



# Varying Environmental and Psychological States in Human Life

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**ICHES2016Nagoya**  
**Special Lecture**



# Introduction

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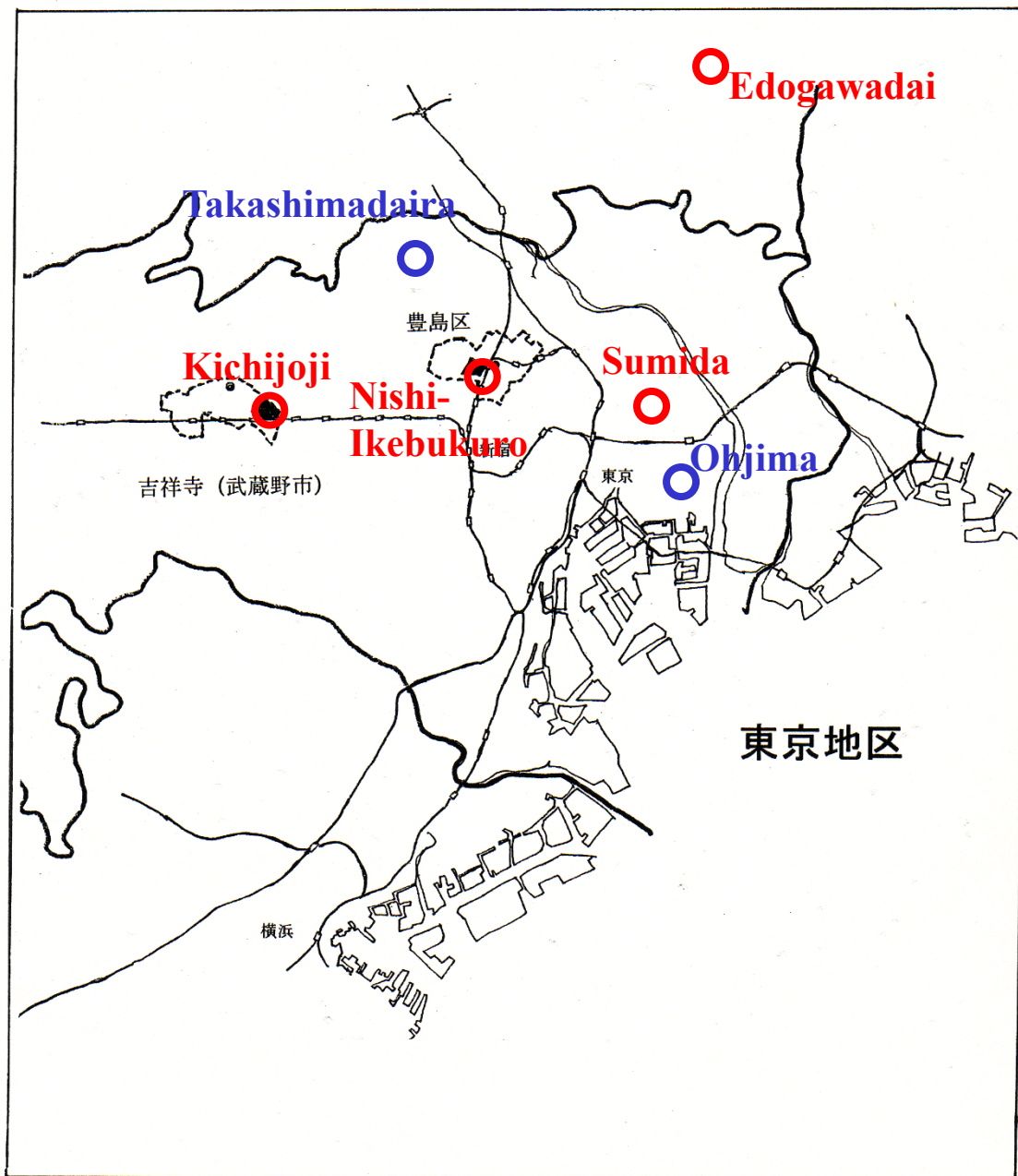
- We experience so many and various unsteady states.
- The surroundings themselves may vary and they relatively change when we move.
- Here, let us consider 3 aspects concerning the relations between humans and surroundings; thermal, visual, and social.
- This lecture is also the summary of my studies for 40 years.



# At the first

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- **In the world of social psychology.....**
- **For example, an analysis of chain structure of dissatisfaction (a part of my doctoral thesis, Dec. 1980)**



1978, 79

## Tokyo Survey

- General residential area
- Apartment houses area

**One area was within 1km<sup>2</sup>.**

**The number of samples was about 500 in each area.**

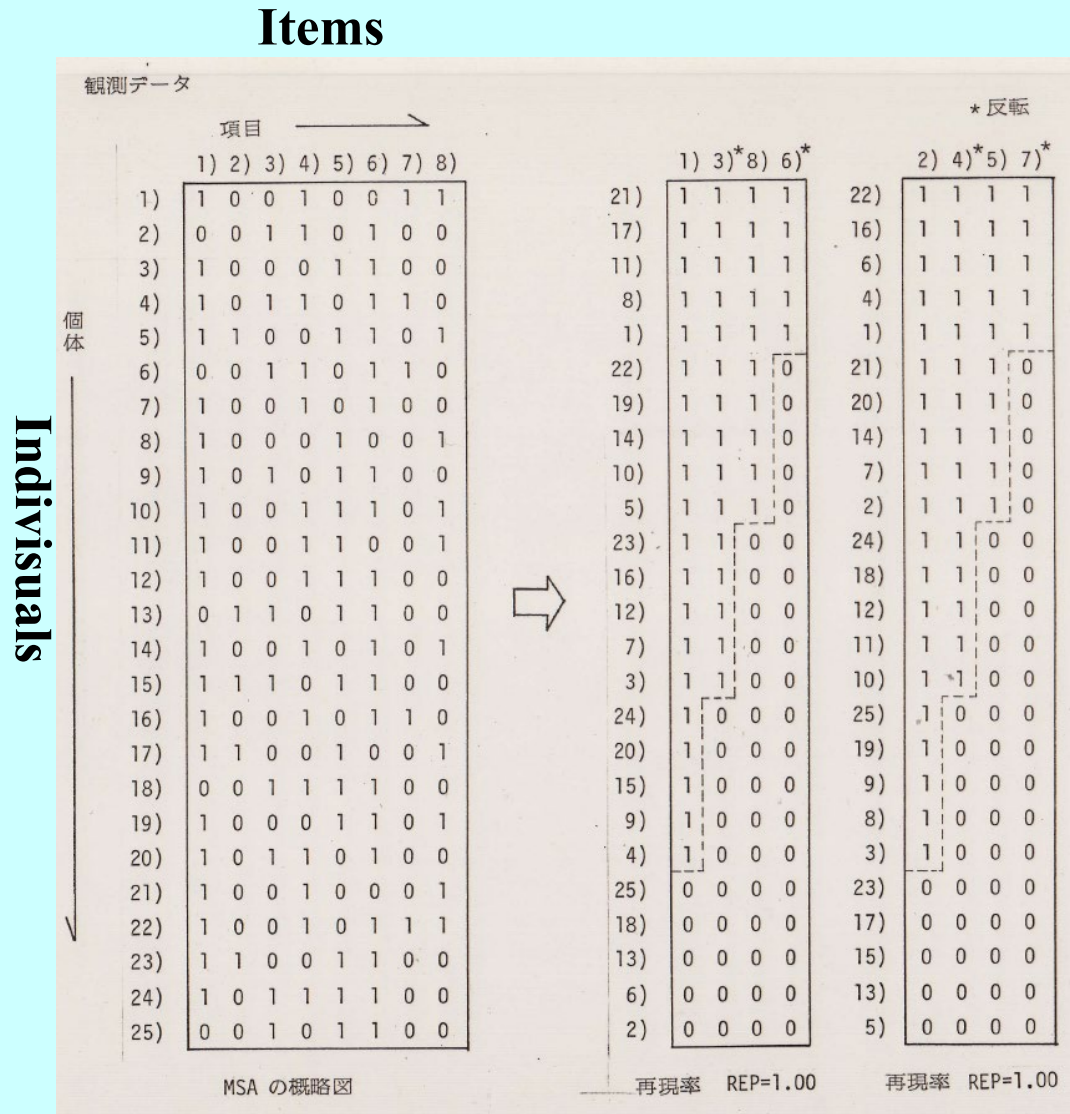
**Housewives were selected.**

**The collection rate was more than 80%.**

**Fifty environmental items were analyzed.**

# MSA (Multiple Scalogram analysis)

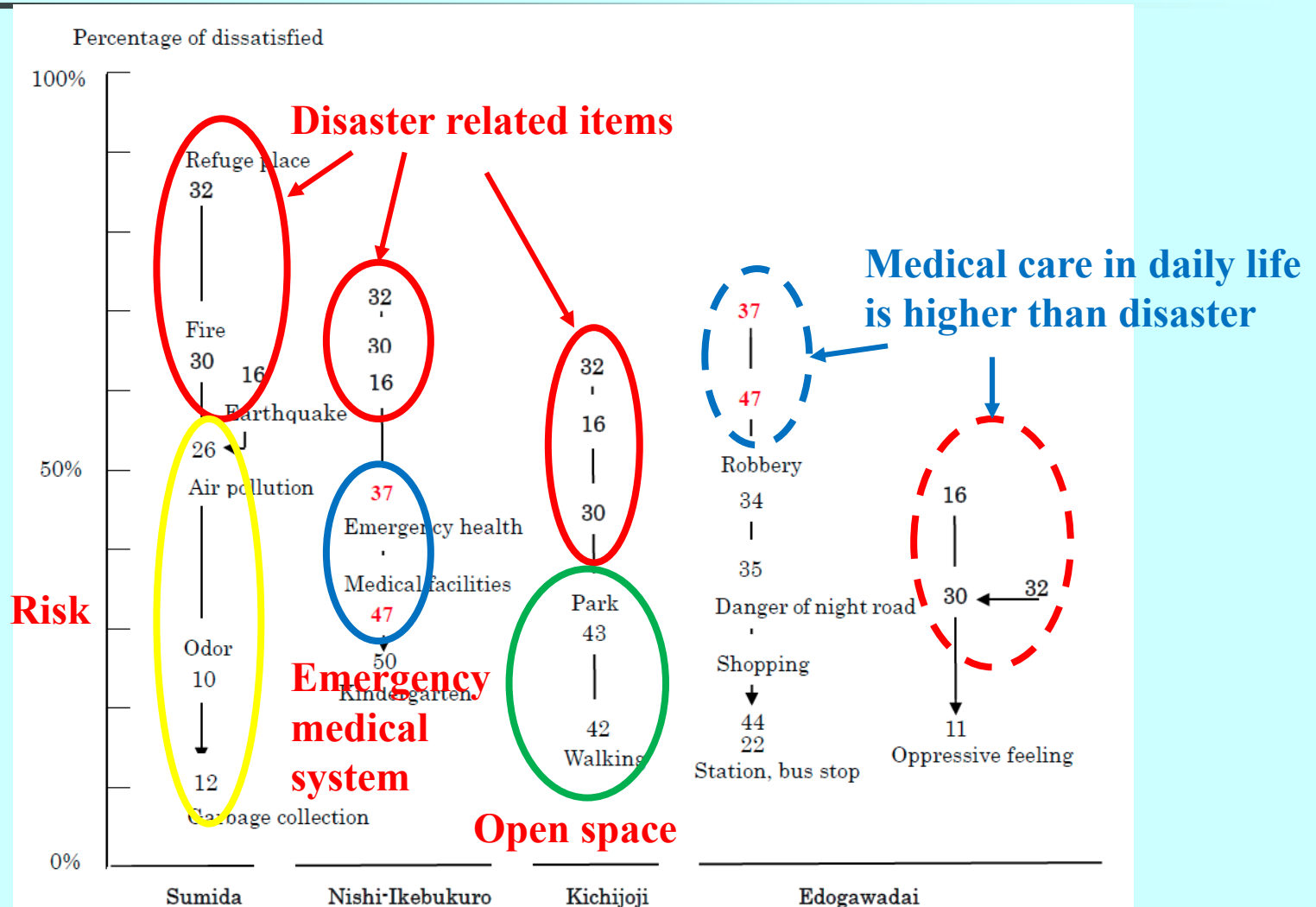
## Guttman scale



A chain structure of dissatisfaction was analyzed.

In the ideal state, if a lower rank item is 'yes,' all higher rank items must be 'yes,' and if a higher rank item is 'no,' all lower items must be 'no.'

# Chain structure of dissatisfaction





# Here,

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- 1) The human mind is not always one – dimensional;
- 2) Differences of terms are very important, because the human mind thinks of various things in words and language;
- 3) The human mind is not binary but somewhat fuzzy.



# Thermal sensation scale usually used

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暑い	+ 3	hot
暖かい	+ 2	warm
やや暖かい	+ 1	slightly warm
どちらでもない	0	neutral
やや涼しい	- 1	slightly cool
涼しい	- 2	cool
寒い	- 3	cold



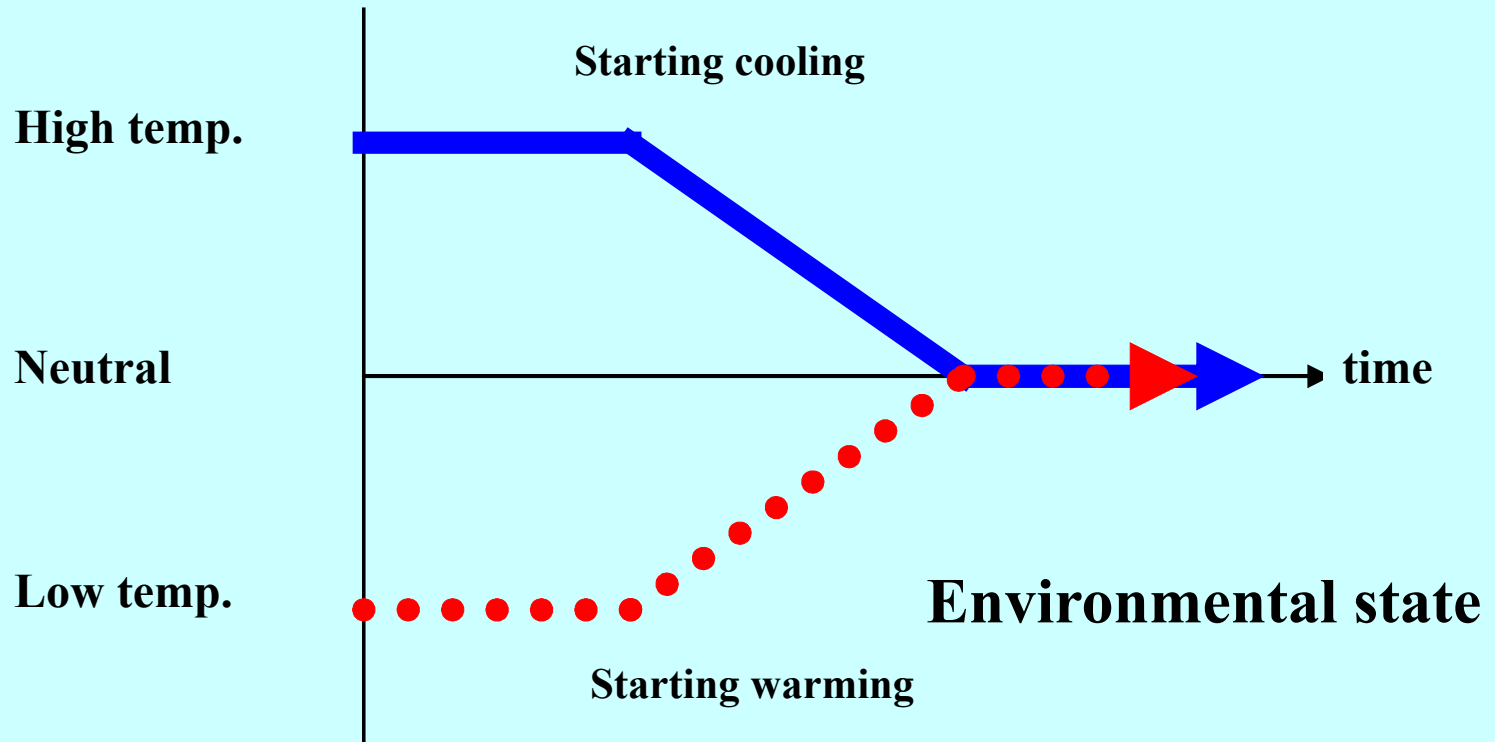


# The cases hard to explain by one-dimensional continuum

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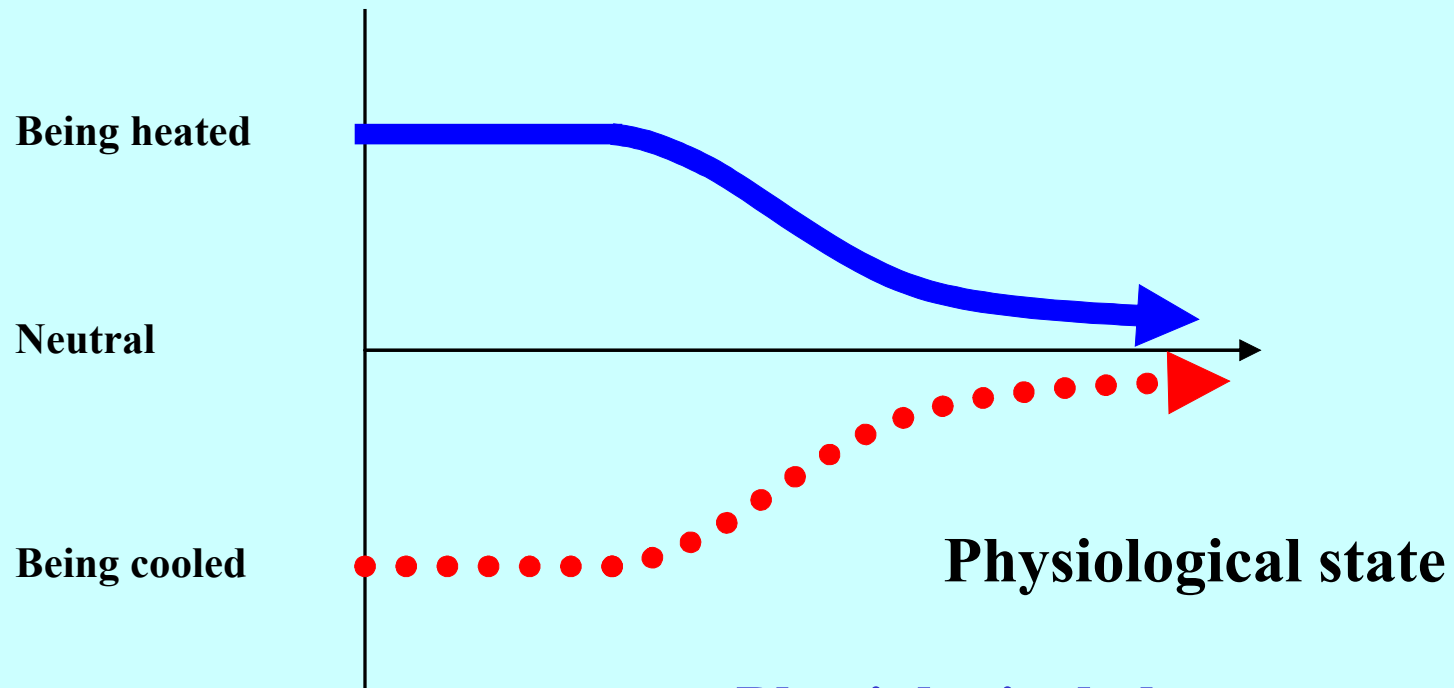
- **Imagine the case when we start cooling in summer because the room temperature is high.**
- **Similarly, imagine the case when we start warming in winter because the room temperature is low.**

# Variation of environmental state



**Consider the values of clo and met are the same in the both cases, here.**

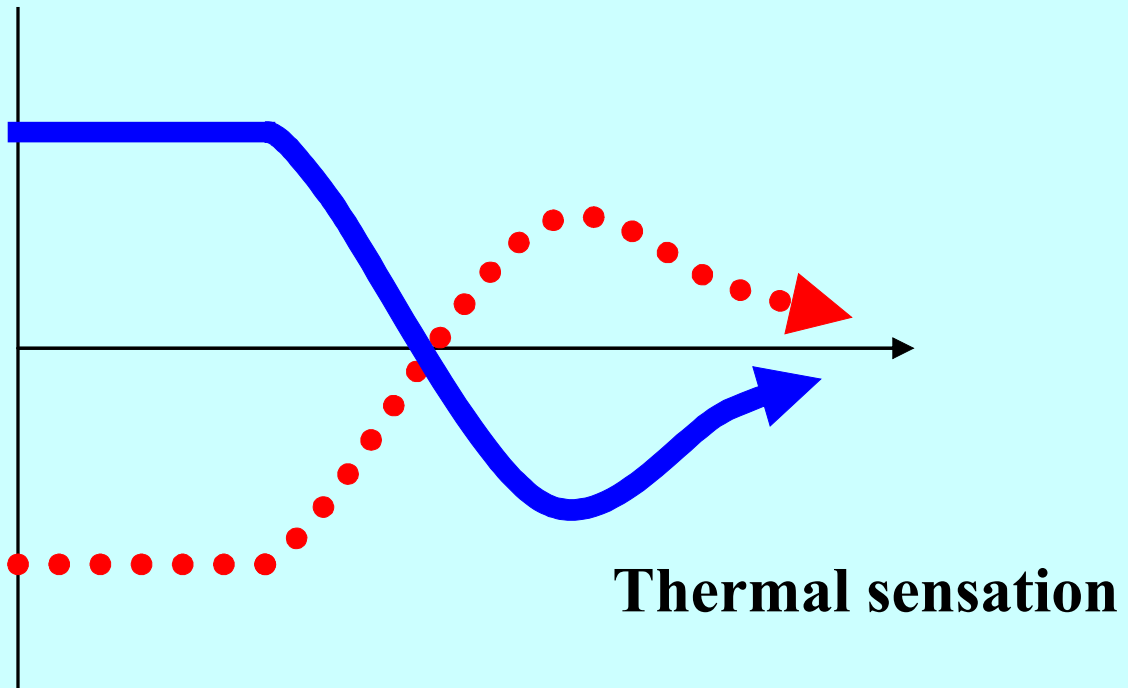
# How does physiological state change?



**Physiological change  
delays against ambient  
change**

# How does thermal sensation change?

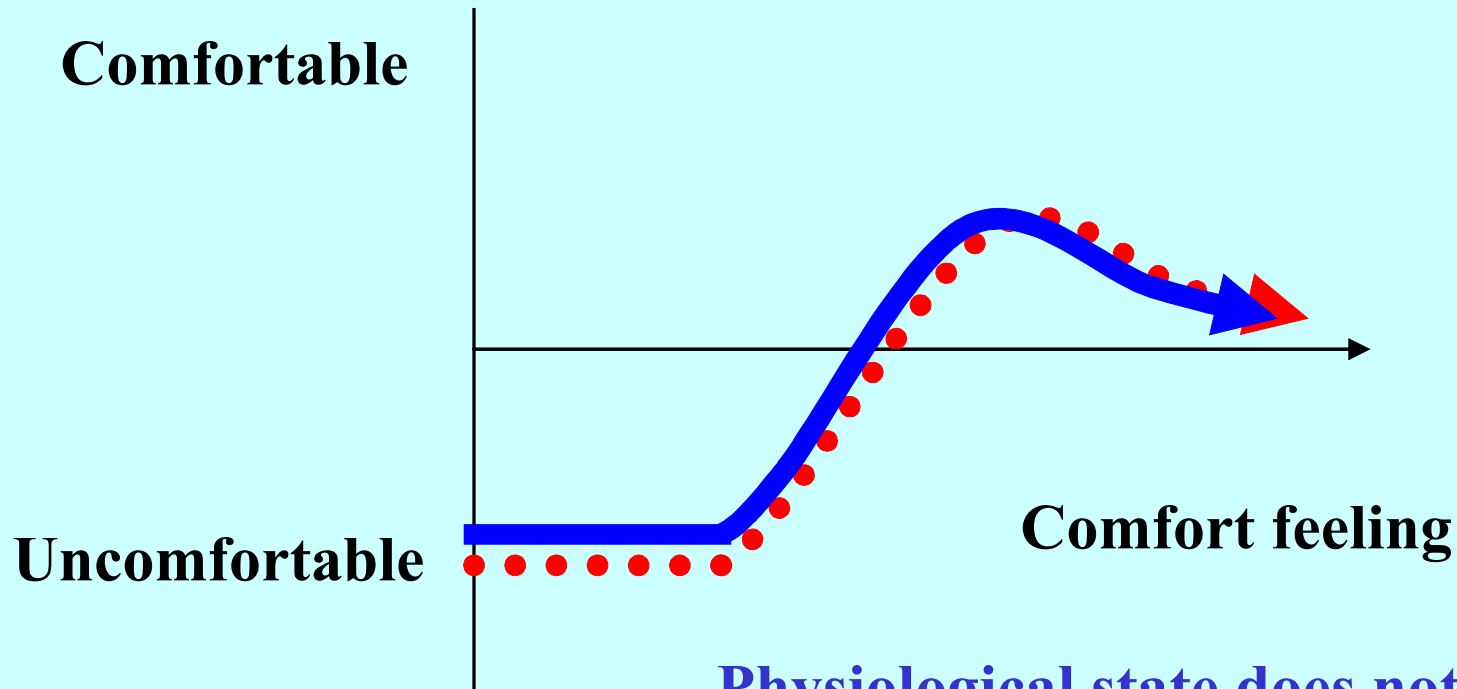
Hot  
Warm  
S. warm  
Neutral  
S. Cool  
Cool  
Cold



Evaluation reverses

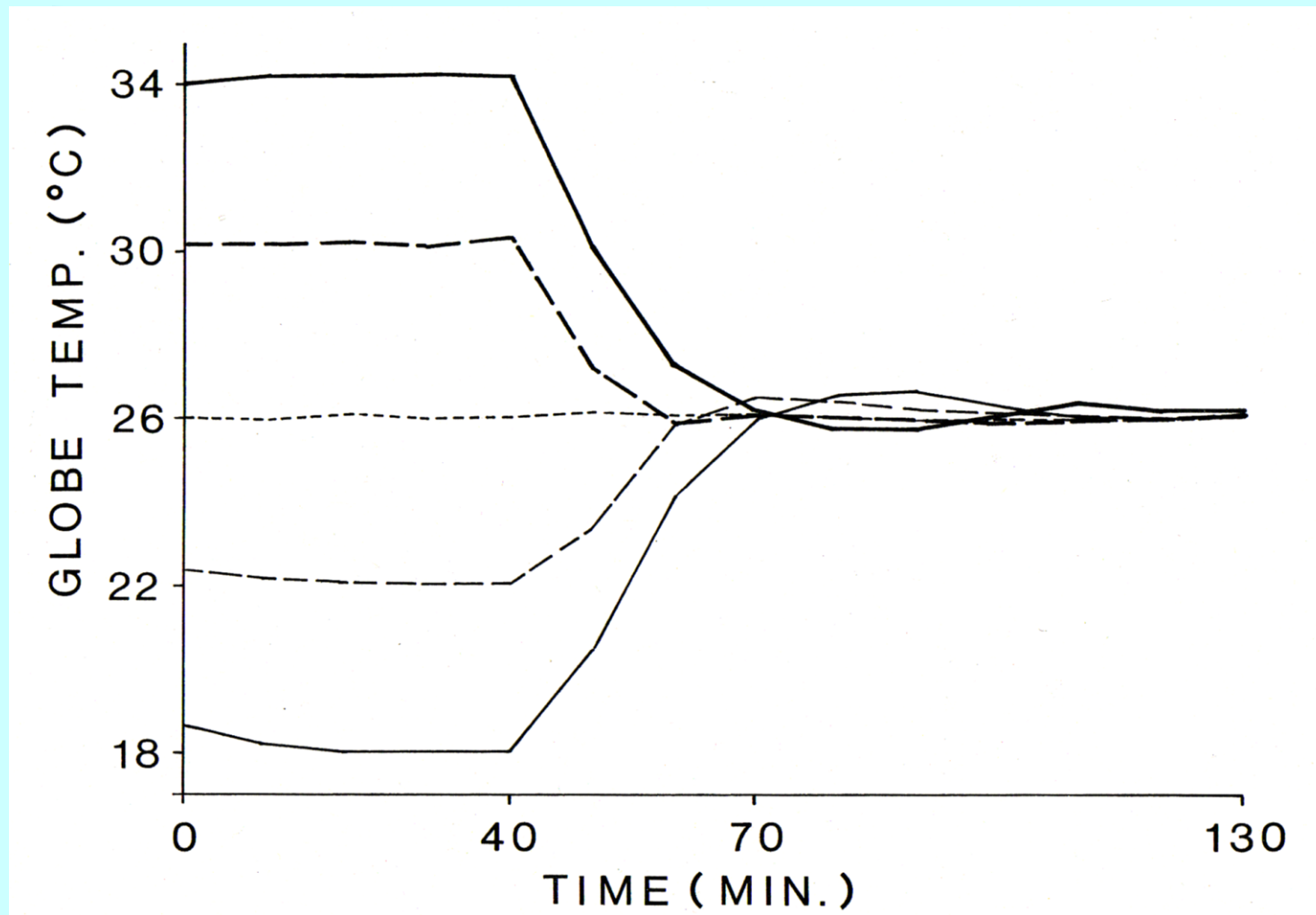


# Comfortable? Uncomfortable?

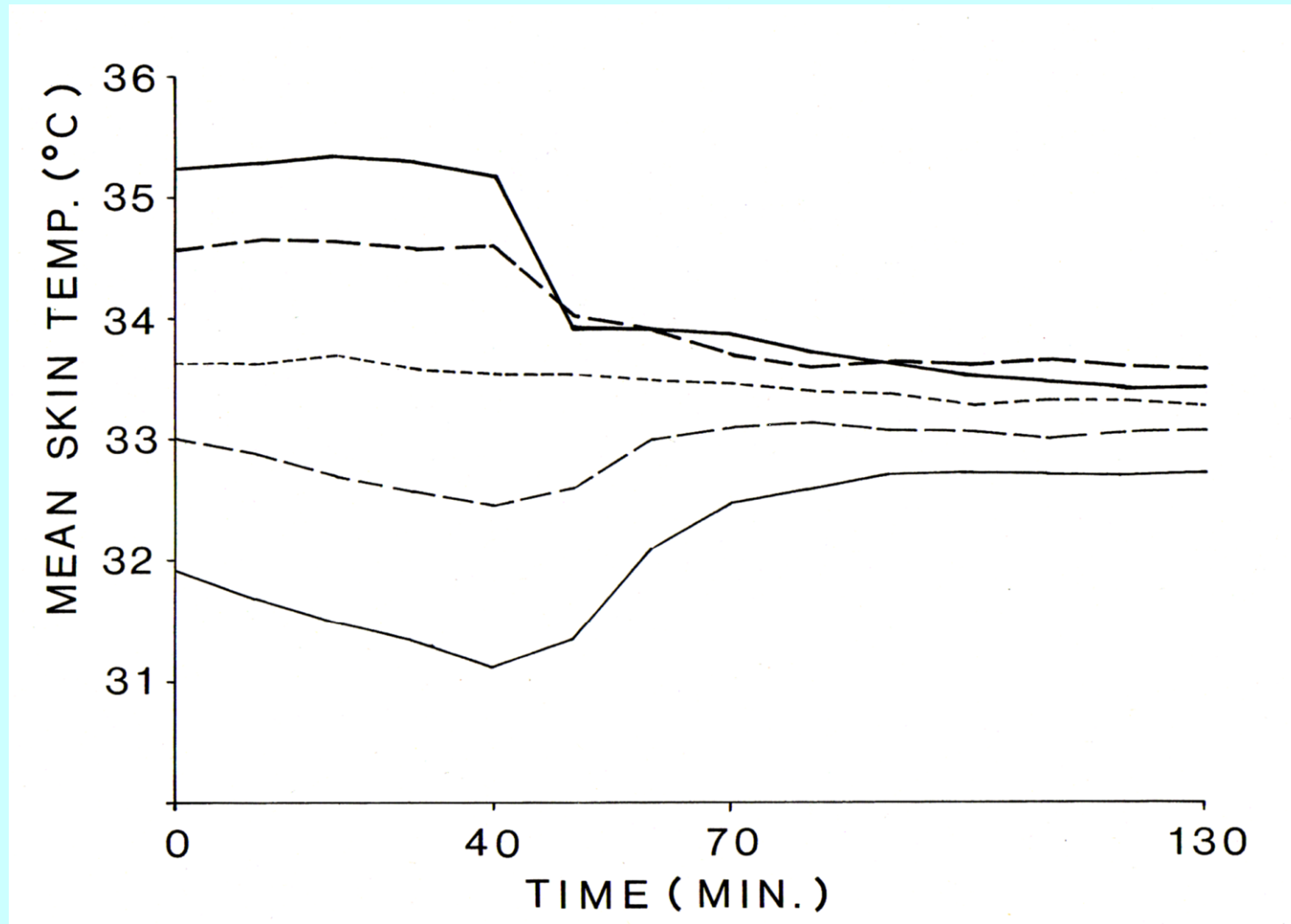


Physiological state does not recover, but comfortable state occurs, and then comfort feeling decreases.

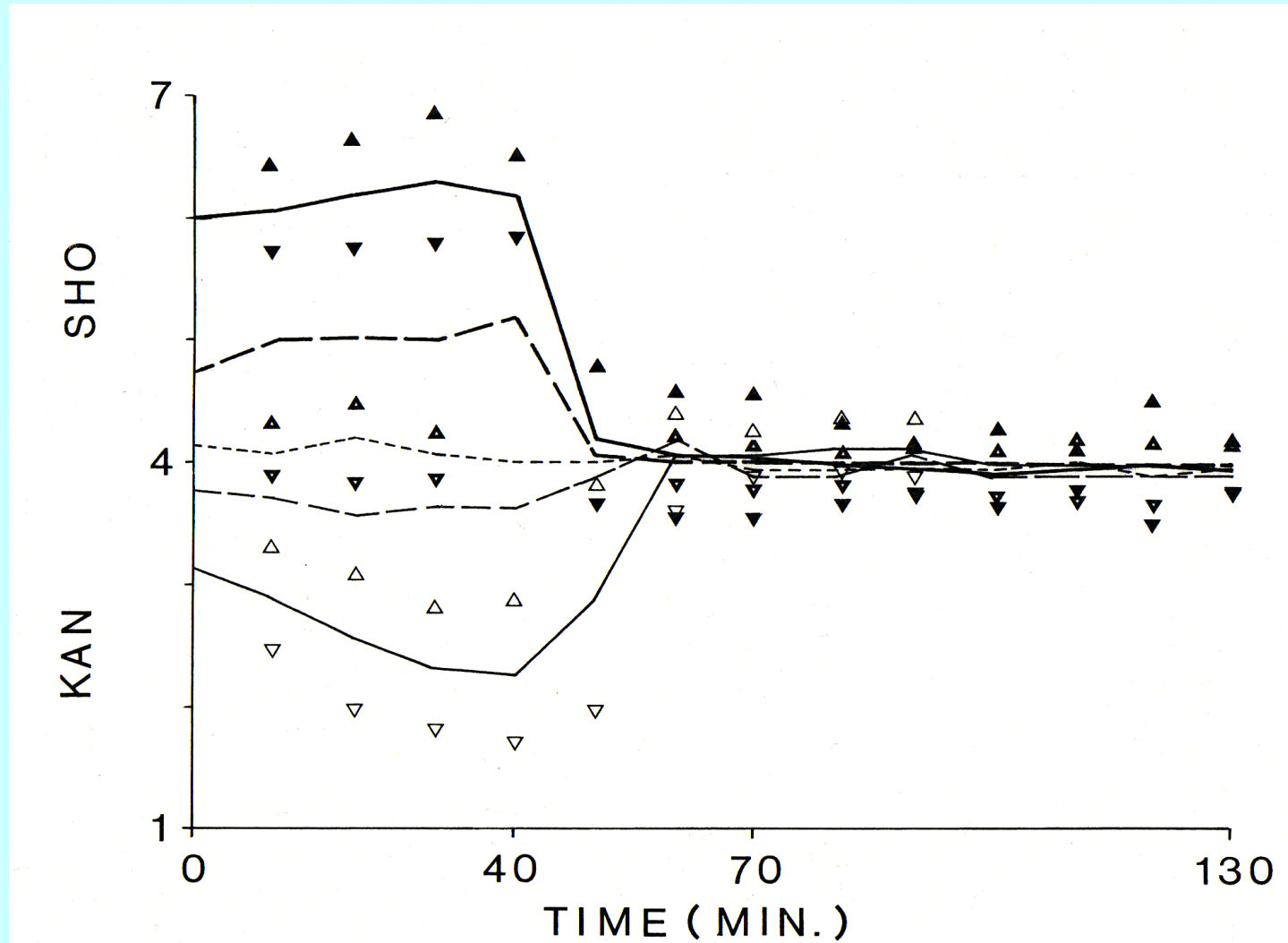
# Experimental results: Globe Temperature (Kuno, 1987)



# Mean skin temperature

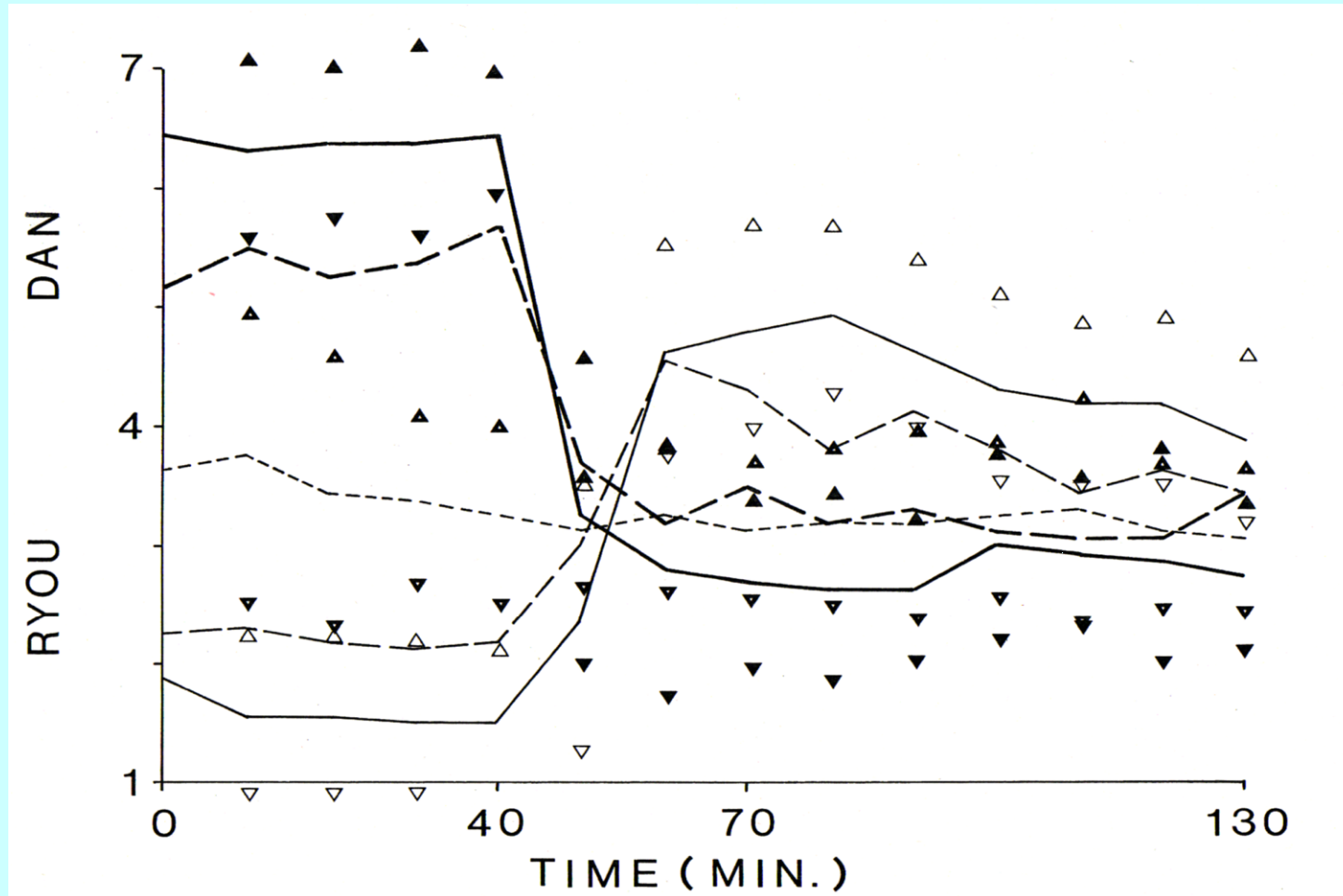


# Kan-Sho (Cold-Hot) sensation

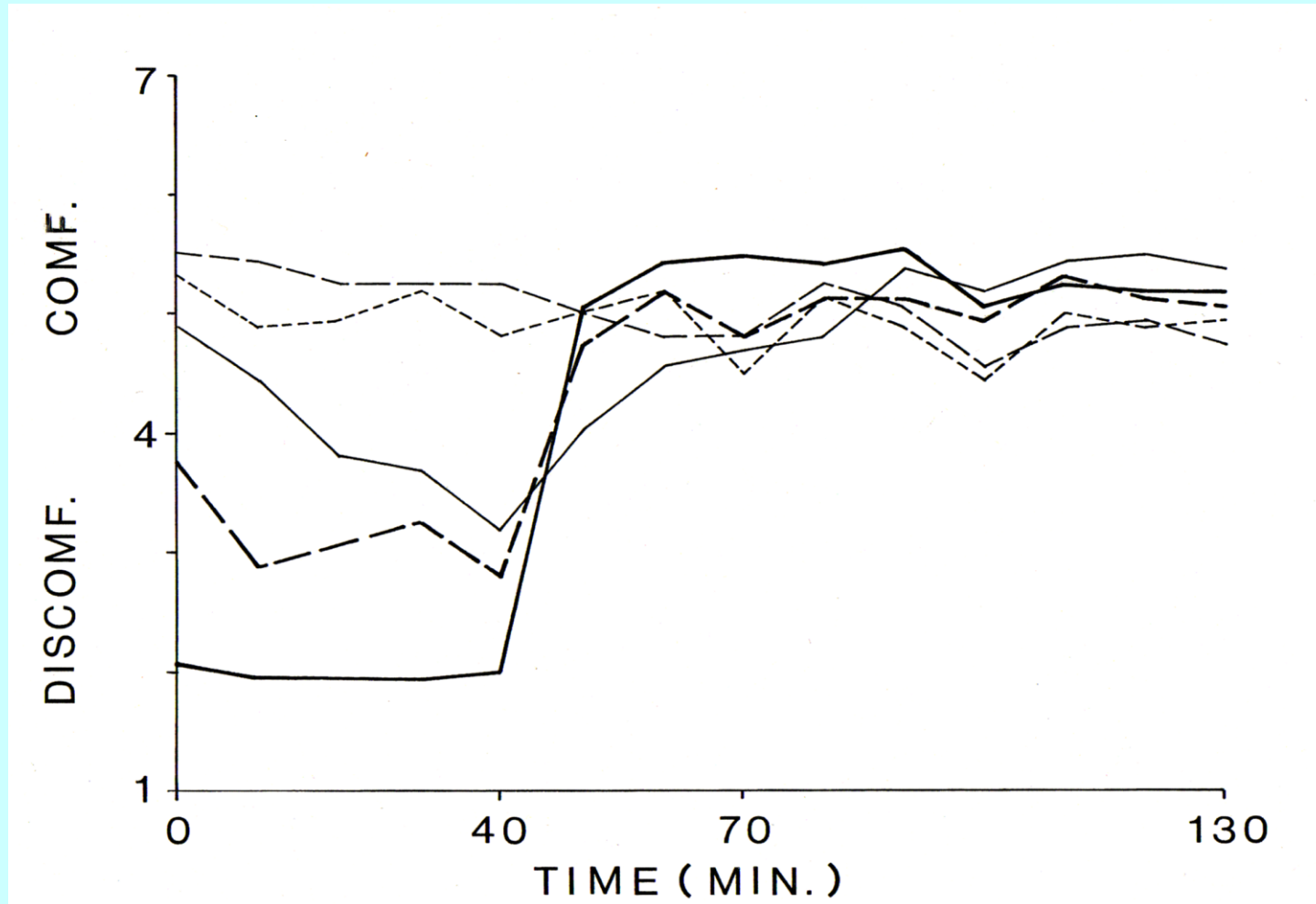


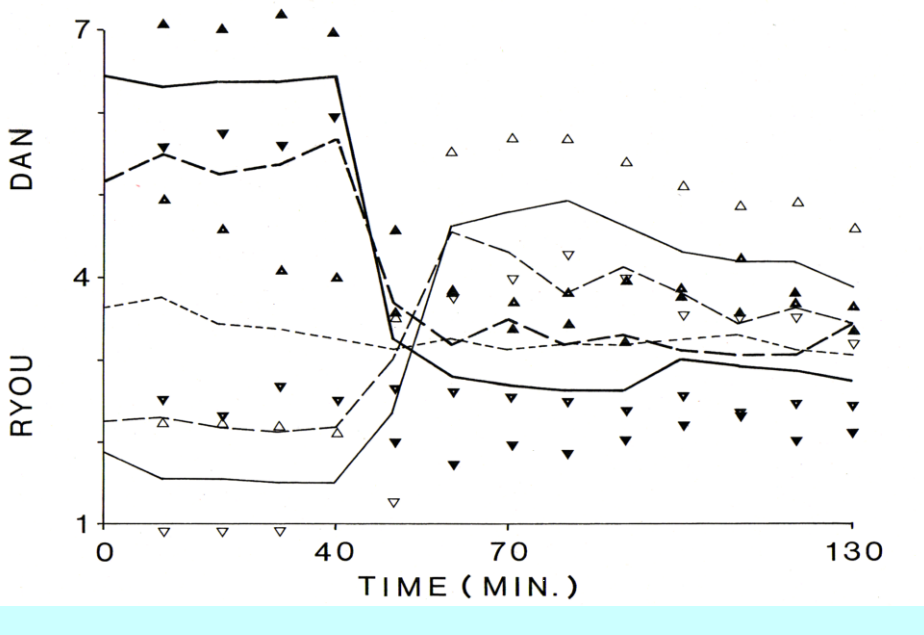
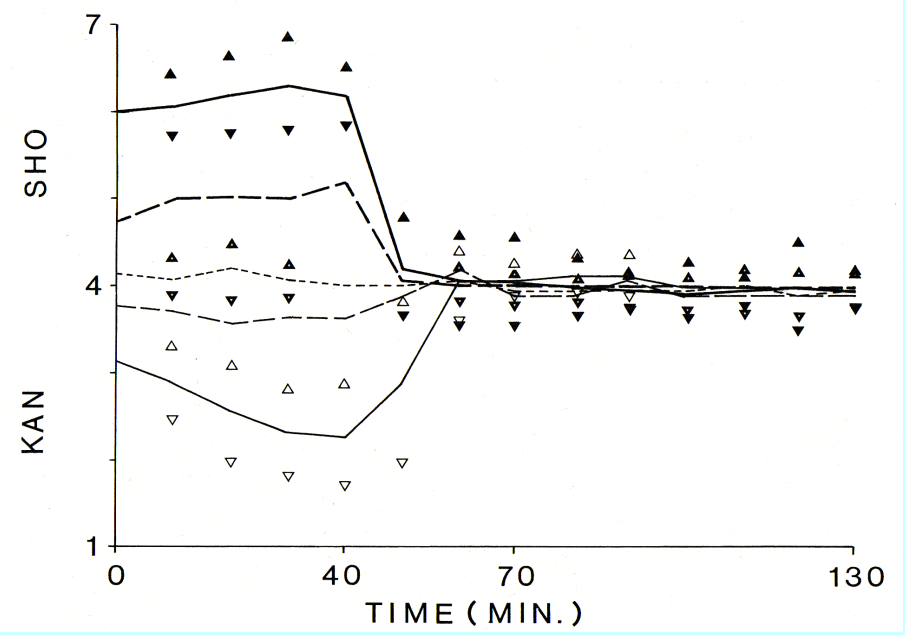
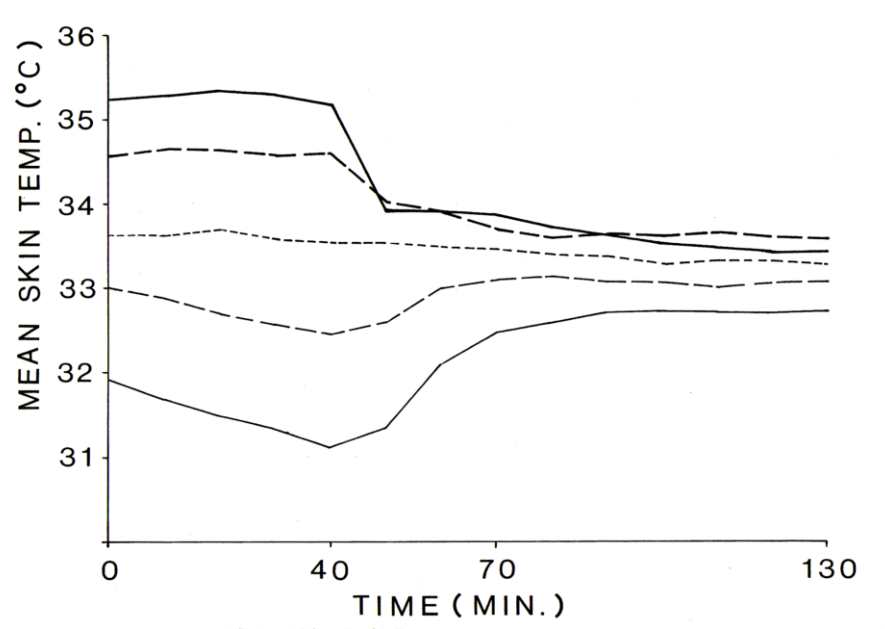
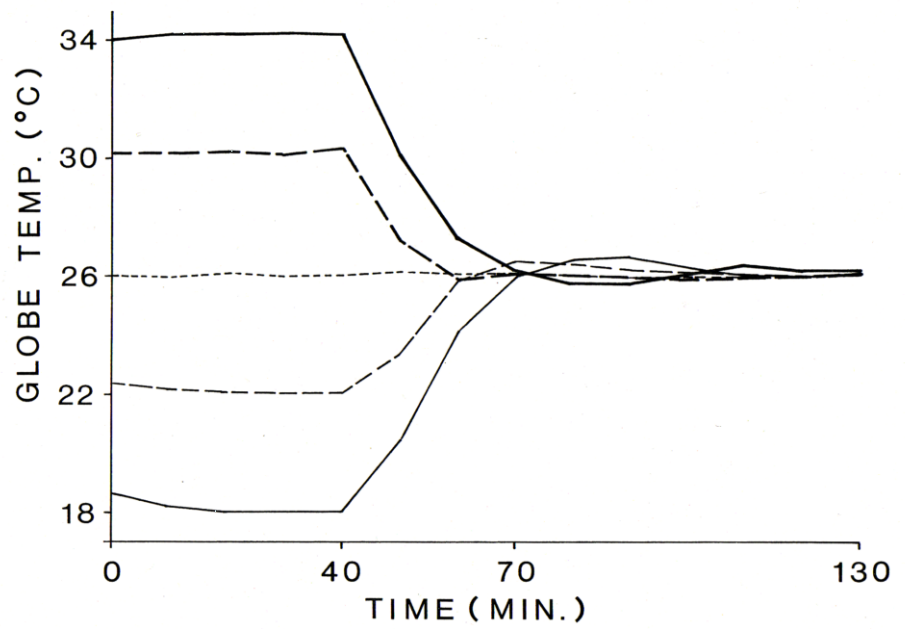


# Ryo-Dan (Cool-Warm) sensation

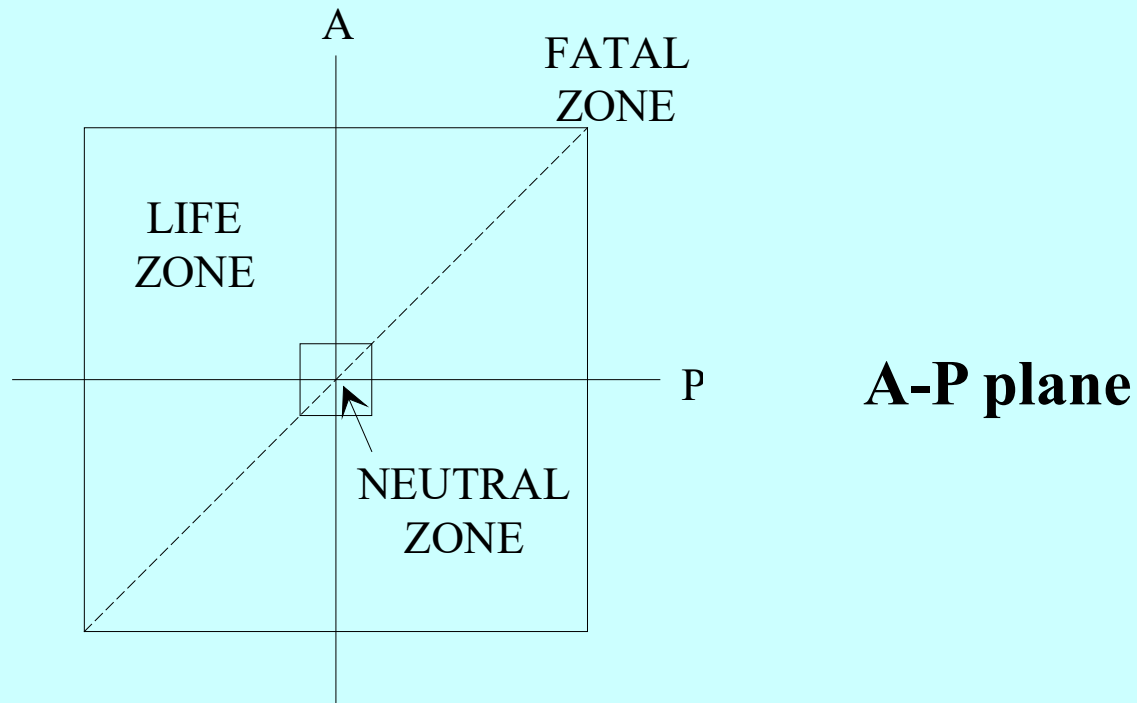


# Comfort feeling



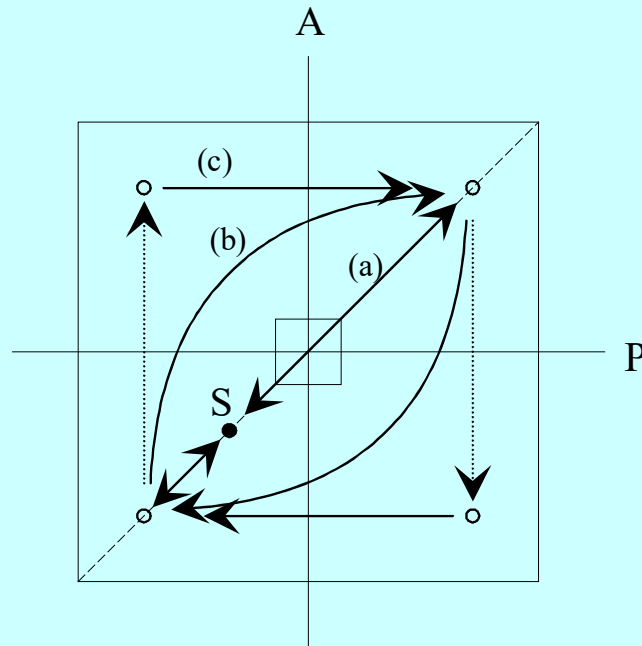


# Two-dimensional Thermal Sensation Model (Kuno, 1987)



A: Ambient condition  
P: Physiological condition  
The dashed line indicates steady state.

# Variation of ambient and physiological states



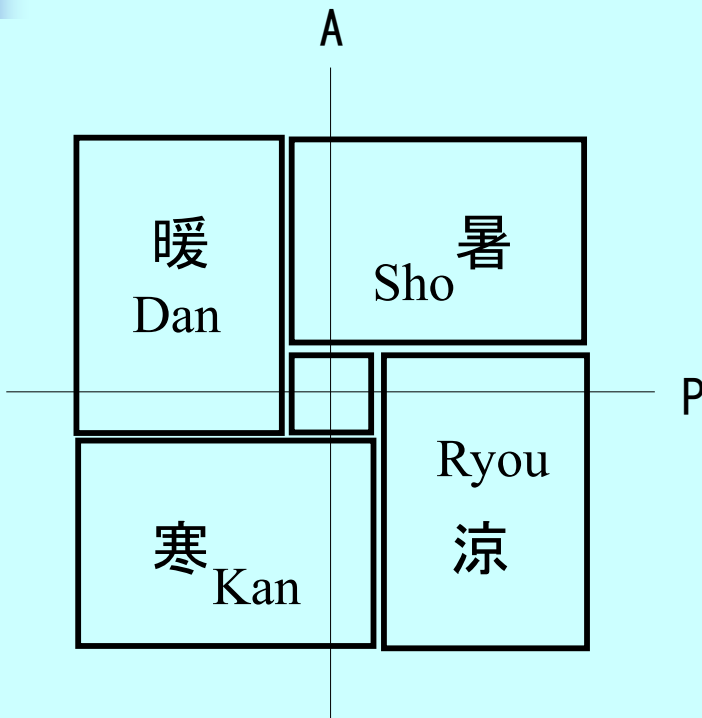
The point S represents certain ambient and physiological conditions.

(a): Very slow change

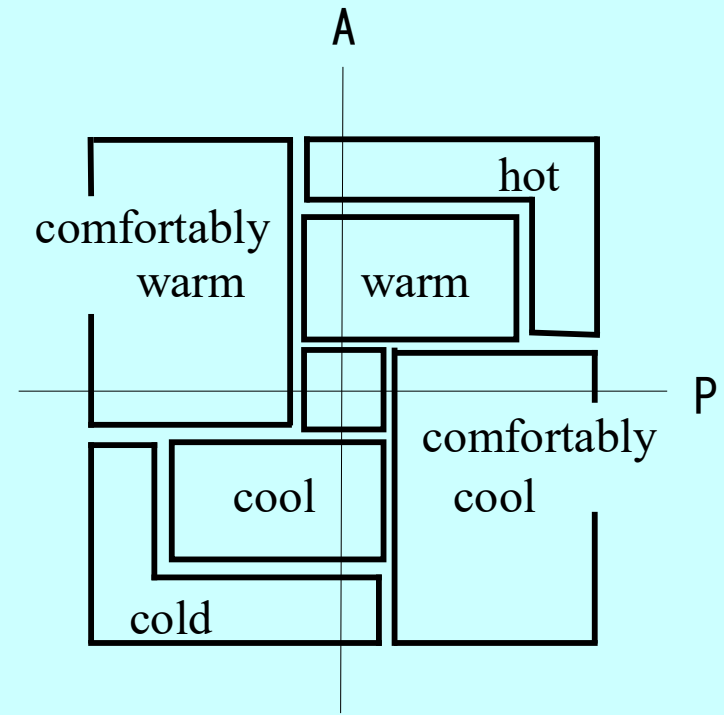
(b): Quick change

(c): Discontinuous change

# Language: L plane



**Japanese**

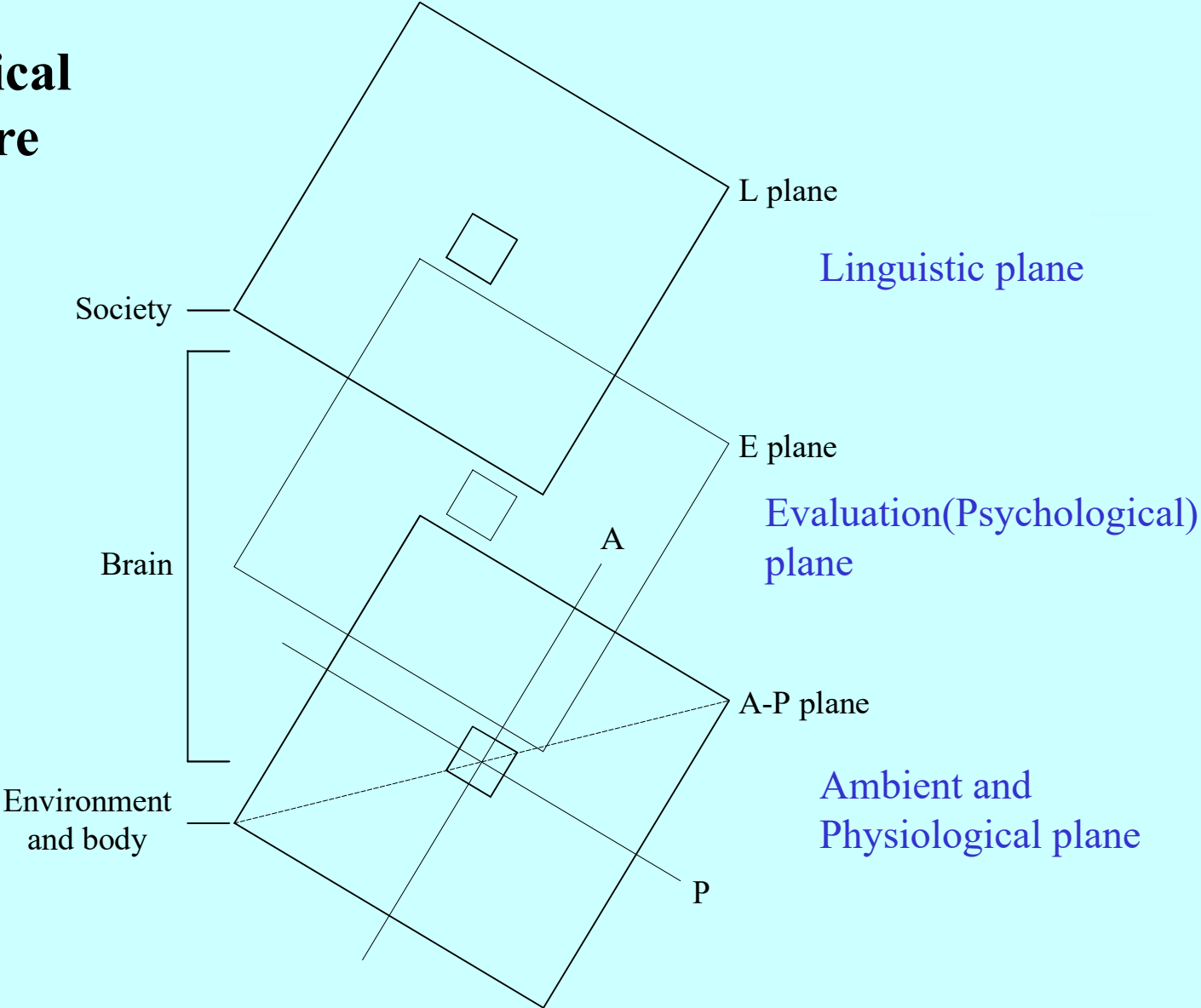


**American English**

**Chinese and Korean students in Nagoya University said their languages were the same as Japanese.**



# Psychological architecture





# Positive and negative thermal pleasure

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- Psychological state ‘lead to’ or ‘is anticipatory to’ physiological state in thermal transients.  
(anticipation: Gagge, 1967)  
**However, it is a seeming phenomenon.**  
**(Kuno, 1987)**
- Positive/negative thermal pleasure  
(McIntyre, 1980)



## Two kinds of thermal comfort:

### ■ Pleasant zone

Positive pleasure 「快」

Pleasantness

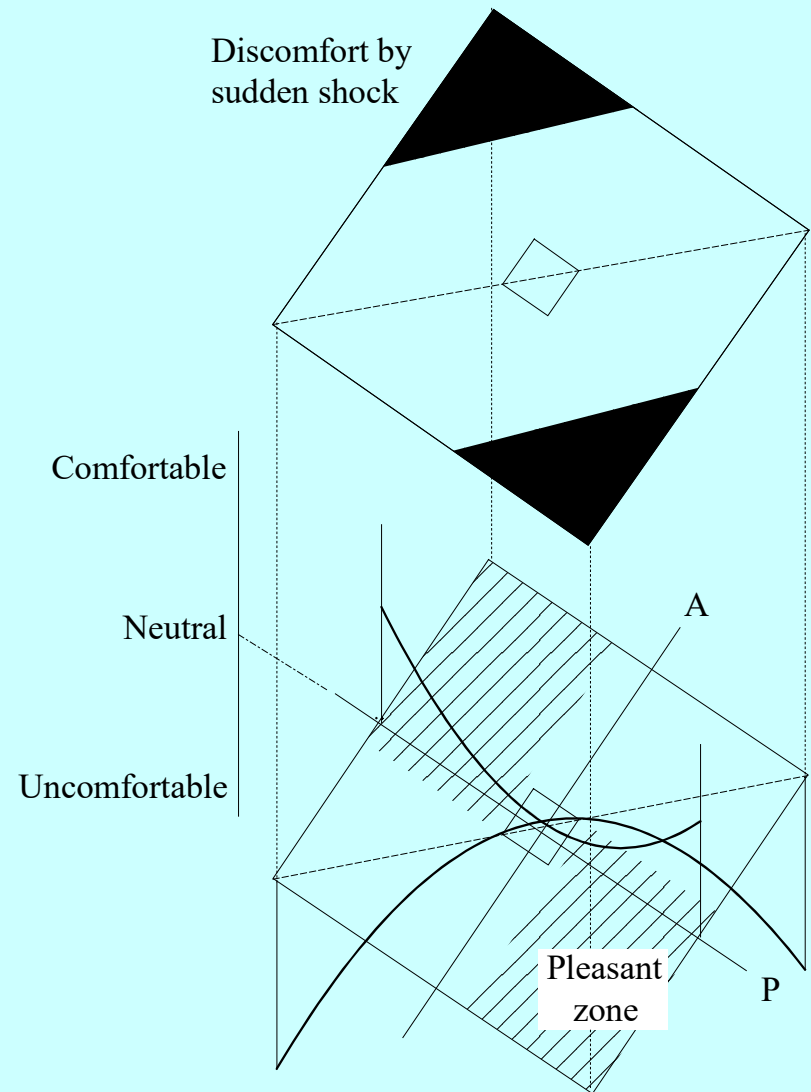
### ■ Neutral zone

Negative pleasure 「適」

No discomfort

and

### ■ Discomfort by sudden shock





# Well, what is comfort?

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- 「快」 : pleasantness/positive pleasure
- 「適」 : neutrality/negative pleasure
  
- Combining the both, 「快適」 : comfort
  
- Because positive pleasure is special, however, there are many cases where only negative pleasure is called comfort.



## **Pleasantness on thermal environment: 3 points**

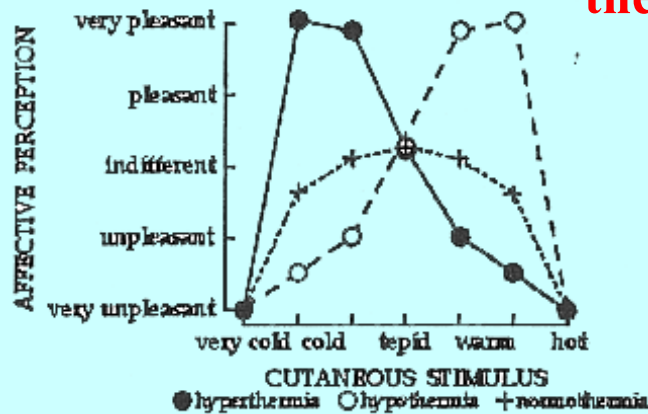
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- **It occurs when discomfort disappears;**
- **It does not continue for a long time; and**
- **It may accompany sudden shock.**

# Cabanac's pleasantness (joy; 1996)

The body temperature was controlled by bathing, and a hand was immersed in a washbowl.

Neutral temp of a hand does not affect whole thermal feeling, because its area is small.



(Chatonnet & Cabanac, 1965)

**Hyperthermia:** 高温状態  
**Normothermia:** 中温状態  
**Hypothermia:** 低温状態

		STIMULUS		
		cold	neutral	warm
INTERNAL STATE	hypothermia	U	I	P
	normothermia	U	I	U
	hyperthermia	P	I	U

(Cabanac, 1981)

**P:** pleasant  
**I:** indifferent  
**U:** unpleasant



## Private letter from Cabanac (23 IX 1996)

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.....

**Obviously we have followed parallel paths. Like the Indian blind wise men, we are studying the same elephant, you, from the environmental point of view, and I from the introspective point of view.**

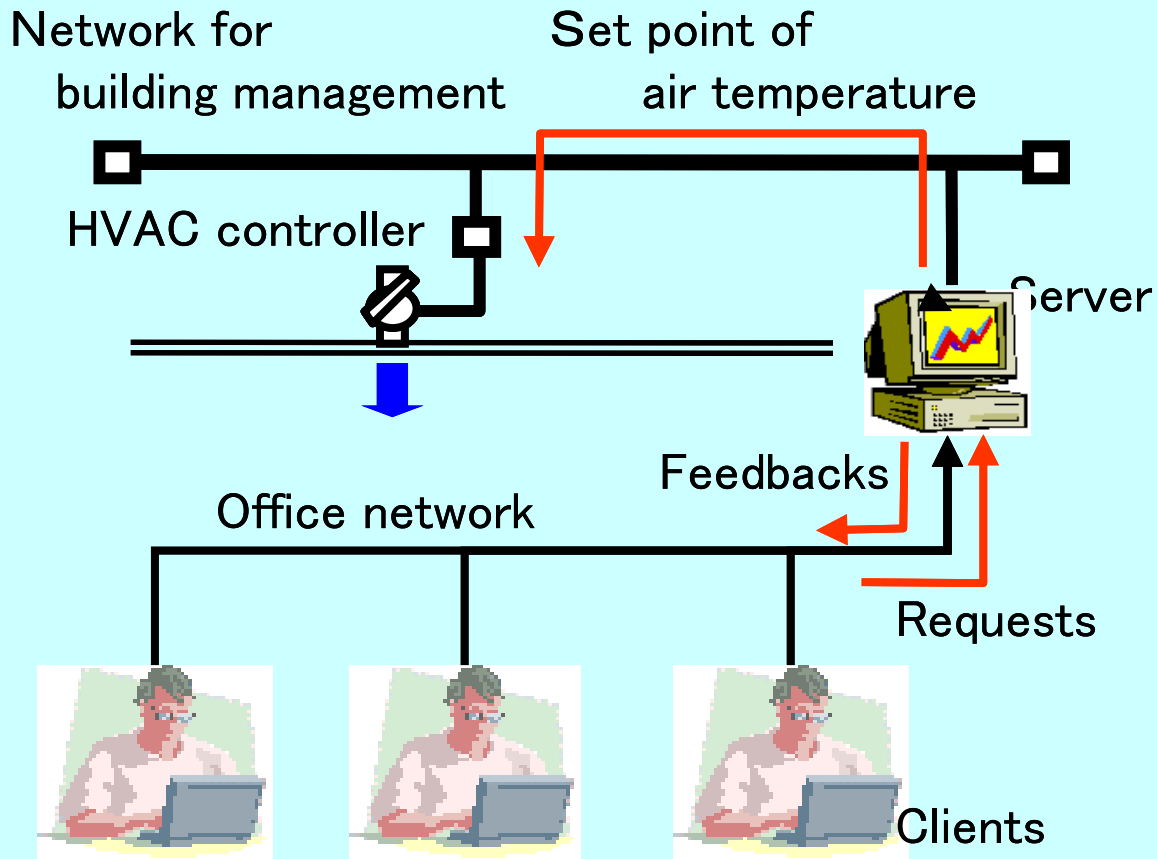
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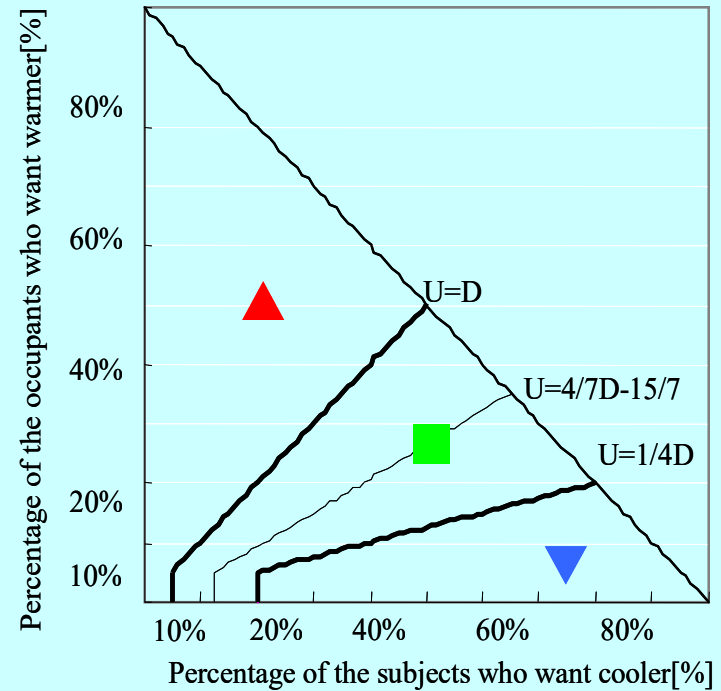
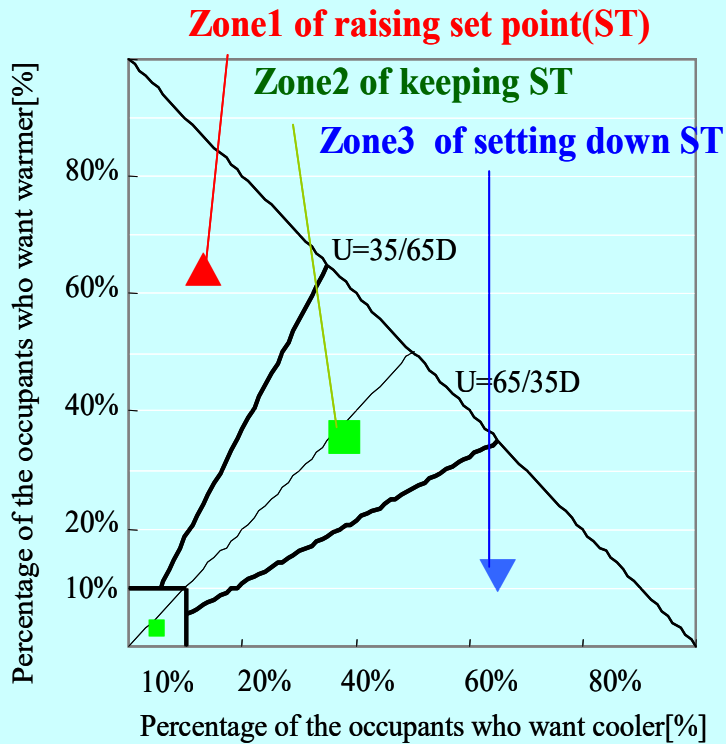
**... because you are the only person I have met in my (now long) career who has originally recognized the necessity to think of comfort in several dimensions and thus, has followed a path similar to mine.**

**Very sincerely yours,**

# Determining the set temperature by occupants' voting



# Comfort mode and Energy saving mode





# Experimental result

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- No particular complaints were made during each experiment, but occupants' impressions after all the experiments were not so favorable toward the energy-saving mode.
- Moreover, the higher the outside air temperature was, the more dissatisfied the occupants felt



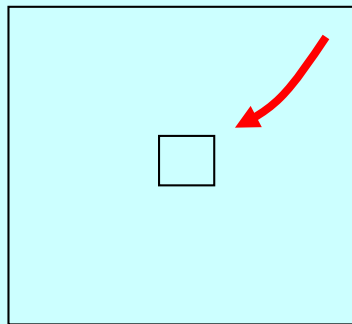


# So, a 'cool room' is needed.

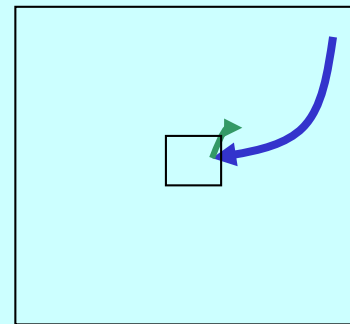
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- It is needed to prepare 'cool room.'
- People enter this room first to eliminate their thermal strain, and then begin to work in their own office space.

**not**

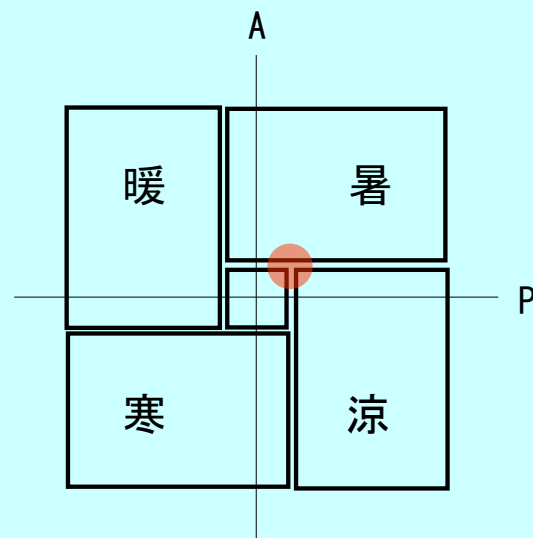


**but**

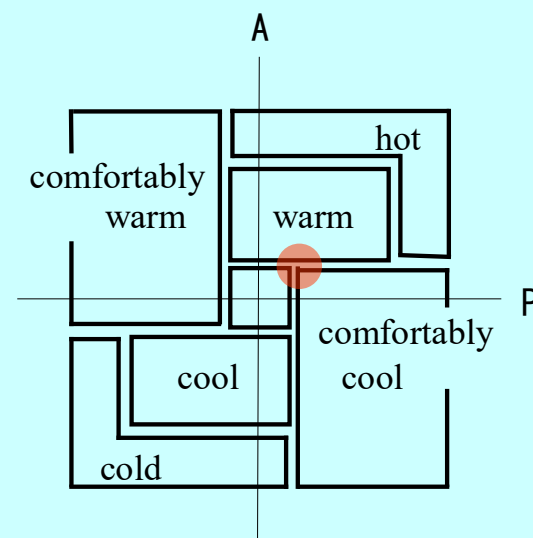


## The border between neutral and warm

- I expressed the borders as fuzzy zones.
- The border between neutral and warm has two aspects.



日本語



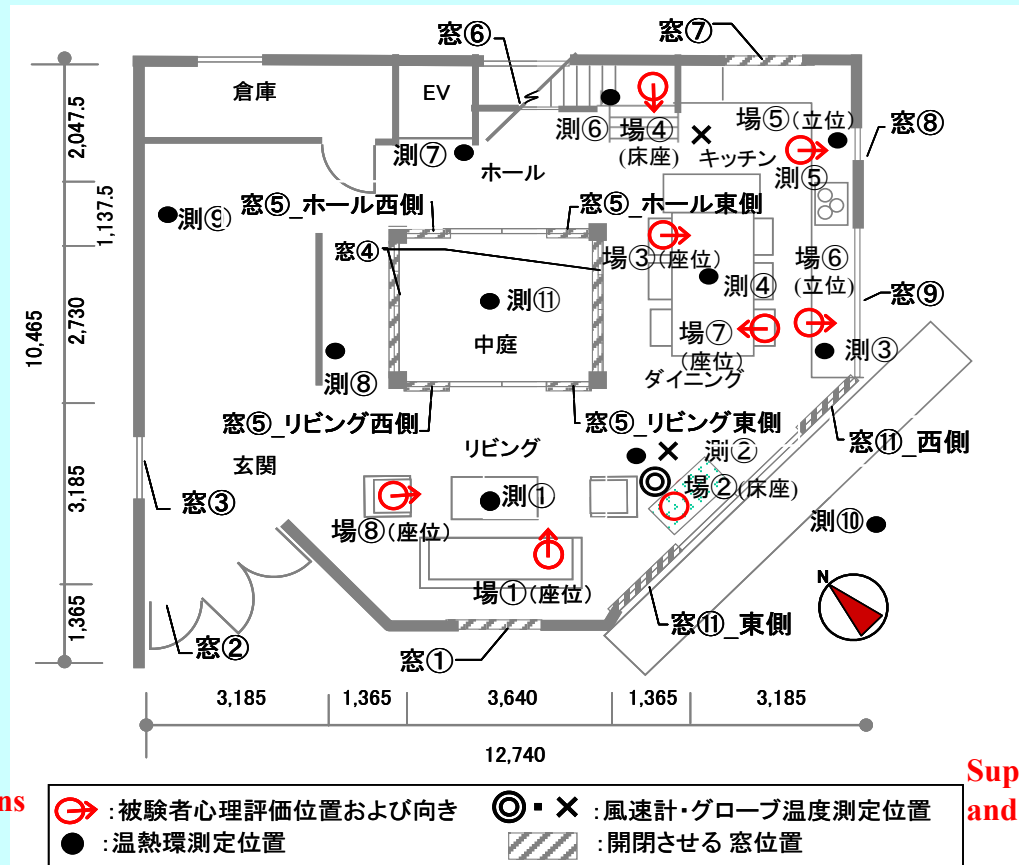
英語

# Natural ventilation in housing (Ko, 2009)

- Model house, Tokyo Electric Power, Urayasu



# Plan



Subject's positions

Measuring positions of thermal environment

Windows to be opened or shut

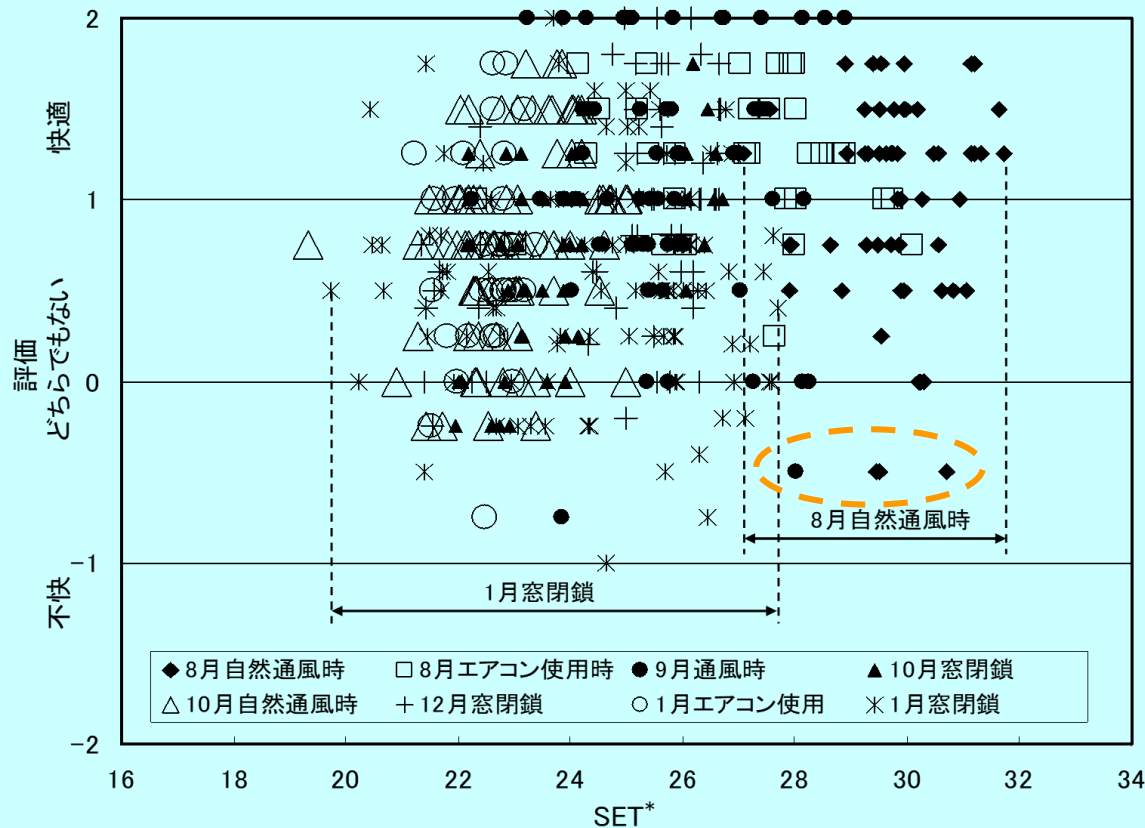
Super sonic anemometer ⊙ and globe temp ×

# SET\* and comfort feeling during 4 seasons

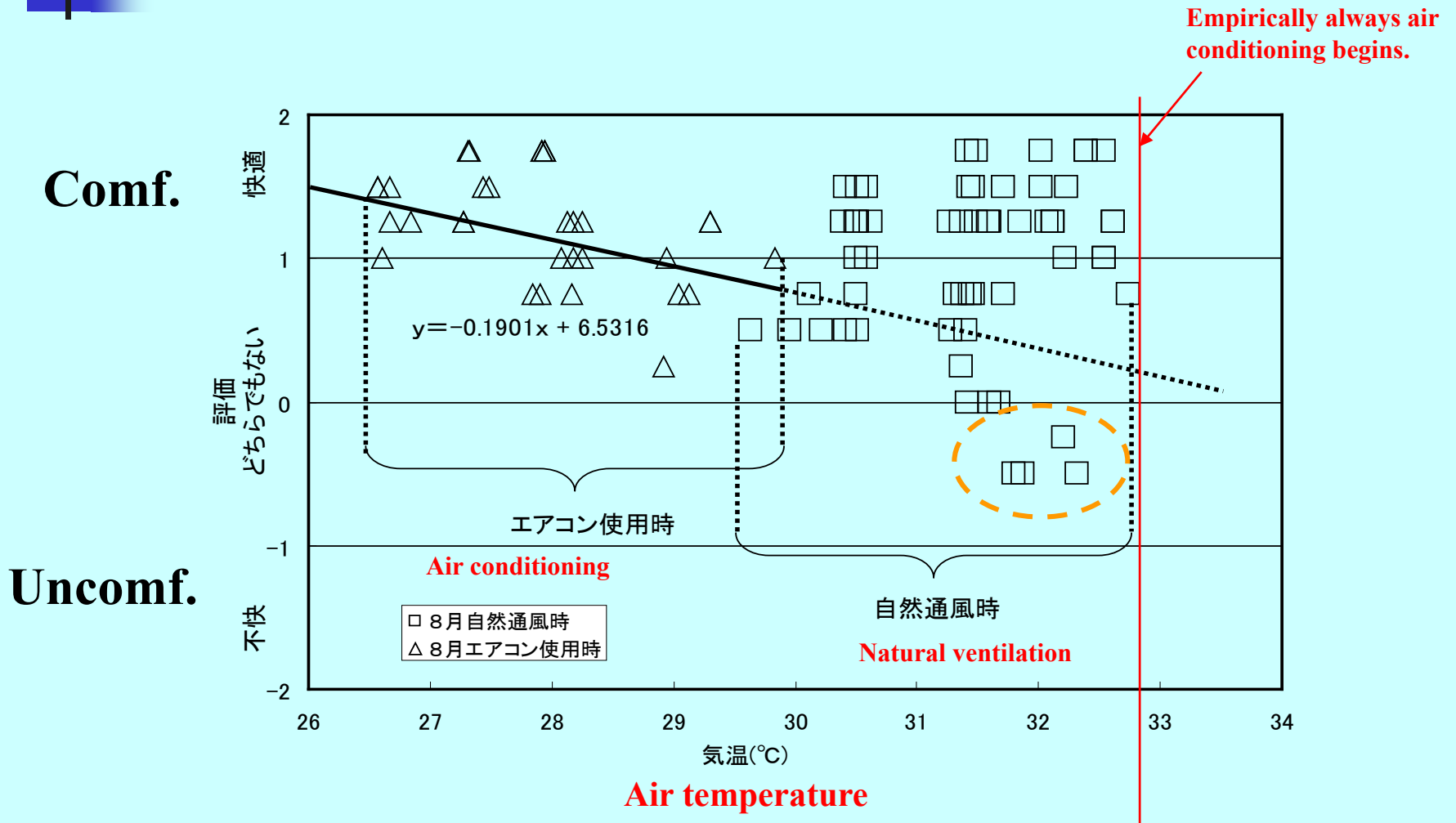
Comf.

Comfort feeling

Uncomf.



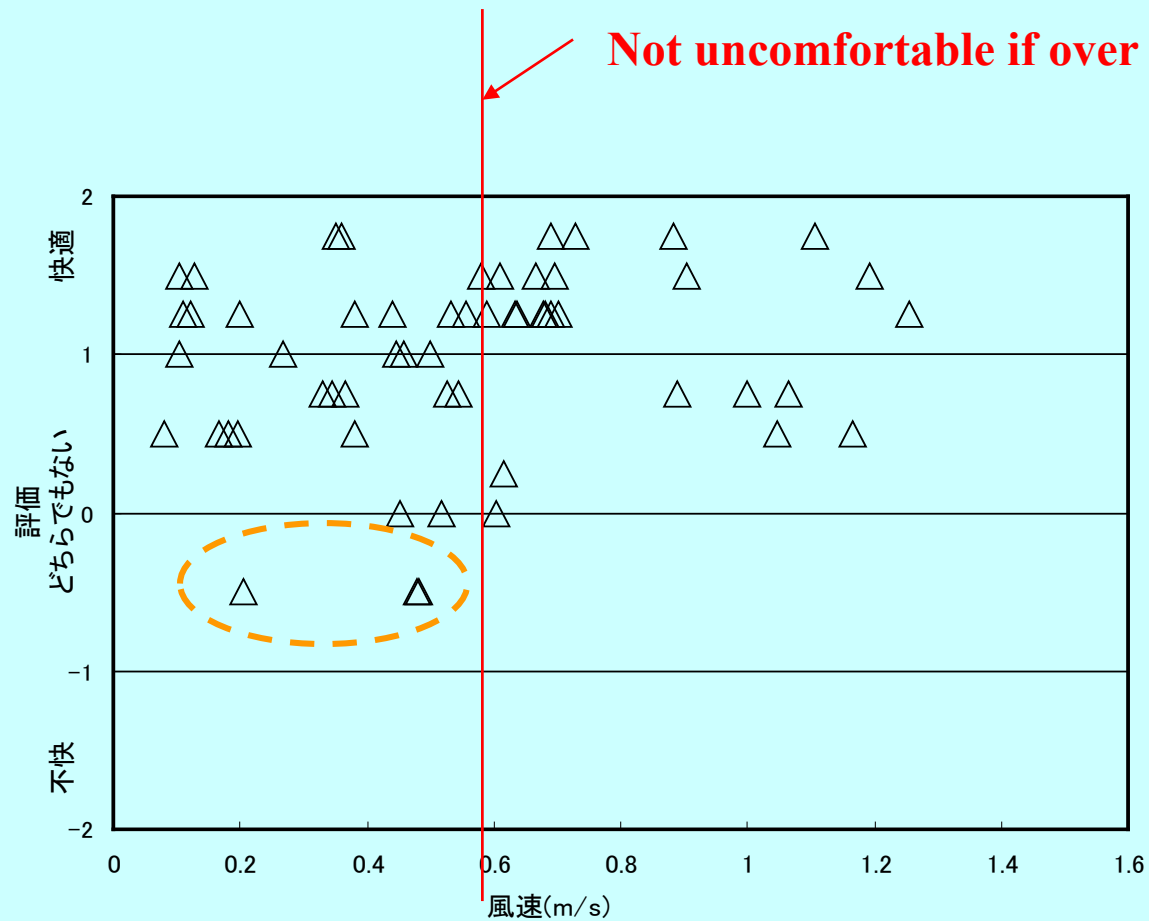
# SET\* and comfort feeling in summer



# Air velocity and comfort feeling in summer

Comf.

Uncomf.



Air velocity

# Other model houses

- We continued experiments.
- **Results were the same.**
- We thought it was a psychological effect.
- However.....



(a) Toyota



(b) Tokai



# Measurement of skin temperatures

- measured mean skin temperatures were lower than those calculated by the two-node model (Saito et al., 2014). **So, next.....**

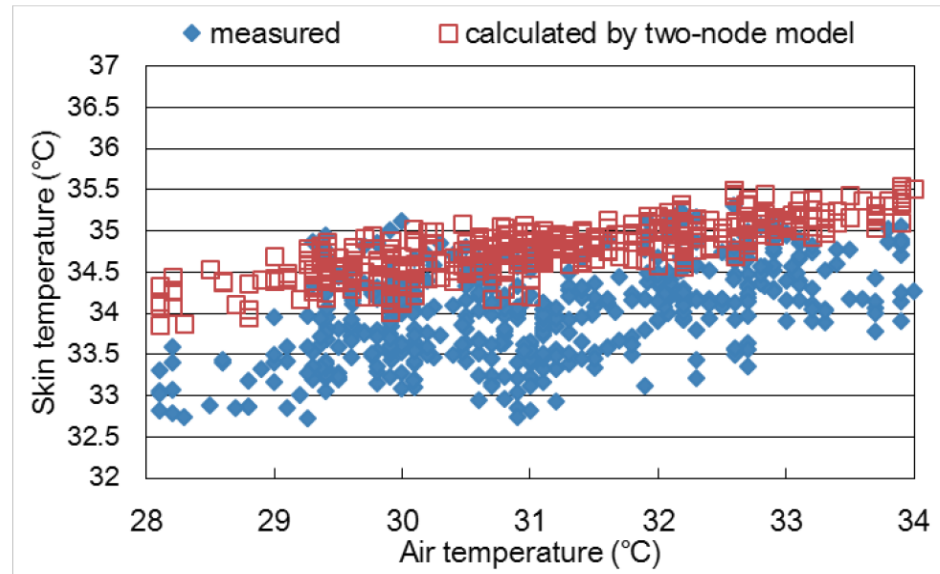
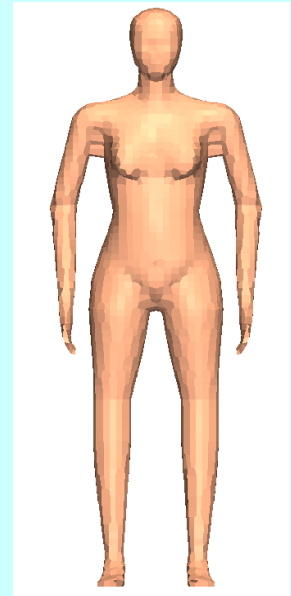
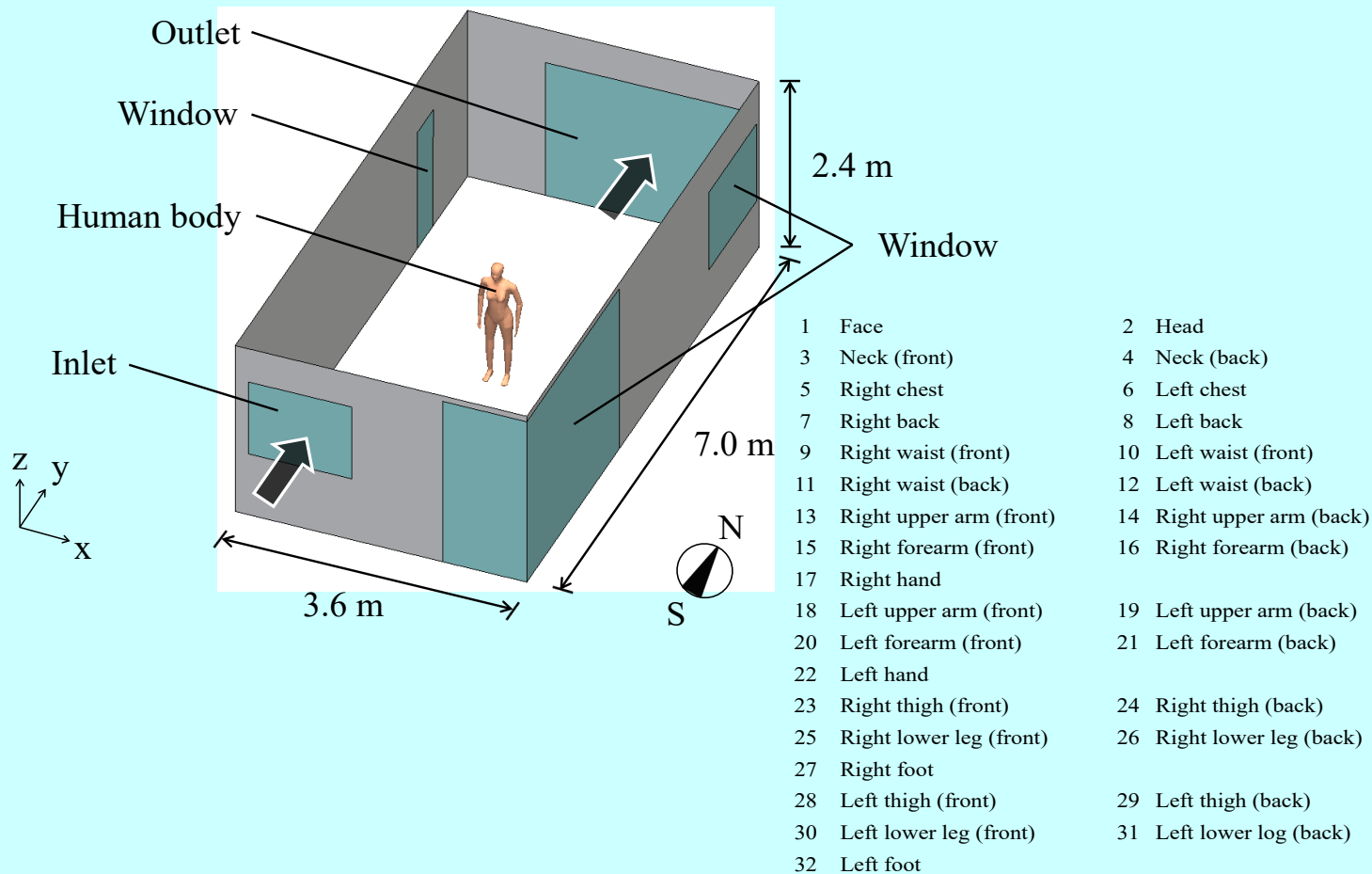


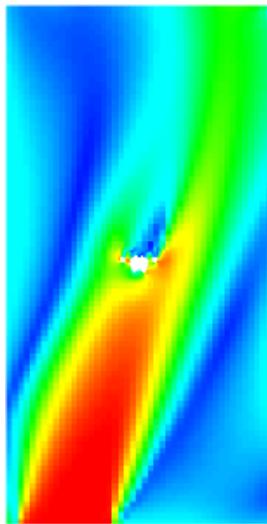
Figure 9. Relationship between air temperature and skin temperature

# A COUPLED ANALYSIS OF CFD AND HUMAN THERMAL MODEL (Matsui et al., 2016)

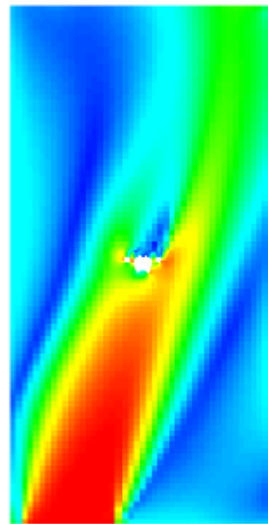


It seems to be allowed up to be 32.6°C.

0 1.0 [m/s]



(a) 59.25T

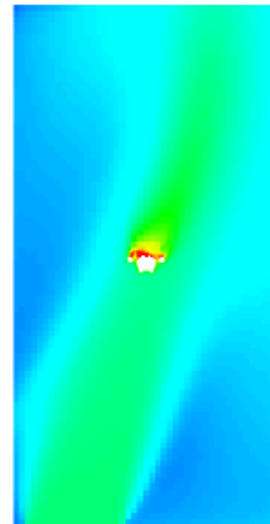


(b) 59.75T

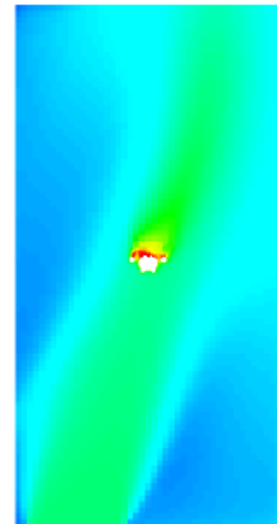
Case 3-3

(1) Indoor air velocity

31.8 32.3 [°C]



(a) 59.25T



(b) 59.75T

Case 3-3

(2) Indoor air temperature

Figure 4. Horizontal distributions of instantaneous indoor air velocity and temperature at a height of 1.2 m (Inflow angle: 20°, Inflow temperature: 32 °C) (T = 60 sec.)



# Gagge's worries

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- **Psychological change in thermal transients:**

He was not satisfied with the expression of 'anticipation.'

- **Treatment of air movement:**

Convective thermal transfer coefficients are different among each part of the body. It causes the problem of asymmetry.



# A “cat-like life style”

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- **Cats:**

- They do not work.
- They can not change their surroundings.
- Humans’ house is so large for them.
- So, they move, look for the most comfortable place and stay there.

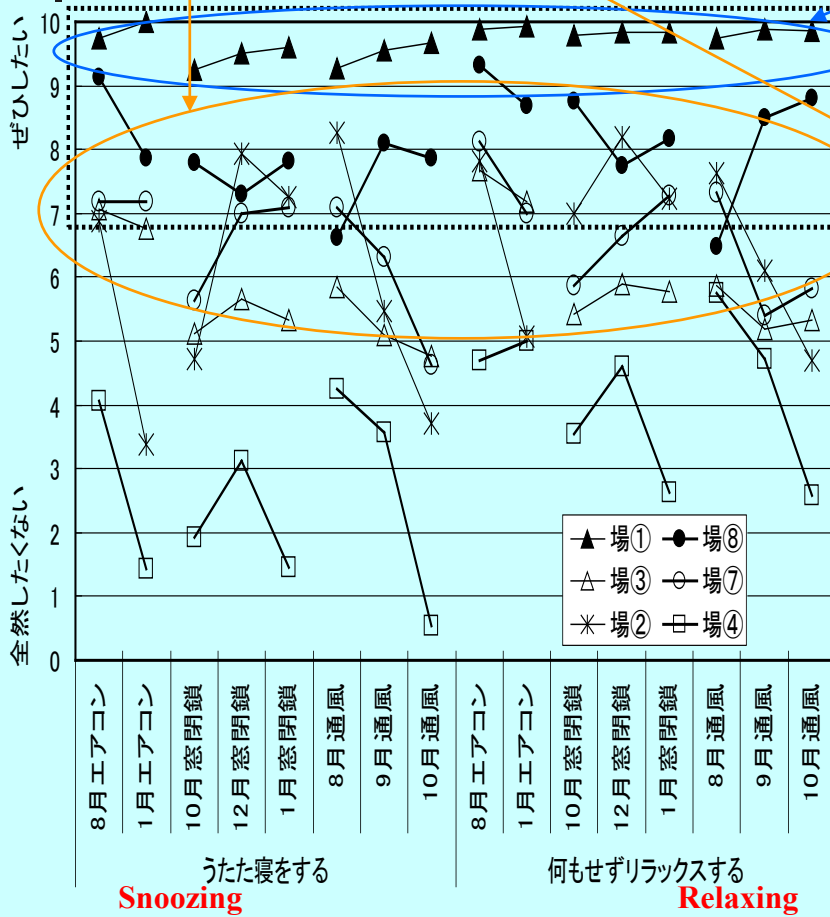
- **Humans:**

- They have always something to work. Relaxing is also one of their works.
- They can change their surroundings in some extent.
- They require both comfort and workability.
- Moreover, they may think economic and/or global issues.
- **So, humans also should choose places and move like cats.**

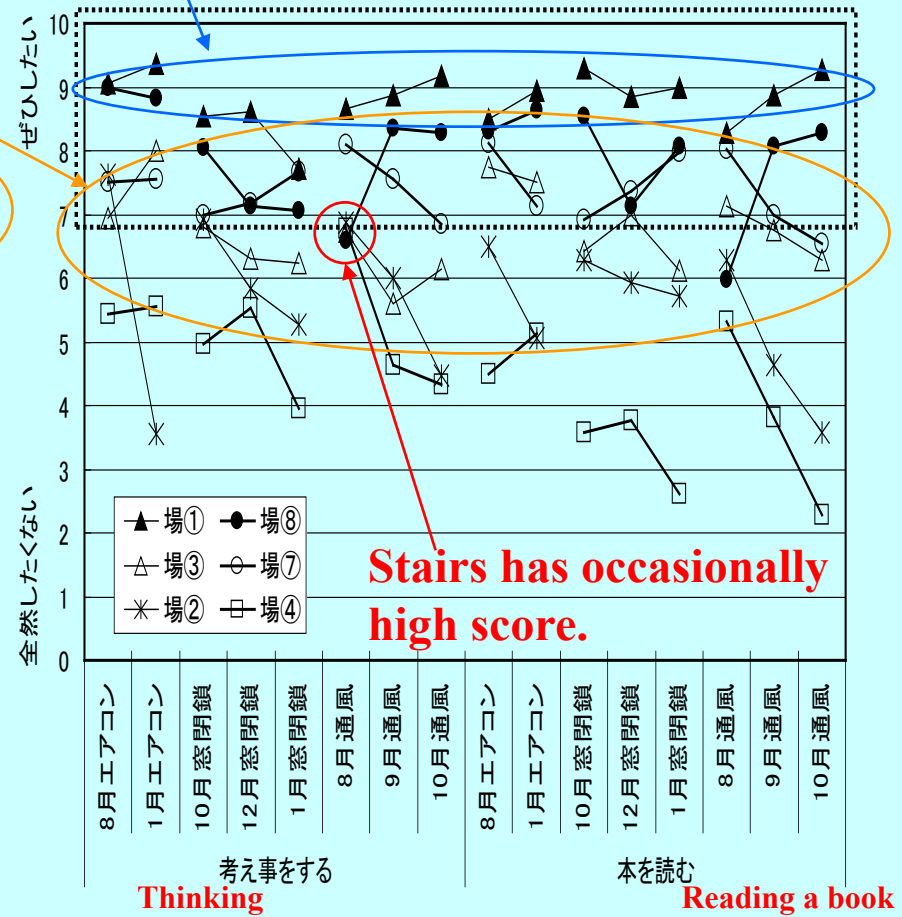
# Choice changes by season

Scores change by conditions.

Sofa in living room has always high score.



(a) 第1因子の『リラックス』の休憩行為



(c) 第1因子の『集中』の思考行為と視作業行為

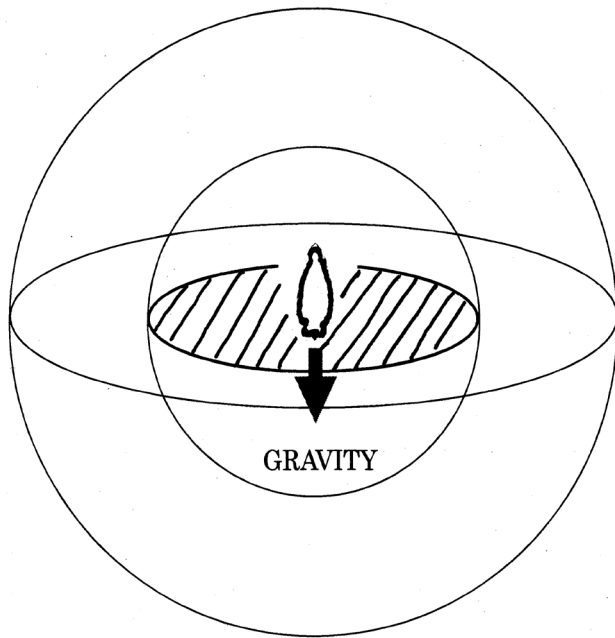


# Cognition of places

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- In the early 1990s, super high-rise buildings exceeding 1,000 m in height, ultra-deep underground architecture, and various atriums were discussed in Japan.
- What are the differences from usual architectural spaces?

# Spaciousness and stableness



**The safest place is under the clear sky and directly on the Earth.**

**We never trust artificial structures.**

**When we imagine beyond the walls, we notice where we are.**

	small	air	sky		
lower $2\pi sr$	stablness	liquid	on the sea	in the sea	
	large	solid	on the ground	bottom of the sea	underground
			air	liquid	solid
			large	spaciousness	small
				upper $2\pi sr$	



# Shanghai International Financial Center



# In the sky



# Prospects floor and visual cliff



# The Gateway Arch, St. Louis







# The statue of Mr. Saigo and the Plaza, Ueno, Tokyo



**Cognition gap**

**The statue gives affordance to the plaza.**







# Under reconstruction





**The plaza became narrow due to AC units.**

**Affordance varied.**



# Railway platform, Nishinippori, Tokyo



**It is a bridge.**



# Unexpectedness

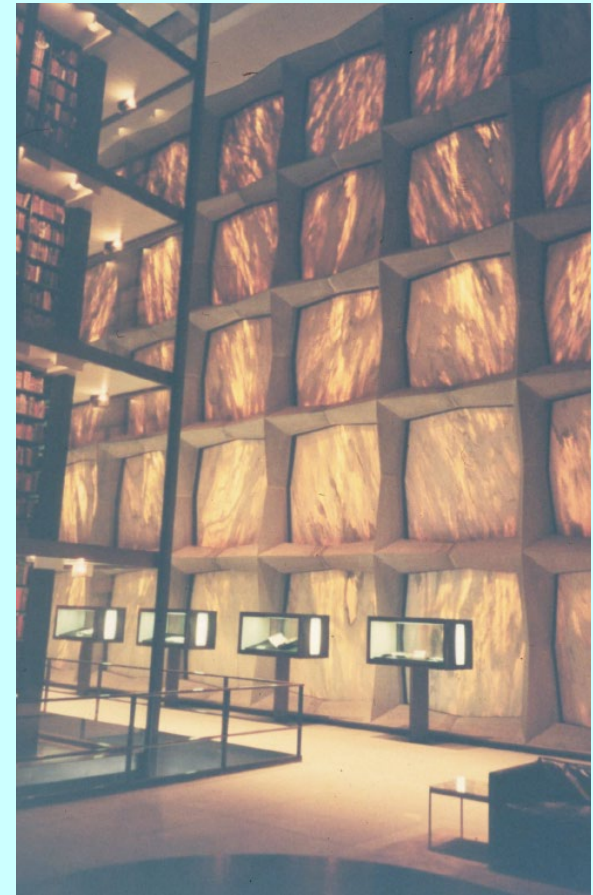
**It looks white.**



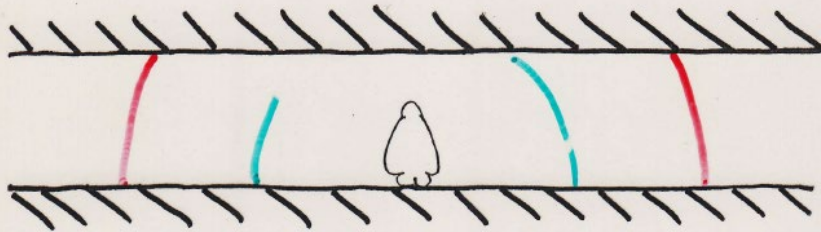
**Beinecke Rare Book &  
Manuscript Library,  
Yale Univ., New Haven**



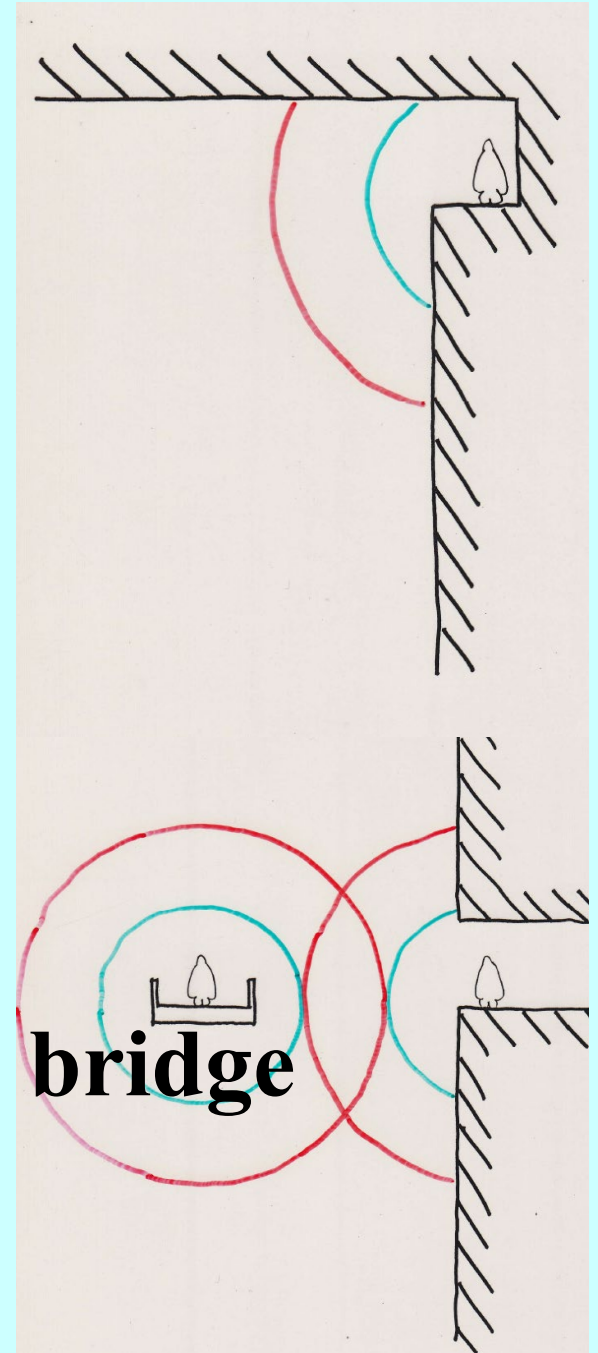
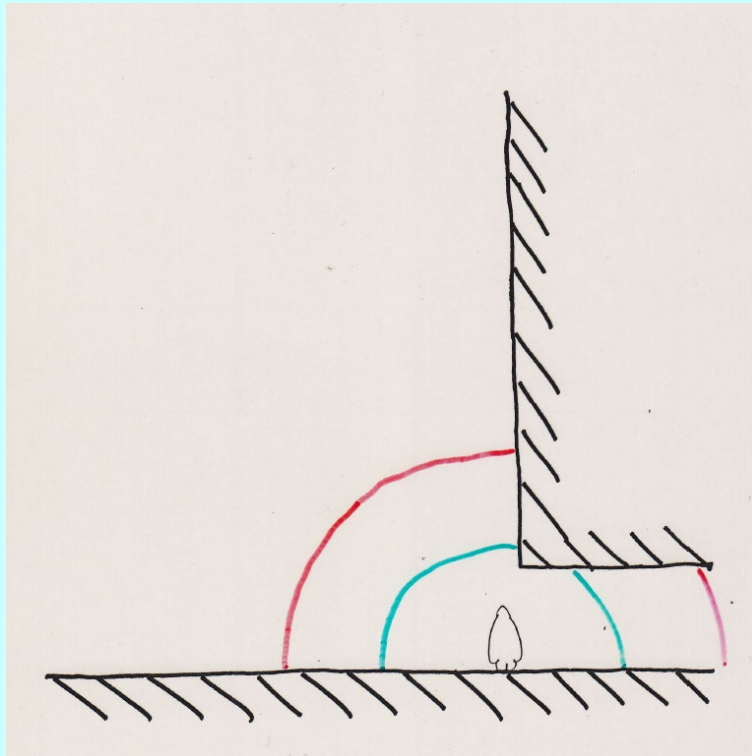
# Marble wall: orange and black



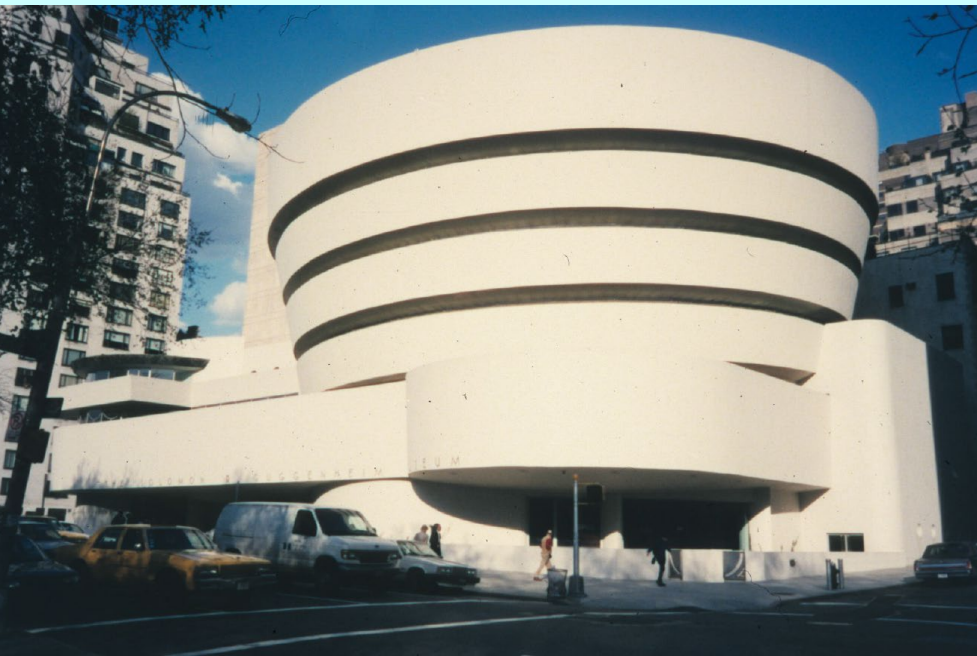
# Various situations in and around an atrium



**office**



**bridge**



Solomon R.  
Guggenheim Museum,  
NY





# New England Aquarium, Boston





**It shows shallow, intermediate, and deep layers in a spiral.**

**It became a model of many aquariums in the world.**





# Toba Aquarium

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## **Bottom of the Sea**

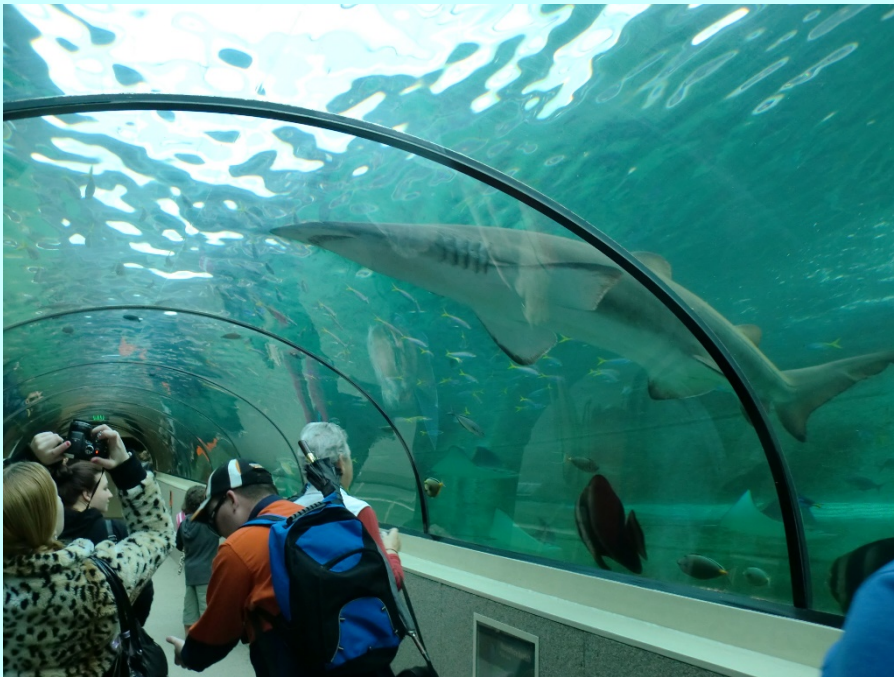


# Asahiyama Zoo, Asahikawa

In the sea: a tube



## Sydney Aquarium



# Asahi-yama Zoo

A seal in the tube



# A bridge over an atrium



Shinjuku NS Building, Tokyo



When we look up, there is a bridge.  
It tempts us to go there.



However, it is strong and not pleasant.



# Another example



Seavans,  
Tokyo



Slender and delicate, it may be appropriate.

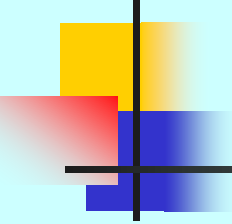




## One property of pleasantness

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- It looks dangerous but is safe, which creates pleasantness.
- Open air spa is very pleasant for healthy people, but very dangerous for sick people.

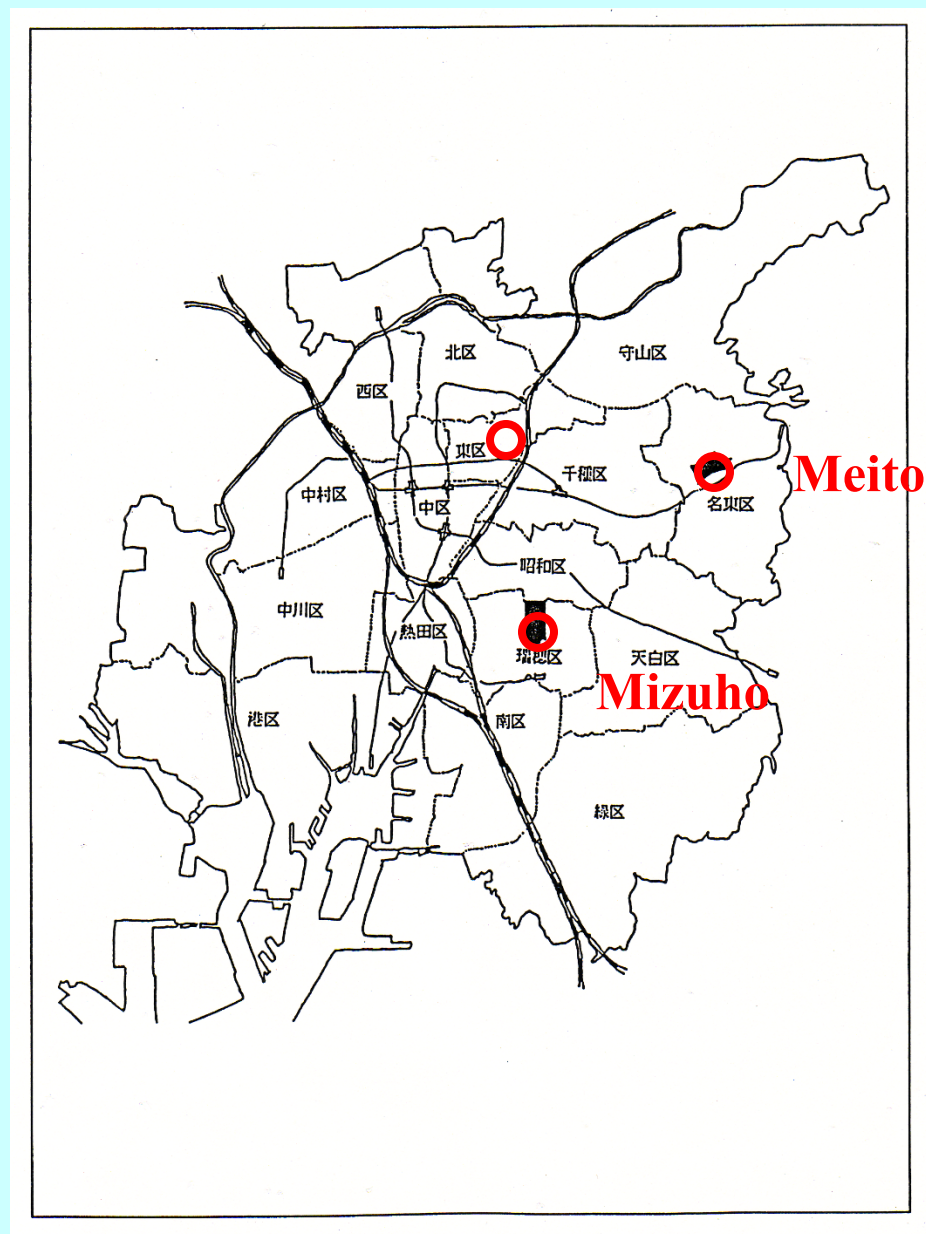


## Finally, inhabitants' awareness, again.

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- The data collection continued until 2005, covering 48 areas in total, including plural surveys of the same areas.
- The next example is secular changes.
- The data of three surveys in the Nishi-Ikebukuro and Kichijoji areas in 1979, 1992, and 1997 and three surveys in the Meito and Mizuho areas in Nagoya in 1991, 1997, 2003 were analyzed.

# Nagoya





# Hayashi Quantification Method Type III

Items

$IT_j$

$X_{itj}$

$IN_i$

(0,1) data

$R \rightarrow \max$



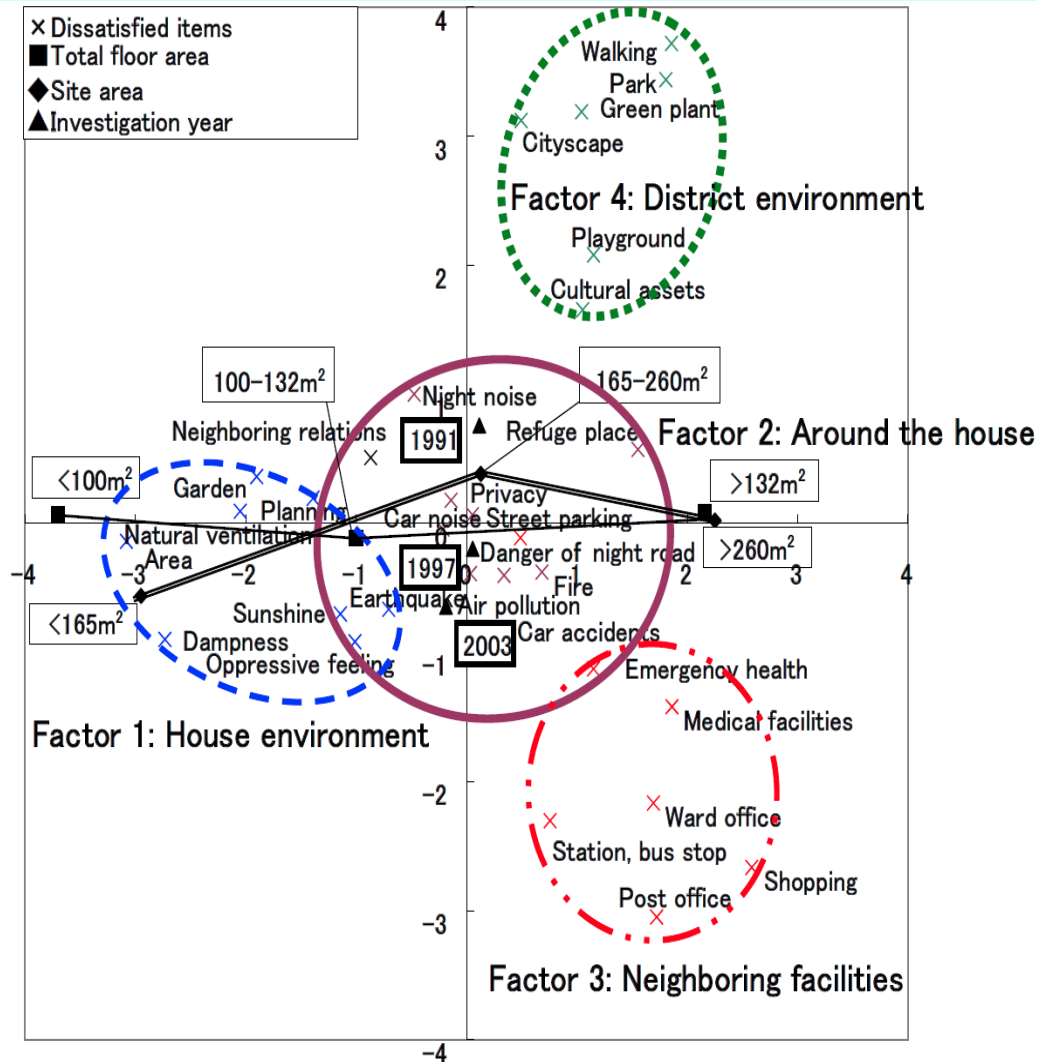
Individuals

$Y_{ini}$

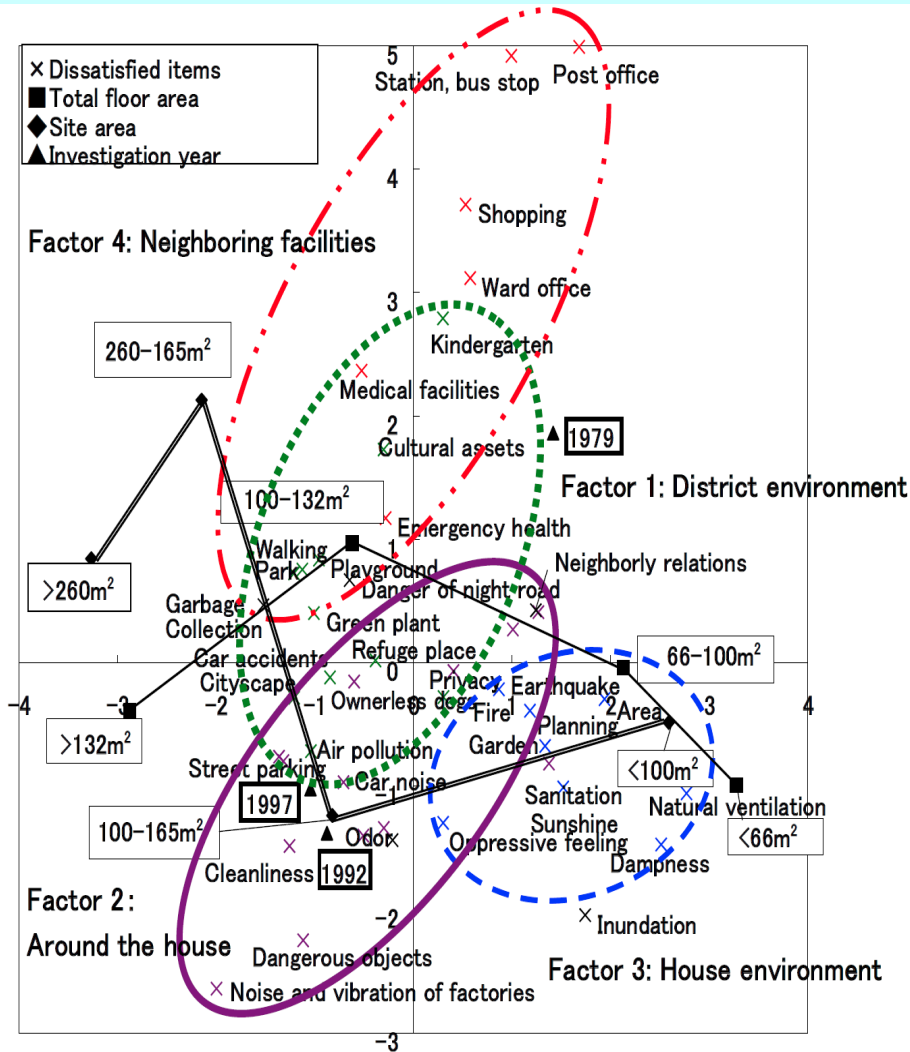
1	1	111	111	111	1	1
11	1111	11	1	1	11	111
1111	11	11	11			
.....						
.....						
.....						

						1	1	1	1			
						11	1	1	1			
						11	11	1	1	11	1	
						1111	111	111				
						1111	111	1	1	11		
						1	11	1	1111	111	1	
						111	1111	11	1	11		
						11111111	111	1111				
						1111	11111111	1				
						11	1	1	11	11	1	1
						111111	1111	111				
						11111	1111	111				
						1	1	1	1	11111	1	
						11	111	1	11			

# Meito (Nagoya), 1991, 1997, 2003

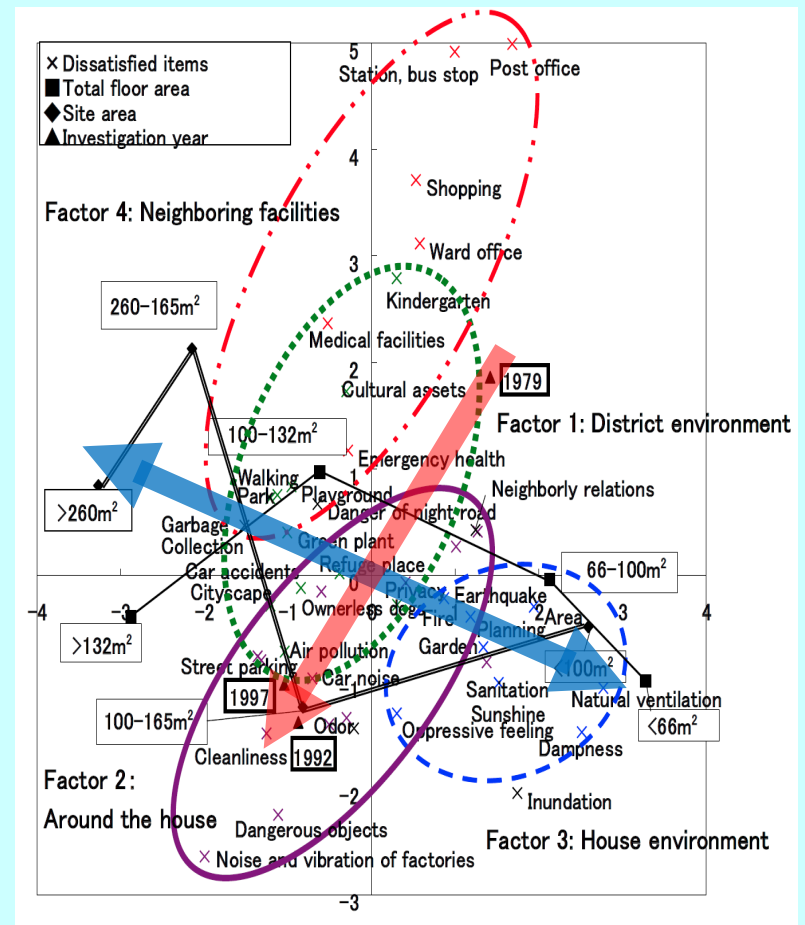
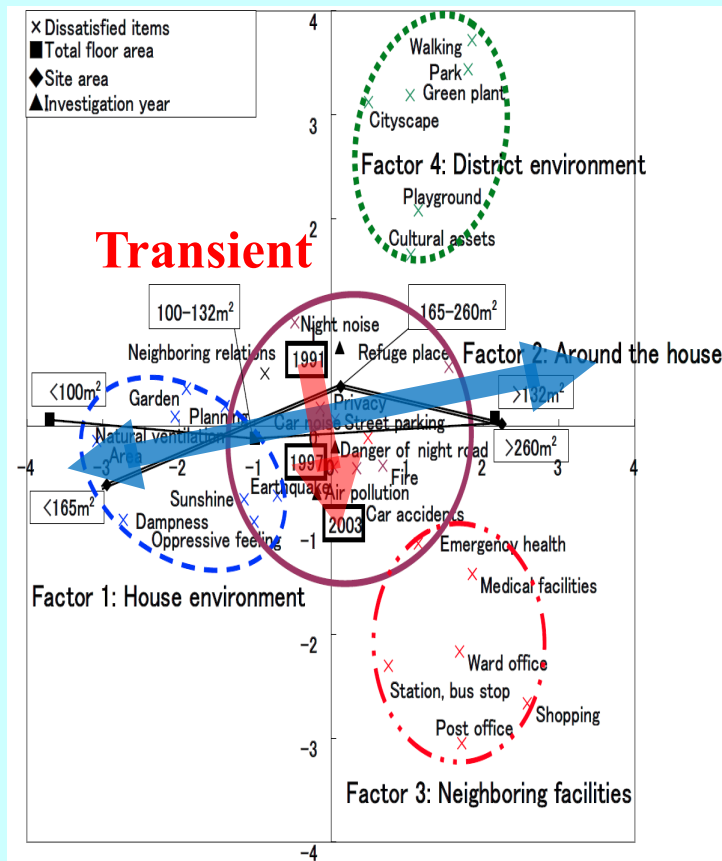


# Nishi-Ikebukuro (Tokyo), 1979, 1992, 1997



# Stable and transient tendencies

Stable







## One more,

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- Hewitt, 1967
- Lighting has gone through the first stage, **useful** lighting, and the second stage, **comfortable** lighting, and is passing into the third stage, **pleasant** lighting.
- Acceptable glare?



## Usual lighting design

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- We can see either rather bright or dark scene, but cannot see the both simultaneously.
- So sufficient visibility and no glare are needed, that is uniform luminance distribution.
- It is plane and monotonous.
- However,.....



## Acceptable glare

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**Direct sunlight into a room in the morning causes not only glare but also pleasantness.**

**The scene at a seashore in the evening has silhouettes of palm trees, yachts, and lovers and the sun glitter of sea's surface. We cannot see all of them simultaneously thus the contrast brings pleasantness.**



## Conclusion

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- Three aspects of the relations between humans and the surroundings were presented: thermal, visual, and social.
- There are both stable and transient properties.
- We live in such a situation.
- There must be ways to use those relations effectively.

**Thank you so much for  
your listening to my lecture.**