

# Detection of Temporary Rest State when Performing Mental Works by Measuring Physiological Indices

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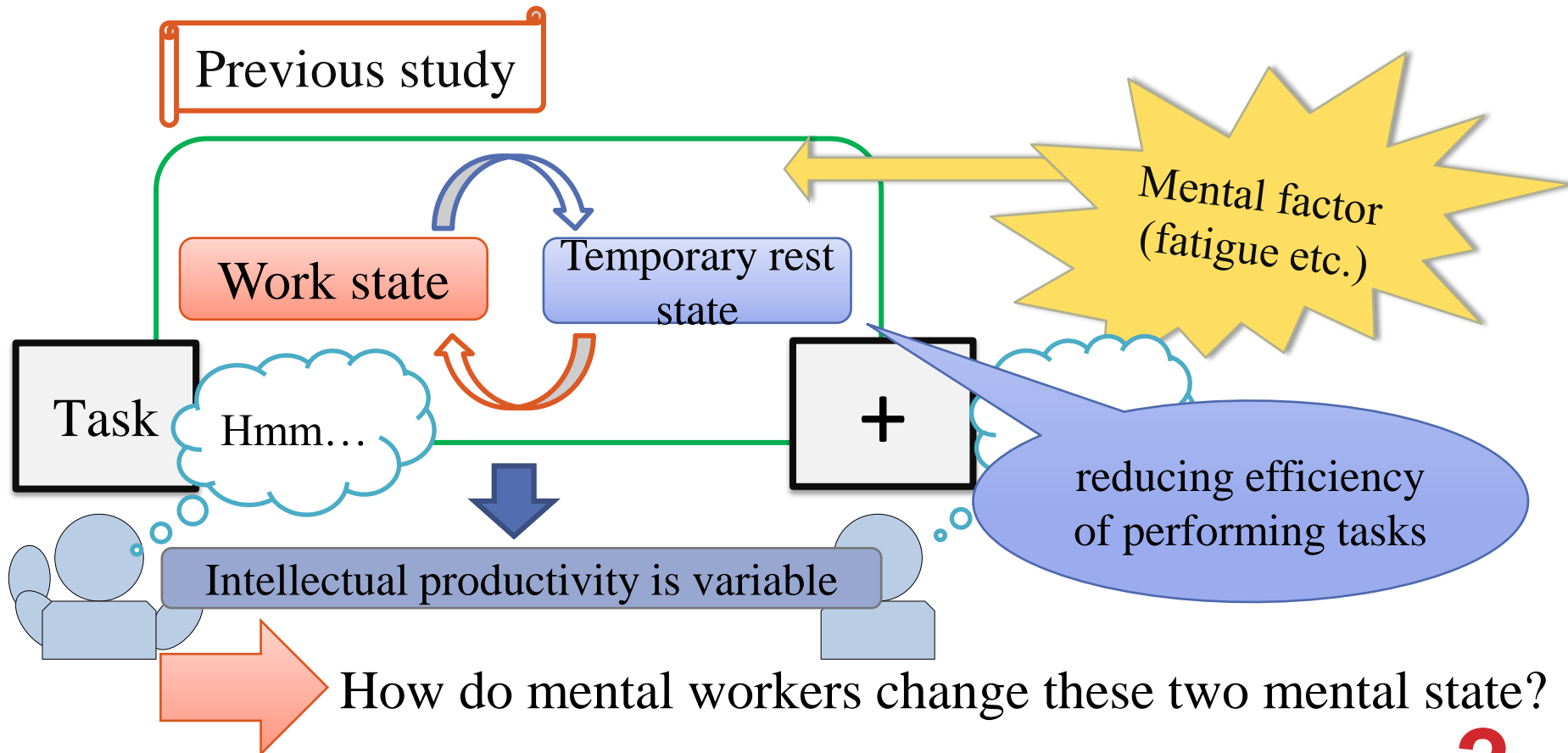
# Introduction

Many offices are aiming at improving intellectual productivity

However

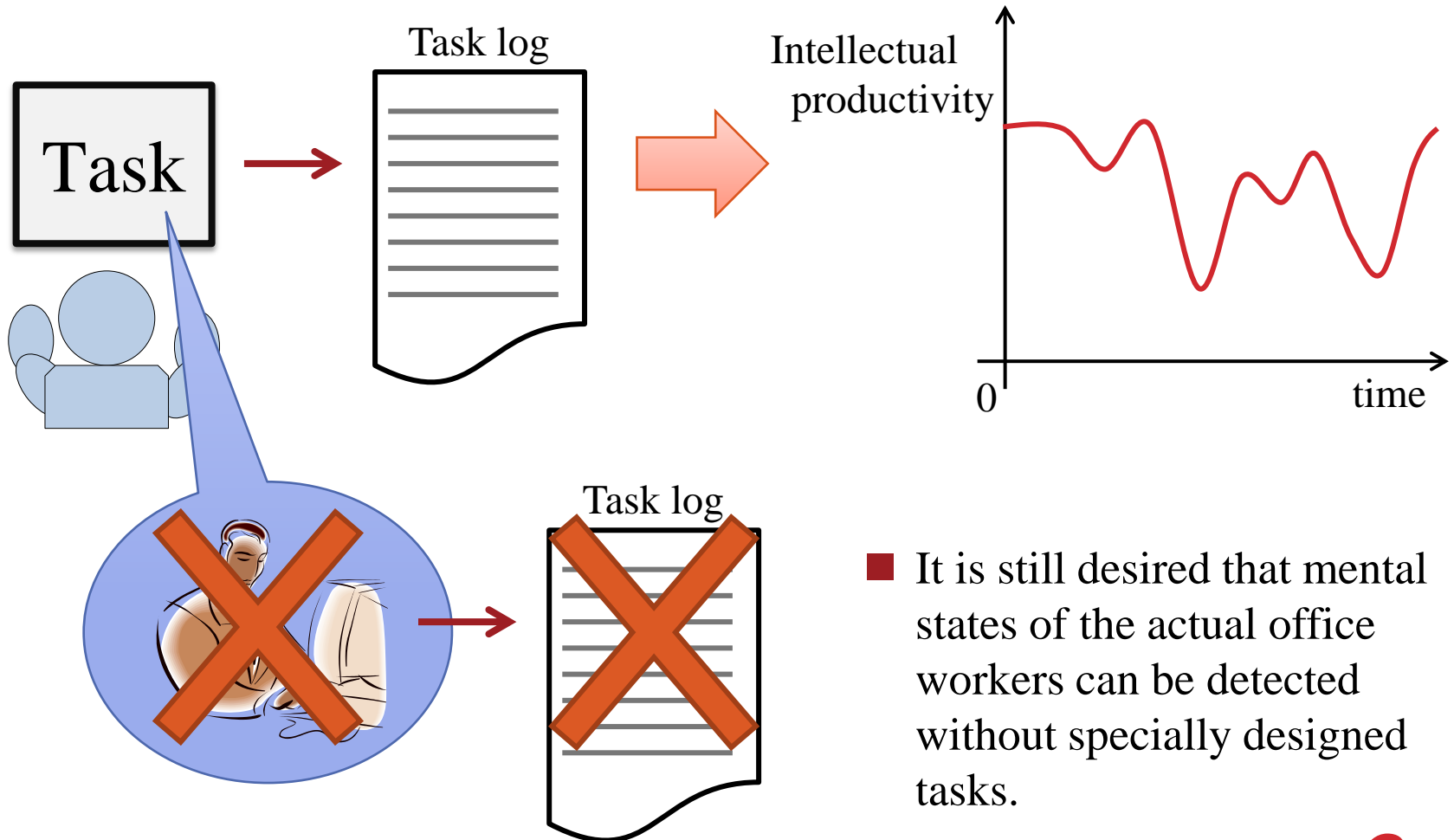
The quantitative evaluation method of intellectual productivity is required

Previous study



# Introduction

## Previous study



- It is still desired that mental states of the actual office workers can be detected without specially designed tasks.

# *Proposal*

*D*etection method of “Work state” or “Temporary rest state”



- employing physiological indices which reflect mental state

*O*nly physiological indices are required for the method.

- No need to use specially designed tasks
- Feasibility of employing actual office works

*Evaluation of intellectual productivity  
in actual offices can be performed.*

# *Choosing Physiological Indices*

*What indices should we choose ... ?*

- ✓ The indices change according to mental state.
- ✓ The feature extraction has high temporal resolution.
- ✓ The load on subjects is low during measurement of these indices.

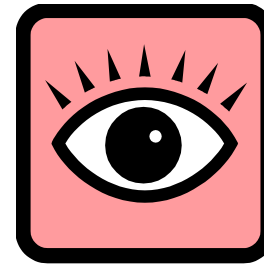
*ECG*



*EEG*



*EOG*



# ECG

## *Electro***C***ardio***G***ram*

- ❑ the signal of heart
- ❑ reflecting autonomic nervous system



## *F***eatures**

1. Sympathetic nerve  
→ Low frequency wave of heart rate  
(0.05 - 0.20 Hz)
2. Parasympathetic nerve  
→ High frequency wave (0.20 – 0.35 Hz)

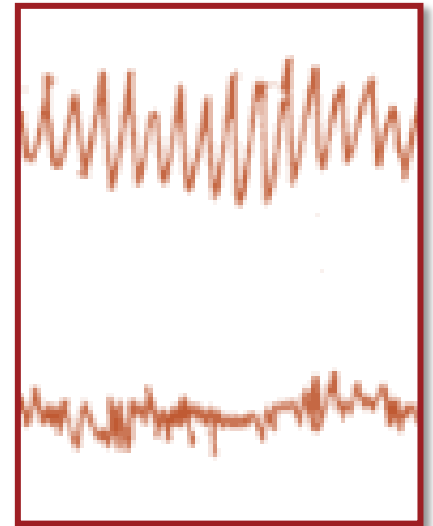
# EEG

## *ElectroEncephaloGram*

- ❑ the signal of brain wave
- ❑ reflecting brain activity

## *Features*

1. Alpha wave  
→ The frequency is 8 - 13 Hz.
2. Beta wave  
→ The frequency is 13 – 30 Hz.



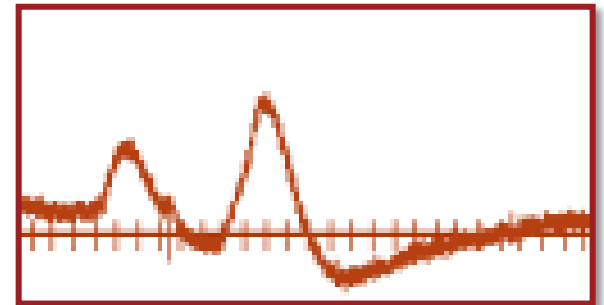
# EOG

## *ElectroOculoGram*

- ❑ the signal of eye movement or blink
- ❑ reflecting psychological state and arousal level

## *Features*

1. The frequency of eye blink
2. The frequency of saccade eye movement





# *Physiological indices*

## *Physiological indices depend on subjects or tasks*

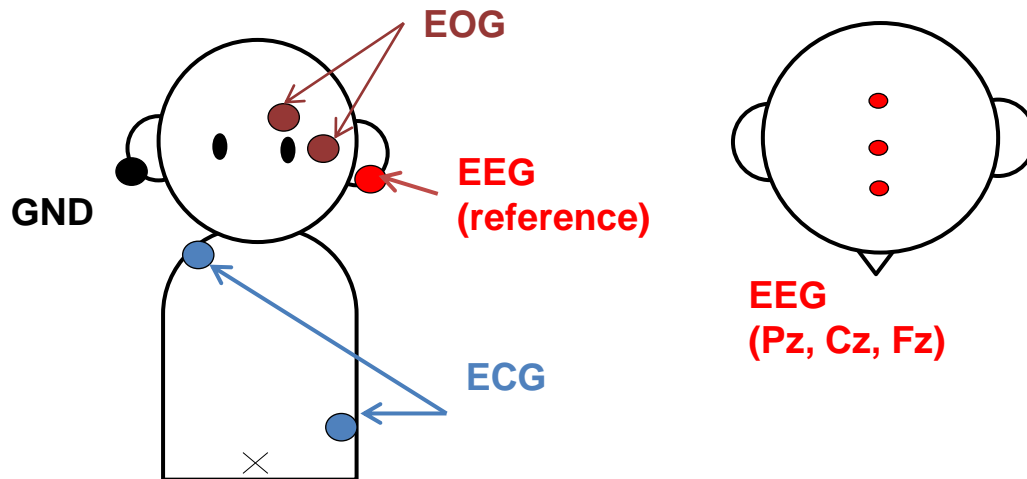
- The standards of detection were calculated for each subject and task.
- Temporary rest state was detected statistically by using Mahalanobis discrimination analysis (MDA)



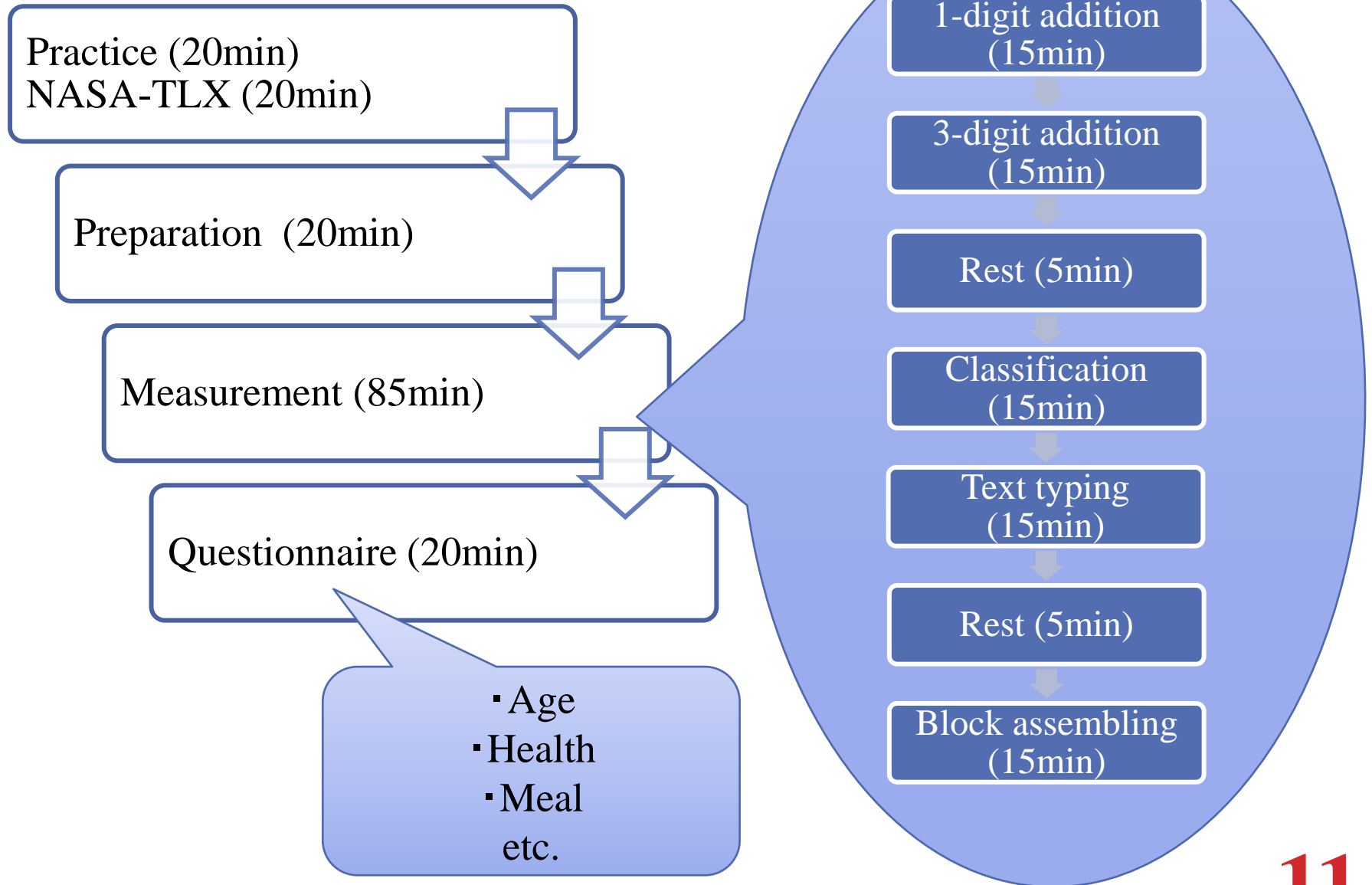
# Measurement of physiological indices

26 subjects (male/university student)  
age: 19-25 (average:21)

5 tasks (7.5min/task  $\times$  2 measurement=15min)  
(1-digit addition, 3-digit addition, classification,  
block assembling, text typing)

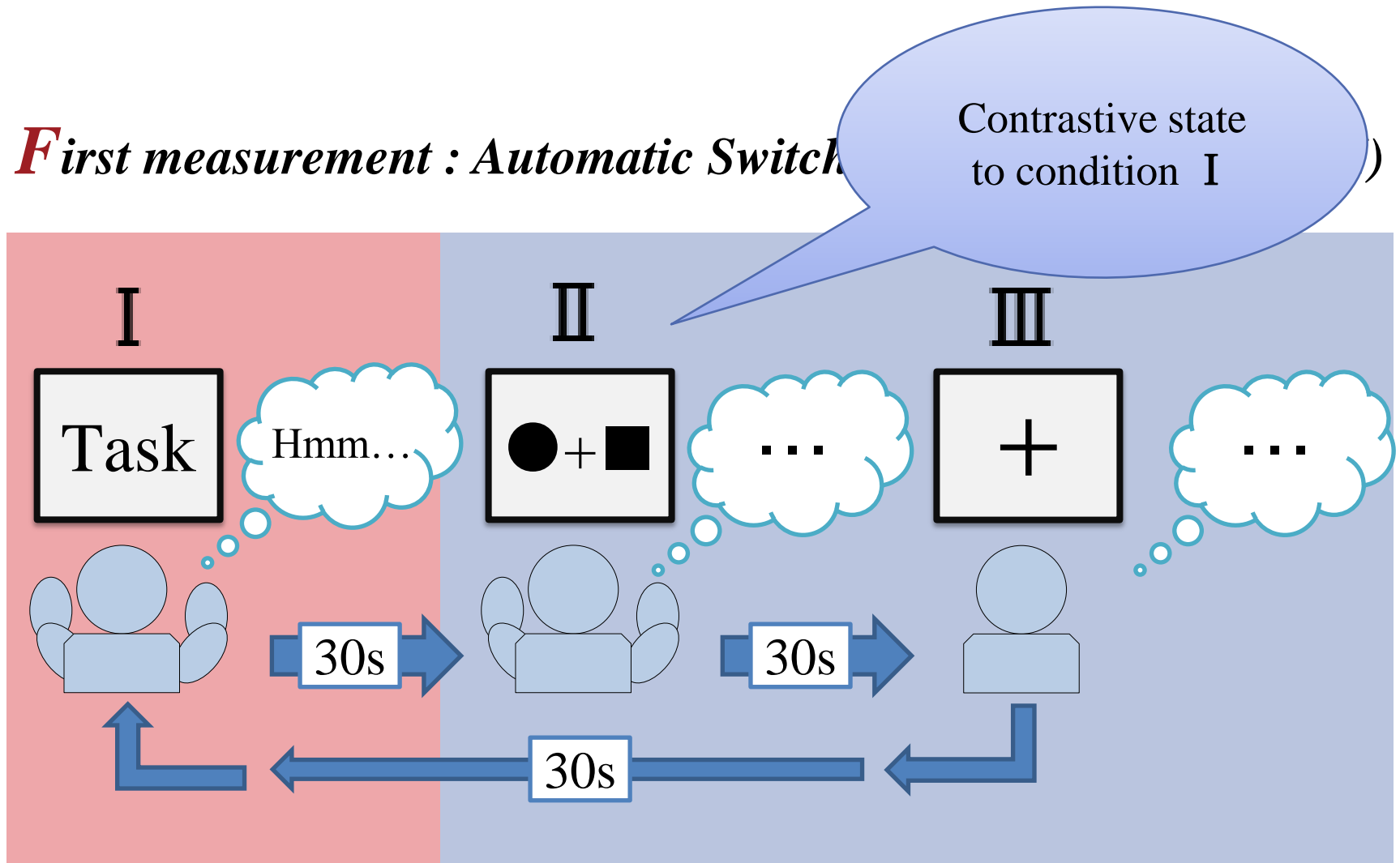


# Measurement's procedure



# Measurements

**First measurement : Automatic Switch**



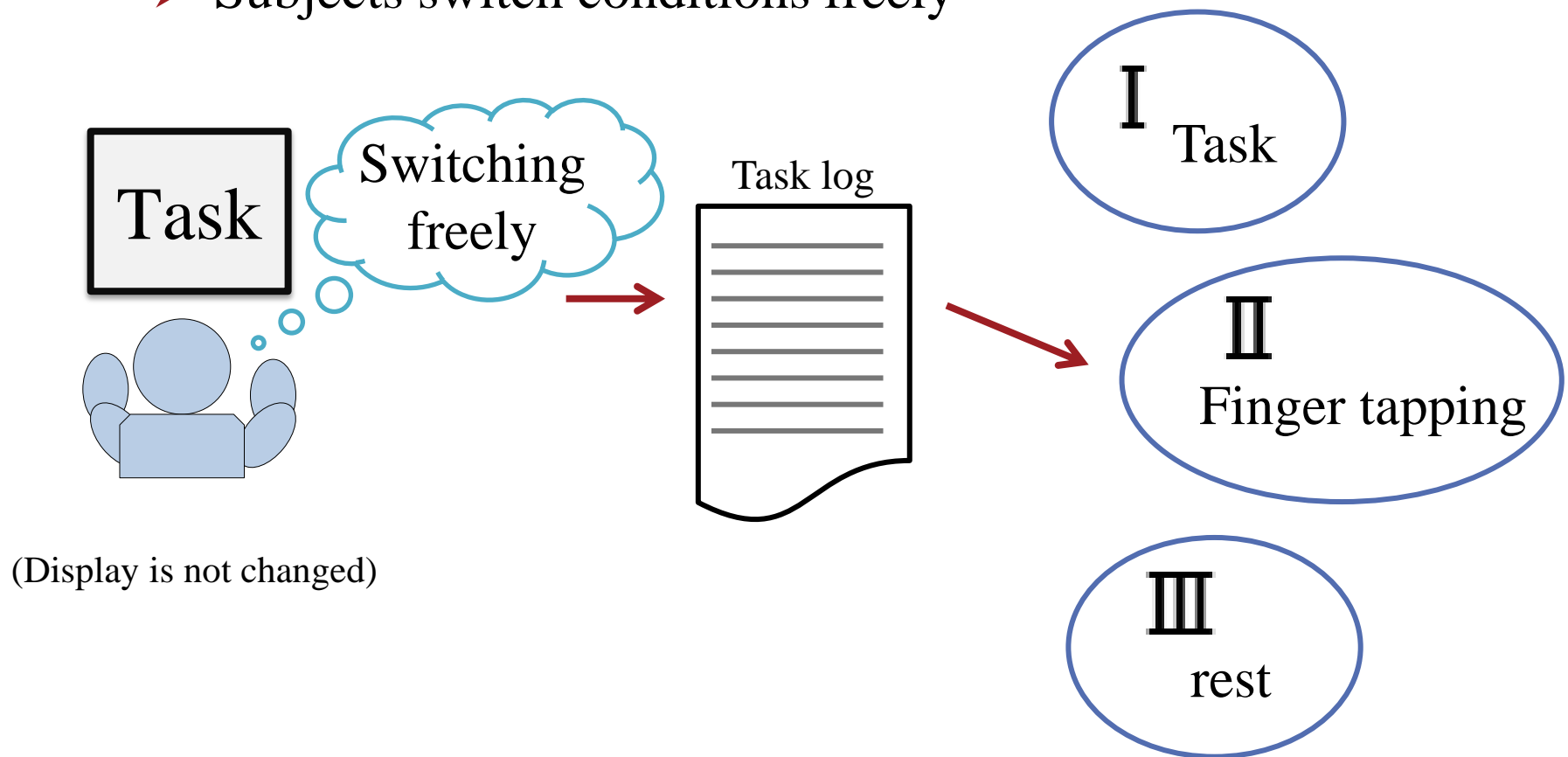
Work State

Temporary Rest State

# Measurements

## *Second measurement : Free Switching Measurement (FSM)*

- Subjects switch conditions freely



# *Data Analysis*

## *Mahalanobis Distance*

- used in multivariate statistics
- considering the correlations of the data with different scales

## *Error rate*

- calculated, substituting the distance for the equation

$$e = \frac{1}{\sqrt{2\pi}} \int_{D/2}^{\infty} \exp\left(-\frac{u^2}{2}\right) du$$

- Correct discrimination probability is  $1-e$

# Result

Task	n	Correct discrimination probability			
		ASM		FSM	
		Mean(%)	SD	Mean(%)	SD
1-digit addition	21	85.4	10.7	83.4	10.1
3-digit addition	21	83.4	9.0	82.6	9.5
Block assembling	20	75.5	5.4	78.3	10.3
Text typing	20	71.0	6.1	81.1	8.0
Classification	21	78.5	7.6	79.3	7.7

# *Discussion*

## *The accuracy inferiority in the case of ASM for only text typing*

- low mental work load
- difference between the time length of Work State  
ASM: 30 seconds  
FSM: 59 seconds (average)

## *Other tasks*

- The accuracy is around 80%




# *Further study*

## *Higher detection accuracy*


- We should consider ...
  - ✓ Physiological indices
  - ✓ Detection methods
  - ✓ Measurement's methods

## *Further study*

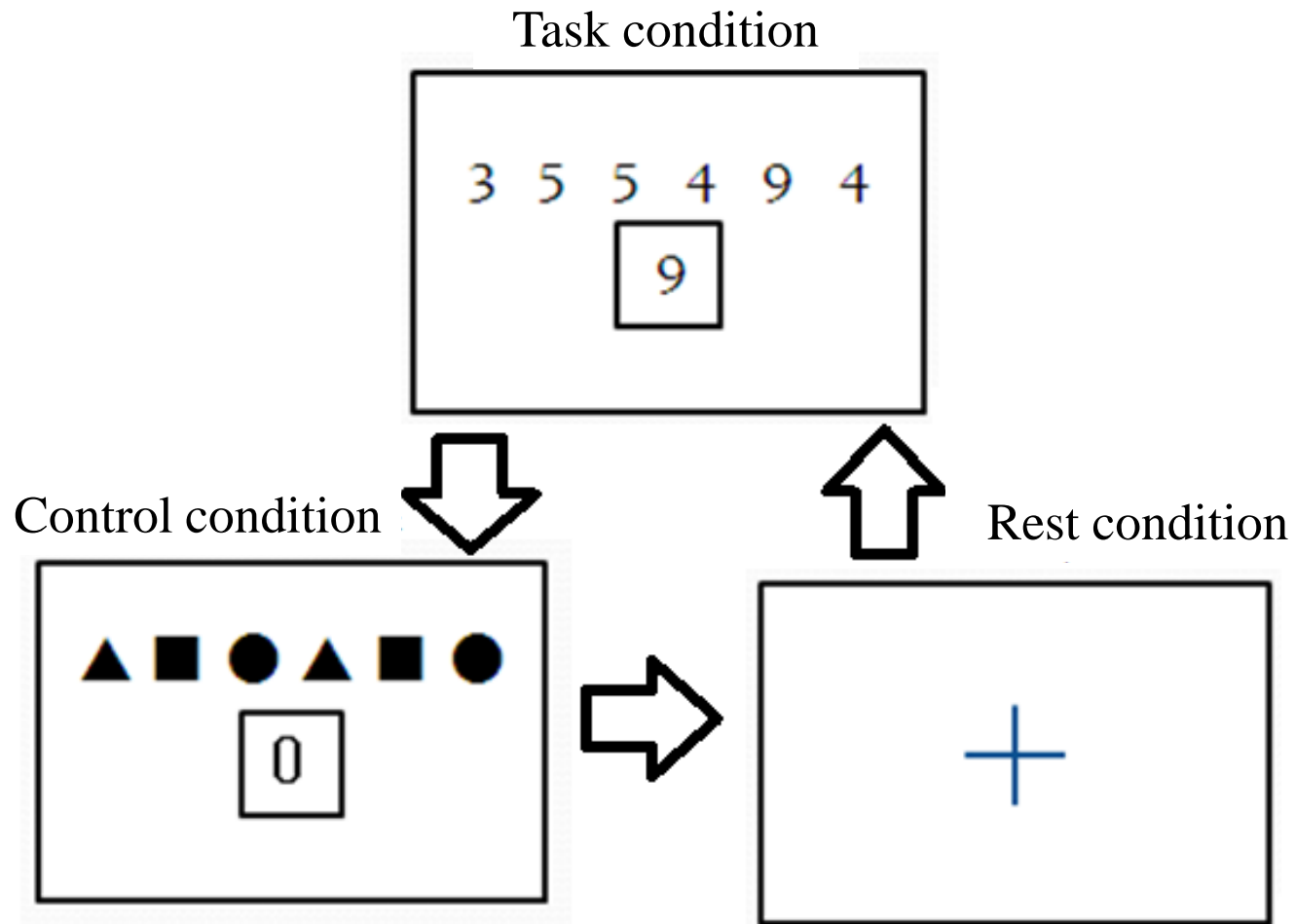
- employing actual office works or their equivalents
- proposal for more practical detection method



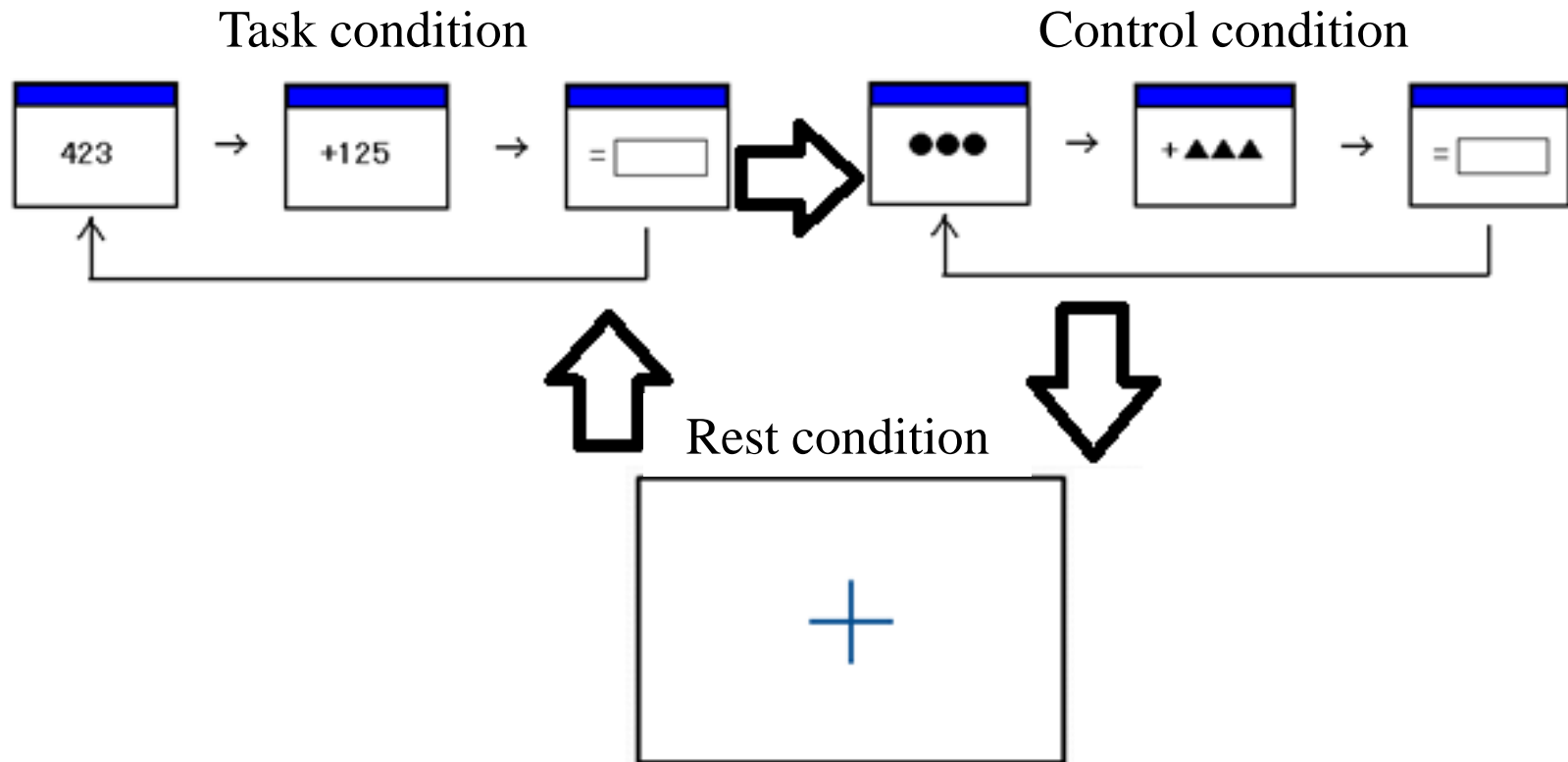
*Thank you  
for attention.*



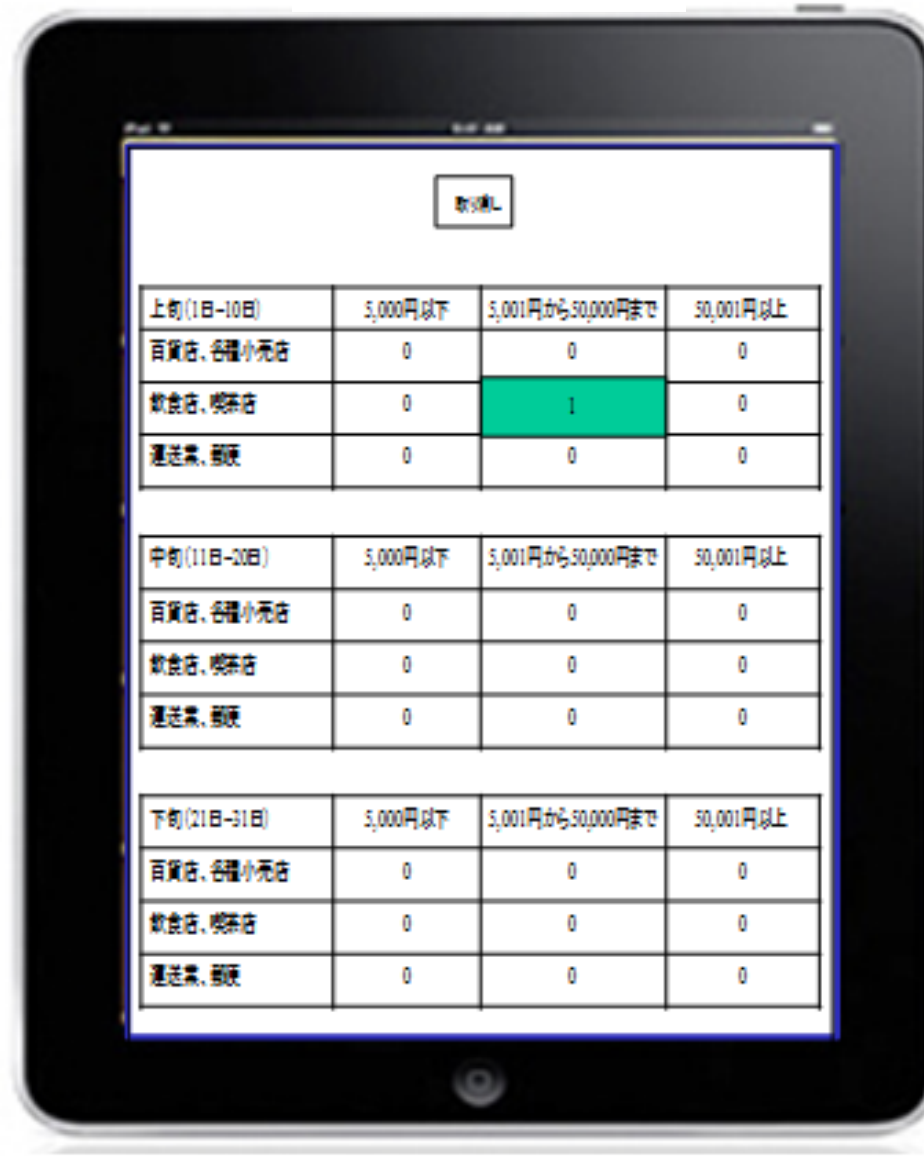
# 1-DIGIT ADDITION



# 3-DIGIT ADDITION



# CLASSIFICATION (TASK CONDITION)




取捨選択

上旬(1日-10日)	5,000円以下	5,001円から50,000円まで	50,001円以上
百貨店、各種小売店	0	0	0
飲食店、喫茶店	0	1	0
運送業、郵便	0	0	0

中旬(11日-20日)	5,000円以下	5,001円から50,000円まで	50,001円以上
百貨店、各種小売店	0	0	0
飲食店、喫茶店	0	0	0
運送業、郵便	0	0	0

下旬(21日-31日)	5,000円以下	5,001円から50,000円まで	50,001円以上
百貨店、各種小売店	0	0	0
飲食店、喫茶店	0	0	0
運送業、郵便	0	0	0

# CLASSIFICATION (CONTROL CONDITION)



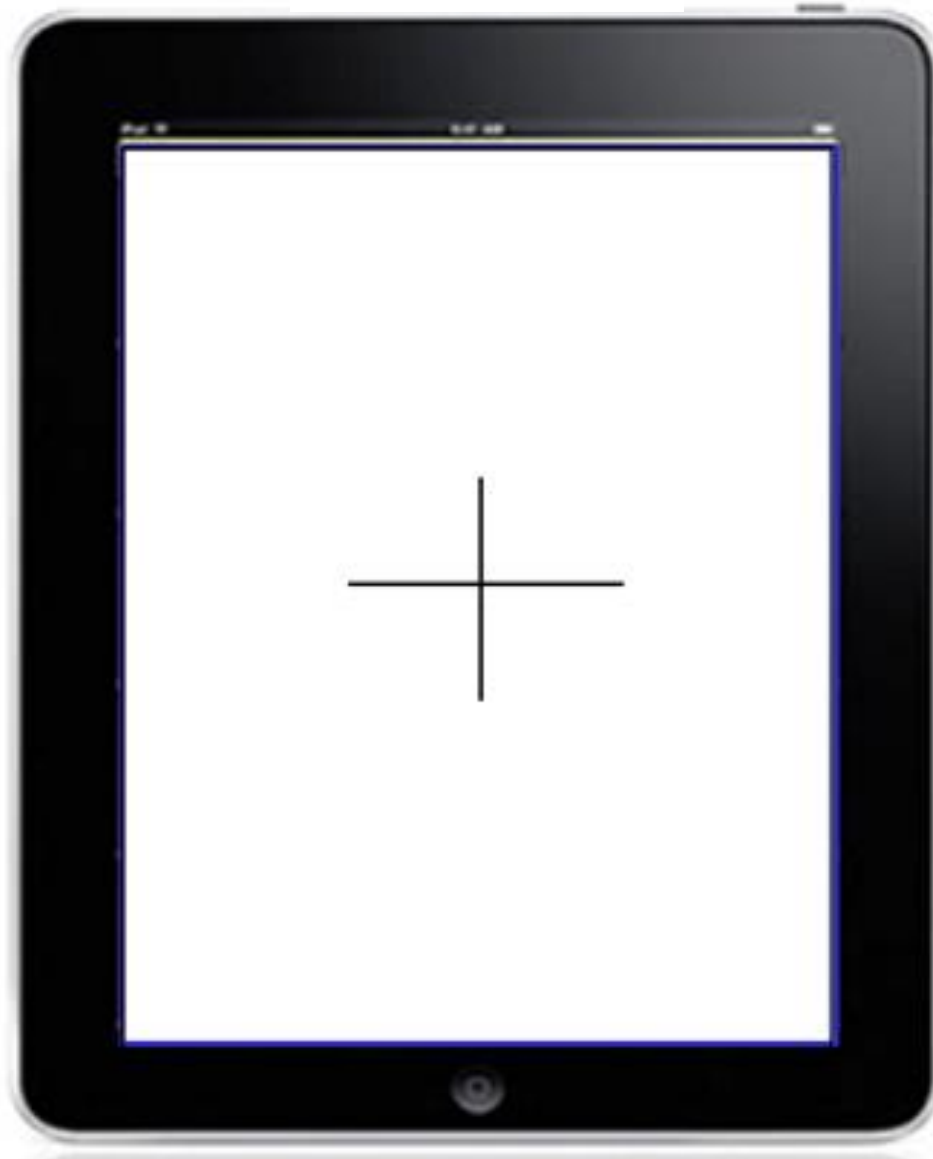
The image shows a tablet displaying a classification control condition interface. At the top, there is a small icon in a box. Below it, there are three tables, each with 4 columns and 4 rows. The first table has a green cell in the second row, third column containing the value '1'. The other cells in the first table and all cells in the second and third tables contain the value '0'.

	0	0	0
	0	1	0
	0	0	0

	0	0	0
	0	0	0
	0	0	0

	0	0	0
	0	0	0
	0	0	0

# CLASSIFICATION (REST CONDITION)



# TEXT TYPING (TASK CONDITION)

ファイル: ことわざ・慣用句

あつか しょうか く ちく  
悪貨は良貨を駆逐する↓

あく さいいえ ほろ  
悪妻家を滅ぼす↓

あ たる おと たか  
空き樽は音が高い↓

あいて けんか  
相手のいない喧嘩はできない↓

あい あい ほう  
愛されるより愛する方がすばらしい↓

あたら ぶどう しゅ ふる かわぶくろ い  
新しい葡萄酒は古い皮袋に入れてはならない↓

あ わか はじ  
逢うは別れの始め↓

あやま もの なに つく た  
過ちのない者は何も作り出せない↓

あと の やま  
後は野となれ山となれ↓

あばたもえくぼ↓



# TEXT TYPING (CONTROL CONDITION)

ファイル:

あいうえお↓

あいうえお↓

あいうえお↓

あいうえお↓

あいうえお↓

あいうえお↓

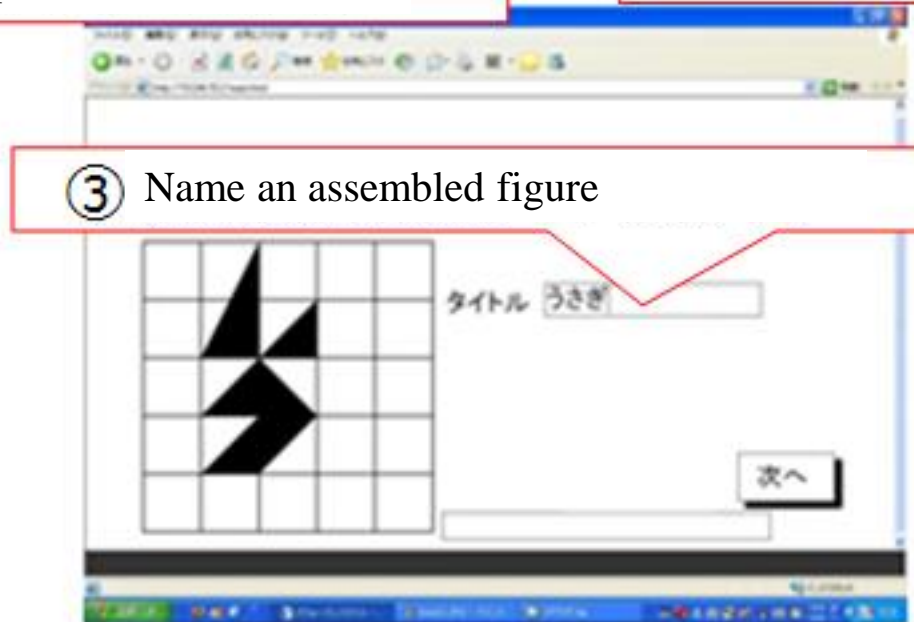
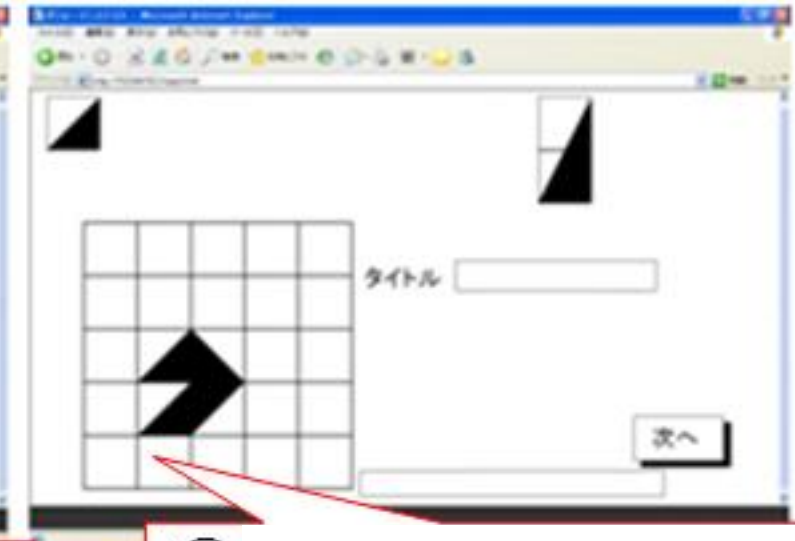
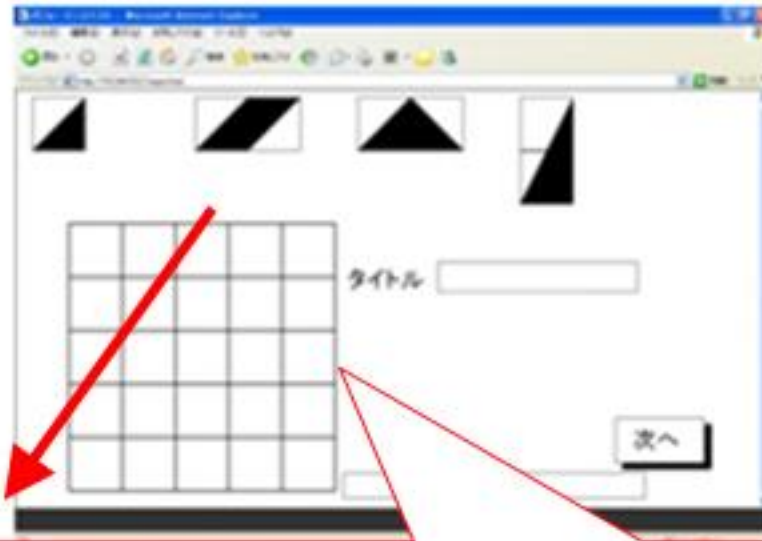
あいうえお↓

あいうえお↓

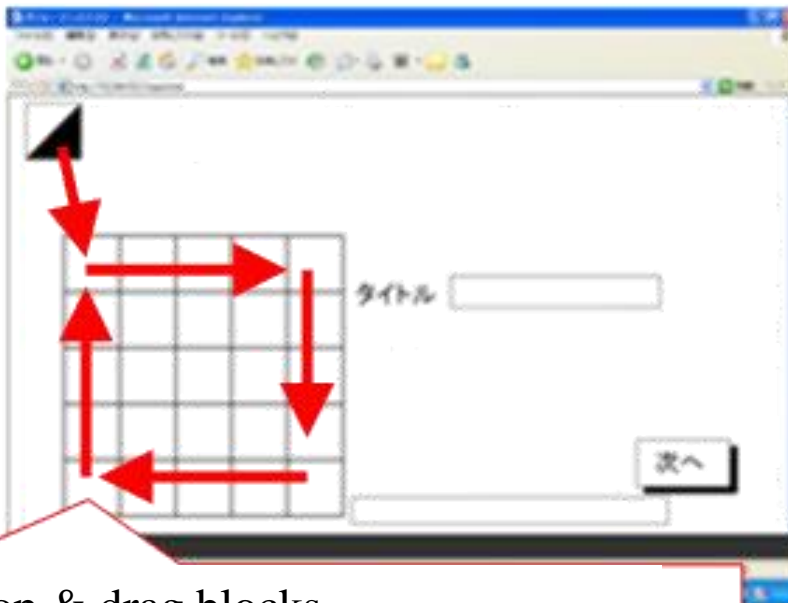
あいうえお↓

あいうえお↓

# BLOCK ASSEMBLING (TASK CONDITION)



# TEXT TYPING (CONTROL CONDITION) (REST CONDITION)



Drop & drag blocks



# QUESTIONNAIRE

年齢・性別	年齢と性別について
就寝時刻	実験前日の就寝時間
起床時刻	実験当日の起床時間
食事の有無	実験前に食事はしたかどうか
カフェイン	実験前にカフェインは摂取したか
飲酒	実験前日から今までで飲酒はしたか
服用中の薬	現在服用中の薬の種類
視力矯正	メガネ及びコンタクトレンズの有無
体調	実験前と後それぞれの体調。良い・ふつう・悪いの3段階評価。 また、だるい・眠い・風邪気味・頭痛・目の渴き・肩の痛み・ 腰の痛みがあるか
そろばん経験	そろばん経験の有無
過去の病気	過去に患った心臓病及び脳の病気の有無。および病名
電極装着経験	電極装着経験の有無
電極拘束感	頭部・目付近・耳朶・首・わき腹の電極装着が気になったか 気にならない・気になる・とても気になるの3段階評価 また、それぞれに対して作業の邪魔になったかどうかの有無
室温	寒い・やや寒い・ふつう・やや暑い・暑い of 5段階評価
湿度	乾燥・やや乾燥・ふつう・ややじめじめ・じめじめの5段階評価
騒音	静か・やや静か・ふつう・ややうるさい・うるさい of 5段階評価
作業状態	A 測定の、コントロール条件下で考え事をしたか レスト条件下で考え事をしたか