Center for Visual Neuroscience

Mini Conference
September 16, 17, 2005
Fargo, North Dakota

AGENDA

Friday, September 16

Part I

9:30 LAB TOURS in Psychology Department, 119 Minard Hall

11:00 BREAK

1:00 Talks begin downstairs in Reimer's Conference Room (lower level)

1:00 Linda Langley, North Dakota State University
"*Aging and the Role of Inhibition in Visual Search*"

1:25 Patricia Reuter-Lorenz, University of Michigan
"*Affective Working Memory: Converging Evidence for a New Construct*"

1:40 Robert Gordon, North Dakota State University
"Selective Attention During Scene Perception"

2:05 Arthur Kramer, University of Illinois
"Aging and Multi-Task Performance: In and Out of the Lab"

2:20 BREAK in Atrium

Part II

2:50 Chris Kelland Friesen, North Dakota State University
"Orienting in Response to Directional Cues"

3:15 Wolfgang Teder-Sälejärvi, North Dakota State University
"Selective Attention to Rapid Tactile Stimuli – ERPs and Source Localization"

3:35 John Foxe, Nathan S. Kline Institute for Psychiatric Research
"Spatiotemporal Dynamics of Human Object Recognition Processing: Integrated high- density electrical mapping, functional imaging and human intracranial studies of 'perceptual closure' processes"

3:50 BREAK in Atrium

4:20 Mark Brady, North Dakota State University
"Collecting Natural Images for Vision Science"

4:40 Daniel Kersten, University of Minnesota
"Natural Images, Natural Percepts and Early Visual Processing"

4:55 Stéphane Rainville, North Dakota State University
"fMRI Evidence for an Intermediate Visual-Shape Population Code in Lateral Occipital Cortex"

Lab Tours/Demonstrations
Psychology Department
119 Minard
9:30 a.m.

Cognitive Aging Lab

Linda K. Langley
Minard 118P

Age Differences in Inhibition during Visual Search ("SearchProbe" Task)

The purpose of this study is to look for evidence of inhibition of return (IOR) in the visual search performance of younger and older adults. In this paradigm (R. Klein, 1988), a visual search task is followed by a probe detection task. Probes are presented at either the location of a potentially searched distractor (on probe) or an empty location (off probe). We expect to find that IOR will be reflected in slower responses to on probes than to off probes, particularly under inefficient search conditions (find an O among Cs), whereas inhibition will be less necessary during efficient search (find a C among Os). We additionally expect to find that older adults will demonstrate a reduced ability to inhibit re-inspection of distractors.

Mark Nawrot (Lindsey Joyce, Chad Stockert)
Eye Movements in the Perception of Depth from Motion Parallax
Minard 118X

Motion on the retina provides an excellent source of information for depth perception. However, in the absence of extra-retinal information, this retinal motion is depth-sign ambiguous. We believe that the pursuit system provides the crucial extra-retinal information for the perception of unambiguous depth from motion parallax. These demonstrations will present a variety of conditions illustrating the role of pursuit in motion parallax.

Chris Kelland Friesen
Gaze- and Arrow-Triggered Orienting Without Awareness?

Minard 119F

One of the characteristics of reflexive orienting in response to peripheral sudden onset cues is that it can occur without awareness (McCormick, 1990). Can orienting in response to nonpredictive central directional cues also occur without awareness? Here, I will demonstrate experiments in which we explored this question by presenting masked gaze and arrow cues in a modified version of the Posner cuing paradigm. On each trial, a cue (a schematic face gazing left or right, or an arrow pointing left or right) is presented at central fixation for 14 ms, followed by a mask. After a variable SOA, a target (X or O) appears equiprobably either at the location indicated by the cue (valid trial) or on the opposite side of the screen (invalid trial). The observer's task is to make a speeded keypress to indicate the identity of the target, and then: (1) to say whether they saw which way the cue was directed, and (2) to guess which way the cue was directed. This method allows for an analysis of cuing effects (RT benefits for validly cued targets) on only those trials on which observers were unable to report the direction of the cue.

Mark McCourt and Barbara Blakeslee
Immersive Virtual Reality Display Systems
Minard 119H

Two immersive VR display systems, one utilizing a head-mounted, position- and orientation-tracked display system, the other utilizing an ultra-wide field of view projection system, will be demonstrated.

Stephanie Simon-Dack and Jake Hillman
High-Density EEG Recording and Analysis Laboratory

Minard 119P, D

The capabilities of the CVN Core laboratory in high-density EEG will be described and demonstrated.

Wolfgang Teder-Sälejärvi
Stimulus Presentation Systems for Multisensory Research
Minard 120

I will present the concepts and plans for two stimulus delivery devices, one being an audiovisual presentation system and the other a tactile stimulator.

The audiovisual device consists of an unique concave array of 11 columns and 5 rows of small loudspeakers and groups of light-emitting diodes (LEDs) that can be illuminated in many configurations. Tones and various light flashes can appear simultaneously (or temporally disparate) in a spatially congruent or incongruent manner. This device will make it possible to research a multitude of cross-modal questions, such as event-related neural activity correlates in response to object disintegration or object formation, object motion, audiovisual memory etc. I will also show a prototype of a tactile stimulator that I have used for three somatosensory studies and explain the plan for the development of a multichannel tactile stimulator system.

Mark Brady
Object Perception Laboratory
Minard 110

We will be demonstrating 3D scene scanning and discussing application of such scanning in our research. We will also be showing the design of our illumination replicator, which is under construction, and discussing its applications.

Lynnette Leone and Mark McCourt
Multisensory Integration
Sound Chamber

Multisensory integration is the process by which the human brain combines information from individual sensory systems on particular neurons which results in a neuronal response that is qualitatively and quantitatively different than the responses of these neurons to individual signals (Calvert, 2001). An example of facilitative multisensory integration is the redundant signals effect (RSE) in which the presentation of two signals from different sensory modalities can result in reaction times and neuronal responses that are faster than the combination of responses to each signal individually. One model used to explain the RSE is neural coactivation in which signals on separate channels interact to satisfy some response criterion. Examination of this model will benefit from an investigation of the temporal properties of the redundant signals effect with regard to conditions in which the response of the visual system is temporally variable. Stimulus spatial frequency is one such condition. In this study, we examine the RSE in response to combinations of high spatial frequency visual stimuli (18 c/degree) and auditory stimuli across a range of stimulus onset asynchronies (SOA's) and compare the results to those obtained in response to combinations of low spatial frequency visual stimuli (0.5 c/degree) combined with auditory stimuli. Support for neural coactivation models would come from changes in the time-course of the RSE which correspond to changes in signal processing in the visual modality.

Rob Gordon
Gordon Eyetracking Lab
Minard 118K

I will demonstrate how we're using the Eyelink II eyetracker to investigate the dynamic representation of objects. In this experiment, we're examining how temporary object representations ("object files") supporting transsaccadic integration change over time. On each trial, subjects view two preview stimuli in peripheral vision. On half of the trials, they immediately initiate a saccade to fixate a small target located between the stimuli; on the other half of the trials they initiate a saccade only when an auditory signal cues them to do so, several hundred milliseconds later. During the saccade, the preview display is replaced with a target display containing an object in one of the preview locations and a nonsense object in the other. The target object may match one of the preview items, or not; when it does, its orientation may be the same as in the preview, or different. The subject's task is to name the object as quickly as possible. I anticipate that object-specific priming of that response (the advantage of previewing the target <u>in the same location</u>) will be reduced as a result of the orientation change when the saccade is executed without delay, but not when a delay is introduced. Such a result would suggest that object representations are dynamic, representing perceptual information initially and more abstract (post-categorical) information over time.

118K – Gordon Eyetracking Lab – Behavioral Study Demo
This demonstration will illustrate one method I've used for investigating the guidance of attention during scene perception. On each trial, a scene is presented for a brief duration (51 or 183 ms); the scene contains either an inserted consistent and inconsistent object (e.g., a globe or lawnmower in a classroom), or two consistent objects. The probe is followed by a mask, in which a probe stimulus (& or %) is embedded. In this experiment, the probe stimulus is always presented at the location of a consistent object, and the subject's task is to identify the probe as quickly as possible. The results of this experiment indicated that, for scenes presented for 183 ms, subjects identified the probe more slowly when the scene contained an inconsistent object elsewhere in the scene than when it did not. This result suggests that attention is drawn to the location of the inconsistent object during scene presentation

Abstracts of Presentations

Linda Langley, North Dakota State University

"Aging and the Role of Inhibition
and in Visual Search"

The goal of this project is to determine the cognitive mechanisms that contribute to adult age differences in visual search, focusing on inhibitory mechanisms. Inhibition of return (IOR), a phenomenon of attentional orienting that is indexed by slower response times to targets presented at previously attended locations, is considered largely intact with age. This talk will describe the findings of three grant-funded studies that examined age differences in IOR. Two studies found age differences in the temporal resolution and spatial distribution of IOR. A third study found similar patterns of inhibition for younger and older adults within a complex search environment. Studies that use eye tracking and electrophysiological techniques to explore aging and inhibition will also be discussed.

Patricia Reuter-Lorenz, University of Michigan

"Affective Working Memory: Converging Evidence for a New Construct"

In daily life emotional feeling states come and go, often influencing our thoughts, decisions and actions in ways that we may or may not recognize. Given the seeming automaticity of emotions, the idea that our mental architecture might include a kind of workspace or working memory for emotion may seem counterintuitive. However, Davidson & Irwin (1999) made just this claim when they proposed the existence of affective working memory. To date there has been little empirical work to directly address the viability of this construct. I will present an overview of new converging evidence from behavioral studies of younger and older adults, and neuroimaging results to support the idea that working memory includes a separable subsystem for the on-line maintenance of affective representations. Affective working memory may serve a vital role in evaluative judgments and decision-making.

Robert D. Gordon, North Dakota State University

"Selective Attention During Scene Perception"

A key to understanding the perception and representation of complex scenes lies in determining the factors that guide attention during scene viewing. In a series of experiments, I have investigated the influence of scene semantics on the allocation of attention. The results of such experiments suggest that attention is drawn preferentially to the locations of inconsistent objects, whose identities conflict with the scene context. Two accounts of this effect will be described, and evidence will be presented that is supportive of one account: that attention is drawn to inconsistent objects because they represent areas of perceptual dysfluency. Thus, semantic factors appear to influence attentional allocation during scene perception by affecting the ease with which objects in the scene are identified.

Arthur Kramer, University of Illinois

"Aging and Multi-Task Performance:
In and Out of the Lab"

I'll speak about our recent research on two distinct but related topics. First, I will briefly describe some of our research on optimizing driver performance across the adult lifespan through the use of collision avoidance devices. Studies in a variety of driving environments with increasing levels of complexity will be examined. Second, I will discuss some of our recent research on changes in the neural circuits, as indexed by event-related fMRI, as a function of adaptive multi-task training with young and older adults.

Chris Kelland Friesen, North Dakota State University

"Orienting in Response to Directional Cues"

My research program is aimed at understanding how, and under what circumstances, humans will orient spatial attention in response to directional cues, such as arrows or another person's eye gaze direction, in the visual environment. Using traditional experimental cuing methods, researchers have shown that nonpredictive centrally-presented directional cues can produce a shift of spatial attention that is reflexive or automatic in nature. After presenting background information on orienting to directional cues and comparing this orienting with traditionally-studied exogenous and endogenous orienting, I will describe some current and recently-completed directional cuing experiments conducted in my laboratory. One recent study tested the reflexivity of this orienting by presenting gaze and arrow cues under conditions of unawareness of the cue. A second recent study compared orienting to nonpredictive gaze cues, arrow cues, and peripheral sudden onset cues within the same subjects. In this study, the time course of reflexive orienting in response to these three cue types was examined by varying both cue-to-target SOA and cue duration. A third within-subject study (in progress), which is pilot work for an ERP study, examines the time course of orienting in response to both spatially predictive and spatially nonpredictive gaze, arrow, and symmetrical symbolic cues. In this study, the goal is to identify exogenous and endogenous components associated with central directional cues that either do or do not have inherent visual properties indicating directionality. Finally, I will outline plans for future studies arising from the results of these studies, as well as plans for several other related research projects.

Wolfgang Teder-Sälejärvi, North Dakota State University

"Selective Attention to Rapid Tactile Stimuli – ERPs and Source Localization"

We investigated the time course and scalp topography of ERPs to rapidly presented tactile stimuli in 15 human subjects. High density EEG and EOG recordings were acquired from 62 electrodes, referenced to the averaged mastoids (bandpass 0.1-100 Hz, sample rate 250 Hz, excessive blinks and eye movements rejected offline). Brief tactile stimuli of 10 ms duration were delivered via four actuator rods (1 mm tip diameter) to the pointer fingers (frequent standard stimuli, p=.45) or middle fingers (infrequent deviant target stimuli, p=.05) of each hand. The inter-stimulus interval (rectangular distribution) varied between 270 and 540 ms. The subject's task was to press a footswitch to targets appearing either at the left or right middle finger in separate runs. Inspection of the grand-average standard-stimulus waveforms and topographical iso-voltage maps revealed a slightly lateralized, relatively sharp early negative component (N45) with a maximum over fronto-central cortex. This early component inverted in polarity over centro-parietal sites and was influenced by the direction of attention. We also observed attention-driven, lateralized modulations of a later component with a central distribution, peaking at about 130 ms.

John Foxe, Nathan S. Kline Institute for Psychiatric Research

"Spatiotemporal Dynamics of Human Object Recognition Processing: Integrated high-density electrical mapping, functional imaging and human intracranial studies of 'perceptual closure' processes"

Humans are capable of recognizing objects, often despite highly adverse viewing conditions (e.g. fog, occlusion, camouflage etc.). The term "perceptual closure" has been used to refer to the neural processes responsible for "filling-in" missing information in the visual image under such conditions. Closure phenomena have been linked to a group of object recognition areas, the so-called lateral occipital complex (LOC). Here we investigated the spatio-temporal dynamics of perceptual closure processes by co-registering data from high-density electrical recordings (ERPs) and functional magnetic resonance imaging (fMRI) while subjects participated in a perceptual closure task. Subjects were presented with highly fragmented images and control scrambled images. Fragmented images were calibrated to be 'just' recognizable as objects (i.e., perceptual closure was necessary), whereas the scrambled images were unrecognizable. Comparison of responses to these two stimulus classes revealed the neural processes underlying perceptual closure. fMRI revealed an object recognition system that mediates these closure processes, the core of which consists of the LOC regions. ERP recordings resulted in the well-characterized N_{CL} component (for negativity associated with closure), a robust relative negativity over bilateral occipito-temporal scalp that occurs in the 230-400 ms timeframe. Our investigations further revealed an extended network of dorsal and frontal regions, also involved in perceptual closure processes. Inverse source analysis showed that the major generators of N_{CL} localized to the identical regions within LOC revealed by the fMRI recordings and detailed the temporal dynamics across these LOC regions including interactions between LOC and these other nodes of the object-recognition circuit. Finally, direct intracranial recordings from human cortex in patients implanted for epilepsy mapping, provides validation of the localization data obtained from the source analyses of surface recordings.

Mark Brady, North Dakota State University

“Collecting Natural Images for Vision Science”

In order to fully understand human vision, we need to understand how humans process natural images. Therefore, psychophysics with natural images is an essential part of vision science. Since natural images are more complex than artificial stimuli, we would also like to find ways to describe natural image structure. Natural image statistics is one such way.

Natural images, as stimuli, and image statistics studies, depend on cameras. It has been widely assumed that any snapshot from any camera will do. This assumption ignores the fact that camera characteristics and settings can have a significant effect on the images and on image statistics. This talk will describe these camera effects and how to control them in an experimental setting.

Daniel Kersten, University of Minnesota

“Natural Images, Natural Percepts and Early Visual Processing”

The traditional model of primary visual cortex (V1) is a retinotopically organized set of spatio-temporal filters. This model has been extraordinarily fruitful, providing explanations of a considerable body of psychophysical and neurophysiological results. It has also produced compelling linkages between natural image statistics, efficient coding theory, and neural responses. However, there is increasing evidence that V1 is doing a whole lot more. We can get insight into early cortical processing by studying both the relationship between image input and neural activity, and between human visual percepts and early cortical activity. I will describe functional magnetic resonance imaging (fMRI) studies which show that V1 activity is modulated by object properties, such as an object's degree of perceptual organization and by its perceived size.

Stéphane Rainville, North Dakota State University

“fMRI Evidence for an Intermediate Visual-Shape Population Code in Lateral Occipital Cortex”

PURPOSE: Humans are exceptionally sensitive to small deviations from circularity. Here we used fMRI to test whether circles have a special status in the coding of shape. **METHODS**: BOLD signals were recorded from 6 participants in a 13 6-mm coronal-slice volume anchored on the occipital pole. A region-of-interest analysis isolated the lateral-occipital complex (LOC) by contrasting BOLD signals from images of intact vs. scrambled tools. In key experiments, observers viewed closed contours that varied in basic shape (i.e. radial frequency) and deviation from circularity (i.e. radial amplitude). Experiments followed a block design where deviation from circularity was varied across blocks, and basic shape was either varied within block (multi-shape blocks) or held fixed (single-shape blocks). Observers performed size judgments to maintain attention. **RESULTS**: BOLD response increased monotonically with deviation from circularity in both multi- and single-shape blocks although responses to single-shape blocks had lower amplitudes. **CONCLUSIONS**: Data suggest that deviations from circle prototypes constitute the basis of increased neural activity. Release from adaptation implicit in higher responses to multi-shape blocks suggests that neural subpopulations selective for different shapes (i.e. radial-frequency contours) underlie shape coding in LOC.