Effect of Touching Care on Fear in French and Japanese Subjects

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***Abstract*— The aim of this study was to investigate the innate vs. acquired (cultural) aspects of affective empathy and emotional regulation. Volunteers watched videos with a virtual reality (VR) headset, triggering negative emotions, while their emotional response were measured by electroencephalographic evoked potentials (EEG). The effect of empathic touch (placing the hand on the back) on emotion regulation was measured. This international study allowed us to compare the regulation of emotions between people living in Japan and those living in France.**

Keywords-Touching care; Electroencephalography (EEG); Fear; Nursing.

I. INTRODUCTION

Touch plays a key role in interpersonal emotional regulation. For instance, touch conveys a sense of strengthened bonds between intimate partners that enhances affect and well-being [1]. Similarly, it plays a crucial role in maternal-child bonds, and promotes the child's ability to self-regulate [2].

Comforting touch involves contact distress-alleviating behaviors of an observer towards the suffering of a target [3]. Indeed, across different cultures, social touch is used to alleviate distress: the interaction between the observation-execution network and emotion regulation network may contribute to pain reduction during social touch [4].

However, is this effect innate, or the outcome of education and cultural biases? The aim of this study is to measure the effect of empathy on the regulation of emotions. Volunteers watched videos with a virtual reality headset, triggering negative emotions, while their emotional response were measured by electroencephalographic evoked potentials (EEG). In order to answer this question, we compared the regulation of emotions between people living in Japan and those living in France (to identify the common points and the differences).

Section II introduces experimental conditions, data collection, and analysis method. Section III shows experimental results. In Section IV, we discuss the results and conclude the paper.

II. MATERIALS AND METHOD

The experiment was approved by the ethics committee of the University of Electro-Communications, and conducted in accordance with the approval research procedure, the relevant guidelines and regulations. Informed consent was obtained from all subjects.

We used three VR videos, and two touching conditions (touching/no touching). The three VR videos were:
1) a horror video [5]
2) a roller coaster perspective movie [6]
https://www.youtube.com/watch?v=injtBhJCNdA
3) a natural water fall movie for the control condition (240 sec. from the beginning) [7]
We used main part of the movie and removed the title and opening and so forth. The horror movie lasts 324 seconds, and the roller coaster movie lasts 204 seconds. The order of the VR movie was randomly selected.

The touching carer was standing behind the subject. We asked the subjects not to control evoked emotions during watching the movie. We used two PCs, one to present the VR video, and another one to record EEG and present instructions.

 ISBN: 978-1-68558-046-9

After watching each VR movie, the subject scored how scared during touching condition comparing to no touching condition on a scale of 1 to 5 (1: strongly scared, 3: no difference, 5: no scared). Then the subject took a rest for more than 30 seconds and continued the experiment.

A. Data collection: Japanese subjects

We recruited seven healthy males (20s-40s) for this experiment.

The touching condition was changed randomly every five seconds and displayed to the monitor. The carer watched the monitor and conducted touching.

The experimental room was air conditioned and ventilated to prevent COVID-19. VR headset (Dell Visor VRP100) was connected to the display PC.

The subject put on EEG cap, then wore the VR headset. The EEG is Polymate Pro MP6100 manufactured by Miyuki Giken Co., Ltd.

We used 17 electrodes placed on F3, F4, C3, C4, P3, P4, O1, O2, F7, F8, T7, T8, P7, P8, Fz, Cz, and Pz. Each electrode was put so that the impedance was smaller than 80kΩ. The sampling rate was 1,000Hz. We recorded 30 seconds EEG in relaxed and eyes closed condition before the experiment. We recorded the synchronous signal of the touching condition and audio signal of the VR movie, as well as EEG signal to synchronize EEG and movie.

B. Data collection: French subjects

We recruited seven healthy subjects (20s-50s / 2 women and 5 males) for this experiment.

The touching condition was changed randomly every 120 seconds. Our experiments in Japan showed startle responses in some subjects when the carer touched. Although the responses are removed by segmentation, we used a different touch time for the experiment in France to relax the startle responses. The experiment instructed the carer about when to touch or stop touching.

VR headset (Occulus Rift S) was connected to the display PC.

The subject put on EEG cap, then wore the VR headset. The EEG is Enobio 8 manufactured by Neuroelectrics.

We used 8 electrodes placed on F3, F4, C3, C4, P3, P4, Oz, Fpz and 3 accelerometer channels (X Y, Z). Each electrode was put so that the EEG Quality Index was smaller than 0.5. The sampling rate was 500Hz (and 100Hz for accelerometer). We recorded 60 seconds EEG in eyes closed condition before the experiment. We recorded the synchronous signal of the touching condition as well as EEG signal to synchronize EEG and touching conditions.

C. EEG Analysis

We define the parts of scalp area as follows:

- Frontal: (F3, F4, F7, F8, Fz);
- Central: (C3, C4, Cz); and
- Parietal(/occipital) : (P3, P4, O1, O2, P7, P8, Pz).

The frequency bands are defined as δ: 2-4Hz, θ: 4-6Hz, α: 6-12Hz, β: 12-30Hz, and γ: 30-40Hz.

For prepossessing, we removed artifacts from EEG. If the instantaneous amplitude is greater than 200μV, we removed 0.25 seconds of signal before and after the point. We analyzed signal after 0.5 seconds from the onset of the recording or condition.

D. PSD

We segmented EEG signals by conditions, then performed the Fast Fourier Transform (FFT), and obtained the Power Spectrum Density (PSD) values for each area, condition, and frequency band.

For each frequency band, channel, and condition, we obtained the difference of PSD logarithm from the baseline state. We used EEG during watching the water fall movie and no touching condition as the baseline state.

$$\text{PSDdiff} = \log(\text{target PSD}) - \log(\text{baseline PSD})$$

E. PSD correlations

For each frequency band, and area, we estimated the correlation coefficient between the logarithm of PSD value and the subjectivity scared score.

III. RESULTS

The section shows our experimental results.

A. Correlation between PSD and subjective fear scores

The tables below report the correlation of PSD and subjective fear reports from Japanese (Table 1) and French (Table 2) subjects. Only the French subjects showed a significant anticorrelation between subjective fear report and parietal alpha activity.

TABLE I. CORRELATION COEFFICIENTS BETWEEN PSD AND SUBJECTIVE SCORE (JAPANESE SUBJECTS)

Frequency range	Area	Horror video	Coaster video
δ	Frontal	0.527	0.322
δ	Central	0.366	0.143
δ	Parietal	0.034	-0.156
θ	Frontal	0.230	-0.038
θ	Central	-0.208	0.025
θ	Parietal	-0.269	-0.049
α	Frontal	0.138	-0.247
α	Central	0.063	-0.195
α	Parietal	0.074	-0.376
β	Frontal	0.519	0.277
β	Central	0.641	0.679
β	Parietal	0.652	0.058
γ	Frontal	0.381	-0.051
γ	Central	0.351	-0.010
γ	Parietal	0.164	-0.570

 ISBN: 978-1-68558-046-9

TABLE II. CORRELATION COEFFICIENTS BETWEEN PSD AND SUBJECTIVE SCORE (FRENCH SUBJECTS)

Frequency range	Area	Horror video	Coaster video
δ	Frontal	-0.555	0.383
δ	Central	-0.581	0.035
δ	Parietal	-0.575	-0.418
θ	Frontal	-0.474	0.522
θ	Central	-0.576	-0.029
θ	Parietal	-0.545	-0.264
α	Frontal	-0.677	0.499
α	Central	-0.710	0.155
α	Parietal	**-0.871***	0.068
β	Frontal	-0.496	0.466
β	Central	-0.611	0.270
β	Parietal	-0.688	0.159
γ	Frontal	-0.355	0.423
γ	Central	-0.496	0.266
γ	Parietal	-0.583	0.126

B. Correlation between PSD and subjective fear scores, Japanese subjects

Tables III-VII show the PSD differences between the three conditions (horror movie, roller coaster, and relaxing waterfall), with or without touch. The water fall condition without touch was used as a reference baseline (hence its difference is null). The horror condition is correlated with a significant broadband increase of EEG activity in frontal and parietal areas. Similarly, there is a general (non-significant) broadband increase of EEG activity in the touch vs. no touch condition. The result of a T-test comparing touch vs. no-touch condition is reported in the last column.

TABLE III. PSD DIFFERENCE: JAPANESE (**: P<0.01, *: P<0.05, H0: PSDDIFF = 0) - DELTA RANGE

Area	Video stimulus	PSDdiff no touch	PSDdiff touch	t-test 2gr
Frontal	Horror	***0.53±0.33**	***0.82±0.67**	No
Frontal	Coaster	-0.10±0.67	0.07±0.59	No
Frontal	Fall	0.00±0.00	0.38±0.47	No
Central	Horror	1.19±1.24	***3.17±2.26**	No
Central	Coaster	0.51±1.08	0.70±1.78	No
Central	Fall	0.00±0.00	0.63±0.97	No
Parietal	Horror	***1.38±0.92**	***2.04±1.55**	No
Parietal	Coaster	0.39±1.56	0.87±1.55	No
Parietal	Fall	0.00±0.00	0.44±0.60	No

TABLE IV. PSD DIFFERENCE: JAPANESE (**: P<0.01, *: P<0.05, H0: PSDDIFF = 0) - THETA RANGE

Area	Video stimulus	PSDdiff no touch	PSDdiff touch	t-test 2gr
Frontal	Horror	****0.74±0.16**	***1.09±0.69**	No
Frontal	Coaster	-0.13±0.83	0.27±0.69	No
Frontal	Fall	0.00±0.00	0.40±0.61	No
Central	Horror	1.17±1.22	***3.43±2.64**	No
Central	Coaster	0.34±1.15	0.65±1.92	No
Central	Fall	0.00±0.00	0.51±0.98	No
Parietal	Horror	***1.58±1.04**	***2.08±1.65**	No
Parietal	Coaster	0.17±1.80	0.69±1.67	No
Parietal	Fall	0.00±0.00	0.31±0.58	No

TABLE V. PSD DIFFERENCE: JAPANESE (**: P<0.01, *: P<0.05, H0: PSDDIFF = 0) - ALPHA RANGE

Area	Video stimulus	PSDdiff no touch	PSDdiff touch	t-test 2gr
Frontal	Horror	****0.81±0.33**	***1.20±0.67**	No
Frontal	Coaster	0.22±0.88	0.74±0.94	No
Frontal	Fall	0.00±0.00	0.45±0.66	No
Central	Horror	1.82±1.79	***4.22±3.10**	No
Central	Coaster	1.00±1.45	1.34±2.51	No
Central	Fall	0.00±0.00	0.63±1.16	No
Parietal	Horror	****1.90±1.02**	***2.52±1.95**	No
Parietal	Coaster	0.80±1.67	1.49±1.87	No
Parietal	Fall	0.00±0.00	0.52±0.71	No

TABLE VI. PSD DIFFERENCE: JAPANESE (**: P<0.01, *: P<0.05, H0: PSDDIFF = 0) - BETA RANGE

Area	Video stimulus	PSDdiff no touch	PSDdiff touch	t-test 2gr
Frontal	Horror	****1.07±0.54**	****1.49±0.81**	No
Frontal	Coaster	0.42±0.95	***1.05±0.77**	No
Frontal	Fall	0.00±0.00	0.65±0.77	No
Central	Horror	1.63±1.92	***4.28±2.66**	No
Central	Coaster	1.16±1.24	1.66±2.10	No
Central	Fall	0.00±0.00	0.77±1.08	No
Parietal	Horror	***2.31±1.67**	****2.95±1.37**	No
Parietal	Coaster	0.79±1.56	1.70±1.62	No
Parietal	Fall	0.00±0.00	0.85±0.90	No

 ISBN: 978-1-68558-046-9

TABLE VII. PSD DIFFERENCE: JAPANESE (**: P<0.01, *: P<0.05, H0: PSDDIFF = 0) - GAMMA RANGE

Area	Video stimulus	PSDdiff no touch	PSDdiff touch	t-test 2gr
Frontal	Horror	***1.09±0.71**	***1.67±1.22**	No
Frontal	Coaster	0.82±1.45	***1.67±1.41**	No
Frontal	Fall	0.00±0.00	0.69±0.96	No
Central	Horror	2.48±3.06	***5.54±4.25**	No
Central	Coaster	2.11±2.28	2.36±3.32	No
Central	Fall	0.00±0.00	0.87±1.80	No
Parietal	Horror	***2.56±1.77**	***3.27±2.51**	No
Parietal	Coaster	1.48±2.42	2.37±2.57	No
Parietal	Fall	0.00±0.00	1.31±1.51	No

C. Correlation between PSD and subjective fear scores, French subjects

Tables VII-XII show the PSD differences between the three conditions (horror movie, roller coaster, and relaxing waterfall), with or without touch. The water fall condition without touch was used as a reference baseline (hence its difference is null). As in the Japanese database, the horror condition is correlated with a broadband increase of EEG activity in frontal and parietal areas, however this increase is non-significant, and not present in the delta range. Similarly, there is a general and broadband increase of EEG activity in the touch vs. no touch condition, significant in the parietal area for the roller coaster condition. The result of a T-test comparing touch vs. no-touch condition is reported in the last column.

TABLE VIII. PSD DIFFERENCE: FRENCH (**: P<0.01, *: P<0.05, H0: PSDDIFF = 0) - DELTA RANGE

Area	Video stimulus	PSDdiff no touch	PSDdiff touch	t-test 2gr
Frontal	Horror	0.18±0.34	***0.61±0.43**	No
Frontal	Coaster	-0.03±0.43	***0.38±0.30**	No
Frontal	Fall	0.00±0.00	0.04±0.17	No
Central	Horror	0.43±0.77	***1.13±1.13**	No
Central	Coaster	0.05±0.63	0.33±0.70	No
Central	Fall	0.00±0.00	0.06±0.14	No
Parietal	Horror	-0.01±0.30	0.32±0.35	No
Parietal	Coaster	-0.10±0.22	0.25±0.33	**Yes**
Parietal	Fall	0.00±0.00	0.01±0.19	No

TABLE IX. PSD DIFFERENCE: FRENCH (**: P<0.01, *: P<0.05, H0: PSDDIFF = 0) - THETA RANGE

Area	Video stimulus	PSDdiff no touch	PSDdiff touch	t-test 2gr
Frontal	Horror	0.13±0.63	0.35±0.56	No
Frontal	Coaster	-0.11±0.44	0.14±0.47	No
Frontal	Fall	0.00±0.00	0.01±0.25	No
Central	Horror	0.19±0.82	0.83±1.39	No
Central	Coaster	-0.10±0.63	0.13±0.81	No
Central	Fall	0.00±0.00	-0.00±0.24	No
Parietal	Horror	-0.05±0.52	0.10±0.65	No
Parietal	Coaster	-0.35±0.41	-0.03±0.60	No
Parietal	Fall	0.00±0.00	-0.08±0.39	No

TABLE X. PSD DIFFERENCE: FRENCH (**: P<0.01, *: P<0.05, H0: PSDDIFF = 0) - ALPHA RANGE

Area	Video stimulus	PSDdiff no touch	PSDdiff touch	t-test 2gr
Frontal	Horror	0.19±0.52	0.48±0.59	No
Frontal	Coaster	-0.08±0.55	0.15±0.43	No
Frontal	Fall	0.00±0.00	0.10±0.19	No
Central	Horror	0.28±0.76	0.98±1.40	No
Central	Coaster	-0.07±0.58	0.24±0.81	No
Central	Fall	0.00±0.00	0.06±0.12	No
Parietal	Horror	0.13±0.38	0.41±0.56	No
Parietal	Coaster	-0.20±0.37	0.25±0.40	No
Parietal	Fall	0.00±0.00	0.06±0.18	No

TABLE XI. PSD DIFFERENCE: FRENCH (**: P<0.01, *: P<0.05, H0: PSDDIFF = 0) - BETA RANGE

Area	Video stimulus	PSDdiff no touch	PSDdiff touch	t-test 2gr
Frontal	Horror	0.06±0.60	0.39±0.69	No
Frontal	Coaster	0.11±0.65	0.28±0.47	No
Frontal	Fall	0.00±0.00	0.19±0.28	No
Central	Horror	0.25±0.82	0.78±1.23	No
Central	Coaster	-0.02±0.62	0.42±0.70	No
Central	Fall	0.00±0.00	0.13±0.15	No
Parietal	Horror	0.13±0.38	0.48±0.58	No
Parietal	Coaster	-0.14±0.45	***0.43±0.32**	**Yes**
Parietal	Fall	0.00±0.00	0.10±0.18	No

 ISBN: 978-1-68558-046-9

TABLE XII. PSD DIFFERENCE: FRENCH (**: P<0.01, *: P<0.05, H0: PSDDIFF = 0) - GAMMA RANGE

Area	Video stimulus	PSDdiff no touch	PSDdiff touch	t-test 2gr
Frontal	Horror	0.05±0.64	0.45±0.67	No
Frontal	Coaster	0.21±0.57	0.34±0.46	No
Frontal	Fall	0.00±0.00	***0.25±0.23**	**Yes**
Central	Horror	0.20±0.87	0.74±1.17	No
Central	Coaster	-0.08±0.63	0.40±0.71	No
Central	Fall	0.00±0.00	***0.17±0.14**	**Yes**
Parietal	Horror	0.11±0.41	0.53±0.58	No
Parietal	Coaster	-0.13±0.46	***0.42±0.31**	**Yes**
Parietal	Fall	0.00±0.00	0.15±0.16	**Yes**

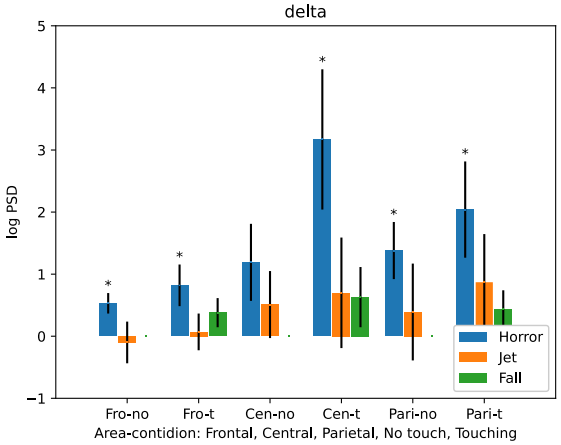

Figure 1 PSD difference: Japanese, Delta (*: p<0.05)

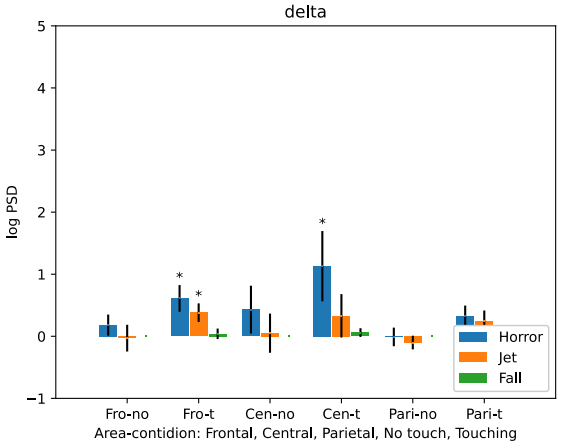

Figure 2 PSD difference: French, Delta (*: p<0.05)

IV. CONCLUSION

In both populations, we can observe similarities in the neural correlates of fear emotional regulation:

- In both populations of subject, a broadband increase of EEG activity is observed in the touch vs. non touch condition.
- More specifically, both Japanese and French subjects had a significant δ range activity increase in the frontal and central areas in touch condition, during the horror video (which was the most fearful stimulus).

Increased EEG activity in the touch condition could be a correlated of improved emotional regulation. For instance, emotional regulation in expert Zen meditators was associated with a similar phenomenon [8]. Furthermore, and more specifically, the observed in δ range increase frontal and central area is a known correlate of emotional regulation: it could reflect the inhibition exerted by the prefrontal cortex and anterior cingulate cortex over emotionally related areas [9]. This tends to confirm a cross-cultural positive effect of touching care on emotional regulation, despite potential differences in cultural representations about body contact and intimacy.

Between the two populations, we can observe differences in the neural correlates of fear emotional regulation:

- In the Japanese population, no significant difference is found in specific areas and frequency ranges when comparing touch vs. non touch cognition. In the French population, several areas presented significant changes between those conditions.
- In the French population only, parietal α activity was anti-correlated with subjective reports of fear. Note that parietal α is associated with the activity of the default mode network, which increases in relaxed state [10].

These differences could be attributed to cultural specificities in emotional regulation strategies. Indeed, previous studies have shown that Japanese subjects experience less intense fear reactions than French subjects [11]. Note that there is also a slight difference in the way the touching care stimulus was applied, which may bias these results. The French subjects had 2 female participants, not the Japanese subjects, and the age span was slightly larger; which could also have introduced some bias.

ACKNOWLEDGMENT

This research project was funded by a KDDI grant.

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 ISBN: 978-1-68558-046-9