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# MEASURING ENVIRONMENTAL PERCEPTION & WEARABLE BIOSENSORS

# 环境感受测度和可穿戴生物传感器

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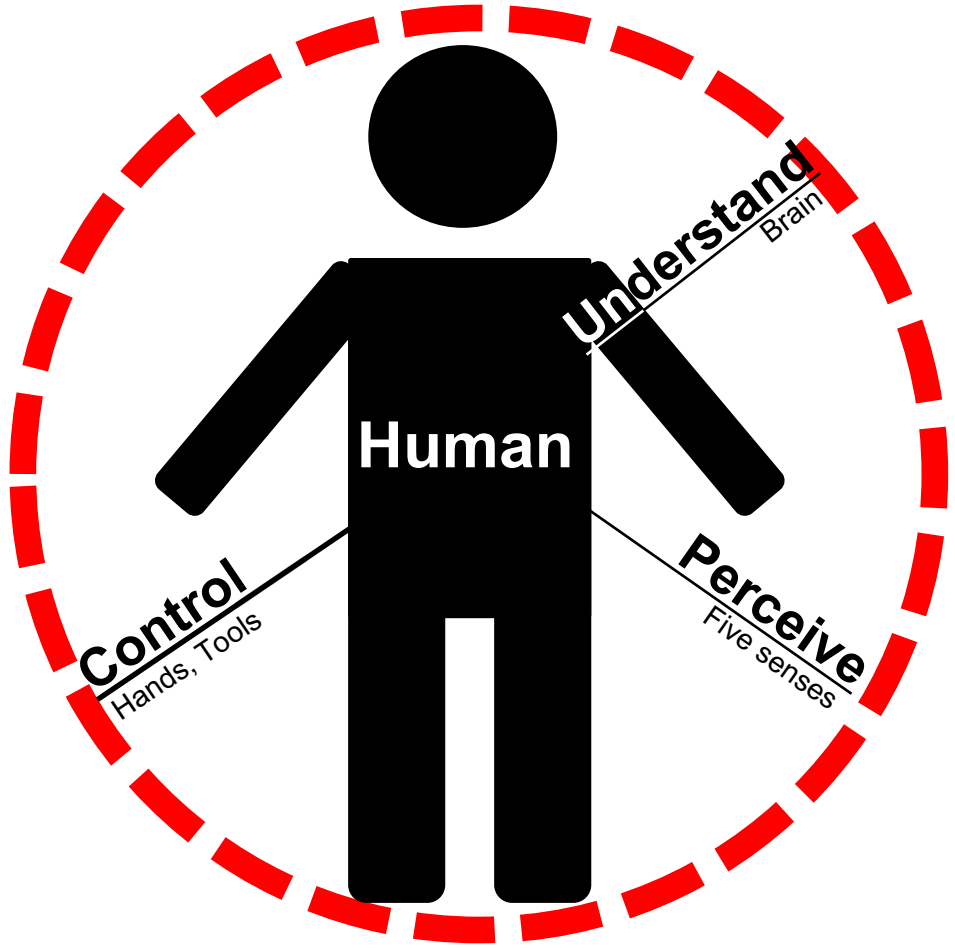
2018.10.11, 清华

# DESIGNERS CUSTOMIZE ENVIRONMENTAL INTERACTIONS FOR HUMAN BEINGS



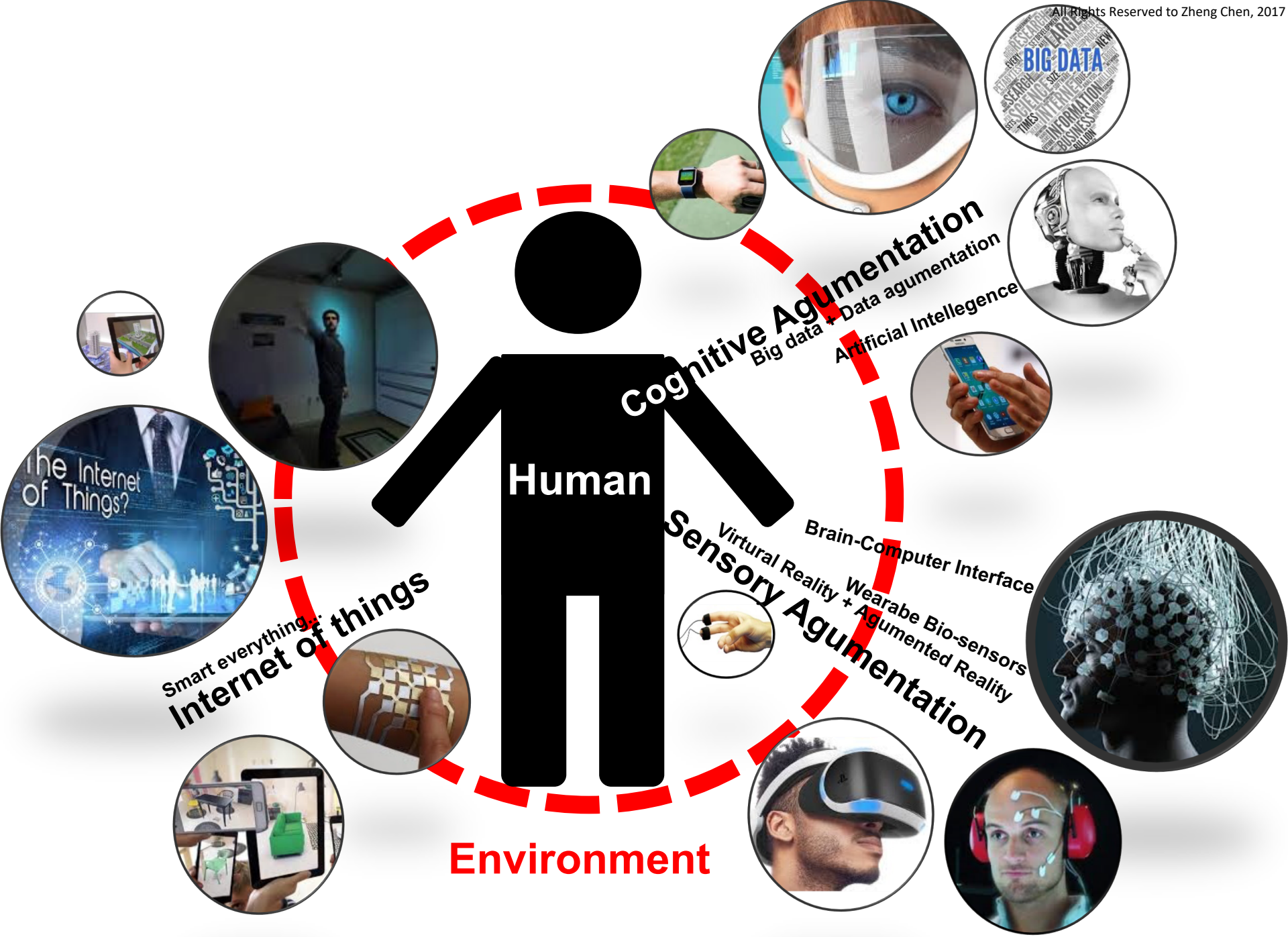
Have you ever

# IMAGINE

how our interactions with environment will change

in 10 or 20 years

?



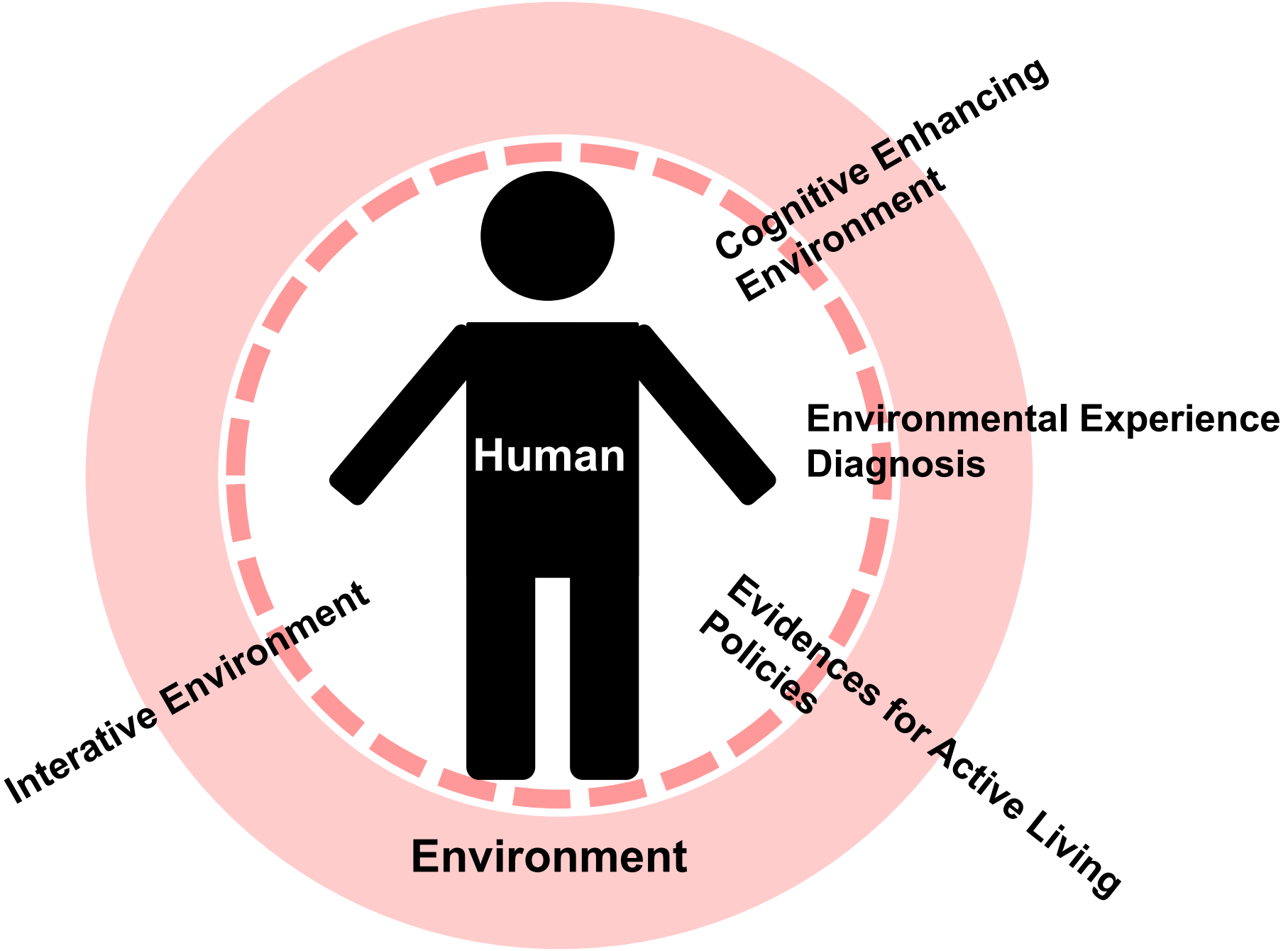
# RETHINKING DESIGN

# POSSIBILITIES

# ?

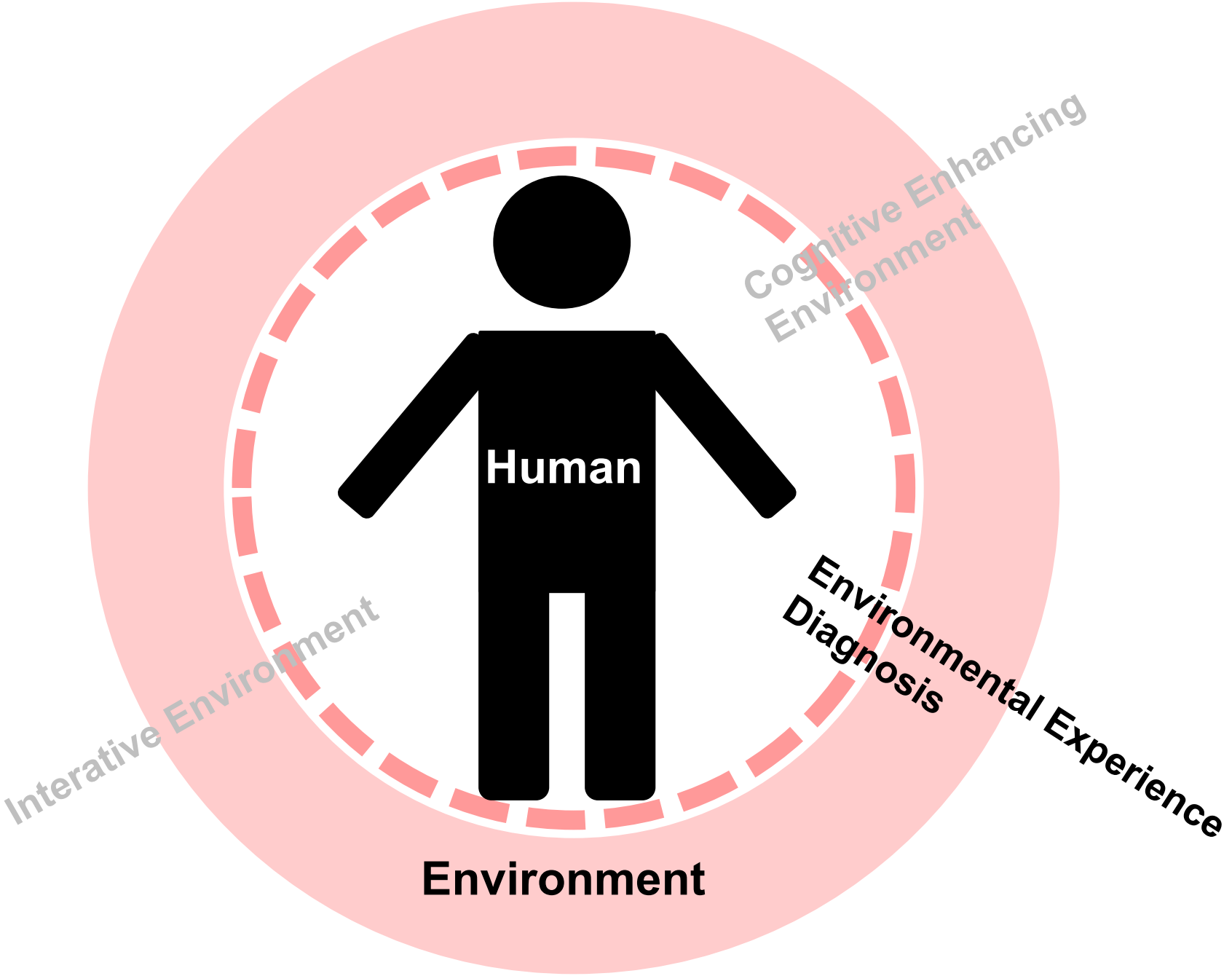
# NEW INTERACTIONS, NEW POSSIBILITIES

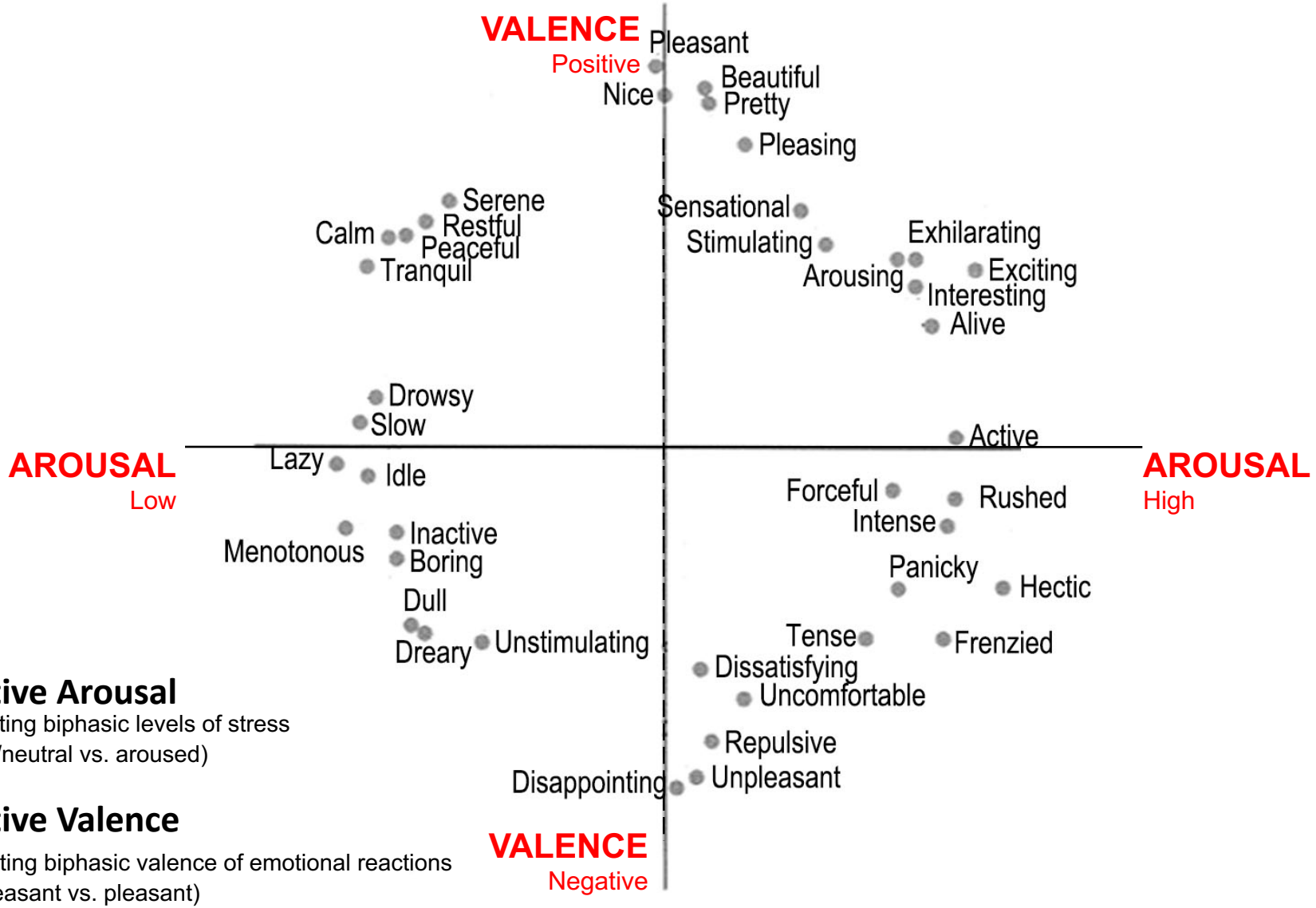




# NEW INTERACTIONS, NEW POSSIBILITIES








## Affective Arousal

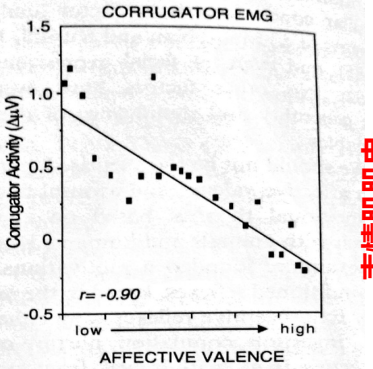
➔ indicating biphasic levels of stress (calm/neutral vs. aroused)

## Affective Valence

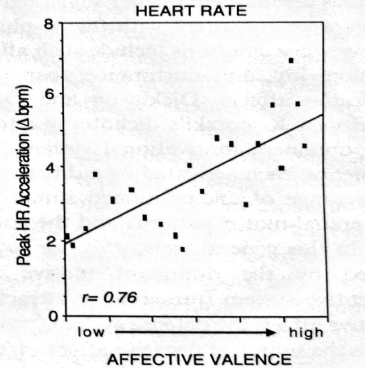
➔ indicating biphasic valence of emotional reactions (unpleasant vs. pleasant)

# Emotional Responses to Environment

Russell, J. A., & Snodgrass, J. (1987). Emotion and the environment *Handbook of environmental psychology (Vol. 1, pp. 245-281).*

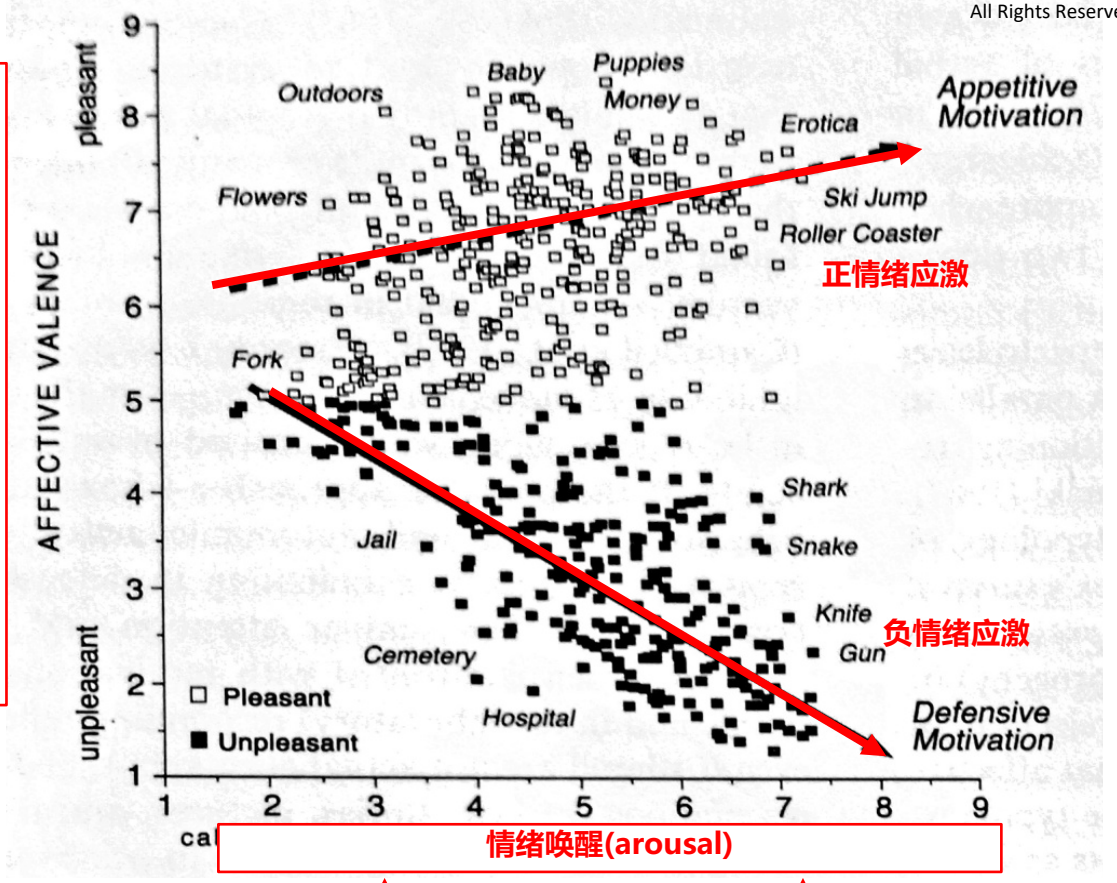



表情肌肌电



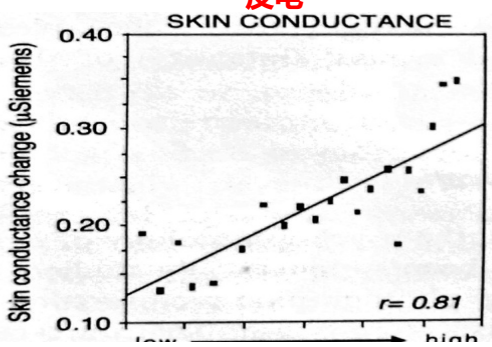

心电

情绪效价(valence)

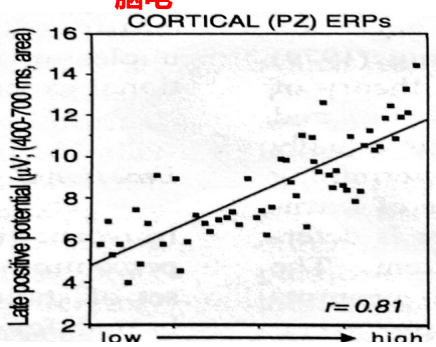



情绪唤醒(arousal)

皮电




脑电




Lang, P. J. (1995). The emotion probe. Studies of motivation and attention. *Am Psychol, 50*(5), 372-385.

# Biosensory Affective Computing during Walking

**Informative?**

- Are portable bio-sensory techniques and in-situ walking measures good enough to capture environmental perception?

**Reliable?**

- Is bio-sensory data able to capture specific visual stressors or interest points?
- Were these results triangulated with narratives provided by participants?
- Did bio-sensory data reveal consistent spatial patterns across runs/ individuals?

# Biosensor Measurement

- **ProComp Infiniti System & BioGraph**
- **Garmin eTrex 20 GPS**







[1] ECG, 3 sensors measured on wrists

[2] EEG

[3] Facial EMG, 3 sensors at forehead

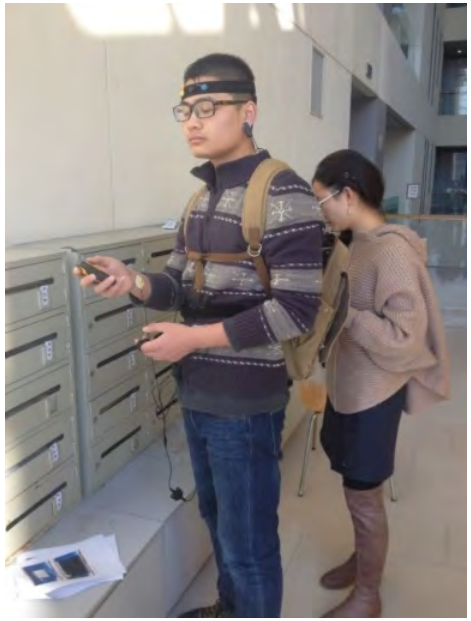
[4] Skin Conductance & Temperture

[5] Respiration, measured at abdomen

[6] Amplifier box

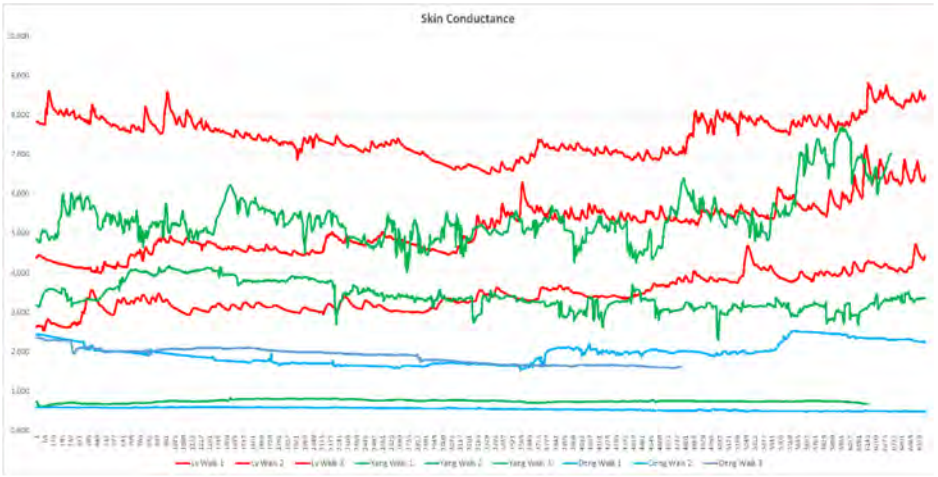
# On-Site Data Collection

- 4 participants (male and female)
- Each participant took 3 consecutive walks (with breaks), fully equipped
- 9 out of 12 walks could be used for further analysis
- Each participant was interviewed about his/her personal experience, feelings, events, descriptions, visual aesthetics



**<u>Obstacles in Data Collection:</u>**

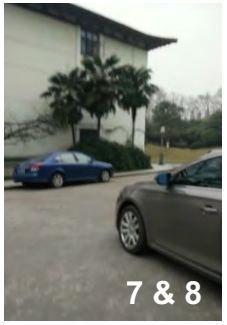
- Technical equipment under outdoor conditions
- Limitations on practicability and measurements



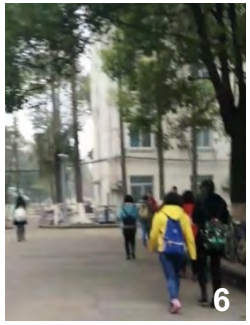
# Site Info


**Description**

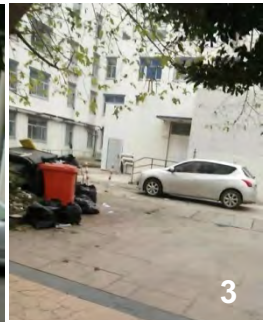
| | |
|---|---|
| **1** | Small street with trees in between sporting grounds |
| **2** | Small footpath through green space with monument |
| **3** | Footpath between tall buildings and parking lots |
| **4** | Major road crossing, medium traffic |
| **5** | Sino-German campus plaza with wide open spaces between buildings |
| **6** | Dormitory buildings alley |
| **7** | Street through green space area |
| **8** | Small alley alongside dormitories and green spaces |

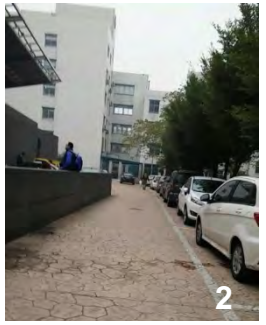



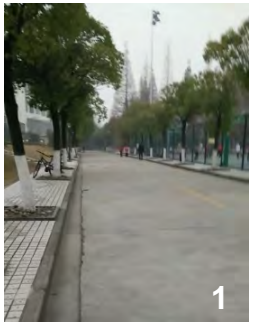




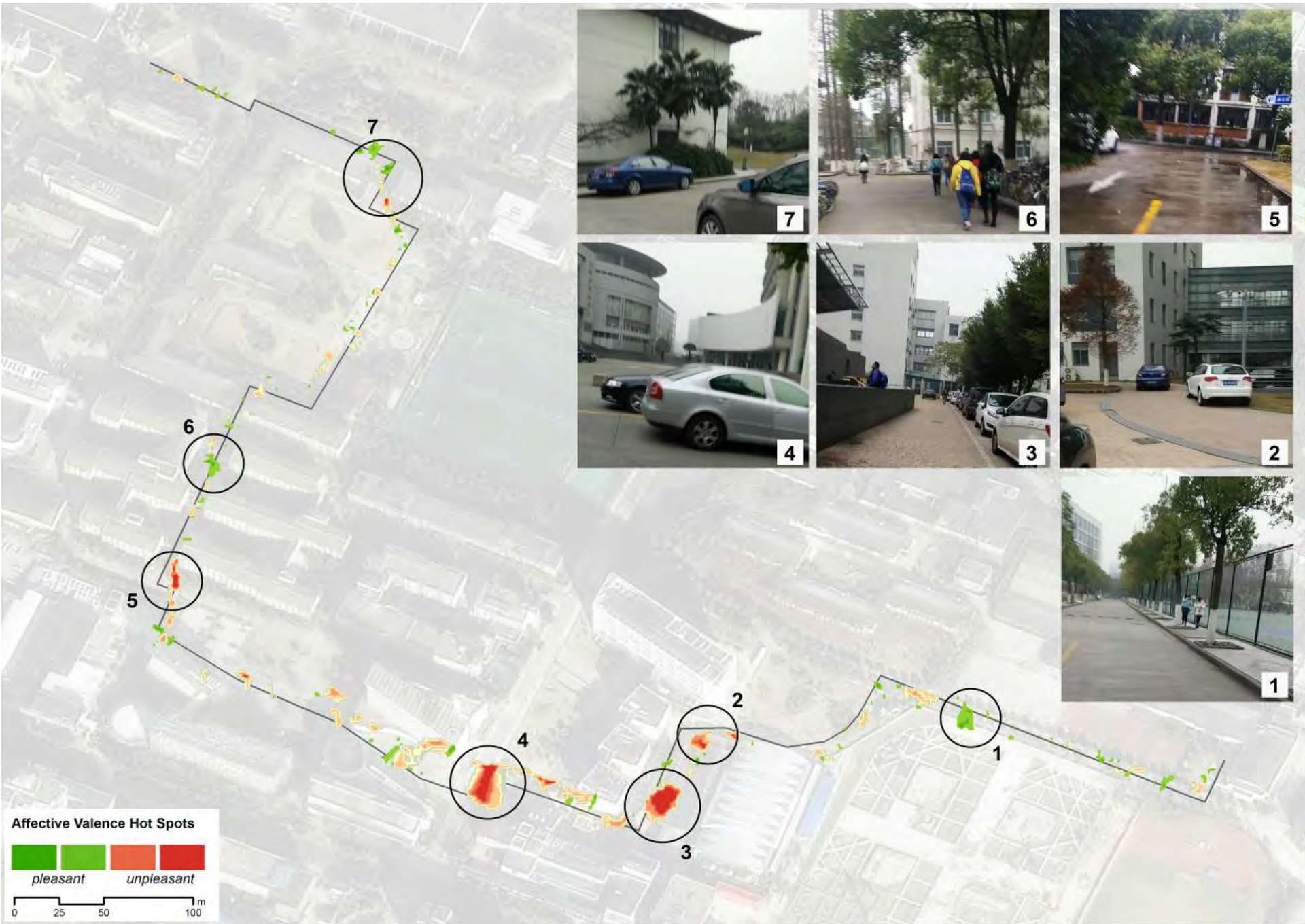




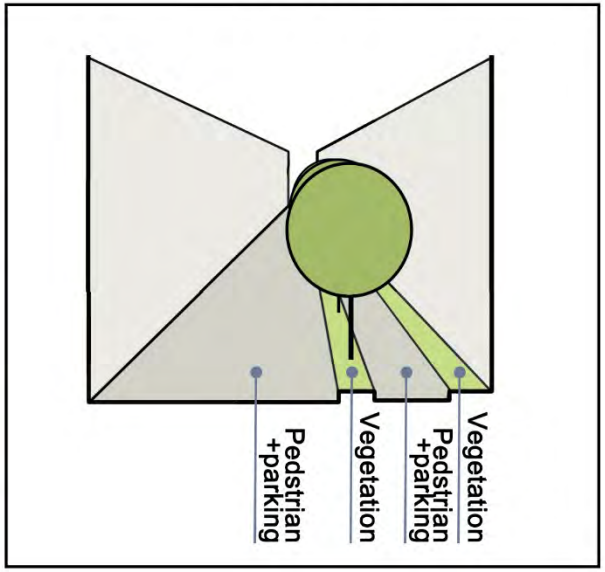
# Affective Mapping Analysis

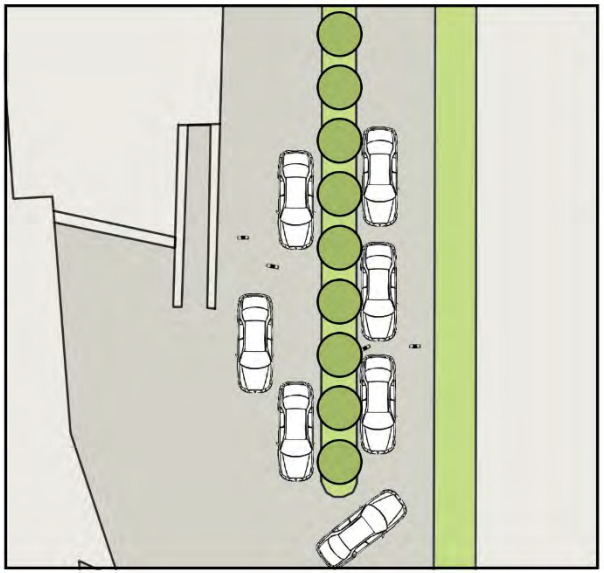


# Design Recommendations

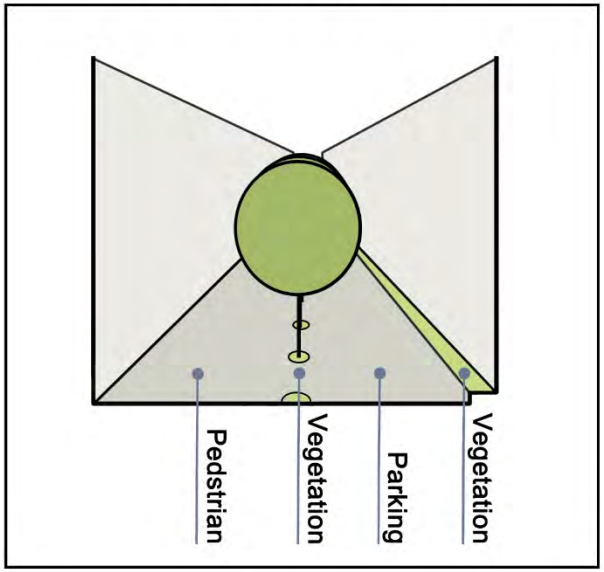
PHOTOS

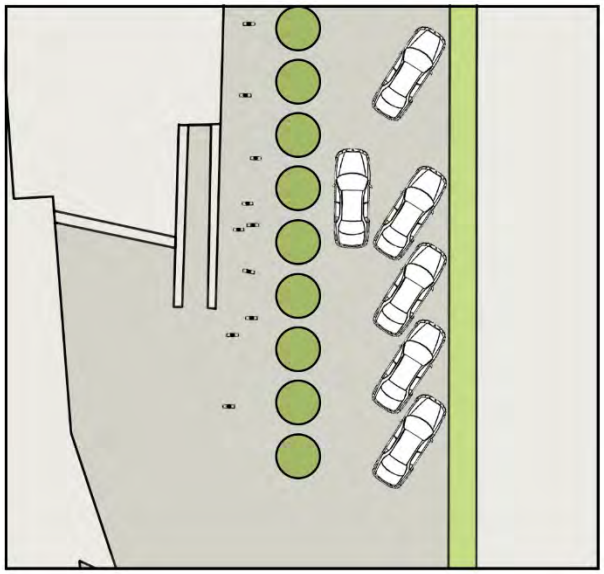
EXISTING



PROPOSED



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# Assessing affective experience of in-situ environment via wearable biosensors for evidence-ba

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[illegible] Received in revised form 30 August 2018; accepted 10 September 2018

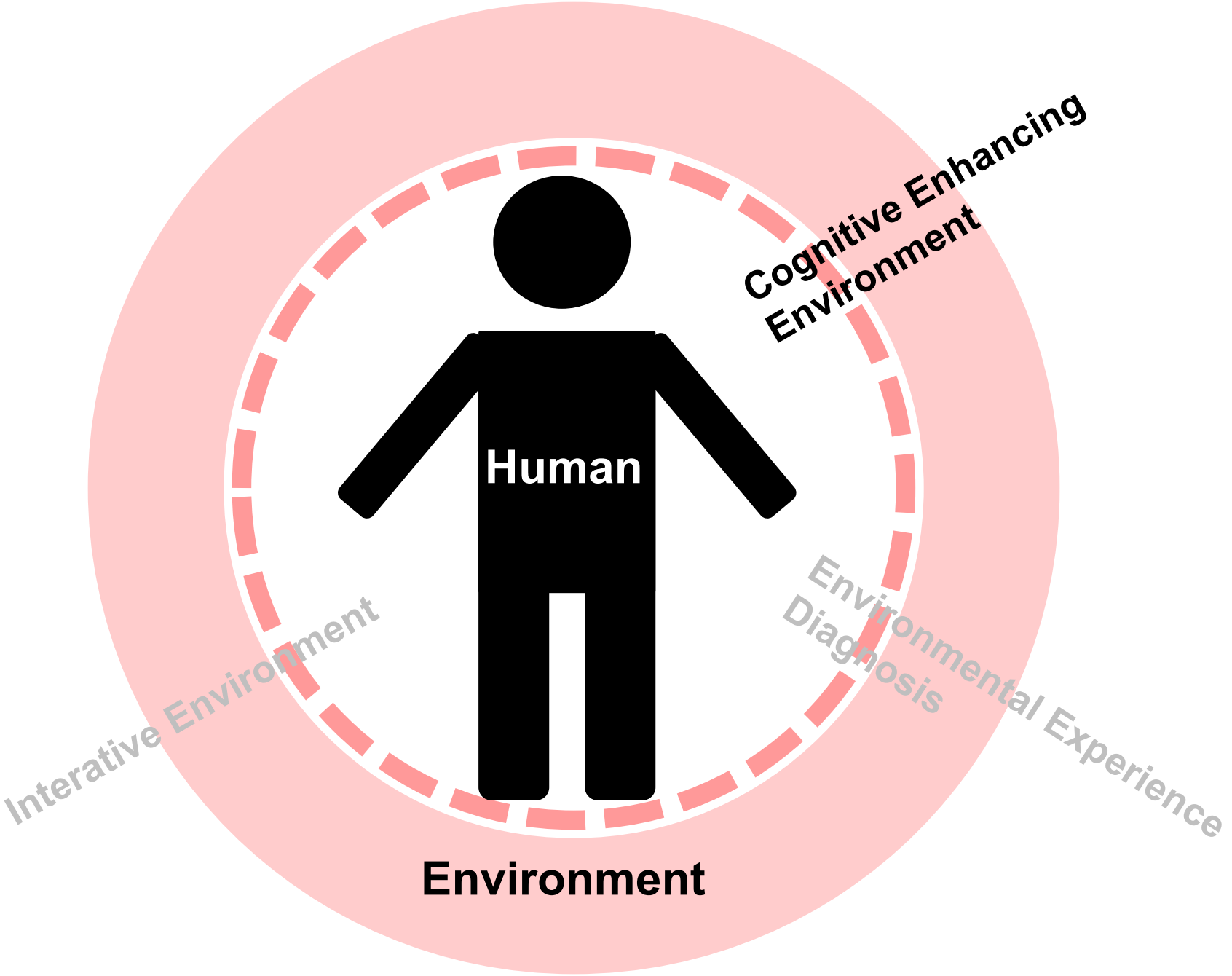
**Abs**

In environmental psychology research, the most commonly used methods are phenomenological interviews and psychometric scales. Recently, with the development of wearable bio-sensing devices, a new approach based on bio-sensing data is becoming possible. In this study, we examined the feasibility of using wearable biosensors to document affective experience during in-situ walk. An eight-channelled Procomp multi-bio-sensing devices (EKG, EEG, skin conductance, temperature, facial EMG, respiration) were used, in addition with a GPS tracker, to measure the in situ physiological affective responses to environmental stimuli. This pilot experiment revealed consistent results between bio-sensing measures and two traditional methods, i.e. phenomenological interviews and psychological Likert scale rating, which indicated that mobile bio-sensing could be a promising method in measuring in-situ affective responses to environmental stimuli as well as diagnosing potential environmental stressor. This new bio-sensory method, as exemplified in this paper, could help identifying negative stressful stimuli and providing evidence-based diagnosis to support design strategies.


*Keywords:* Environmental neuroscience; Affective mapping; Environmental experience

# NEW INTERACTIONS, NEW POSSIBILITIES






RESTORATIVE LANDSCAPES
FATIGUE/ATTENTION
STRESS
EMOTION

# Experiment Design

In situ multi-sensory exposure (20 minutes)
Between-subject design

Restorative
Man-made nature
Campus garden
n=16

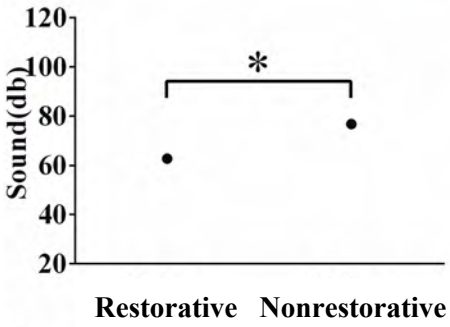
Nonrestorative
Urban environment
Elevated highway
n=16

# Condition

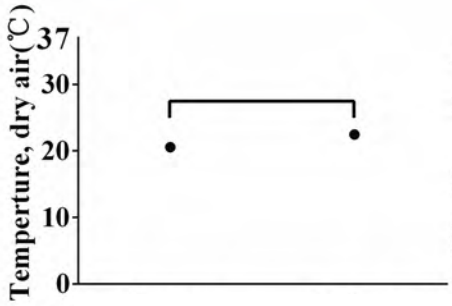
## Restorative


## Nonrestorative

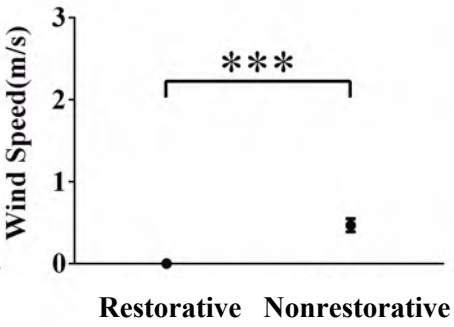

## Acoustic intensity



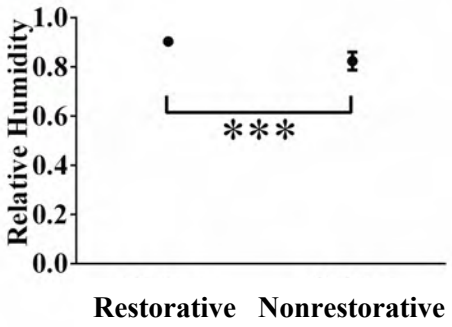

## Temperature




## Wind Speed




## R. Humidity




*=p<.05; ***=p<.001

# EEG(Electroencephalograph) Data Collection

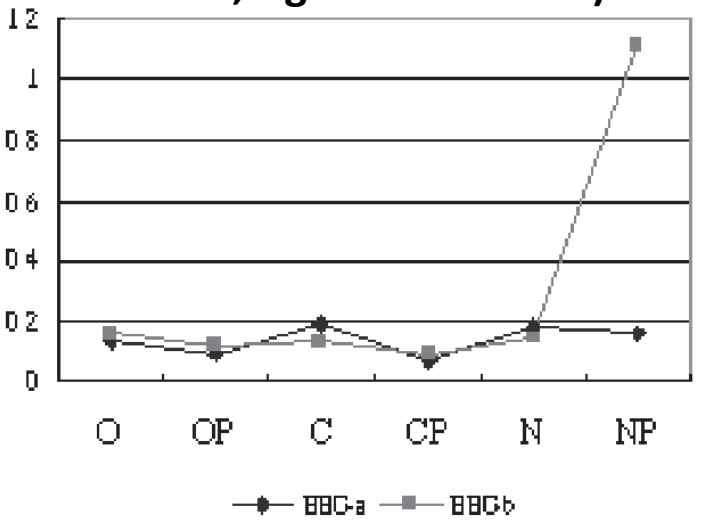
- EEG data were collected using Emotiv (14 channels, 128 samples per second).

| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z | AA | AB | AC | AD | AE | AF | AG | AH | AI | AJ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SIGI:1 | recordid:1 | sampling | subject:1 | labels:CO | chan:36 | unit:emotiv | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | 34 | 0 | 3996.92 | 4580 | 4182.05 | 3962.05 | 4424.62 | 4244.62 | 4402.05 | 4540 | 4547.69 | 4162.05 | 4226.15 | 4464.1 | 4064.1 | 4361.54 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1701 | 1706 | 0 |
| 3 | 35 | 0 | 4040 | 4420 | 4225.08 | 4011.79 | 4448.21 | 4225.13 | 4275.33 | 4548.72 | 4583.59 | 4196.97 | 4267.18 | 4506.67 | 4104.62 | 4405.64 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1702 | 1703 | 0 |
| 4 | 36 | 0 | 4065.13 | 4441.03 | 4241.54 | 4026.67 | 4452.82 | 4222.56 | 4255.33 | 4559.49 | 4422.05 | 4239.49 | 4291.28 | 4554.87 | 4134.36 | 4436.97 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1701 | 1701 | 0 |
| 5 | 37 | 0 | 4050.77 | 4427.69 | 4222.56 | 4010.26 | 4442.56 | 4233.33 | 4537.44 | 4363.08 | 4455.38 | 4249.74 | 4281.54 | 4525.13 | 4126.15 | 4428.21 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1702 | 1699 | 0 |
| 6 | 38 | 0 | 4055.33 | 4417.44 | 4209.23 | 3997.44 | 4440.51 | 4242.05 | 4570.26 | 4353.85 | 4417.95 | 4236.41 | 4265.13 | 4510.77 | 4105.59 | 4406.21 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1701 | 1697 | 0 |
| 7 | 39 | 0 | 4041.03 | 4427.69 | 4221.54 | 4010.26 | 4445.13 | 4236.97 | 4550.77 | 4348.72 | 4394.36 | 4215.33 | 4262.56 | 4517.95 | 4106.67 | 4411.79 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1703 | 1696 | 0 |
| 8 | 40 | 0 | 4053.33 | 4437.44 | 4231.79 | 4022.05 | 4457.95 | 4239.49 | 4546.67 | 4346.15 | 4384.1 | 4199.49 | 4266.67 | 4524.62 | 4117.44 | 4421.03 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1702 | 1695 | 0 |
| 9 | 41 | 0 | 4043.59 | 4422.56 | 4220.51 | 4009.23 | 4461.54 | 4242.05 | 4549.74 | 4328.72 | 4379.49 | 4200 | 4251.28 | 4510.77 | 4102.56 | 4409.74 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1703 | 1696 | 0 |
| 10 | 42 | 0 | 4054.87 | 4411.28 | 4210.77 | 4000.51 | 4447.18 | 4234.36 | 4545.13 | 4321.03 | 4387.18 | 4210.77 | 4240 | 4498.97 | 4098.46 | 4402.05 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1703 | 1696 | 0 |
| 11 | 43 | 0 | 4046.67 | 4426.21 | 4217.95 | 4014.87 | 4447.18 | 4226.72 | 4537.95 | 4334.36 | 4402.56 | 4223.59 | 4256.92 | 4509.23 | 4119.49 | 4415.38 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1703 | 1701 | 0 |
| 12 | 44 | 0 | 4045.64 | 4431.79 | 4216.41 | 4022.05 | 4460 | 4245.64 | 4547.18 | 4333.85 | 4388.72 | 4212.82 | 4265.13 | 4514.36 | 4116.46 | 4414.36 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1705 | 1701 | 0 |
| 13 | 45 | 0 | 4041.03 | 4425.08 | 4215.38 | 4014.36 | 4454.87 | 4251.79 | 4562.56 | 4329.23 | 4380.51 | 4207.69 | 4259.49 | 4513.33 | 4109.23 | 4411.28 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1705 | 1706 | 0 |
| 14 | 46 | 0 | 4058.46 | 4436.46 | 4229.74 | 4020.51 | 4448.21 | 4236.41 | 4560.51 | 4343.08 | 4409.23 | 4233.85 | 4271.28 | 4527.18 | 4127.18 | 4431.28 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1706 | 1706 | 0 |
| 15 | 47 | 0 | 4061.03 | 4444.1 | 4237.69 | 4020.51 | 4454.87 | 4236.92 | 4555.38 | 4341.03 | 4410.26 | 4239.49 | 4270.26 | 4526.67 | 4127.69 | 4430.77 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1706 | 1706 | 0 |
| 16 | 48 | 0 | 4051.79 | 4432.82 | 4217.95 | 4010.26 | 4455.9 | 4247.69 | 4555.9 | 4350.77 | 4390.77 | 4222.05 | 4256.92 | 4516.92 | 4115.53 | 4416.92 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1706 | 1706 | 0 |
| 17 | 49 | 0 | 4070.26 | 4440 | 4232.31 | 4020 | 4455.9 | 4247.69 | 4564.62 | 4343.59 | 4416.92 | 4236.92 | 4266.72 | 4528.72 | 4125.13 | 4431.79 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1705 | 1705 | 0 |
| 18 | 50 | 0 | 4077.44 | 4445.64 | 4237.95 | 4025.64 | 4460 | 4246.15 | 4560.51 | 4346.72 | 4454.87 | 4255.38 | 4275.9 | 4532.31 | 4130.77 | 4440.51 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1704 | 1705 | 0 |
| 19 | 51 | 0 | 4058.46 | 4436.46 | 4223.08 | 4017.95 | 4465.59 | 4250.26 | 4565.64 | 4355.38 | 4405.59 | 4226.72 | 4262.05 | 4514.87 | 4117.44 | 4420.51 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1703 | 1702 | 0 |
| 20 | 52 | 0 | 4054.36 | 4436.97 | 4219.49 | 4016.41 | 4465.64 | 4249.23 | 4555.85 | 4355.38 | 4381.54 | 4204.62 | 4250.77 | 4506.67 | 4110.77 | 4411.28 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1702 | 1701 | 0 |
| 21 | 53 | 0 | 4051.28 | 4430.77 | 4217.95 | 4008.21 | 4454.36 | 4250.26 | 4424.62 | 4340 | 4372.82 | 4199.49 | 4238.46 | 4502.56 | 4097.44 | 4410.26 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1702 | 1699 | 0 |
| 22 | 54 | 0 | 4048.72 | 4425.13 | 4217.44 | 4004.1 | 4445.64 | 4252.82 | 4441.03 | 4337.44 | 4373.33 | 4199.49 | 4243.08 | 4507.18 | 4095.38 | 4414.36 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1701 | 1700 | 0 |
| 23 | 55 | 0 | 4078.46 | 4454.36 | 4243.59 | 4031.79 | 4469.23 | 4257.95 | 4299.49 | 4345.64 | 4421.54 | 4236.92 | 4265.13 | 4543.59 | 4139.49 | 4446.67 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1702 | 1698 | 0 |
| 24 | 56 | 0 | 4095.38 | 4473.85 | 4257.44 | 4045.13 | 4484.62 | 4225.64 | 4228.72 | 4355.38 | 4467.69 | 4290.77 | 4312.82 | 4567.69 | 4171.79 | 4468.72 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1701 | 1698 | 0 |
| 25 | 57 | 0 | 4069.74 | 4455.85 | 4238.46 | 4021.03 | 4465.08 | 4236.97 | 4524.62 | 4346.15 | 4451.79 | 4271.28 | 4287.69 | 4540 | 4145.64 | 4445.64 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1702 | 1698 | 0 |
| 26 | 58 | 0 | 4054.87 | 4439.49 | 4227.18 | 4011.28 | 4452.82 | 4248.72 | 4565.64 | 4330.26 | 4376.92 | 4209.23 | 4255.9 | 4509.74 | 4114.87 | 4420 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1702 | 1697 | 0 |

# Attention/Fatigue and EEG Power

Increasing alpha activities, especially at frontal lobes, is usually used as an indicator of restoration in environmental psychology.

**Chang (alpha at front, back, left, right of forehead)**




**Ulrich (averaged alpha at C3,P3, C4,P4)**

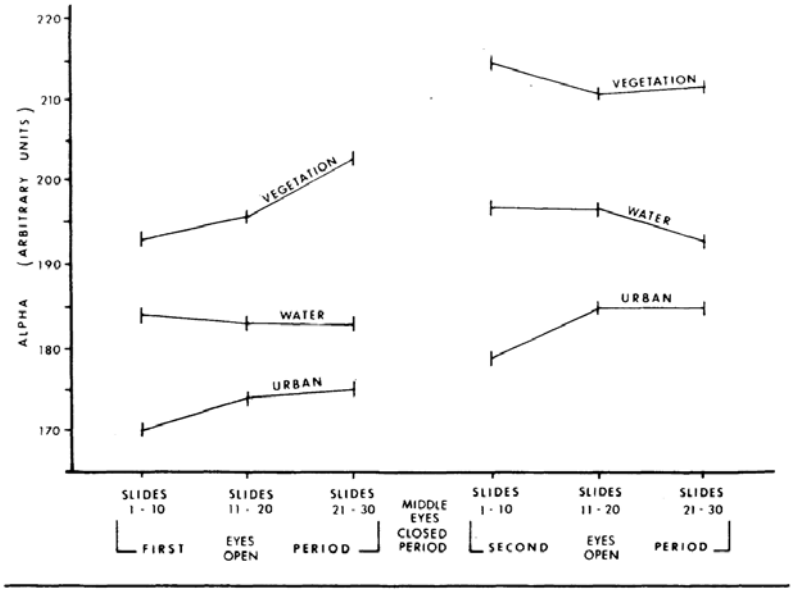



Figure 5: Eyes-open alpha as function of environment viewed.

**Chiang ( alpha at FP 1 )**

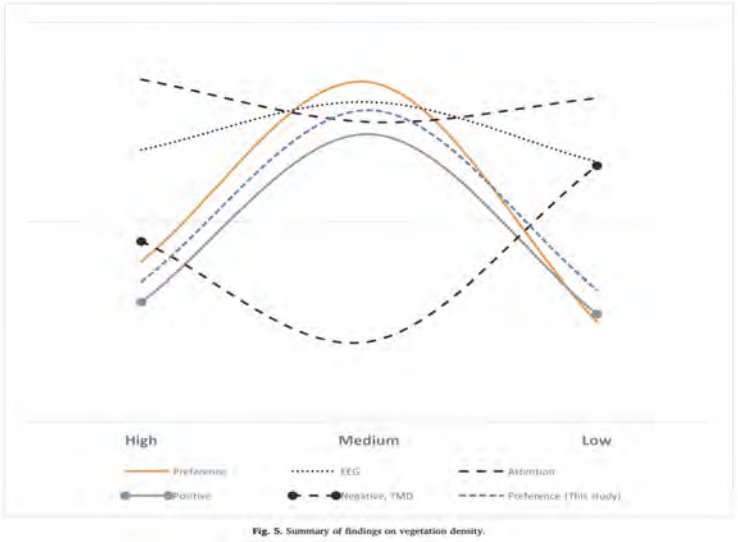



Fig. 5. Summary of findings on vegetation density.


Ulrich, R. S. (1981). Natural versus urban scenes some psychophysiological effects. *Environment and behavior, 13*(5), 523-556.

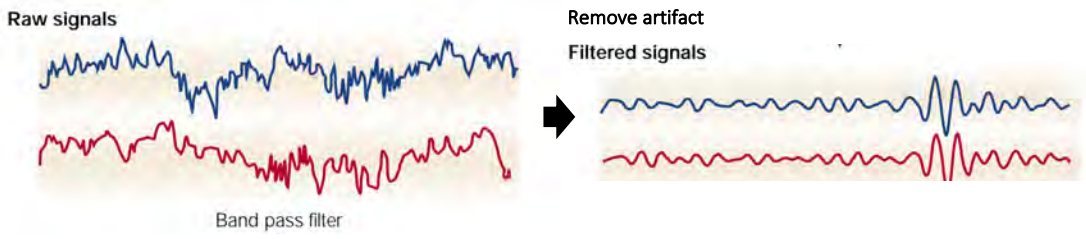
Chang, C.-Y., & Chen, P.-K. (2005). Human response to window views and indoor plants in the workplace. *HortScience, 40*(5), 1354-1359.

Chiang, Y.-C., Li, D., & Jane, H.-A. (2017). Wild or tended nature? The effects of landscape location and vegetation density on physiological and psychological responses. *Landscape and Urban Planning, 167*, 72-83. doi: http://dx.doi.org/10.1016/j.landurbplan.2017.06.001

# EEG Analysis

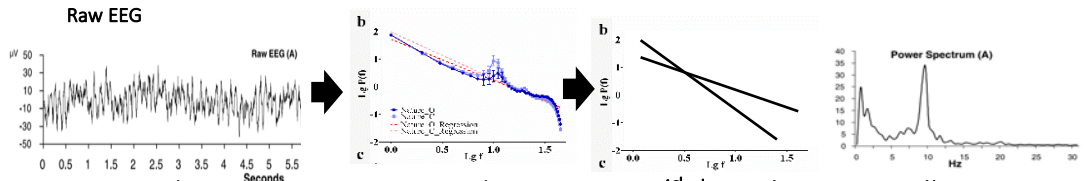
**Imagine recording our on-going conversations from hallway**

## Pre-Processing



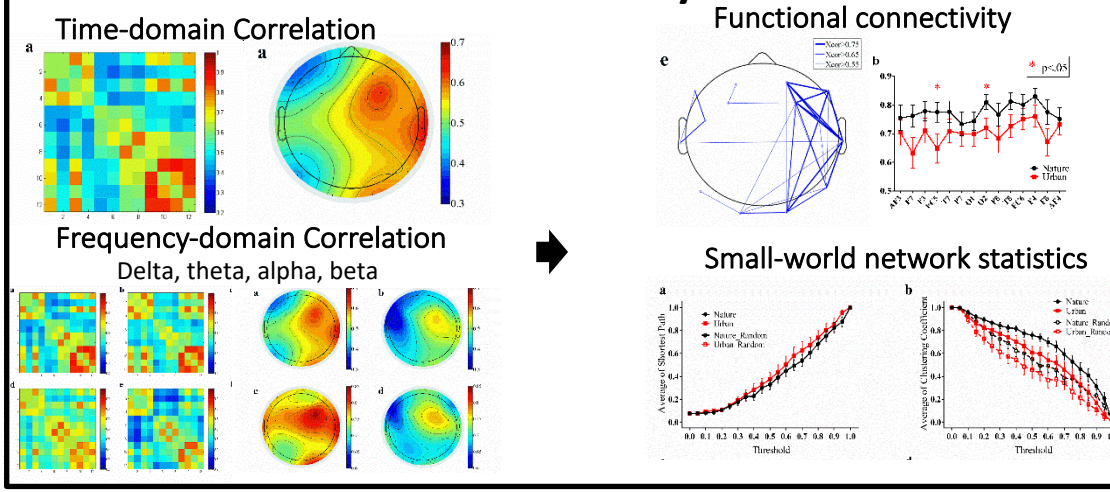

Remove noise like people walking, door open/closed…

## Fast Fourier Transformation




Separate different speakers, e.g. Speaker A contributes 40% of this conversation

## Functional Connectivity Network



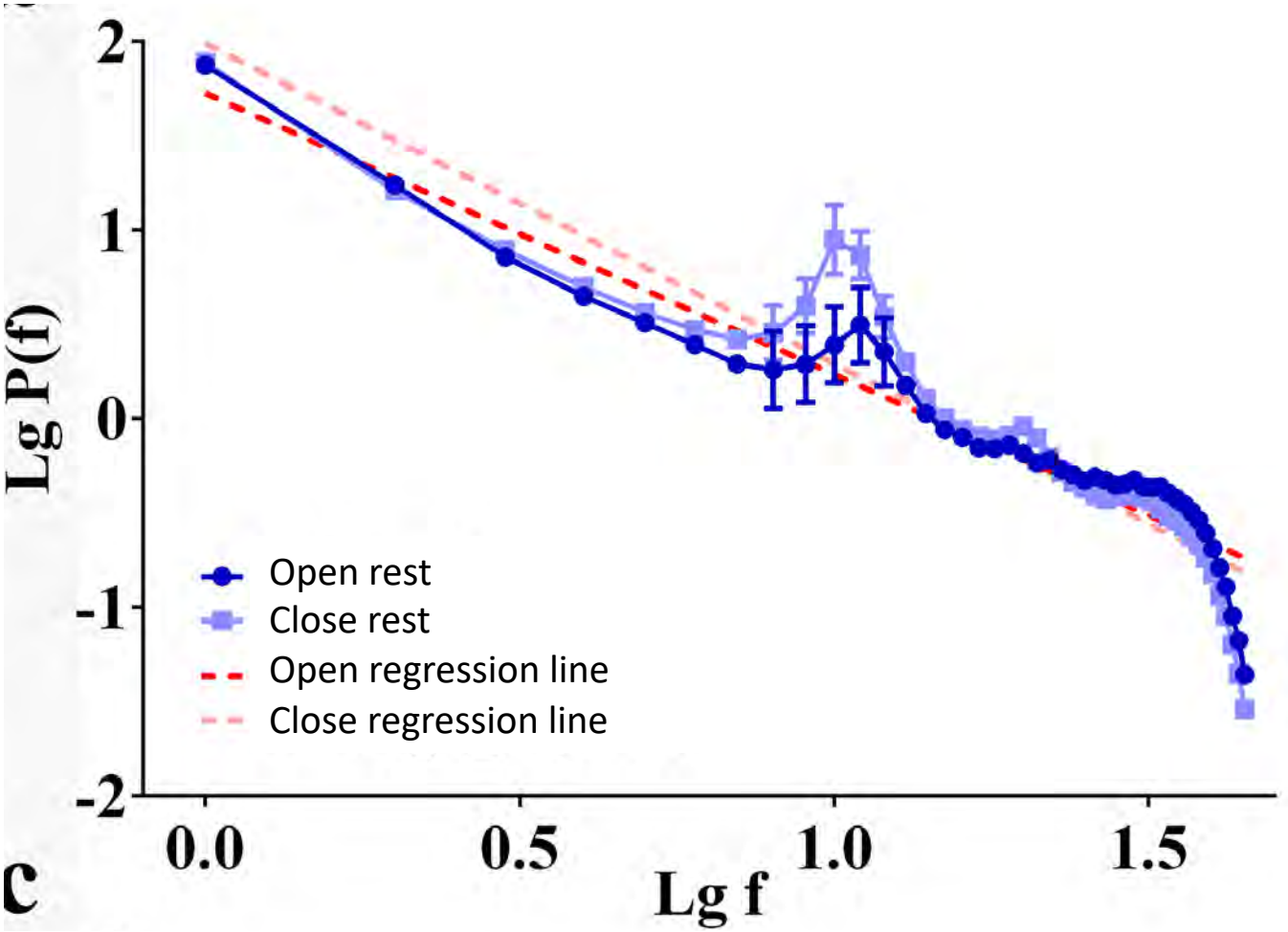

Understand who is talking to whom

# EEG Power Spectral Analysis

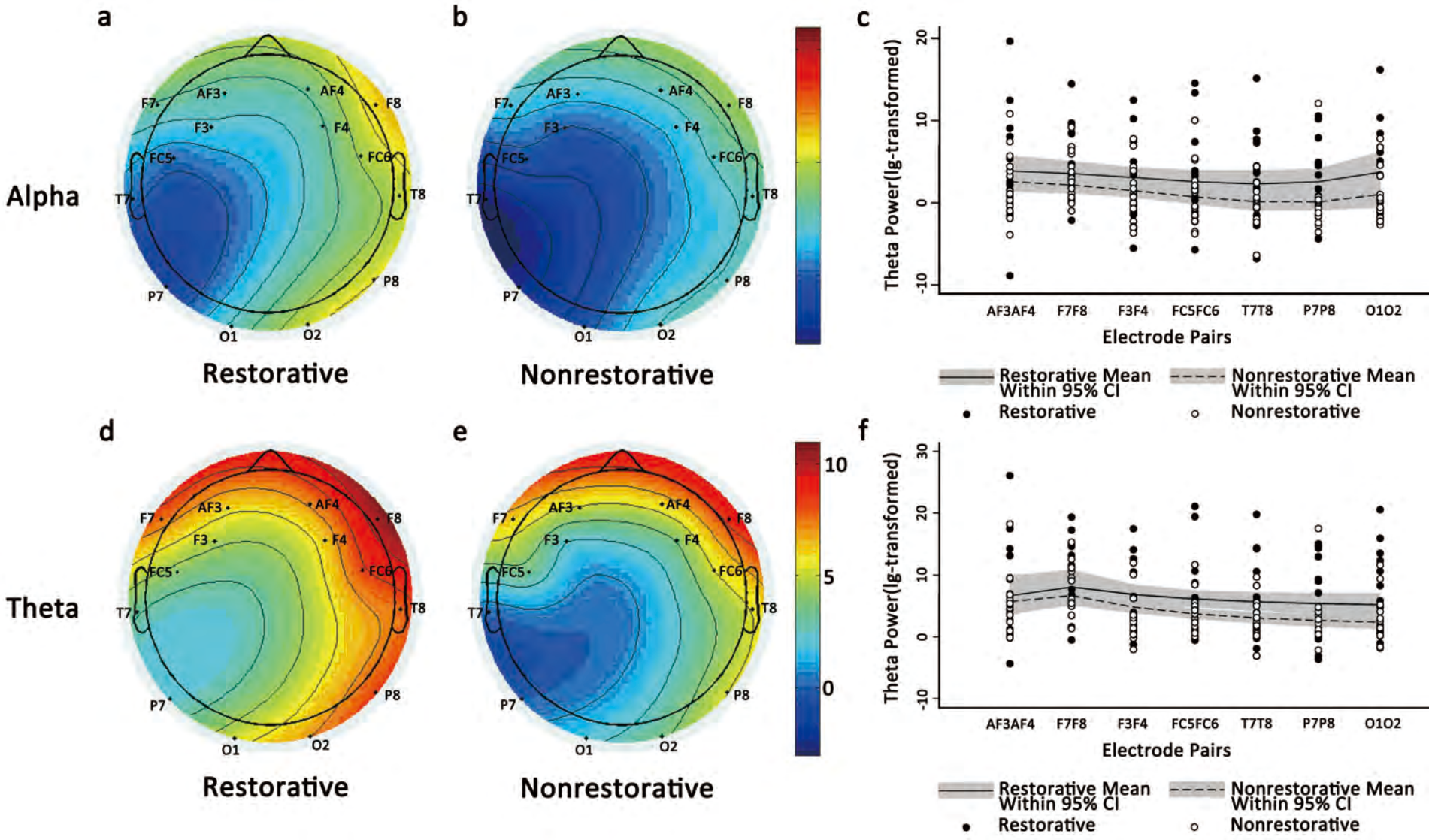
Occipital Lobes (O1, O2) during eye-open and eye-close before a nature exposure

Slopes: $1/f^{\beta}$ Statistics β "noise"

"Bumps": Oscillation in alpha, beta…

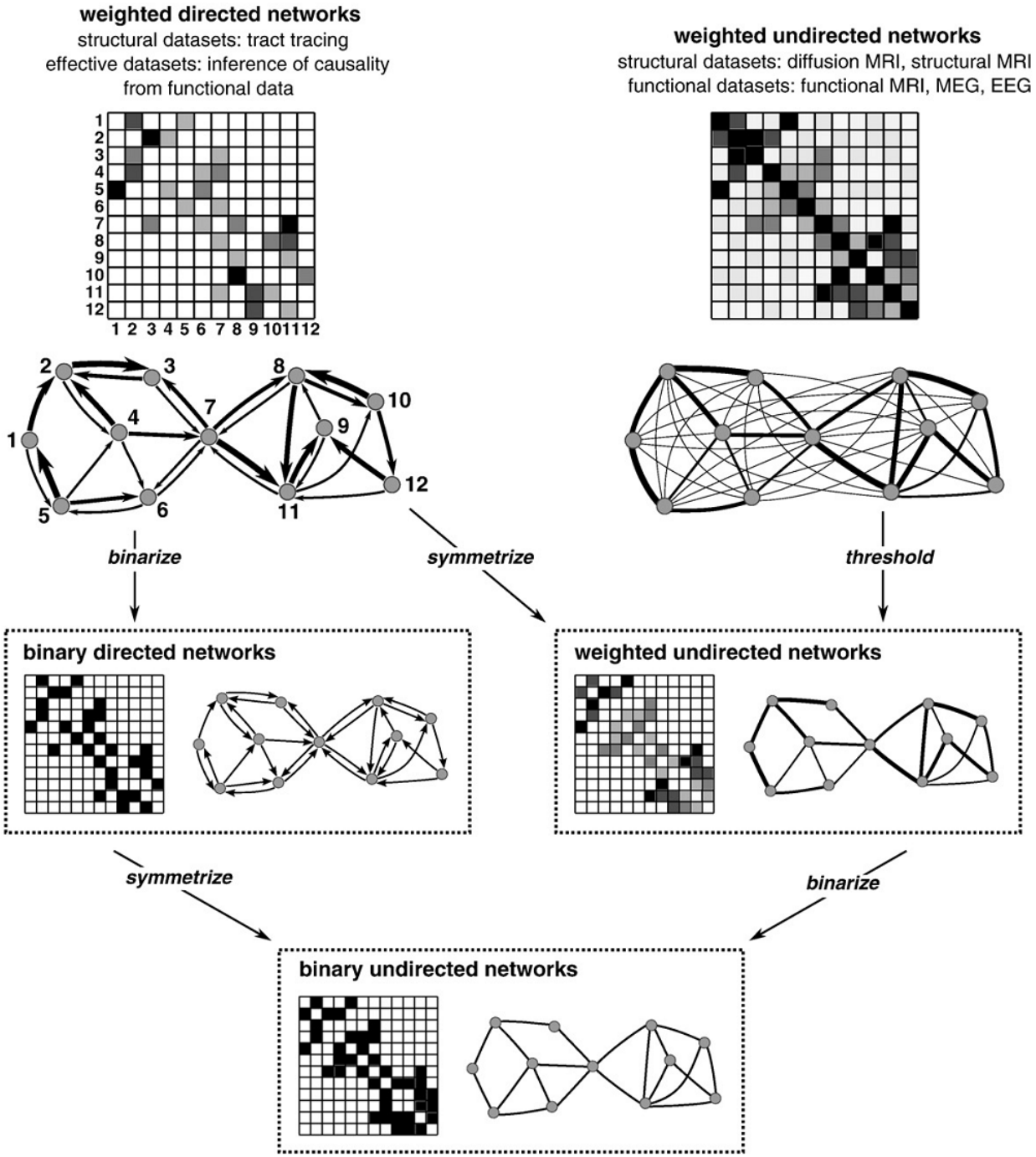


# Alpha and Theta Power Brain Maps



# Brain Functional Connectivity Network

Functional connectivity analysis




Rubinov, M., & Sporns, O. (2010). Complex network measures of brain connectivity: uses and interpretations. *Neuroimage, 52*(3), 1059-1069.

# Brain Functional Connectivity Network

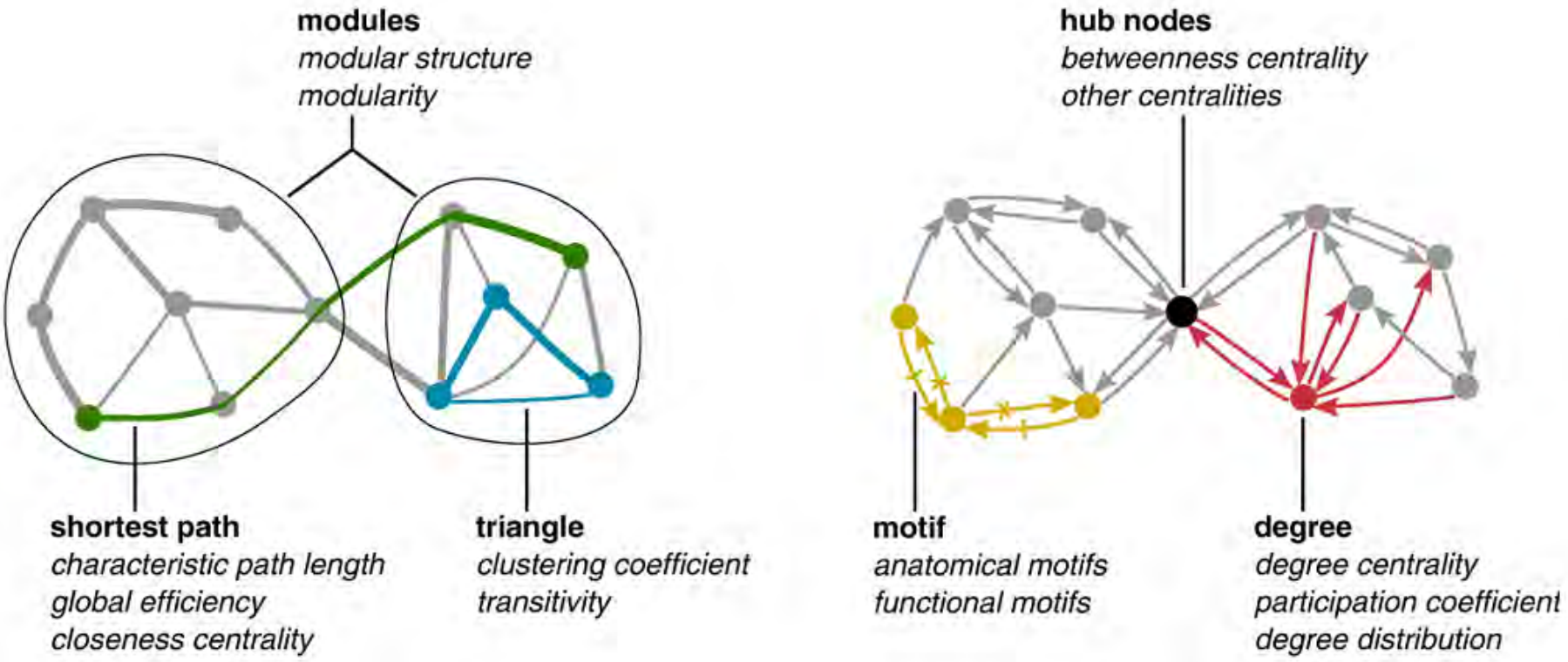
Network Analysis

**An efficient network usually reveals characteristics of a small-world network**

**higher functional integration**
**smaller average shortest path length ($L_{mean}$)**

**+**

**higher functional segregation**
**larger clustering coefficient ($C_{mean}$)**




**We used the index $C_{mean}/L_{mean}$ to describe brain connectivity efficiency**

Rubinov, M., & Sporns, O. (2010). Complex network measures of brain connectivity: uses and interpretations. *Neuroimage, 52*(3), 1059-1069.

# Restorativeness and Functional Connectivity Efficiency

Research on meditation indicates that restorativeness during meditation is associated with functional connectivity and network characteristics. psychology.

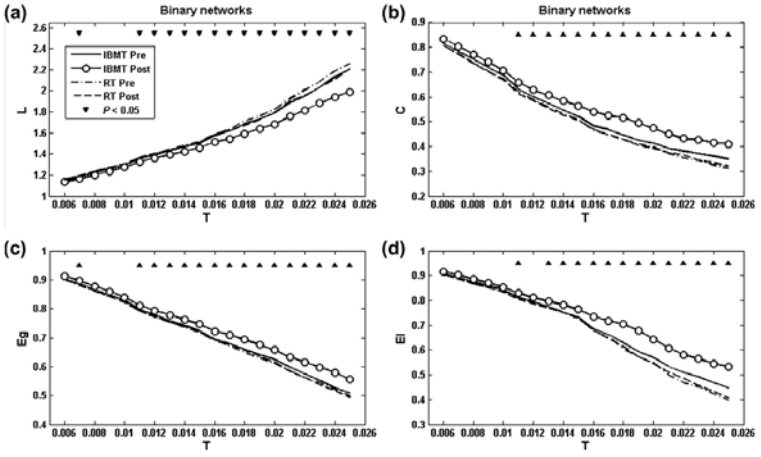



Table 1
*Summary of Meditation Studies Using Electroencephalographic (EEG) Methods*

| Study | Meditation type | *N* | Experimental design | Findings |
|---|---|---|---|---|
| Das & Gastaut (1957) | Kriya yoga | 7 | Advanced yogic meditators Rest → meditation → rest | State: alpha activity decrease, frequency increase; Samadhi with increased amplitude fast beta activity; no alpha blocking to stimuli; resting alpha with increased amplitude and wider distribution after meditation vs. before<br>Trait: NA |
| Wenger & Bagchi (1961) | Yoga | 14 | Rest vs. meditation | State: Alpha activity increase, no alpha blocking<br>Trait: NA |
| Anand et al. (1961) | Raj yoga | 6 | Rest vs. meditation | State: increased alpha power during Samadhi; no alpha blocking to visual, auditory, or painful stimuli during meditation<br>Trait: high alpha amplitude at rest, beginners with higher alpha showed greater zeal to continue |
| Kasamatsu & Hirai (1966) | Zen | 70 | Meditators vs. controls EEG during eyes-open rest or meditation | State: increased alpha amplitude → decreased alpha frequency → alpha activity spreading frontally → theta bursts (→ alpha persists in eyes open rest state), nonhabituating alpha blocking<br>Trait: increased alpha amplitude |
| R. K. Wallace (1970) | TM | 15 | Rest vs. meditation Some photic and auditory stimuli | State: decreased alpha frequency and increased lo alpha amplitude; alpha blocking with no habituation<br>Trait: NA |
| R. K. Wallace et al. (1971) | TM | 36 | Rest vs. meditation | State: increased alpha (8–10 Hz) amplitude, some participants with theta bursts<br>Trait: NA |
| Banquet (1973) | TM | 24 | Rest vs. meditation, with repeated sessions Some photic and auditory stimuli | State: decreased alpha frequency → theta activity in some; deep meditation states with generalized fast frequencies at 20 and 40 Hz, persistent alpha activity after meditation, no alpha blocking, no statistics<br>Trait: none reported |
| Williams & West (1975) | TM | 19 | Photic stimulation during rest | State: NA<br>Trait: more early alpha induction, less alpha blocking during rest session; maintenance of low-arousal state without progression toward sleep |
| Younger et al. (1975) | TM | 8 | Meditation-4 sessions per participant | State: 40% in sleep Stages I or II (range 0–70%)<br>Trait: NA |
| Tebecis (1975) | TM, self-hypnosis | 42 | Rest → meditation/self hypnosis, meditation/self-hypnosis → rest | State: none<br>Trait: higher theta power in meditators and self-hypnosis |
| Pagano et al. (1976) | TM | 5 | Napping vs. meditation, 5 conditions per individual | State: 40% time in meditation met criteria for sleep Stages II–IV<br>Trait: NA |
| Ghista et al. (1976) | Ananda Marga | 5 | Before, during, and after meditation | State: increases in alpha and theta power<br>Trait: NA |
| Bennett & Trinder (1977) | TM | 32 | Meditators vs. controls, each participant had 2 analytic tasks and 2 spatial tasks; tasks and meditation-relaxation order counterbalanced | State: trend toward less variation in asymmetry during meditation compared with control relaxation; only alpha asymmetry assessed<br>Trait: greater left asymmetry on analytical tasks, right asymmetry on spatial tasks |
| Hebert & Lehmann (1977) | TM | 13 | Meditators vs. controls | State: frontal-central theta bursts more common during meditation, associated with peaceful "drifting," not drowsy<br>Trait: more theta burst subjects (30% vs. 0%) |
| Morse et al. (1977) | TM, hypnosis, PR | 2<br>48 | Rest → meditation → rest<br>Randomized order induction of various relaxation states | State: all relaxation methods induced equal alpha in some but not all participants<br>Trait: none reported |

*(table continues)*


Cahn, B. R., & Polich, J. (2006). Meditation states and traits: EEG, ERP, and neuroimaging studies. *Psychological Bulletin, 132*(2), 180

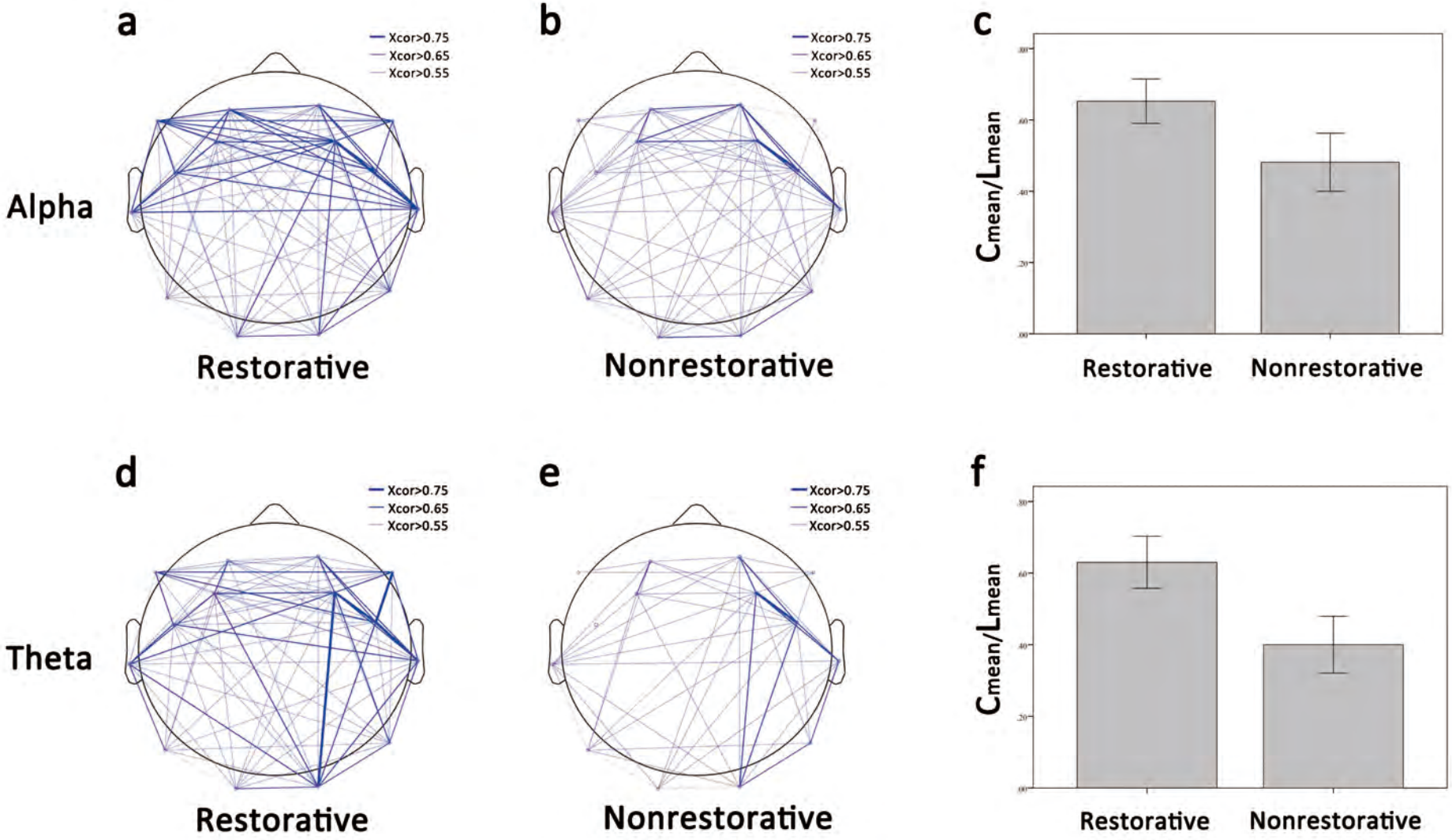
Xue, S.-W., Tang, Y.-Y., Tang, R., & Posner, M. I. (2014). Short-term meditation induces changes in brain resting EEG theta networks. *Brain and cognition, 87*, 1-6.

# Better brain functional connectivity

## Higher EEG Correlation

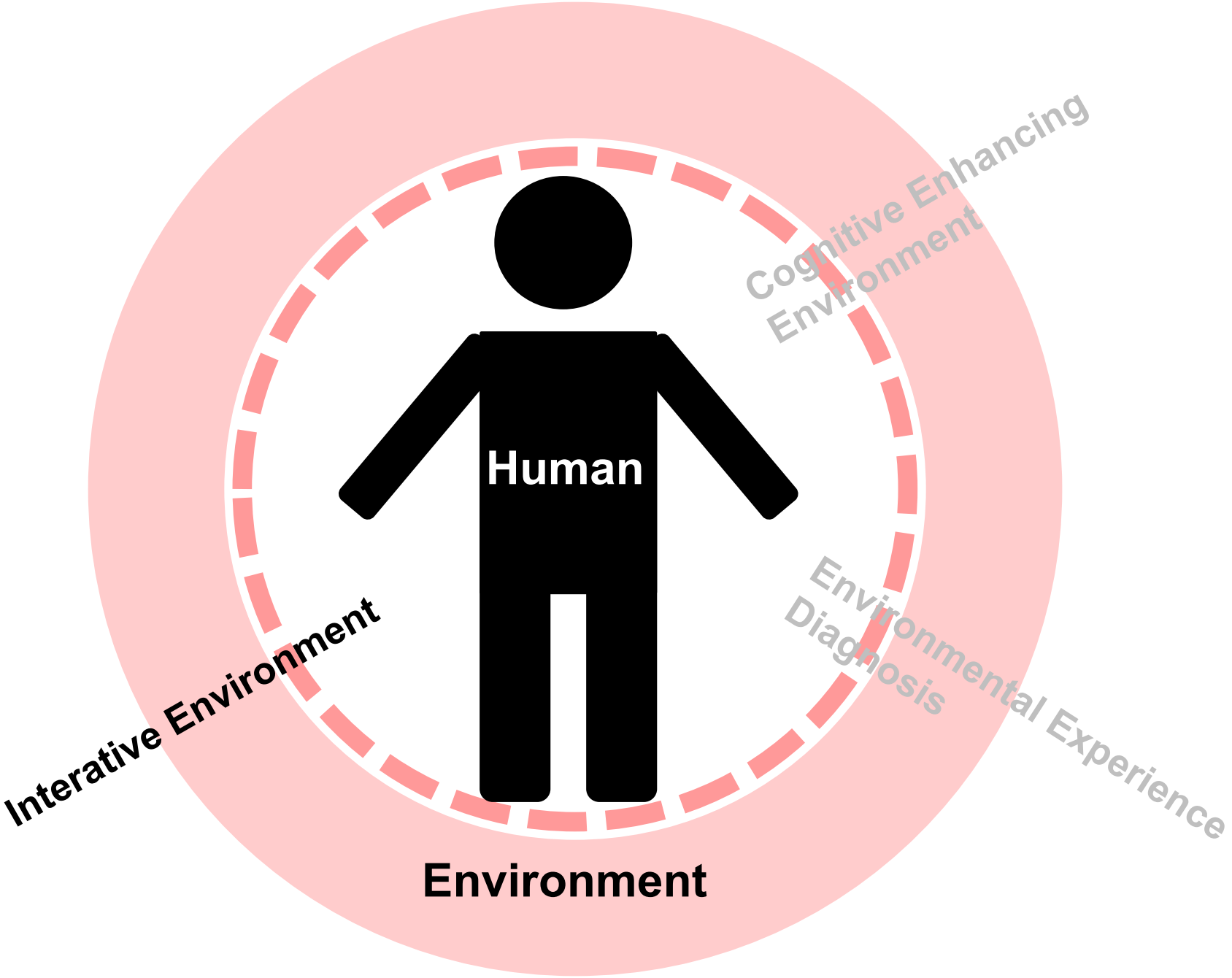
The EEG correlations revealed the information flow within brain.

When the EEG correlations are higher, the more shared information that different brains are “talking” about.



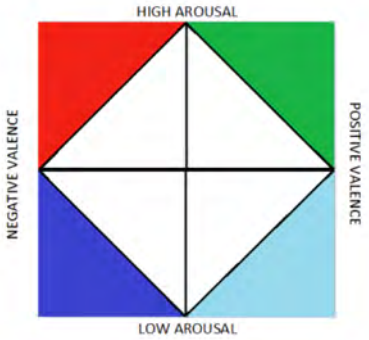
# NEW INTERACTIONS, NEW POSSIBILITIES





# POSSIBLITIES WITH WEARABLE BIOSENSORS

Mary Czerwinski, Microsoft Research 2015

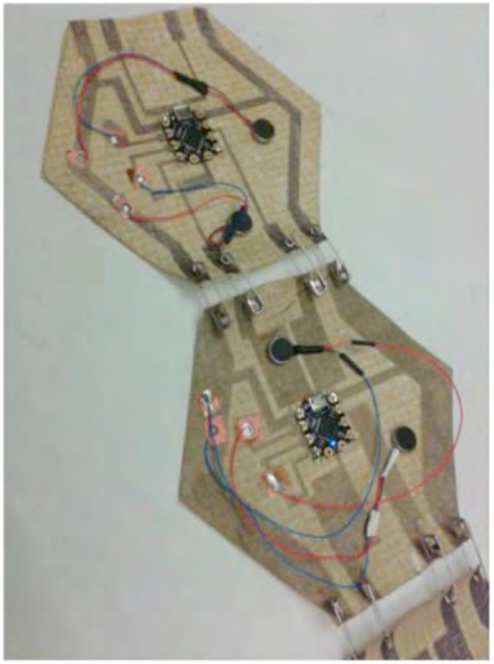



## BioCrystal: An Ambient Tool for Emotion and Communication 2015

Biofeedback helps with the self-awareness, stress-management and interpersonal communication. BioCrystal uses physiological data to evaluate user's affective states in real-time and signals the states via an ambient display.
提高人的情绪自觉。

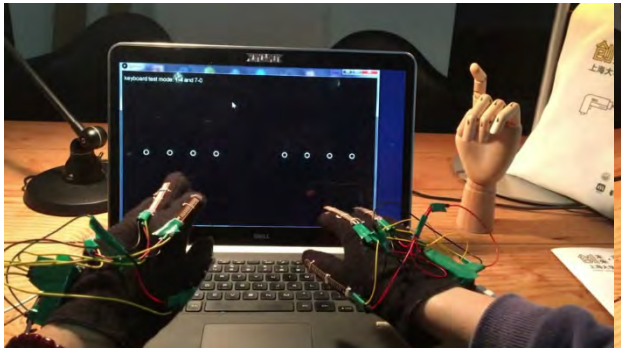
## SWARM: An Actuated Wearable for Mediating Affect 2015

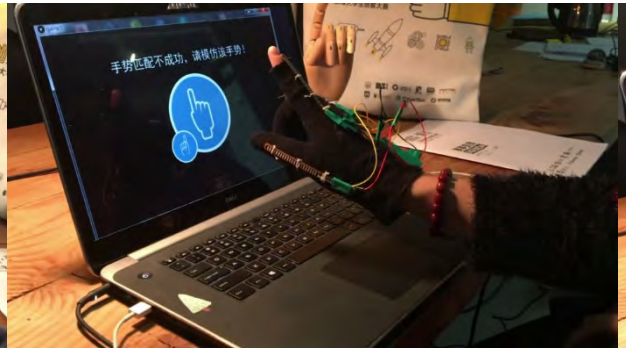
A wearable device is introduced to aid in interpreting and/or enhancing one's personal emotions and alerting the wearer of others' emotions; People with vision or hearing impairments may not receive important visual or verbal cues of others' emotions. Thus, universal design (making the device inherently accessible)was central to the project.
可穿戴设备增强了情绪解读和他人情绪预警的体验，更有利于有试听障碍的用户。

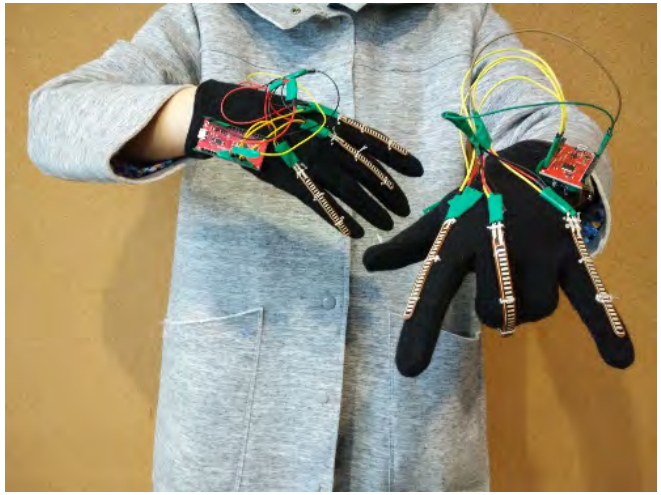


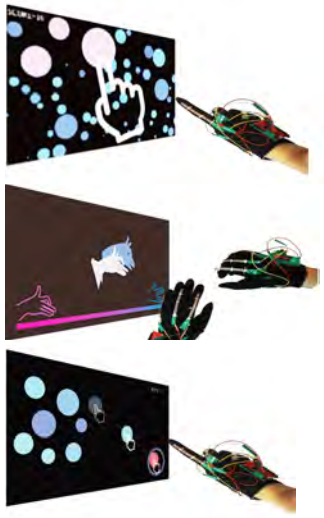
# Exploring HCI interventions for special needs

Students and I explored possibilities using HCI devices with simple sensors to turn boring Alzheimer-preventing cognitive training into enjoyable interactive games.







手眼敏捷度训练

手眼精准度训练

视觉识别度训练

# THANKS !

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