P300-based CIT using simultaneous visual and auditory stimulus presentation method

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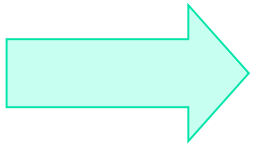
New indices on CIT: From ANS to CNS

ANS

- respiration
- electrodermal activity
- heart rate
- pulse volume



CNS

- EEG
- MEG
- ERP → P300, N400, CNV
- fMRI
- fNIRS

The validity of the detection of deception using P300

Study	Number of participants	Percent of correct decision
Allen & Iacono(1997)	60	86.7%
Farwell & Donchin(1991)	20	90.0%
Ellwanger et al.(1996)	27	88.9%
Ellwanger et al.(1997)	14	82.4%
Johnson & Rosenfeld(1992)	17	76.5%
Miyake et al.(1986)	8	87.5%
Neshige et al.(1991)	9	100.0%
Rosenfeld et al.(1987)	10	90.0%
Rosenfeld et al.(1988)	7	100.0%
Rosenfeld et al.(1991)	13	92.3%
Sasaki et al.(2001)	33	87.9%
Weighted average	221	87.8%

conventional autonomic polygraph method：83.9%(Ben-Shakhar & Furedy, 1991)

SPR 43rd Annual Meeting

Symposium 7

The Concealed Information Test: Theory and Applications

The P300-based guilty knowledge test: Does it stand the test of time?

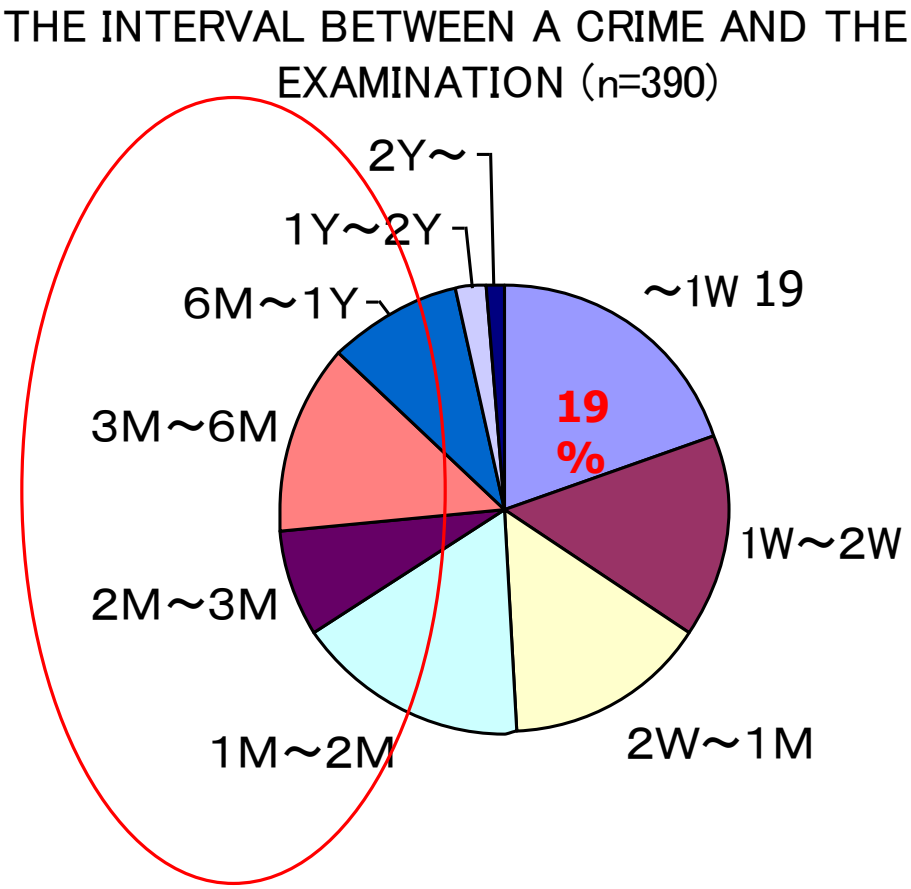
University of East Asia

Shinji Hira

Features of early CIT laboratory studies using P300

- The interval between a memory task and CIT examination was relatively short

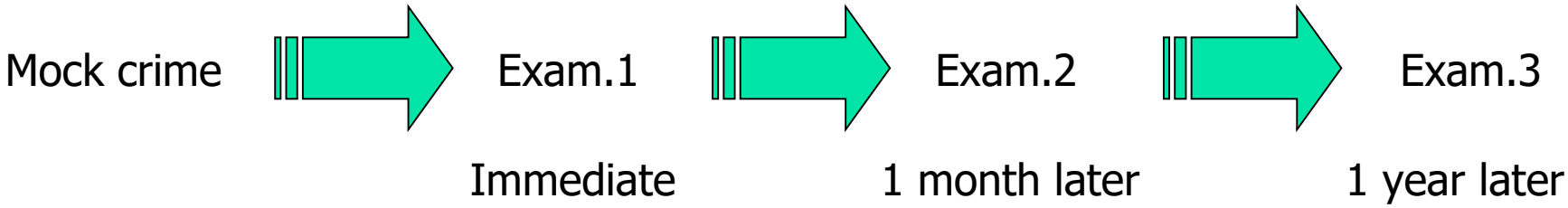
1. Rosenfeld et al.(1988)
   - The examination was carried out immediately after a memory task.
2. Farwell & Donchin(1991)
   - The examination was carried out on the next day of a memory task.



- The interval between a crime and the CIT examination is usually more than a week
  - More than 51% (199/390) of the CIT examinations were carried out at least one month after the criminal investigation had begun. （The Osaka Police Headquarters; August, 1998 - July, 1999）

The effects of retention intervals on detection of deception using P300

- Does it stand the test of time?
  - The P300-based CIT examination was carried out once immediately after the commission of the mock crime, and then repeated one month and one year after the commission of the crime.



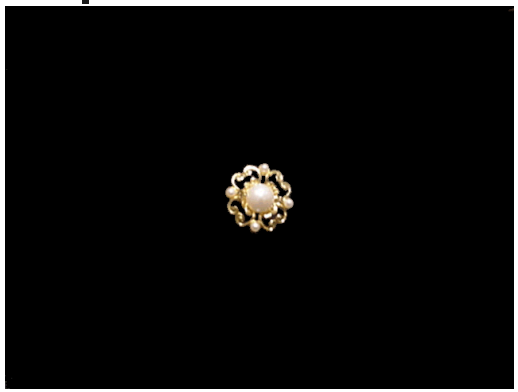
Method

- Participants
  - Five undergraduate students（2 female, 3 male）
  - Informed consent was obtained from all participants
- Apparatus
  - Polygraph（Nihon Koden　EEG-7410）
  - InstEP System（INSTEP）
  - Display（Nanao　FlexScanT550）
- Dependent Measures
  - EEG（Fz,Cz,Pz）
  - RT

Method (continued)

- Procedure
  - Mock Crime
    - All participants were instructed to steal one of the five precious goods (Earrings, Brooch, Ring, Necklace, Watch) in another room.
  - Instructions for EEG measurement
    - When a picture is presented on a computer screen, please push a button as quickly as possible. Please make an effort not to reveal the item you stole during the examination.
- Stimuli
  - Five Pictures：10 × 10 cm
  - Duration：300 ms
  - ISI (interstimulus interval)：2500 ms
  - Stimulus repetition: 80 times for each stimulus at random

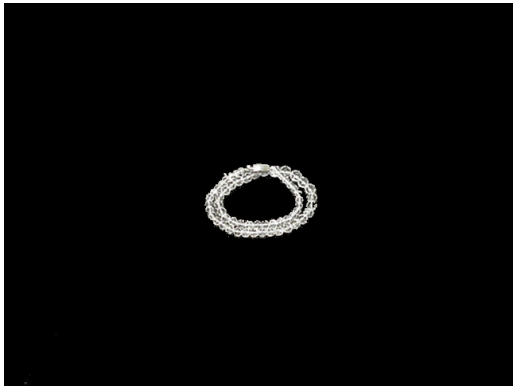
Five pictures used in this experiments



Earrings

Brooch

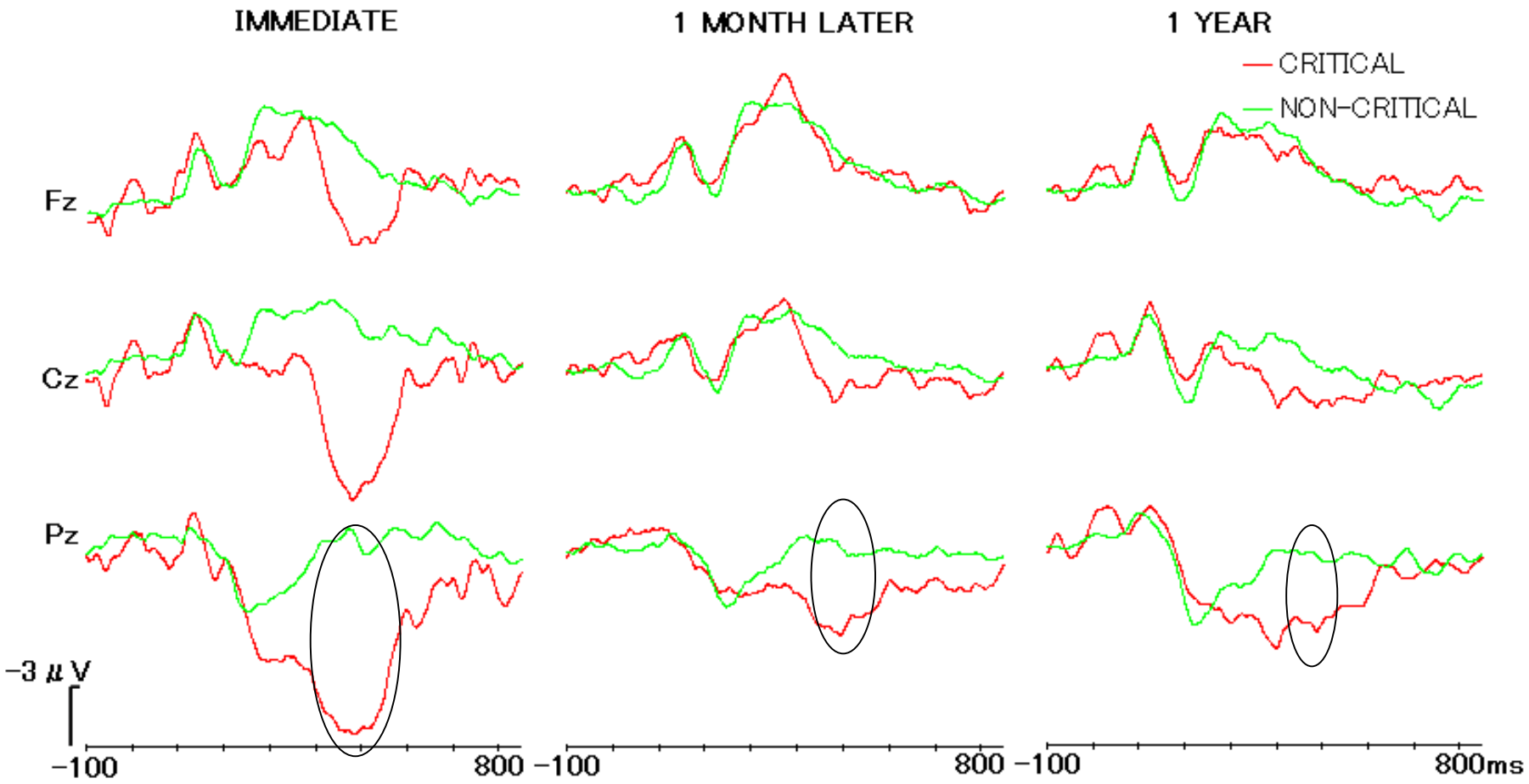
Ring



Necklace

Watch

Grand average waveforms contrasting critical/non-critical items at the Fz, Cz, and Pz (*n*=5)



The P300-based CIT has high reliability

- The P300-based CIT was effective even 1 month and 1 year after the commission of the mock crime.
- This result suggests that field applications (that have considerable delays between the commission of crime and the administration of the CIT) may be feasible, with P300 as the dependent variable.

Does it stand the test of time? "Yes"

The theme of recent P300 based-CIT in Hira Lab

- "Recall Facilitation" procedure
  - Presented by Yuki Hamamoto
- Comparison of auditory and visual stimulus presentation during the P300-based CIT
  - Misaka, Hira, & Furumitsu (2009)
- The examination of simultaneous auditory and visual stimulus presentation method during the P300-based CIT
  - Hira, Saragai, Hamamoto, & Furumitsu (2016)

Comparison of auditory and visual stimulus presentation during the P300-based CIT

	Merit	Demerit
Auditory presentation	Ignoring questions could be relatively difficult.	Less information could be provided in one question.
Visual presentation	Much information could be provided in one question.	Ignoring questions could be relatively easy.

Method

- Participants
  - Fourteen undergraduates experienced both the auditory and the visual stimulus condition (within design)
  - Informed consent was obtained from all participants
- Apparatus
  - Brainwaves were recorded from Fz, Cz, and Pz sites by TEAC polygraph system (Polymate AP1524)
  - The participants wore the Noise-cancelling headphone (SONY MDR-NC500D) to cut environmental noise in the auditory condition
- Dependent Measures
  - EEG-P300（Fz,Cz,Pz）
  - RT

Method (continued)

- Procedure
  - The participants were asked to pick up only one candy in a bag and to taste it. Although they were told that the bag contained six different flavored candies, it actually contained only Strawberry flavored one.
  - Their task during the ERP-based CIT procedure was to conceal which flavored candy they chose, and if they couldn't, the decision was guilty.
  - During the CIT, participants were asked to push a button in his/her dominant hand to the target stimulus and the other button in his/her non-dominant hand to other stimuli (critical and non-critical stimuli).

Method (continued)

- Stimuli
  - Target stimulus :Banana（バナナ）
  - Critical stimulus: Strawberry（イチゴ）
  - Non-critical stimulus: Grape（ブドウ）, Orange（ミカン）, Apple（リンゴ）, and Lemon（レモン）
    - In the auditory condition, the stimuli were presented through digitized human voice
    - In the visual condition, each word was presented on a computer screen
  - ISI (interstimulus interval)： 1800 ms (±20%)
  - Duration：400 ms

Results: Peak amplitude of P300 (Pz)

Auditory condition < Visual condition

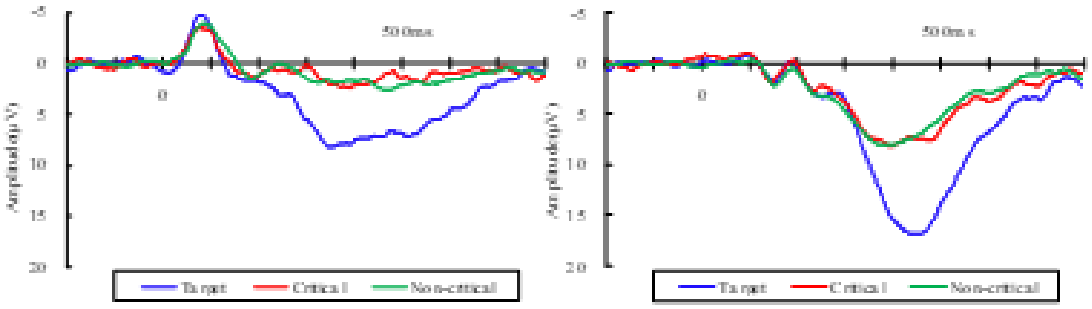


Figure 1. Grand average waveforms in the auditory (left) and the visual condition (right).

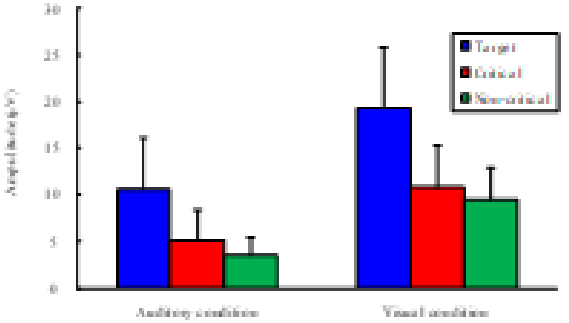


Figure 2. The Pz-recorded P300 amplitudes in the auditory and the visual conditions.

Discussion

- In the present study, the peak amplitude of P300 in the visual condition was significantly larger than that in the auditory condition. This may due to the difference of attentional processing resource allocation between two conditions.
- In the visual presentation of the stimuli, it was possible to grasp whole information in an instant from a visually presented word. In the auditory presentation condition, however, the participants should pay their attention to each syllable to recognize a whole word and this prolonged processing resulted in overall decrease of attentional resource to discriminate words.
- As a result, this was reflected to the decrease of P300 amplitude.

P300-based CIT using simultaneous visual and auditory stimulus presentation method

- This study examined the effect of simultaneous presentation of auditory and visual stimuli during the P300-based concealed information test (CIT)

- We compared pictures and words as the visual stimuli

Method

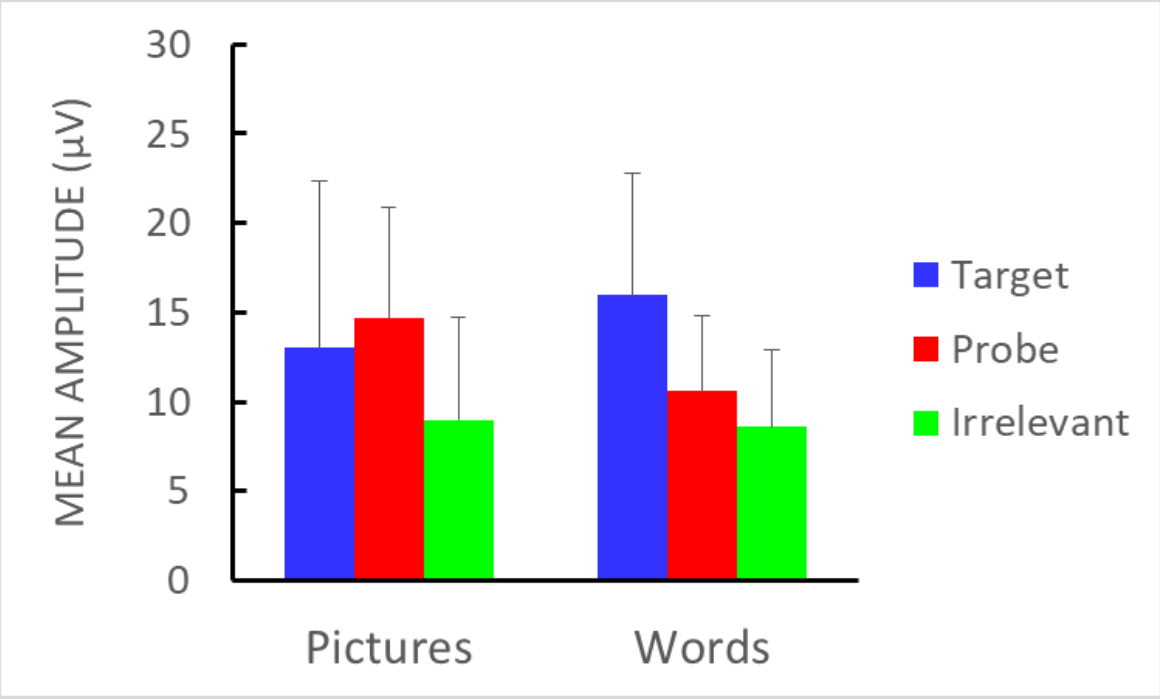
- Participants
  - Ten undergraduates experienced both the picture condition and the word condition (within design)
  - Informed consent was obtained from all participants
- Apparatus
  - Brainwaves were recorded from Fz, Cz, and Pz sites by TEAC polygraph system (Polymate)
  - The participants wore the Noise-cancelling headphone (SONY MDR-NC500D) to cut environmental noise in the auditory condition
- Dependent Measures
  - EEG-P300（Fz,Cz,Pz）
  - RT

Method (continued)

- Procedure
  - All participants were instructed to steal one of five items from a room.
  - After the mock crime, all participants underwent the P300-based CIT.
  - There were two main conditions: a picture as visual stimulus with auditory stimulus, and a word as visual stimulus with auditory stimulus.
  - Each stimulus was simultaneously presented using a computer display and headphones.

Results: Peak amplitude of P300 (Pz)

- Picture condition > Word condition



Another data of P300-based CIT using simultaneous visual and auditory stimulus presentation method

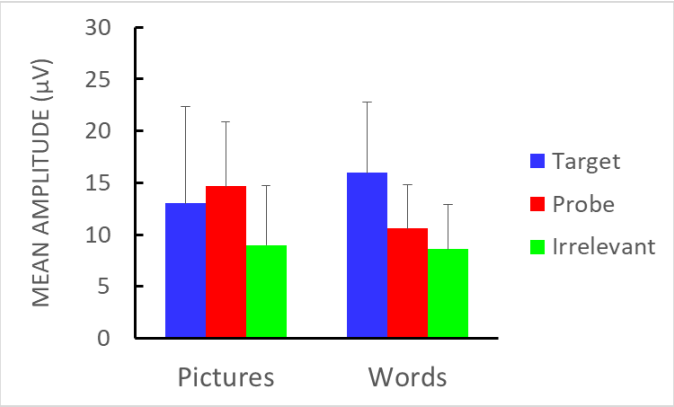


Figure 1. Comparison picture and Word

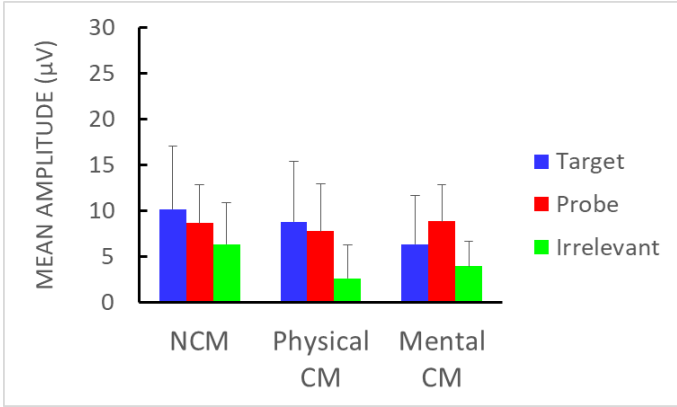


Figure 3. Comparison of no-CM, Physical CM and Mental-CM

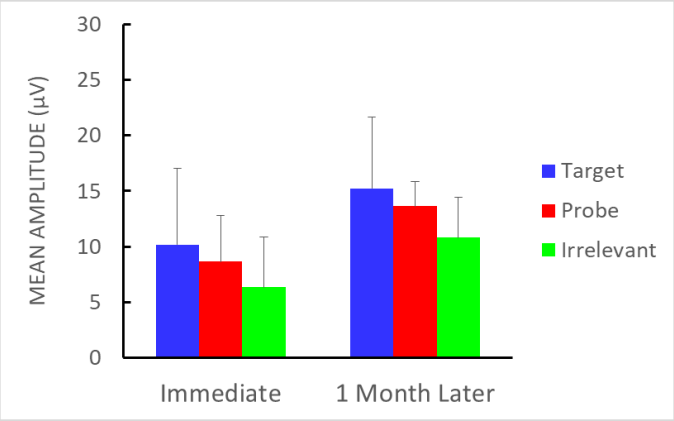


Figure 2. Comparison immediate and 1 month later

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White Paper 2016 by the National Police Agency: Prevention of international terrorism

https://www.npa.go.jp/hakusyo/h28/index.html

Prevention of international terrorism using the P300-based CIT

- Establishment of searching type information detection using event related potentials for prevention of international terrorism and organized crime
  - JSPS KAKENHI Grant Number JP17K04475 (2017-2019)
- Tomorrow's Demonstration

Construction of a psychological research network towards prevention of international terrorism

- P300, ANS
  - Hira Lab. (Fukuyama University)
  - Rosenfeld Lab.(Northwestern University)
  - Ewout Meijer (Maastricht University)
- Reaction time
  - Bruno Verschuere（University of Amsterdam）
- Eye movements
  - Gershon Ben-Shakhar(Hebrew University of Jerusalem)
  - Ailsa E. Millen (University of Stirling)
- Forced Choice Paradigm
  - Robin Orthey (University of Portsmouth, Maastricht University)

Thank you for your attention!!

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