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Brain Fingerprinting: Replication and Countermeasures

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Brain Fingerprinting (BFP)

- Detects presence or absence of knowledge about a specific event (a criminal offence for example) (Farwell & Smith, 2001) (Farwell & Donchin, 1991) (Farwell, 2008)

- Uses P300-MERMER: *memory and encoding-related multifaceted electroencephalographic response.* MERMER elicits at 500 ms and extends up to 1200-1500 ms as a negative brainwave extension of P300

Brain Fingerprinting (BFP)

99% (or above 90%) determination accuracy

Dr. Larry Farwell Has Offered a $100,000 Reward for Beating a Brain Fingerprinting Test

And Reported the Results in a Peer-Reviewed Journal

Dr. Farwell has offered a $100,000 reward for beating a Brain Fingerprinting test. Despite this $100,000 reward, no one has ever beaten a Brain Fingerprinting test. Dr. Farwell even taught subjects the countermeasures that have proven effective against other, fundamentally different, non-Brain Fingerprinting methods. Countermeasures had no effect on Brain Fingerprinting.

Like the highly motivated subjects who were criminal suspects in cases where Brain Fingerprinting could have an impact on the judicial outcome -- e.g., where Brain Fingerprinting was ruled admissible as scientific evidence in court -- all subjects who were motivated by Farwell's $100,000 reward were in every case correctly detected by Brain Fingerprinting.

Dr. Farwell and his colleagues Dr. Drew Richardson, the former chief of the FBI's chem-bio-nuclear counterterrorism response team who conducted Brain Fingerprinting research with Dr. Farwell at the FBI, and Graham Richardson, published the results of the "Real Crimes Real Consequences $100,000 Reward Brain Fingerprinting Study" in the leading peer-reviewed journal *Cognitive Neurodynamics.* Here is the article:

How it works?

- Lab setting: Hear a story about an incident and turn the relevant facts to stimuli.
- If a subject narrated the story to us = > Ground-truth Information Present (GT-IP)
- Another subject who did not tell us the story = > Ground-truth Information Absent (GT-IA)
- Divide the stimuli into two sets: **probes** and **targets.**
  - GT-IP: know both probes and targets
  - GT-IA: know targets only
- Formulate a third type of stimuli: **irrelevant** (two for each target and two for each probe): not known to either, non-relevant to the context being tested

Sea Witch case

	Information from the subject	Short descriptions	Irrelevants	
T	Dunedin Harbour	The place the group started their trip from	Marlborough Sounds	Bay of Islands
P	Waikouaiti	The name of the bay the group sailed to	Anakoha	Tutukaka
T	Sausages	Food that the group ate once they moored at the destination	Fruit salad	Weetbix
P	Threw up	Something the daughters did when they got to the open ocean	Dived in	Slipped over

T = Target
P = Probe

Task

Look at the screen, identify the targets, and press the left button.

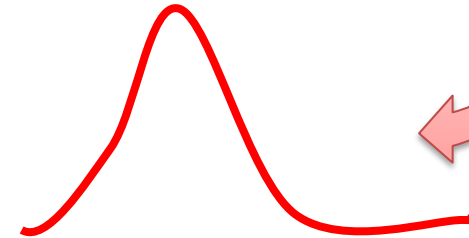Also, identify anything other than target and press the right button.

Stimuli processing

The place the group started their trip from

Dunedin Harbour (Target)

GT–IP or GT-IA

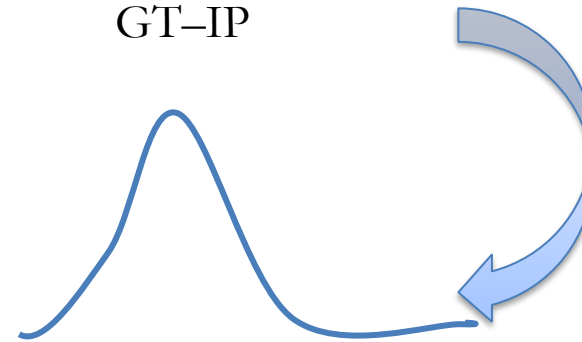**Marlborough Sounds (Irrelevant)**

GT–IP or GT-IA

Stimuli processing

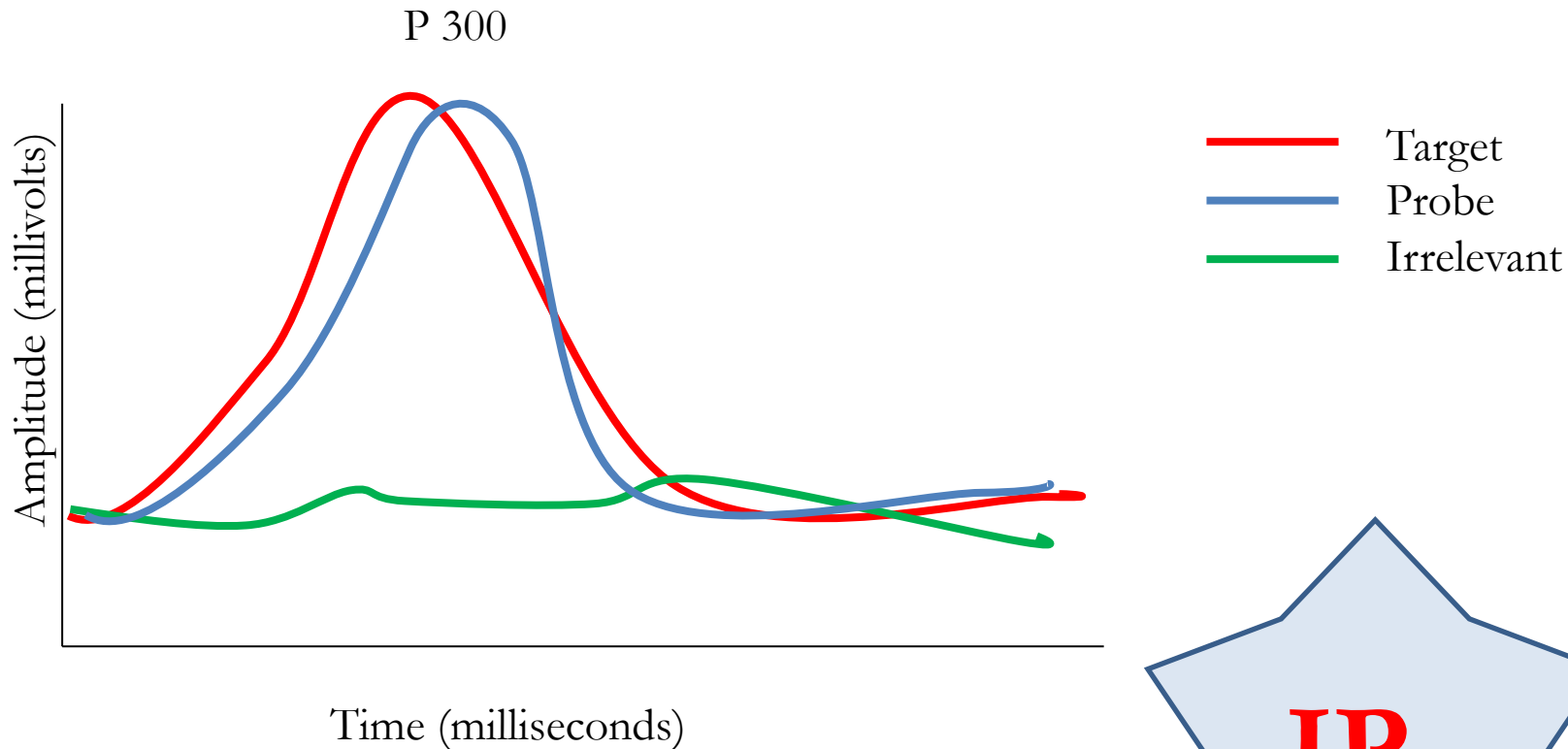The name of the bay group sailed to

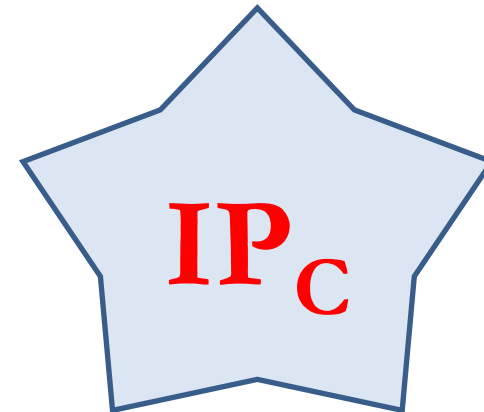Waikouaiti (Probe)

GT–IP

GT-IA

Analysis

- Compare if the **probe** amplitude is closer to the **target** amplitude or to the **irrelevant** amplitude

- A random sub-sample of timeseries data (epoch 300 – 1800 ms) between probe, target, and irrelevant ERP responses, use a double-centred correlation to compare them, and repeat it 1000 times.

- The **frequency** of probe-target correlation being **greater** than probe-irrelevant correlation is calculated as a percentage, that is termed *bootstrapping probability*.
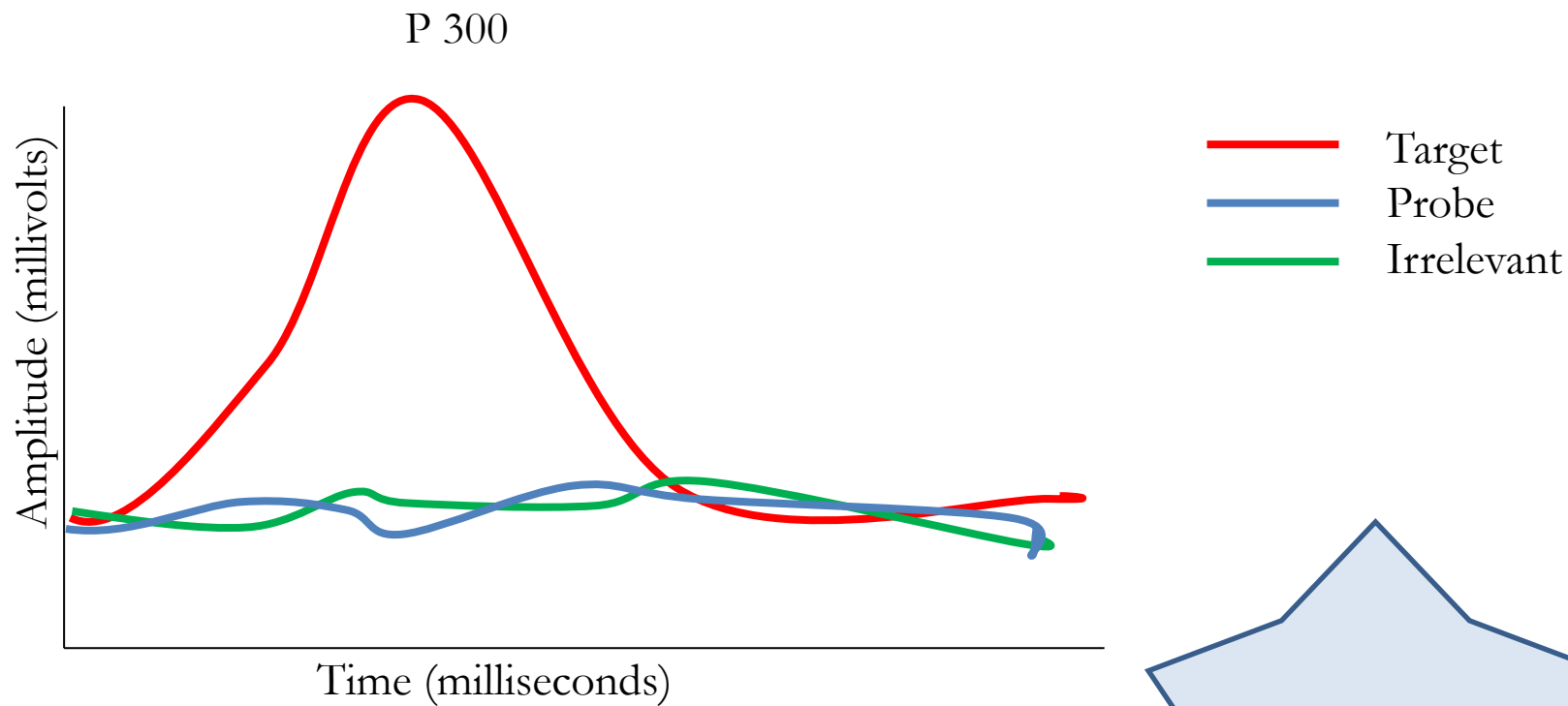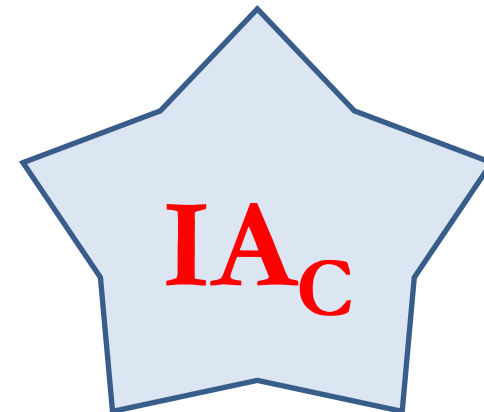
Indeterminate
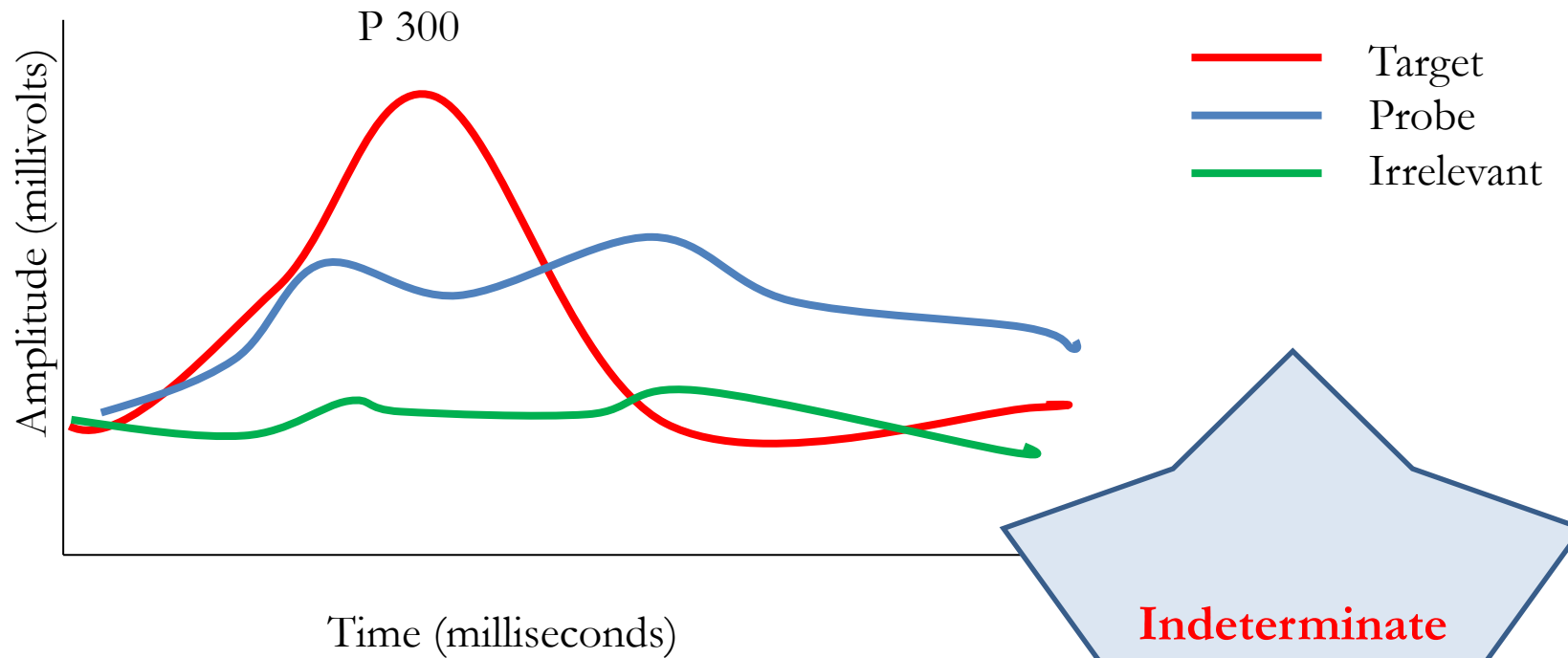
If the bootstrapping probability is between 30% to 90%

- $n = 17$ ($n = 5$ ground-truth IP and $n = 12$ ground-truth IA) from a parolee housing facility in Christchurch
- **Blind** tested on real-crime incidents that they had committed and served time for
- Four subjects excluded due to inability to complete the test
- One subject excluded as they did not complete the test
- 12 subjects completed the test
- Outcomes:
  - IP: 2/2. Mean bootstrapping probability : 98.7%
  - IA: 6/10. Mean bootstrapping probability: 99.4%
  - Error: One false positive, a GT-IA being classified as IP with 93.5% bootstrapping probability
  - Indeterminate: 3 subjects (originally GT-IA)
  - Determination accuracy: 91.7%

Re-testing the false positive subject

- On another incident: GT-IA => IP_C
- On his own crime incident: GT-IP => Indeterminate

BFP Countermeasures Study

- Bergström studies: No access to Farwell's system and not following 20 Scientific Standards

- Study design: Phase 1 and Phase 2

- Phase 1: 32 subjects (16 GT-IP and 16 GT-IA): tested on real-life incidents

- Phase 2: 16 subjects: re-tested with manipulation on real-life incidents. Randomly assigned to *memory suppression* or *thought substitution* groups

- 31 subjects met BFP requirements

- Correct determination: 29/31 subjects

- Correct IP: 15/16
  - Indeterminate: 1 (originally GT-IP)

- Correct IA: 14/15
  - Error: One false positive, a GT-IA being classified as IP with 98.5% bootstrapping probability

- Determination accuracy: 96.8%

Phase 2 Results

- Phase 2: 16 subjects: re-tested with manipulation on real-life scenarios. Randomly assigned to *memory suppression* or *thought substitution* groups

- All 16 subjects were again determined as IP

- Neither *memory suppression* nor *thought substitution* countermeasure could conceal information that BFP was trying to reveal

- We had no grounds to claim $100K offered by Farwell to beat BFP ☹

A False Positive Pattern

- Replication study: Error: One false positive, a GT-IA being classified as IP with 93.5% bootstrapping probability

- Countermeasures study: Error: One false positive, a GT-IA being classified as IP with 98.5% bootstrapping probability

- Iacono (2008) stated that the "guilty knowledge testing" tests tend to have a false positive rate of 2% - 5%, but this is common for other types of incriminating tests too. In addition, psychophysiological memory detection techniques may result in false positive even if administered properly.

- The scientific community still value P300-based tests over autonomic measures of guilt detection (Iacono, 2008).

Conclusions

- The BFP results correctly matched crime-incident episodic memories in most tested Ground-truth IP subjects (2/2 in the Replication study and 15/16 in the Countermeasures study)

- And for a majority of Ground-truth IA subjects (6/10 in the Replication study and 14/15 in the Countermeasures study)

- One false positive in each study

- A total of four Indeterminates in both

- Claims from previous studies that BFP has no false positives and no Indeterminates have not been confirmed.

- Identified four subjects who could not complete the test (not reported in Farwell studies)

- However, the cognitive countermeasure were ineffective against BFP.

- Bergström vs. Farwell: mock burglary vs. real-life scenarios

- Contrary to what Farwell claims and practices, we conclude that BFP is not yet at a stage where it can be used as a robust and completely accurate crime-detection tool.

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Thank you

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