**Project Title:** Objective Methods to Test Visual Dysfunction in the Presence of Cognitive Impairment  
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**Background:** Injury to the visual system commonly results from traumatic brain injury (TBI), but may be difficult to detect in patients with cognitive impairment who cannot reliably perform standard tests of vision, such as perimetry (visual field testing). Objective reflexes to visual targets using the pupil, evoked potentials, or eye movements may provide an ideal solution.

**Objective/Hypothesis:** Natural reflexes of the brain, such as the pupil light reflex, light evoked potentials from the eye and brain, and the ability of a patient’s eyes to fix and follow a moving visual target are powerful, underutilized approaches for diagnosing and monitoring dysfunction at specific locations along the visual pathway from the eye to the brain. Researchers propose to optimize these objective approaches, making it possible to accurately assess vision over the spectrum of a patient’s condition from unconsciousness to awake, but cognitively impaired. Optimization of signal to noise by informed selection of visual stimuli and innovative analysis approaches will provide a new low cost solution for objective assessment of visual function in traumatic brain injury in patients over a wide range of cognition.

**Hypothesis:** Specific areas of the visual pathway in the eye and brain can be interrogated by a battery of visual stimuli designed to provide a broad inventory of system-wide functioning after traumatic brain injury.

**Specific Aims:** In preparation for testing of cognitively impaired patients, investigators will first optimize three objective tests of visual function and validate them against standard behavioral tests of visual field sensitivity which can be performed accurately by cognitively intact patients. Once validated in cognitively intact subjects, then these tests can be used in cognitively impaired patients. Normal eyes and eyes with well-defined damage to the retina, optic nerve, or visual cortex will be used to compare the different modalities of testing.

The three objective modalities of visual testing to be measured are a) pupil contractions to focal, regional, and diffuse light stimuli, b) evoked potentials to focal and diffuse light elicited from the retina and visual cortex, and c) eye position correlated with moving visual targets varying in spatial properties.

**Aim 1:** In normal eyes, define range of values for pupil light reflexes, evoked potentials and eye movements to targets changing in resolution.

**Aim 2:** In eyes with damage to the retina or optic nerve, define range of values for pupil light reflexes, evoked potentials and eye movements to targets changing in resolution.

**Aim 3:** In eyes with damage to primary visual cortex (V1), define range of values for perimetric pupil light reflexes, evoked potentials and eye movements to targets changing in resolution.

**Study Design:** Cross-sectional study of normal subjects and patients with damage to different locations in the visual pathway; the retina, optic nerve, and visual cortex. Objective measures of visual function will be validated by comparison to standard visual field testing to determine sensitivity and specificity using Receiver Operator Characteristic (ROC) curves.

**Relevance:** Objective neurologic reflexes will be optimized for testing of visual function in patients whose cognitive state may limit usefulness of standard vision tests. By applying these tests and validating them against standard vision testing, patients and military personnel with visual dysfunction can then be better diagnosed and characterized to improve outcomes of therapeutic interventions. The successful outcome of this study will also allow application of objective tests to assess patients over a wider range of impaired consciousness and cognitive dysfunction. This will define the hardware requirements needed to record these reflexes efficiently and inexpensively in a variety of military arenas.