My program of research is aimed at understanding the basic cognitive and neural mechanisms underlying language and memory systems across the adult lifespan. I adopt an interdisciplinary and multi-method approach to this work, drawing on theories and methods in cognitive science, neuroscience, gerontology, linguistics, and quantitative and experimental psychology. Our methodologies include the non-invasive study of human brain activity (e.g., via event-related brain potentials [ERPs], transcranial magnetic stimulation [TMS]), recordings of eye movements and pupil dilation via eye tracking, and studying and relating these measures to behavioral performance (e.g., reaction time, memory). Below, I provide a snapshot of three inter-related lines of research within this program, as well as future research plans.

Cognitive Aging and Individual Differences in Language Use. The mechanisms underlying the comprehension of language are complex, involving the recruitment of a highly distributed set of neural systems supporting sensory and cognitive processing. Normative aging can begin to compromise these systems, negatively impacting the ability to comprehend language and learn from text and speech. One primary line of my research investigates how aging and individual differences in adulthood impact language comprehension and memory, and how sensitive on-line measures of moment-to-moment language processing (e.g., ERPs, eye tracking, and reaction time) reveal mechanisms of these differences [e.g.,5,8,17,18,23,32,44,46]. For example, I have shown that age-related changes in working memory and language experience are dissociable across the adult lifespan, and have differential impacts on lexical, semantic, and syntactic processing [see 33, 3* for reviews]. In more recent work, we have begun exploring the compensatory role of literacy experience in middle age and older adulthood [5,8, 23, 25]. For example, we recently published the first study using eye tracking to characterize literacy differences in eye movement control during reading among community dwelling adults with very low literacy[3]. This work has the potential to improve adult literacy assessments and interventions by focusing on real-time language and cognitive processes during reading.

In another novel applied direction, my lab has begun examining the cognitive and neural correlates of effortful listening when processing acoustically degraded speech[1,2, 3*, 3**], and exploring ways to offset effortful listening. For example, we have examined how assistive text captioning offsets the negative effects of sensorineural hearing loss and background noise on speech processing and memory. Our first paper reporting these results was recently published in *Ear and Hearing* (ranked 2nd in Audiology and Speech Language Pathology). Ongoing student-led work is focusing on understanding how text features (e.g., caption errors, intermodal asynchrony) influence the captioning benefit [e.g., 3**], and using eye tracking and ERPs to study real-time audio-visual integration of text and speech.

Bridging the Gap Between the Behavioral and Neural Study of Comprehension. I have worked to develop methods and paradigms to bridge the gap between the behavioral and neural study of language comprehension. For example, in one line of work, I have examined the neural mechanisms underlying the allocation of covert attention across the visual field in sentence reading. This work has combined behavioral, eye tracking, and neurophysiological measures to probe (a) lexical semantic processing in parafoveal vision [11, 13, 23, 24], (b) the relationship between concurrent foveal difficulty and parafoveal visual attention [11, 31,46], and (c) how age-related cognitive and sensory change modulates visual attention allocation in reading [23, 46]. Findings have highlighted important neurophysiological constraints on models of reading. For example, in an invited letter in *Trends in Cognitive Science* (Impact Factor: 15.402) [13], my colleague and I drew on findings from this work to argue for constraints on recent computational models of attention control in reading. One emerging line of this work involves developing methods to simultaneously record and co-register event-related brain potentials with eye movement behavior (e.g., fixation onsets and saccades) during natural reading. This work will allow us to examine neurophysiological mechanisms of naturalistic reading behavior in ecologically valid environments. To achieve these aims, my colleagues and I were recently awarded a grant from the National Science Foundation (PI: Schotter, Co-Is: Drew, Payne) to convene a workshop bringing together experts in attention, eye tracking, and EEG research to develop best practices for EEG and eye-tracking co-registration in applied vision science, including reading.

Related to this work, I have also conducted several studies using simultaneous measures of pupil dilation and ERPs to better understand the neural mechanisms underlying the cognitive pupillary dilation response (PDR) in language, memory, and attention tasks[1,4,1**]. One project, headed by my student Sara LoTemplio, used a novel approach to examine trial-to-trial variation between the P3b ERP component and the PDR in an attention task, showing that both physiological responses independently predicted variability in response behavior. This paper was published this year in *Psychophysiology*[4] (IF: 4.016). In another project, headed by my student Jack Silcox, we have used the PDR as a measure of effort when listening to acoustically challenging speech and have shown that PDR-mediated increases in listening effort modulate the N400 ERP component (a neural marker of semantic memory retrieval) and subsesquent speech memory. This work was recently published in the journal *Cortex* (IF: 4.027)[1]. These findings have implications for understanding how acoustic degradation negatively impacts high-level language and memory processes. Towards this aim, I have recently been awarded a grant from the Utah Center on Aging to extend this work into older adults with sensorineural hearing loss, and currently have an NIH R21 (NIDCD Early Career Award) that has been *recommended for funding*, pending Council Review.

In other ongoing work in this area, I have studied sustained attention in language processing by examining within-person (intra-individual) moment-to-moment variability in behavioral and neural indices of language processing [1,5,12,17,18,22,38]. This work has begun to reveal the mechanisms underlying trial-to-trial variability in language processing (i.e., why is it that we can sometimes process language efficiently, and other times we seem to 'zone out'). I have developed a novel method for conducting single-item level measurement, visualization, and analysis of event-related brain potentials [35] and I've recently extended this work by co-registering single-trial behavioral and neural measures during a reading task [18, 22]. These results have revealed neural processes that are obscured by traditional averaging methods. For example, we provided the first direct electrophysiological evidence for the role of cognitive control processes in regulating moment-to-moment reading behavior [22], with implications for the assessment of comprehension in special populations [e.g., 16,18]. My student Clara Lopes is currently writing up a project (funded by Google, LLC, PI: Payne) to extend these prior findings into studying variability in semantic prediction in reading [6**].

Finally, in collaboration with Dr. Brian Mickey (Psychiatry, UofU) and the Non-Invasive Neurostimulation Program, we are conducting a series of projects (initially funded by a VPR Seed Initiative Grant, PI: Payne) examining the role of speech-related neural systems in language comprehension. In this project, we have developed a novel methodology combining non-invasive brain stimulation (e.g., transcranial magnetic stimulation [TMS]), functional speech mapping, and the simultaneous recording of high-density EEG. Our first study from this project has revealed that TMS to the left (but not right) inferior frontal cortex temporarily eliminates the beneficial effects of predictability on verbal memory[2**]. We believe such findings have the potential to advance causal models of the neurobiology of language and memory with implications for improving communicative competence and language remediation in aging and in certain clinical populations.

<u>Cognitive Resilience in Older Adulthood</u>. There exist considerable individual differences in cognitive and brain functioning in older adulthood, such that some adults in late life can outperform their younger counterparts in complex cognitive domains, while others show considerable deficits. What are the mechanisms that underlie this variability in aging? My line of research that addresses this question relies on the collaborative analysis of several large scale cognitive interventions (e.g., Senior Odyssey[41] and ACTIVE[19]) and longitudinal studies (e.g., MIDUS[7,9]). A primary goal of this work has been to highlight the role that dispositional and personality characteristics play not only in understanding trajectories of cognitive aging but also in understanding individual differences in responsiveness to interventions to promote cognitive health in aging (see our reviews in [2*, 27]). I have been seeking continued grant funding to continue this line of work both in both large-scale longitudinal studies and through intensive ambulatory assessment designs via home-based computerized assessments and interventions of cognitive functioning [e.g., 2*, 22].