Evaluation of brain activity in patients with chronic lower back pain using a non-contact brain activity detection sensor

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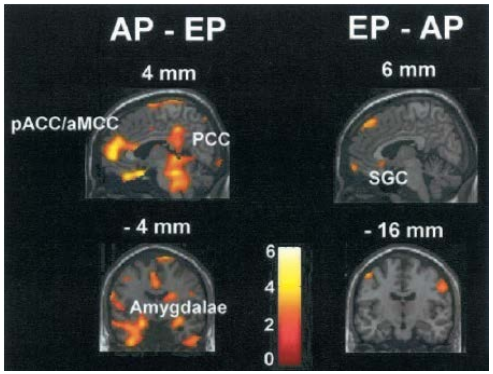
Introduction

Brain areas associated with emotion and fear are activated by arthritic pain (AP) rather than external pain (EP)

Kulkarni et al. Arthritis Rheum 2007

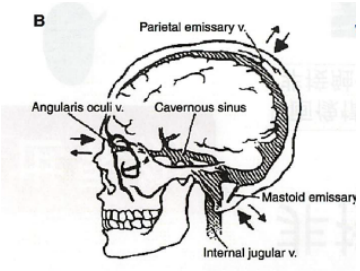


Chronic pain is known to be associated with emotion-related areas in the brain

Most investigations used fMRI, NIRS, and EEG to assess brain activity upon pain

These are troublesome tasks!!

Non-contact brain activity detection sensor



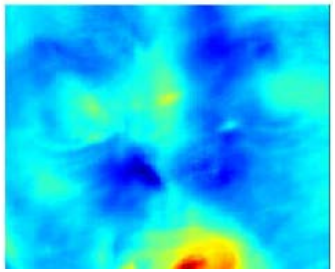
When brain activity increases, brain temperature increases

Brain temperature is associated with blood supply to the face

White et al. J Appl Physiol 2011

Brain activity ↑
Brain radiates heat

Blood supply to face ↑



Converted RGB data

RGB data ≒ Blood supply ≒ Brain activity

We quantified brain activity as RGB data from face images obtained by video

RGB: red, green, blue

Hypothesis

Patients with psychological problems associated with lower back pain (LBP) will exhibit a large blood supply after stimulations associated with LBP

Purpose

①To detect brain activity of patients with chronic lower back pain (CLBP) using a non-contact brain activity detection sensor

②To investigate the association between brain activity and various scores of LBP and psychogenic factors

Subjects

Chronic lower back pain (>NRS 5) for three months

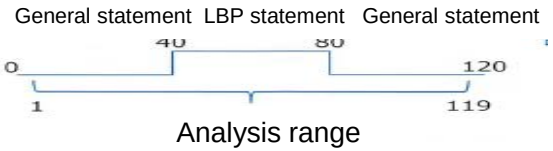
Lower back pain (LBP) group: 19 subjects (4 males, 15 females; mean age: 70.8 y.o.)
Control group: 10 subjects (10 males; mean age: 39.8 y.o.)

Lumbar spinal stenosis	12 cases	Lumbar spondylosis	2 cases
Lumbar vertebral fracture	1 case	Lumbar kyphoscoliosis	1 case
Lumbar spondylosis deformans	1 case	Sacroiliac	1 case

Methods

Subjects hear some statements via headphones

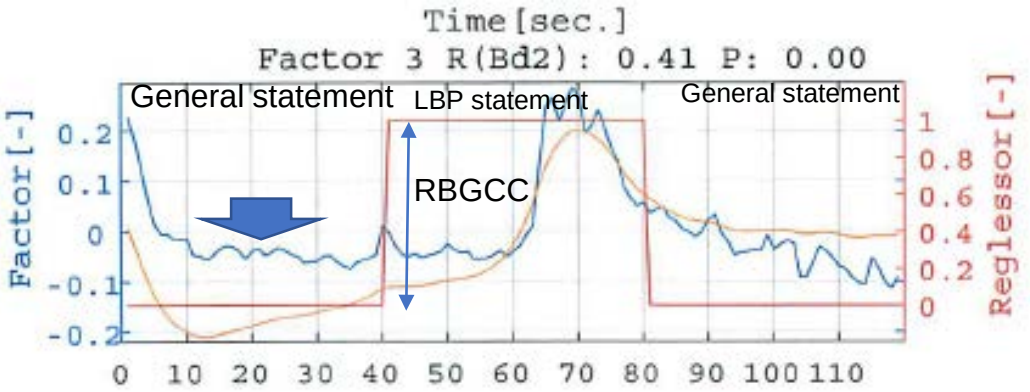
40 seconds: General statements
40 seconds: Statements on lower back pain
40 seconds: General statements



Analysis range

General statements:
e.g., I was born in summer
I like sushi

Statements on lower back pain:
e.g., I can't work because of LBP
I think that my diagnosis of LBP is wrong



Waves show brain activity(⇩). We regarded brain activity upon hearing general statements as the baseline and calculated the change of brain activity upon hearing LBP statements from the baseline as the correlation coefficient.
We defined this correlation coefficient as the **RGB correlation coefficient (RBGCC).**

Examined variables

Non-contact brain activity detection sensor

RGB correlation coefficient (RGBCC) (range: 0–1)

High brain activity is represented by increased RGBCC
RGBCC: 0 = no change in brain activity from baseline
RGBCC: 1 = maximum score

Pain assessment

① **JOA back pain evaluation questionnaire (JOABPEQ)**
Five domains: pain-related disorders, lumbar spine dysfunction, gait disturbance, social life dysfunction, psychological disorders

② **Oswestry Disability Index (ODI)**

③ **Numerical Rating Scale (NRS)**

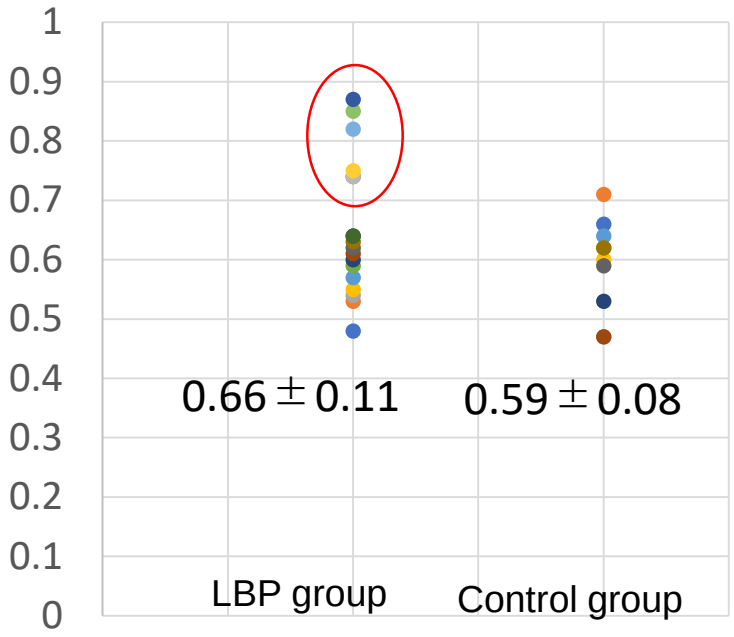
④ **Pain Catastrophizing Scale (PCS)**
Three domains: enlarged view, rumination, helplessness

Analysis

1) Comparison of RGBCC between control group and LBP group
2) Study of the correlation between RGBCC and various pain assessments

Results

1) Comparison of RGB between control and LBP groups



Although there were no significant differences between the two groups, RGBCC in the LBP group tended to be higher than in the control group.

(P=0.07, Welch's t-test)

We divided the LBP group into two subgroups

L group (12 cases): RGBCC is under 0.7 (low brain activity for LBP statements)
H group (7 cases): RGBCC is over 0.7 (high brain activity for LBP statements)

2) Comparison between L and H groups

		L group	H group	P value
	Age	72.8	67.4	0.53[a)]
	Gender	2:10	2:5	0.27[c)]
	NRS	6.8	7.4	0.66[a)]
	ODI	47.2	47.9	0.91[a)]
JOA BPEQ	Pain-related disorders	23.8	28.3	0.73[b)]
	Lumbar spine dysfunction	52.0	63.0	0.43[b)]
	Gait disturbance	24.8	30.6	0.61[b)]
	Social life dysfunction	40.8	30.3	0.20[b)]
	Psychological disorders	41.3	25.9	0.05[b)]
PCS	Enlarged view	68.3	74.2	0.76[b)]
	Rumination	15.0	18.0	0.40 [b)]
	Helplessness	11.3	11.4	0.97[b)]

Psychological disorders in H tended to be lower than in the L group
Rumination in the H group was higher than in the L group

High RGBCC may indicate psychological problems with LBP

Discussion

Brain activity and chronic LBP

RGBCC calculated using this approach was not associated with measurements of LBP or functional disability by NRS or ODI

Severe LBP or pronounced disability due to LBP did not influence brain activity

Patients with high RBGCC score

This study

✓ High score for psychological disorders by JOABPEQ was linked to high RGBCC

There was an association between brain activity and psychological disorders

✓ High score with rumination of PCS

It is possible that patients with chronic LBP always think about LBP

Hippocampus and amygdala might be activated in chronic LBP patients with psychological disorder according to JOABPEQ

These results suggest that this tool can potentially be used to evaluate brain activity in patients with CLBP who have psychological disorders

Conclusion

Non-contact brain activity detection is useful to assess psychological disorders regarding LBP

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