘either is acceptable’, or ‘neither’. Furthermore, with regard to touch-duration, when ‘How long was the touch-duration?’ (see below: projected duration), and ‘how long was the touch-duration wished to be’ (wished duration) were statistically compared, the results revealed that wished duration was significantly (p=0.014) longer for touch-duration rated ‘pleasant’ (113.21 sec) vs ‘unpleasant’ (15.91 sec). Moreover, the projected duration and the wished duration were significantly correlated (r=0.667, p<0.001).

3.2.3 IAR evaluation (impression rating)

Items related to IAR evaluation of stimulators by subjects before and after touch (it was 4 of 20 items) indicated the following were significant: ‘positive’ (positive vs negative; p=0.029), ‘not conceited’ (not conceited vs conceited; p=0.017), ‘friendly’ (friendly vs unapproachable; p=0.047), ‘broad-minded’ (broad-minded vs narrow-minded; p=0.016).

3.2.4 Personal space (PS)

Results of the 8-direction comparison (Fig. 2) of differences of post-stimulus loading (PSL) vs after resting (ARt) [i.e. load less rest (PSL-ARt)] and PSL vs after-touch (AT) [i.e. touch less load (AT-PSL)] revealed the following features (PSL-Art and AT-PSL as significance): significant differences were established at the front (4.48 mm, -2.43 mm; p=0.034), right-front (7.30 mm, -7.14 mm; p<0.001), right (4.29 mm, -5.68 mm; p<0.001), rear (5.00 mm, -11.61 mm; p<0.001), left-rear (5.45 mm, -7.75 mm; p=0.002), left (4.43 mm, -5.50 mm; p=0.004), and left-front (6.82 mm, -5.95 mm; p<0.001). PS expanded ARt, while AT, PS contracted: viz., PS was expanded by stimulus while touching contracted PS.

3.2.4.1 Relationship between changes in PS and STAI scores .

In differences between PSL vs ARt in PS and STAI scores, significant relationships were noted in the rear (r=0.278; p=0.038). Both PS and STAI on stimulus were increased compared to resting: viz., stimulus mimicked anxiety, leading to expansion at the rear as indicated. With regard to differences between PSL vs AT in PS and STAI scores, relationships were established in the following: left-front (r=0.272; p=0.042), front (r = 0.388; p = 0.003), right (r=0.427; p<0.001), rear(r=0.383; p<0.001), and left (r=0.439; p<0.001). PS after touch was smaller after PSL, and anxiety was attenuated by touching (as indicated by reduced STAI scores), suggesting that PS was also contracted by touching.

3.2.4.2 Relationships between PS on and IAR to stimulators after touching.

On the IAR 20 items on the IAR , on negative correlations were established between ‘bad person vs good person,' negative correlations were established for the following directions: left front (r=-0.322; p=0.017), front (r=-0.377; p=0.005), right front (r=-0.368; p=0.006), right (r=-0.312; p=0.020), rear (r=-0.269; p=0.045), and left (r=-0.329; p=0.014); while for item on 'responsible vs irresponsible,' positive correlations were established as follows: front (r=0.310; p=0.021), right-front (r=0.271; p=0.048), right (r=0.373; p=0.005), and left (r=0.299; p=0.032). Additionally, positive correlations were showed between the item 'discreet vs indiscreet' and left-front (r=0.333; p=0.013) and right-front (r=0.328; p=0.015) on PS and between the item 'friendly vs unfriendly' and left-front (r=0.279; p=0.039) and front (r=0.373; p=0.005) on PS.

However, between for 'diffident vs confident' and each directions on PS were shown negative correlations were shown: left-front (r=-0.303; p=0.025), right-front (r=-0.298; p=0.029), right (r=-0.310; p=0.021), and left (r=-0.269;p=0.047). In short, the distance differences from others contracted for those who rated 'good person' and 'friendly' was shortened, while those for subjects who opted 'irresponsible,' 'indiscreet,' and 'diffident' was extended.

3.3 <u>Rating the physiological indexes</u>

3.3.1 CNS function rating: EEG

3.3.1.1 Laterality difference in the forehead respective brain sites. (Fig. 3)

Significant laterality differences between resting and stimulus-loading (SL) were apparent in α1 waves of the forehead (Fp1, Fp2): i.e. the frequencies of α1 waves were significantly (p=0.035) less in the left (Fp1) than right forehead (Fp2) on SL. As for the touch responses between SL and BK-touching, α1 waves increased significantly (p=0.035) more at the left (Fp1) than right (Fp2) forehead on touching. As for the difference in touch responses between SL vs UA touching, the α1 waves – in a similar fashion - were significantly (p=0.044) more enhanced in the left (Fp1) than the right (Fp2) forehead on touching.

3.3.1.2 Comparison of differences between 'Rt vs SL' and between 'SL vs back (BK-touching)'

Changes of incidence at each wavelength in all sites were investigated.

The δ waves at the forehead (Fp1, Fp2) and frontal region of the head (F3, F4) increased significantly on SL compared to Rt, and decreased significantly on BK-touching compared to SL (Fp1, p<0.001; Fp2, p<0.001; F3, p=0.009; F4, p<0.001), respectively.

With regard to other wavelengths at various brain-sites, α1 waves decreased on SL compared to Rt,

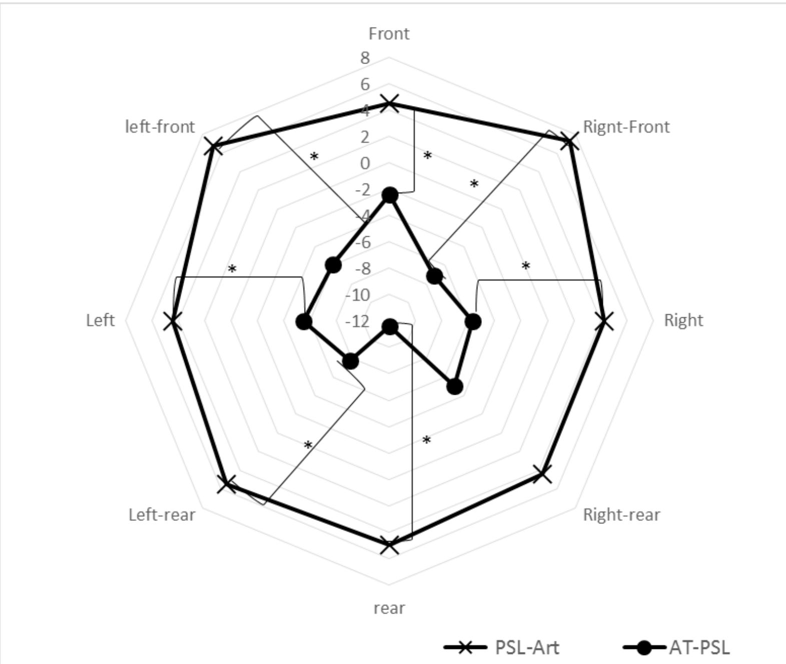

Fig. 2: Personal space (PS) 8-direction comparisons for post-stimulus loading (PSL) vs after resting (ARt), and PSL vs after-touch (AT).Personal space (PS) 8-direction comparisons for post-stimulus loading (PSL) vs after resting (ARt), and PSL vs after-touch (AT).

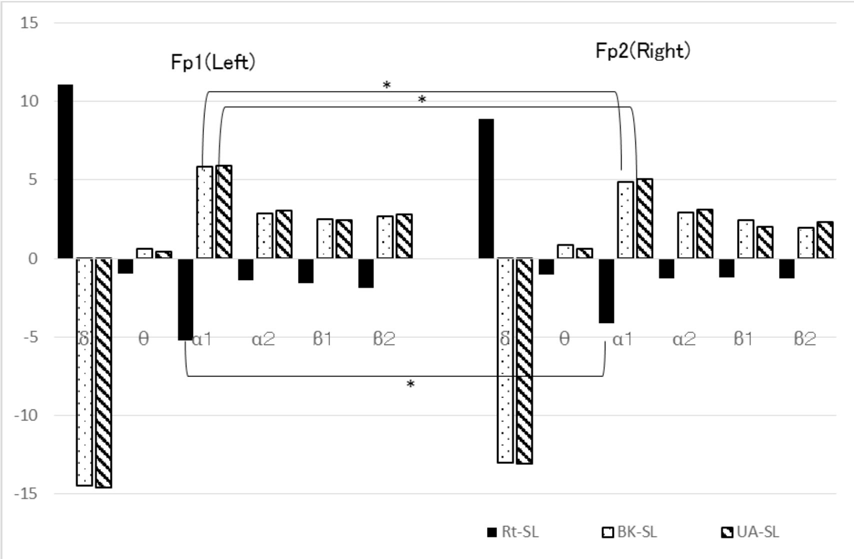

Fig 3. Laterality difference in the forehead. Rt: resting, SL: stimulus-loading, Bk: Back-touching, UA:Upper arm-touching

and increased on BK- touching compared to SL (Fp1, p<0.001; Fp2,p<0.001;F3, p=0.002; F4, p=0.002; T3, p<0.001; T4, p<0.001; C3, p=0.016; C4, p=0.016; P3, p<0.001; P4, p<0.001; O1, p<0.001; O2, p=0.002).

With regard to β waves, β2 waves from the temporal and central regions, β1 and β2 waves from the parietal and occipital sites were enhanced on SL compared to Rt, while these waves were reduced on BK-touching compared to SL (T3, p=0.024; T4, p<0.001; C3, p=0.034; C4, p=0.023; P3(β1), p<0.001; P4(β1), p=0.006; P3(β2), p<0.001; P4(β2), p=0.005; O1(β1), p<0.01; O2(β1), p<0.001; O1(β2), p=0.010; O2(β2), p=0.002).

Furthermore, α2 (fast waves), β1 and β2 waves were reduced during SL compared to Rt, and increased on BK-touching compared to SL in the frontal region (Fp1(α2), p<0.001; Fp2(α2), p<0.001; Fp1(β1), p<0.001; Fp2(β1), p<0.001; Fp1(β2), p<0.001; Fp2(β2), p=0.002).

3.3.1.3 Comparisons of differences between 'Rt vs SL and between 'SL vs upper-arm (UA)-touching'

At both the forehead and frontal region, δ waves were increased during SL compared to Rt, and were lower on UA-touching than during SL (Fp1, p<0.001; Fp2, p<0.001; F3, p=0.001; F4, p<0.001). With regard to other frequencies, α1 waves were reduced during SL compared to Rt, and enhanced on UA-touching compared to during SL (Fp1, p<0.001; Fp2, p<0.001; F3, p=0.002; F4, p=0.002; T3, p<0.001; T4, p<0.001; C3, p=0.007; C4, p=0.006; P3, p<0.001; P4, p=0.001; O1, p=0.002; O2, p=0.002).

As for fast-waves, β2 waves from the temporal region while β1 and β2 from the parietal and occipital regions were enhanced during SL compared to Rt, and were attenuated on UA-touching compared to during SL (T3, p=0.038; T4, p=0.005; P3(β1), p<0.001; P4(β1), p=0.007; P3(β2), p<0.001; P4(β2), p=0.024; O1(β1), p<0.001; O2(β1), p<0.001; O1(β2), p=0.018; O2(β2), p=0.008).

As for fast-waves from the forehead α2, β1 and β2 waves were reduced on SL compared to Rt, and were enhanced on UA-touching compared to during SL (Fp1(α2), p<0.001; Fp2(α2), p<0.001; Fp1(β1), p<0.001; Fp2(β1), p<0.001; Fp1(β2), p<0.001; Fp2(β2), p<0.001)

3.3.1.4 Comparisons of differences between 'SL vs BK-touching and 'SL vs UA-touching'

No significant differences were noted in the changes in the frequency of waves for the two touch-sites.

3.3.2 ANS function rating (Figs. 4, 5)

Differences of the means of HR, HF value (index for PNS activity), and LF/HF value (index for SNS activity) were compared for the respective events.

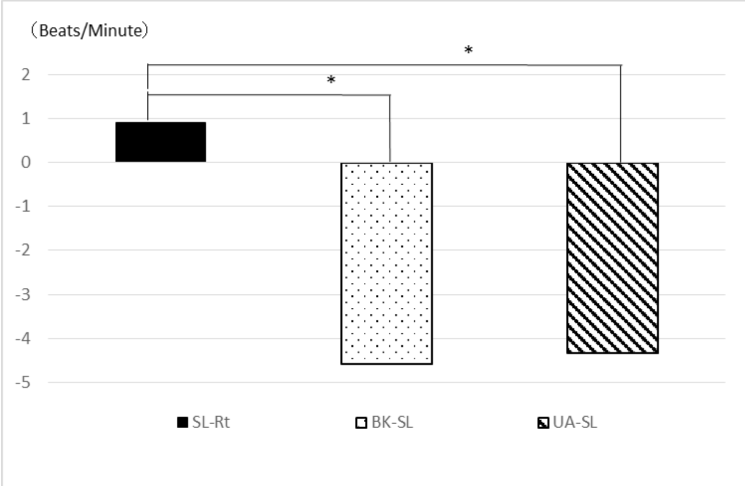

Fig. 4: Compare for the respective events on differences of the means of HR. Rt: resting; SL: stimulus-loading; Bk: back-touching; UA: upper arm-touching

3.3.2.1 Comparisons of the differences between 'Rt vs SL' and between 'SL and BK-touching'

The HR (p<0.001) and LF/HF (p<0.001) values were remarkably enhanced during SL compared to Rt; but were significantly reduced on BK-touching compared to SL. However, the HF values (p<0.001) were significantly reduced on SL and were markedly increased on BK-touching compared to during SL.

3.3.2.2 Comparison of differences between 'Rt vs SL' and between 'SL vs UA-touching'

Both the HR (p<0.001) and LF/HF values (p=0.005) significantly increased on SL compared to Rt and markedly attenuated on UA-touching compared to SL, while the HF values (p<0.001) portrayed the reverse tendency.

3.3.2.3 Comparison of differences between 'SL vs BK-touching' and 'SL vs UA-touching'

Both the HR and LF/HF values did not indicate any significant differences for these two sites. On comparing to SL, HF values increased significantly (p=0.036) on BK-touching compared with UA-touching.

4 Discussion

4.1 Psychological effects induced by touch

We monitored the psychological state of subjects by measuring their STAI, PS, and IAR. Additionally, subjects were free to express their pleasant and unpleasant feelings with regard to the 11 touch-related component elements in order to concretely assess their subjective psychological states during the touching. Based on the STAI results, anxiety was enhanced on PSL compared to Rt, and it was attenuated on touching. PS expanded on SL, PS contracted on touching. Furthermore, when evaluating PS concurrently

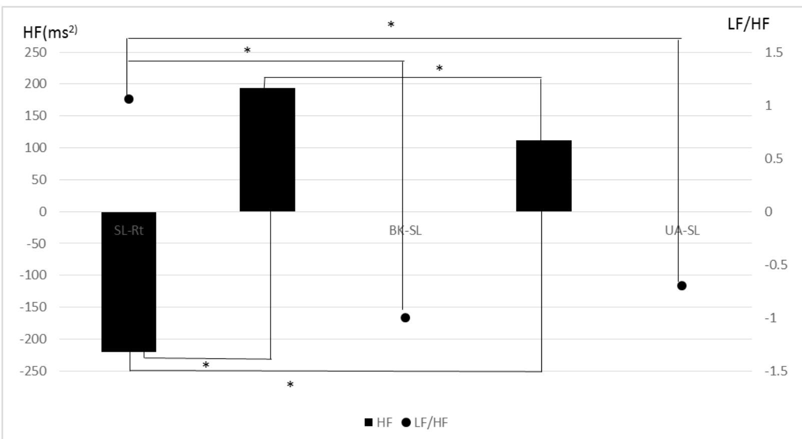

Fig. 5: Comparison for the respective events on the difference of HF value (index for PNS activity) and LF/HF value (index for SNS activity). Rt: resting, SL: stimulus-loading, Bk: Back-touching, UA: Upper-Arm-touching

with STAI, although PS was expanded on the whole when anxiety increased, it was contracted on touching. As for IAR, subjects rated the stimulator as positive, non-conceited or conceited, friendly, and broad-minded. With regard to the touch-associated component elements, the respective elements did not show any significant differences with respect to either the BK or UA, implying that both the sites were appropriate as perceptions were not site-dependent in this study. Furthermore, many subjects gave a pleasant rating for the 7 elements such as 'touch-duration', 'touch-site', 'touch-gesture', 'touch-sensation', 'touch surface area', 'distance from stimulator', and 'touch-intensity', although the time-interval was rated an important decisive factor for 'touch-duration' (see below). The touch methods giving pleasant feelings were favorable for both touch sites (i.e. BK and UA), for a duration of 50-sec, with hand fully opened such that the hand of the stimulator was just in contact with the subject (i.e. not over-extended or not excessively contracted). Additionally, individual differences were noted in the time-interval; differences in time-length perceived as pleasant depended on conditions and individual. With regard to time-intervals, the following was reported: (1) a certain 'perceptual illusion' appeared to exist on perceiving the time via physical vs. subjective experiences, and (2) this illusion occurs under conditions where the subject participates actively. In other words, the subjective experience of time changed depending on the type of initial active approach of the subject: i.e. time passes away fast when one participates actively, while time seems to linger on when one participates reluctantly.[22] For the touch-duration in this study, subjects rating the touch-duration as pleasant as felt the duration to be longer than did the subjects who rated it as unpleasant. From this we infer that with respect to duration, what was pleasant in touching was not perceived to be the result of active engagement, but rather the unpleasant in touching appeared to have been induced via passive engagement. In short, it is uncomfortable for stimulator to concentrate consciously on touch, and in fact spontaneously natural touch is preferred. This result was also reflected by the following comments given by subjects: '10-30 sec was pleasant; however, it might be different if my mood was not good,' 'touch-duration might be better if not too long,' 'touch-duration was required to last for a certain time-length,' 'was unpleasant as touch-duration was too long,' and 'casual feel of touch-duration is good enough.' As for comments on 'touch-sensations,' warmth of the hand (based on body temperature in the surrounding environment without warming or cooling of the hand) elicited the following feelings: 'warm and comfortable feeling,' 'feeling relieved,' 'feeling secured,' 'feeling calm,' 'feeling of human warmth,' 'remembering the tight squeeze of parents when young,' 'feeling of nervousness being loosened,' 'feeling of being provided with support,' 'feeling of being cuddled,' and 'gentle.' However, since certain subjects felt an unpleasant 'hot' sensation, the temperature of the hand had to be taken into consideration. That shows the following; if the body temperature is high, cold hand may feel comfortable. And those who feel cold may feel warm hand as pleasant. Furthermore, with regard to the 'surface area of hand,' 'touching with whole hand opened' and 'better to have the contact area extended to a certain degree' were deemed favorable (Table 3). When coupled with touch-intensity, better to have the touch extended as a whole with a certain amount of intensity was deemed desirable. Comments concerning the necessary factors for effective touching other than those aforementioned touch-related component elements include the following: 'touch would be felt pleasant when stimulator was thought of having goodwill or having a complete understanding of subject,' 'necessary to have mutual-trust relationship with the stimulator,' 'to have subject-stimulator communication before touching,' 'subject's impression of the stimulator before touching,' and 'an atmosphere where the stimulator could get to be known.' In fact, the mutually interactive relationship of these factors could elicit effective touching. As for relationships with the touch-stimulator, although unknown to the subject, the above-mentioned evaluations of subjects changed after touching. Investigations on PS revealed the following: the more the stimulator was rated as good-natured/kind person by the subject, the shorter subject-stimulator distance became (except for right-/left-rear direction); the more the stimulator was rated as responsible, the more the subject-stimulator distance contracted (except for position from the behind); the more indiscreet the stimulator was rated, the more likely for the subject-stimulator distance from the left-front and right-front direction to be extended. Furthermore, when the stimulator was rated as friendly, the more the subject-stimulator distance from the left-front and front direction contracted. AS for 'absence/presence of confidence,' the more confident the stimulator appeared to be, the more the subject-stimulator distance from the left-front and front direction contracted. AS for 'absence/presence of confidence,' the more confident the stimulator appeared to be, the more the stimulator-subject distances from the left-/right-front and left/right directions were contracted. In other words, although the stimulator invaded the PS of the subject in performing touching, it is desirable to avoid approaching the subject from behind (or other position felt to be unpleasant by the subject) in order to smoothly assume a position for performing the touch. This clearly suggests that the subject perceived factors such as being friendly, responsible, sensible, confident, etc. as behaviors reflecting the attitude of the stimulator.

In interpersonal relationships, the more the physical distance contracts the more the closeness of the mutual relationship is enhanced; and the more goodwill a person has toward another, the smaller the PS becomes: i.e. behaviors that in fact coincide with our present findings. However, even though those who felt unpleasantness when the subject-stimulator distance was taken as 'too close' rated 'the interpersonal distance,' 'saying something to the subject,' and 'within field of vision or not' as critical factors. Furthermore, the state and response of stimulator in infringing the PS of subject, and assumption of the subject-stimulator distance are necessary for proper assessment of touching by the subject.

Some unfavorable touch-related comments from the questionnaire — such as 'surprised at sudden touching,' 'touch-duration being too long,' 'did not understand the need of touching,' and 'being too close' — were obtained. For touching to have a useful effect, care should be taken to avoid arousing these unfavorable feelings and to incorporate touch-related component elements such as the relationship with the subject, and saying something to the subject just before touching. Additionally, it would be better for the stimulator to understand the psychological state of the subject, explain the concrete purpose/intent of the touching, and adopt touch-conditions that will provide the most effective outcome, including a situation where an appropriate subject-stimulator position for performing touch without causing anxiety and excessive infringement of PS was in place. Furthermore, it is essential for the stimulator to understand his/her own conduct and create a reliable impression to ensure the subject is placed in a restful and comfortable posture. Compared to other professions, nurses are required to routinely conduct themselves in a proper manner as they are bound to come into contact physically with patients consciously or unconsciously when varying out their duties.

4.2 Physiological effects mimicked from touching

4.2.1 CNS effects

In the awake state at rest with the eyes closed, α waves mixed with β activity are predominantly displayed on EEG; α tracings appear predominantly from the occipital to parietal regions, with the highest amplitudes in the vicinity of the central area, and lower amplitudes in the forehead and temporal regions. Frequencies and waves generally do not show any difference for bilateral anatomically similar sites, albeit differences of ca. 1 Hz, if any, can exist. Beta waves appear in diffusedly distributed regions. In regions such as the forehead and temporal regions where α activities are attenuated, β waves appear relatively dominant. Similar to α activity, β waves do not exhibit bilateral physiological differences. Any attempt to perform mental calculation with eyes closed will enhance brain activity, and immediately reduce the amplitude of α waves, portraying predominantly low-voltage waves in the foreground. When stimuli enter the eyes with eyes opened, a sudden increase in tracing (amplitude and frequency) is noted. Also for other stimuli (e.g. physical sensory stimuli such as that of pain), brain activity as a whole would most likely be enhanced on perceiving exogenous stimuli and α waves would be attenuated. Furthermore, emotions such as anxiety, mental tension, and amazement exhibit the same aforementioned wave-events. All these stimuli evoke extensive changes in the activity level of the whole cerebral cortex via activities of the brain stem ascending reticular activating system and hypothalamus leading to the attenuation of α rhythms.[23] Changes in α waves are known to be affected to a certain extent by the arousal and psychological activity levels reflecting the state of cerebral function and psychophysiological activity due to endogenous and exogenous dynamic changes.[24] In this study, similar to prior findings, α waves from the from the occipital to the central region as well as the parietal region were reduced and β waves enhanced on SL than Rt, indicating the subjects' brains were activated. In the same regions, β waves were reduced and α waves were enhanced on touching, demonstrating that the touch-stimulus exerted an attenuating effect on the arousal level from prior elevated brain activity levels. Furthermore, α waves are known to appear bilaterally in the forehead region. As in the case of forehead tracings of responses to video stimuli, exposures to dislikes and likes have hitherto been shown to activate the right and left forehead regions, respectively. In cases of exposure to odor stimuli, pleasant was related with left brain activity. From these findings positive emotions have been reported to elevate brain activity levels in the left forehead region.[25] Additionally, the frequencies of α waves in the left frontal region fluctuate, and tend to have spectra in concert with the extent of pleasant feeling (the more pleasant, the nearer to -1) while sensitivity of the right frontal region varies according to levels of the arousal sensation (the calmer, the nearer to -1).[26] As for the results of the present study, β-wave differences were not observed, thus their relationship with emotions in this case is unclear. However, as α1 waves were elevated more in the left than right forehead, touching probably enhanced arousal levels, although further study is warranted with respect to the spectral fluctuations.

4.2.2 ANS evaluation

Heart-rate (HR) and LF/HF values increased while HF value decreased with stimulus-loading (SL) compared with resting (Rt). However, on touching both BK and UA, the HR and LF/HF values decreased while HF values increased more than SL. Based on these findings, SNS activity elevated on SL, while PNS activity elevated on touching. Therefore, SL induced stress/anxiety, while touching buffered physiological stress/anxiety.

4.2.3 Limitations

When the touch is performed in the clinical settings, it is necessary to consider various effect. Touching performed in the present study indicated that obvious psychological and physiological effects were induced, although the results were dependent on the limited number of the subjects, and the environmental and touch-conditions employed. Furthermore, effects evaluated in the field of nursing using touch as an actual nursing skill should be subject to further study so as to place touch as a nursing technique on a scientific basis, and the role of clinical nursing care using touch remains an important issue to be resolved.

5 Conclusions

Results of the present study demonstrated that touch is an effective psychological/physiological approach for subjects in an anxious and stressful state.

In the psychological evaluation, touch clearly elicited favorable impressions on the subject by inducing pleasant feelings, buffering anxiety, and reducing personal space (PS).

In the physiological evaluation, EEG tracings revealed that stimulus-induced elevated brain activity levels were effectively reduced after touching. Evaluations of ANS functions demonstrated that SNS activity levels were enhanced on stimulus-loading (SL), while PNS activity levels were elevated on touching. In other words, stress/anxiety elevations were induced by SL while physiological stress/anxiety were obviously buffered by touch.

Furthermore, as part of a touch method aimed at giving pleasant feelings, both touch sites (BK or UA) were found to be useful in the touch conditions used in the present study. Additionally, conditions such as touch-duration within an extent of 50 sec, touch with the surface area of hand of stimulator fully extended, whether the stimulator did or did not extend and contract his/her arm excessively on touching (i.e. an optimal distance), and touching at an appropriate hand temperature suitable for the environment and location were deemed desirable. On touching, the stimulator actually infringes upon the individual PS of subject, and to perform effective touch without infringing the PS of subject, stimulator should avoid approaching the subject from behind the subject. Goodwill, friendliness, posture, personality, responsibility, sensibility, and confidence of the stimulator are reflected in their performance of touch. The present study was conducted in a laboratory; however, to place touch as a nursing technique on a scientific basis, it is definitely more appropriate to repeat this study in an actual nursing setting.

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