The Evidence
Never Lies !

Detection of Concealed Information:
P300 Response to a Visual GKT in a Virtual Mock Crime

Jinsun Hahm, M.A. & Jang-Han Lee, Ph. D

Ph. D. Candidate
Clinical Neuro-pSychology Lab.
Department of Psychology
Chung-Ang University, Korea
Email: iset77@hanmail.net

INTRODUCTION

1. Deception (Lie) detection

1990 year

- **Polygraph - innervated by ANS as a result of emotional effect of deception**
- **Question techniques – Control Question Test (CQT)**
  Guilty Knowledge Test (GKT)
- **Polygraph + CQT → limitations**

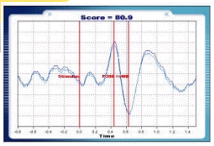
• High rates of false-positive guilty identification
• ANS responses are contaminated by current mood states independent of guilty or anxiety of detection
(Kleinmunts & Szucko, 1984; Lykken, 1979)

2. GKT + Cognitive indicators in psychophysiology

GKT(Guilty knowledge)
- any information relevant to the crime can be known only by the perpetrator
- Multiple-choice format
- Forensic investigations

Event related potentials (P300)
- Indices of the orienting response elicited by subjective significance (meaningfulness)
- Innervated by the CNS

You murdered the man in a___
house ?
bank ?
store ?
hotel ?
service station ?



P300-based GKT

- **P3 amplitude : an index of recognition of concealed information by perpetrators**
  (Rosenfeld et al., 2002; Farewell & Donchin, 1991)
- **Typically, three kind of stimuli presented to participants**
  Probes (concealed information), Irrelevants, Targets

3. Basic assumptions

- **Guilty participants : P3 amplitudes in probes > irrelevants**
- **Innocents : probes = irrelevants**

4. Another Deception-related cognitive workload: RT

- **Deceptive answers to questions – require more thinking**
  (Lykken, 1998)
- **Possession of concealed knowledge increased RT**
  (Seymour et al., 2000)
- **A direct measure of the activity within the CNS**

5. Virtual Mock crime

- **Limitations of Previous mock crime studies**

- Few field studies and mock crimes under realistic situations (Suzuki, 2004)
- The stake are not high for the liars (Vrij & Mann, 2001)
- Lack of participants' motivation (regardless of various rewards)
- Lack of realistic crime situation (Abootalebi, 2006; Langleben et al., 2002)

- **Simulated mock crime benefit of a virtual environments**

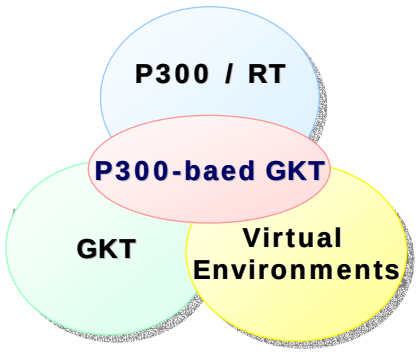
- high motivation (free selection of crime goods not committing the designated crime)
- Interaction with artificial environments
- Immersion and presence feeling
- Successful representation of real crime factors (crime tool, stolen goods, features of the victims)

Construction of crime situation based on crime factors

Exposure and reexperience of crime scene using VR

Detection of guilty knowledge

6. Purpose of this study



- examine how P300 change during GKT in virtual mock crime
- Investigate whether virtual environment-based mock crime and P300-based GKT are useful detection of concealed information

METHOD

1. Participants

- 38 male undergraduate students (19~27), mean age=24.03

2. Materials and Instruments

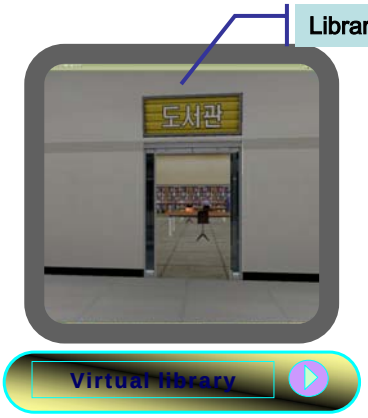
2.1 Virtual mock crime

- The virtual library environments (Pentium IV PC, HMD, keyboard)
- Normal appearance : a chair, a dictionary, and a file binder

- **Mock crime Scenario : based on theft in property crimes**

  concealing a lost roll of the bills which had been found in the library into three objects with the liberty of choice

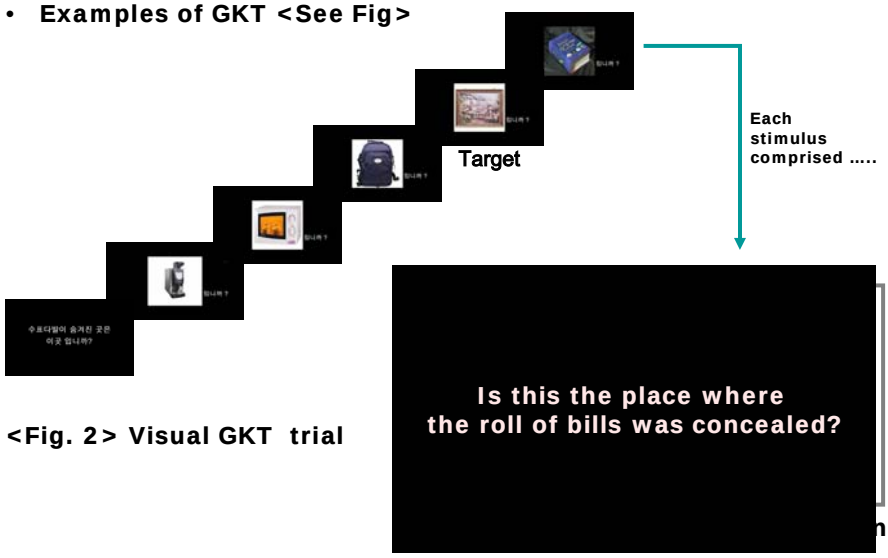
  <See Fig. 1>



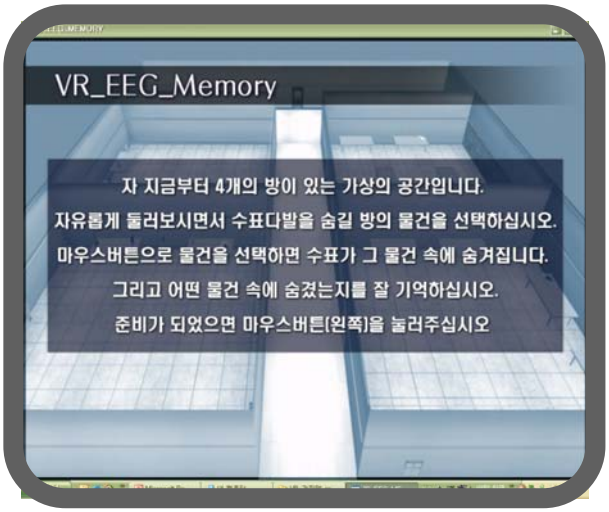
2.2 question series of GKT

- **a crime-relevant objects + four crime-irrelevants**
- **Size- 12.1*12.1cm**
- **GKT protocol is similar to previous studies** (Resenfeld et al., 2004; Abootalebi et al., 2006)

- **Examples of GKT <See Fig>**



<Fig. 2> Visual GKT trial

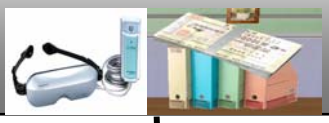


Virtual library & Mock crime

3. Procedure

- Participants were randomly assigned to one condition
  - Guilty (N= 18)
  - Innocent (N=20)
- practice trial + mock crime scenario instruction

- concealing behavior in a virtual library
  - HMD, keyboard
- Self-report measurement
  - SSQ, Presence, and immersion



- P300-based GKT
  - 6min 6s

- Psychophysiological and behavioral measurements
  - P300 & RT
- Data acquisition
  - 4 scalp sites (Cz,PZ,P3,P4 using QEEG-4(Laxtha Inc.)

• Mock crime scenario

Two separate roles in virtual mock crime

Innocent condition

Participants had never concealed a roll of bills instead exploring the library freely

↓

Were instructed to answer honestly

Guilty condition

Participants were instructed to conceal a lost of bills into 3 objects

↓

were asked to memorize the concealed objects
For assurance, write the list on a piece of paper

↓

were instructed to hide their information and to behave mentally as innocent

4. Data analysis

- P3 was recorded with silver electrodes attached to site PZ, P3, P4, Cz using QEEG-4(Laxtha Inc.)

- Setting : 256 Hz sampling rate, 16-bit resolution

- Repeated measures analysis variance
  (2 group * 3 stimulus)

Results

P300 amplitude and latency

P300 amplitude

Guilty group : probes > irrelevants

Innocent group : probes = irrelevants

Interaction effects ($F(2,72)= 5.374$, $p= .007$)

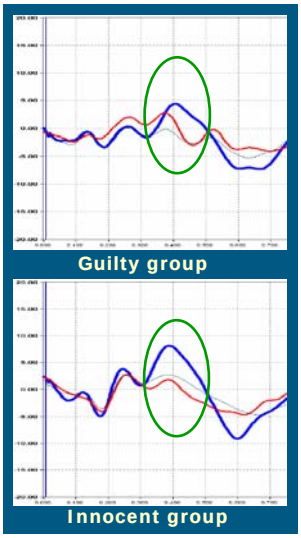
P300 latency

Guilty group : probes < irrelevants

Innocent group : probes = irrelevants

Marginal interaction effects ($F(2,72)= 2.962$, $p= .058$)

	Group	
Stimulus	Guilty	Innocent
Amplitude (microvolt)		
Targets	8.30 (4.33)	11.55 (5.49)
Probes	5.90 (4.83)	4.56 (4.50)
Irrelevants	3.58 (3.76)	5.40 (3.03)
Latency (ms)		
Targets	388 (4)	378 (9)
Probes	376 (4)	405 (3)
Irrelevants	368 (3)	405 (3)



Targets Probes Irrelevants

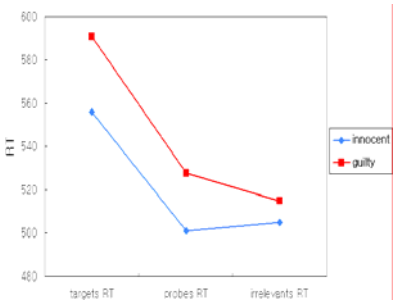
Behavioral response time

- Guilty participants: slower responses to all stimuli than innocents

- Although not significant,

Guilty condition : a trend toward a slower response to crime-relevants than to irrelevants

	Group	
Stimulus	Guilty	Innocent
RT		
Targets	591 (6)	556 (6)
Probes	528 (7)	501 (7)
Irrelevants	515 (7)	505 (6)



Self-report questionnaires

Guilty and innocent groups were not different

- age, state anxiety
- simulator sickness
- virtual reality
- presence
- immersion

TABLE. MEANS AND STANDARD DEVIATIONS OF DEMOGRAPHICS AND MEASURES IN EXPERIMENT CONDITION

Condition	Guilty	Innocent	*t*
	M (*SD*)	*M* (*SD*)	
Demographics			
Age	24.10(1.97)	24.05(1.67)	-.087
Anxiety	38.60(8.03)	37.80(8.59)	-.304
Memory score	10.78(2.33)	11.26(2.09))	.687
Simulator Sickness Questionnaire			
Nausea	59.15(15.66)	56.76(19.20)	-.430
Oculomotor	86.03(26.29)	76.56(32.52)	-1.013
Disorientation	64.73(32.02)	64.03(29.41)	-.072
total	776.66(223.747)	730.21(264.08)	-.600
Virtual reality Q	9.40(1.76)	8.75(2.57)	-.933
Presence Q	101.25(16.43)	108.80(18.49)	1.365
Immersion Tendencies Q	111.95(16.24)	114.75(17.62)	.523

Anxiety = Spielberger State Anxiety Inventory, Memory score = Rey-kim memory test, Simulator Sickness Questionnaire, Nausea = nausea, stomach awareness, increased salivation, burping; Oculomotor = eyestrain, difficulty focusing, blurred vision, headache; Disorientation = dizziness, vertigo; Total = (Nausea + Oculomotor + Disorientation)*3.7

Discussion

Findings

- **P3 responses : a valid signature for detection of concealed information**
- **Virtual mock crime : a useful method in the detection of deception**
- **The first empirical study demonstrating P3 changes and a virtual relity in forensic investigations**

Limitations & Further study

- **Consideration about individual differences can influence detection**
- **Lying is a complex process – need to integrate physiological signals and brain imaging**

Applied interests

- **Ranking of concealed information clues**


1st


2nd



3rd

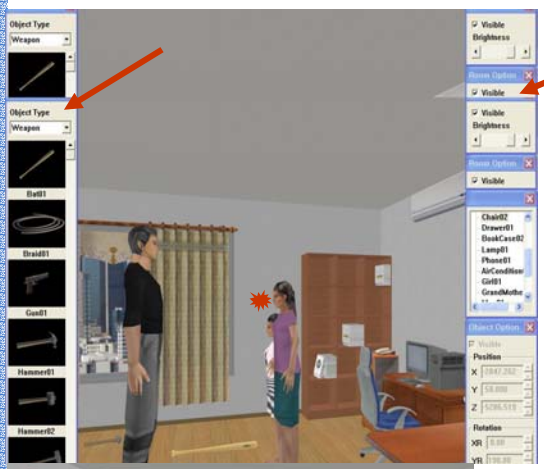
- **Current Criminal statistics (2006' Analytical Report on Crimes)**
  - **Property crimes / Larceny (theft)**
  - **Hiding places of stolen goods :** **Unidentified !**

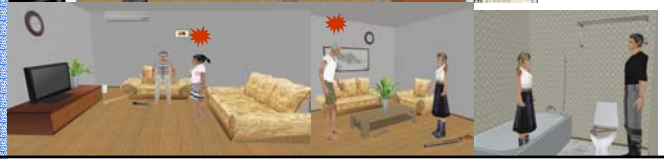
Supreme Prosecutors' Office of the Republic of Korea

- **Provides information for developing the successful representation of actual crime-scene using VR**

- **Fake illness (Malinger) in medical detection**

Under progress of VR-Crime development for reconstruction of real crimes





1. Scenes of crime
- bedroom, kitchen bathroom furniture arrangement

2. Goods of crime
- stolen objects or weapons

3. Time of Crime
- day and night, brightness of room

4. Features of the victims and perpetrators
- sex, age, appearance, positions

Thank you for your attention !

Acknowledgement

This work was supported by the Korea Science and Engineering Foundation (KOSEF) grant funded by the Korea government (MOST) (M10640010003-06N4001-00310)