SPCN 2020 Keynote
THE CONSCIOUS AND UNCONSCIOUS VISION

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23 September 2020
• Introduction
• Methods
• Telescopic and Periscopic Visual Systems
• Characteristics of Eye Movements
• Extraction of the Hidden Information
• Discoveries and Inspirations
The amount of information entering the brain directly from the retina is very large. An approximate estimate of this volume has been obtained by multiplying the upper cutoff frequency of impulse rate of axons in the optic nerve and the number of fibers in the optic nerve $4.56 \times 10^6$ bit per second [Schober, 1956]. In Pavlov Institute in the 50’s by Vadim Glezer and Ilya Tsukkerman in experiments based on arbitrary (conscious) data retrieval from memory is dramatically less.
According to Preeti Verghese and Denis Pelli, the “processor” of the selective attention is the bottleneck of the visual system channels which can allocate only 30-60 bits of information, which narrow down the obtainable data. In recent years, special attention has been paid to channels transmitting unconscious information. It should be noted that unconscious information largely determines the "intuitive" assessment of the background-target situation and the operator's decision-making.
The visual system channels transmitting conscious and unconscious information.
Methods

Masking. To achieve this goal our research formation of a dynamic image of the target hidden in background environment with different types of camouflage was carried out. Dynamic images were formed on a CRT display, with refresh rate 160 Hz. On the screen subjects see the mask, but not see under it the hidden signals. Besides the mask that covered the signal, we used additional masks to further distract the attention. It is like a well-known effect of unattentional blindness, which consists of ignoring the visual target - signal in conditions of distraction of attention by another signal in another part of the visual field.

We provide recordings of the brain unconscious reactions and the eye The simultaneous facial muscle movement recordings as a mimicking reaction are also provided.

The recordings contain multi-modal EMG and EEG control signaling data.
The unconscious stimulus perception.
The gaze fixation “point” (+); the pseudo goal (vertical stripes), the stimuli of unconscious priming (hidden face).
S (deg) screen size and position of the complex image during one realization.
t (s) time, order of frames with different realizations of “noise windows” with and without “hidden face”.
Telescopic and Periscopic visual systems

• Telescopic visual system – It is the central foveal which reveals mainly the conscious vision. It has high spatial resolution, but a low temporal resolution.

• Periscopic vision includes all the human visual field. The periphery of the field of view has high temporal resolution, but a low spatial resolution.

• Periscopic vision solves the following tasks: monitors the surrounding scene, detects a target, provides preliminary target recognition with a coarse resolution, controls the oculomotor system, aims the foveolar part of the retina with high resolution. This is mainly unconscious vision.
The purpose of this work is to develop masking conditions for selective activation of the supposed channels of unconscious reception of hidden information, to be observed optically.

The “objective” physiological methods (control of eye movements and human facial expressions) permit us to determine whether the observer has perceived this information.
“Witch's Circle”

This is a projective test after unconscious transmission of information to the brain.
The main characteristics of eye movements of the "Control" and "Experience" tested groups of

<table>
<thead>
<tr>
<th>№ image</th>
<th>Duration of finding the gaze on the object, ms</th>
<th>The number of gazes transferred to an object from other areas</th>
<th>The number of gaze movements inside the object</th>
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<tbody>
<tr>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>3218±1512 (I)</td>
<td>3.4±1.7</td>
<td>4.6±2.4</td>
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<td>2</td>
<td>2938±635.3</td>
<td>3.4±1.4</td>
<td>5±1.8 (I)</td>
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<td>3</td>
<td>2334±634.5</td>
<td>3.0±1.6</td>
<td>4.4±1.7</td>
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<td>5</td>
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<td>6</td>
<td></td>
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<tr>
<td>Experience</td>
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<td></td>
</tr>
<tr>
<td>1</td>
<td>2335±695.6</td>
<td>4.2±1.2</td>
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<td>2817±2429.4</td>
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<td>6±3.9</td>
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<td>3.3±0.9</td>
<td>3.8±1.1</td>
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<td>6.5±4.6 (I)</td>
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<td>11</td>
<td>2535±858.3</td>
<td>4.6±1.6</td>
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</table>
Facial Expressions resulting from Unconscious Vision
A Close Look
The electrical reactions of the muscles in smile to sequential presentation of a series of frames containing images of smiling faces and images of sad faces.


1 - reaction to the images of smiling faces, 2 - to sad faces.

The abscissa the time of stimulus presentation from the start. Averaging over 12 subjects.
UNCONSCIOUS VISION

m. zygomaticus

A EMG

m. corrugator

CONSCIOUS VISION

funny
sad
neutral

t (s)
Occipital – frontal cortex interaction


Extraction of the Hidden Information

• In order to reveal that the unconscious signal was received by the observer, we checked the effect of its action on the decision-making on the control of involuntary eye movements or facial muscles of the subject.

• This "missing" information unconsciously affects the decision-making process, planning, organization and control of movements, since it is in it that some statistical properties of environmental images are evaluated. To extract hidden information from memory, objective (optical or electrophysiological) research methods are required. Our results confirm this assumption. In this work, the possibility of transmitting conscious and unconscious signals through different channels of the visual system, which differ in their optical (spatio-temporal) characteristics and transmit various information, has been considered.
Discoveries

- Unconsciously received and stored information can influence the main process of decision-making, planning and organization of movement. Analysis of involuntary movements shows that, based on their assessment, it is possible to claim that the unconscious stimulus is actually stored in the human brain and it influences decision making. This influence can be identified in conditions of uncertainty (equal choice). Unconsciously received signals and unconscious computation some statistical patterns in their appearance unconsciously (like intuition) influence decision making under equal conditions of contribution.

- Physiological ideas about the interaction of central and peripheral vision propose a new system of automatic unmanned vehicle control. Peripheral vision selects an area of interest in the field of view and gives a signal for movements. The new artificial recognition and controls systems confirm that periscopic vision is based on common statistical assessments of the situation, provides prediction and bias in decision making at the bifurcation point. Such an organization is a new control principle for systems based on the technology of integrating computing resources and physical objects.
The possibility exists by controlling the parameters of dynamic images of the mask for the formation of unconscious signals.

These unconscious signals determine decision-making by the person and the organization of his movements.

Engineering of such neurotechnological approaches permits us to develop new navigation systems.
A New Vision – 
Ying and Yang, 隱陽 
unconscious and conscious

• The conscious and unconscious vision are subtle, intertwined mechanisms leading to human reflections. They are manifested in visual system, best illustrated by the ancient principles in Taoism, the Taijitu (太極圖).

• The Pavlov Institute of Physiology is looking forward collaboration with the National Central University, through Dr. Narisa Nan Chu, in pursuit of such promising realization and development.
References for Slides 3 & 4


References for Slide 22
