



Project Overview

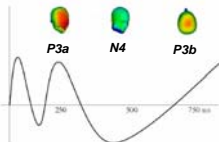
Deception

Arguably one of the most complicated and dynamic socio-cognitive tasks performed by the brain, it is not surprising that ERP research has not identified a singular waveform exclusively associated with the process of deception. Instead, there are a number of waveforms that may result from the differing stimuli present during an interview process:

P3a - an early waveform with positive anterior distribution and latency between 250-350 ms

P3b - a positive waveform with parietal distribution and latency between 350-600 ms

N4 - an anterior waveform with negative deflection with latency of about 400 ms



These three waveforms may work together in a process of deception in which a question is asked, attention is switched, workload demands are assessed, memory for the truthful information is accessed, motivation to deceive is considered, and then a decision to deceive is made. To be sure, a more accurate technology for detecting deception will have broad reaching public relevance.

The Two-Stimulus Paradigm

Directed Lie Procedure

Participants view (on 29" Color Video Computer Monitor) autobiographical statements that are true or false (randomly presented) followed by a second stimulus to which they responded with a key press indicating agreement or disagreement. During the experiments, a total of 40 of each response type were presented.

EXP 1: Low Workload

Experiment: Know truth value and task at stimulus 1
 Demographics: Aged 18-43 (M = 21.38); N=39



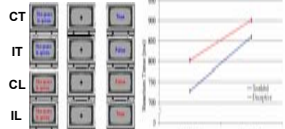
EXP 2: High Workload

Experiment: Know truth value only at stimulus 1
 Demographics: Aged 18 to 21 (M = 19); N=19



Behavioral Findings

Reaction time (RT) was defined as the latency between the onset of Stimulus 2 and the subject's response. Our analysis indicates that RT values are less for truthful responses than for deceptive.



We find no interaction between response congruity and deception in either experiment. For this reason further analysis of the incongruent data was not undertaken.

Data Acquisition

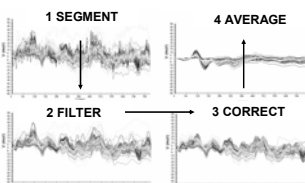
ERP data were recorded using the EGI System Geodesic Sensorset:

- 128-channel array
- Sampling rate F = 250 Hz
- Impedance value z = 100 KΩ



Data Processing

Data are segmented using an 100 ms baseline and an 800 ms post-stimulus period. As human EEG peaks in the alpha band (10-12 Hz) data are band-pass filtered at 0.1-33 Hz. Any "bad" channels (e.g., eye blink) are then replaced with their nearest neighbor average and responses are averaged to increase the signal-to-noise ratio: $SNR \propto \sqrt{N}$

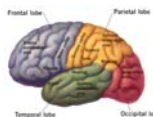


Traditional Waveform Analysis

Neurophysiology of Attention

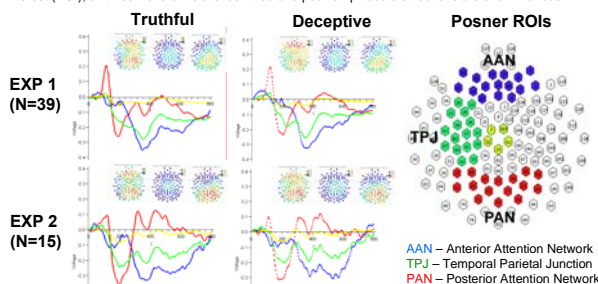
We utilize the well-known Posner constructs of attention to posit that activity in the frontal, temporal and occipital regions will have the greatest physical significance for our task:

- Frontal Lobe - Organization, Executive Control
- Temporal Lobe - Short-Term Memory, Orienting
- Occipital Lobe - Visual Reception and Recognition



Regional Waveforms and Peak Identification

Subject grand average data were scaled and then regional waveform data are plotted for select regions of interest (ROI); all three waveforms are identified and peak amplitude distributions are shown for each.



ERP Energy and Cognitive Activity

Energy from Power

We integrate the instantaneous channel-power over successive time intervals to obtain a measure of the energy emitted during individual response trials:

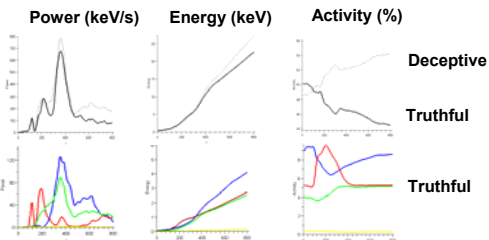
$$E_n^{C_i}(t) = \frac{1}{z} \int_0^t V_n^C(r') V_n^C(r') dt',$$

where z is the impedance value. The differences in response energy are set by population dynamics.

$$E_n^{C_i} = E_n^{C_j} + k_p T \ln \left(\frac{N_n^{C_i}}{N_n^{C_j}} \right)$$

EXP 1
Cortex
Average

EXP 1
Posner
ROIs



Cognitive Activity

We define the cognitive activity for ROIs with a weighted sum of the ratio of the channel-energy for one state to the total energy from both states:

$$\eta_{ROI}^{C_i}(t) = \frac{E_n^{C_i}}{E_n^{C_i} + E_n^{C_j}}$$

By construction, the sum over all channels and responses is unity, i.e.,

$$\sum_{n=1}^{128} \eta_{ROI}^{C_i}(t) + \eta_{ROI}^{C_j}(t) = 1.$$

Neocortical Interactions

Attention Based Activity

We observe that cognitive activity levels over the AAN tend toward a minimum value at nearly the same time that activity levels over the PAN reach their maximal values. It is plausible to assert that attention switching between executive control functions in the frontal areas and access to language processing skills in posterior regions may account for this.

Load-Switching Time

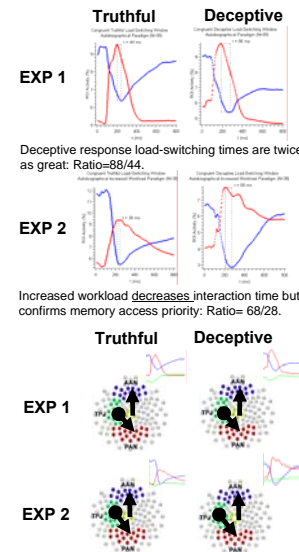
We assess neocortical interaction times by determining the latency for extrema of the regional activity values. Hence we define the load-switching time as the difference in the maximal PAN and minimal AAN latency values:

$$t_{ls} = t_{PAN_{max}} - t_{AAN_{min}}$$

"Neocortical Circuits"

A straight forward model of cognition wherein access to memory (TPJ) precedes stimulus processing (PAN) and task execution (AAN) illustrates that truth and deception utilize similar neocortical circuits with different timing.

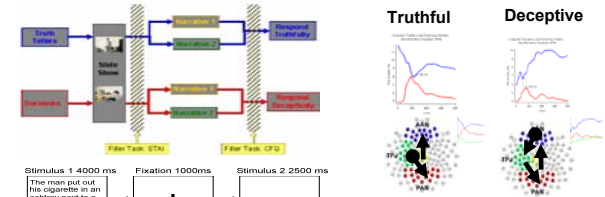
EXP	TASK	PAN MAX (ms)	TPJ MIN (ms)	AAN MIN (ms)
1	CT	200	124	244
1	CL	188	136	276
2	CT	220	132	248
2	CL	208	136	276



Continuing Efforts

Misinformation

Participants (N=8) in two groups were shown 70 slides in which a repairman comes into an office and steals several items. Afterward participants performed a filler task for five minutes. Then they read a narrative of the slides to "refresh" their memories. The narratives each misnamed two items from slides.



Responding deceptively to misinformation takes longer: Ratio = - 60/40.

This research should allow us to determine the impact of neuropsychology, cognitive abilities, and personality variables on the processes of attention and memory, and allow us to separate deceptions from misremembered facts. Early executive control (AAN) appears evident in our plot data for Deceivers.