Throughout my tenure as a graduate student, I have developed interests in three major areas: visual cognition, theory of mind, and applied learning, cognition and instruction. It is through my work in these three areas that I have gained experience in a variety of methods and analyses that have given me breadth within the broad field of cognitive psychology. In order to highlight these diverse experiences, this narrative is split up into three parts which focus on specific work completed over the past decade.

Visual Search

Our visual system is constantly bombarded with information. In order to function at a reasonable level, we must be able to quickly and effectively decide what is relevant and what should be ignored. Several factors influence the degree to which we are successful in accomplishing this task of locating objects of interest amongst distractors in what is known as visual search.

The majority of research on visual search is based on methods that measure the amount of time it takes for an observer to locate a target in a cluttered array. Reaction times are plotted as a function of increasing set sizes, and the slopes of the resulting lines are compared to estimate search efficiency. Relatively flat slopes indicate efficient search through parallel processing, while increasing slopes are indicative of search requiring more focused attention.

In the past 30 years, several models and theories of visual search have been proposed based on reaction time methods. However, these methods are limited in that visual search is comprised of both temporal *and* spatial information, with reaction times capturing only the former. Since moving our eyes is an integral part of natural search behavior, understanding the behavior of the eyes in a visual search task is a logical and necessary step. It has been argued that eye movement measures contain all the necessary information captured in a reaction time paradigm, while contributing additional dependent measures that further characterize search. My primary research interests are devoted to understanding the underlying cognitive processes that lead to success or failure in visual search tasks through the measurement of eye movements.

Search for Multiple Targets

In many every-day situations, observers must search for more than one target at a time. For example, drivers are constantly flooded with stimuli, and typically more than one object is of interest. For instance, an early morning commuter may be searching for both a place to get coffee *and* an open parking space. As a less benign example, airport security screeners are one of the best lines of defense against threat objects such as guns, knives and bombs. In this case, an observer is given a very limited amount of time to search for objects that differ in shape, size, color and orientation. Costs or breakdowns associated with searching for multiple items at once can be detrimental at best, and, at worst, catastrophic.

When searching simultaneously for multiple objects, what conditions produce a benefit, or, alternatively, result in a cost compared to searching for the individual targets separately? In my research, I have elucidated conditions in which search for multiple targets can be as efficient as conducting two separate individual searches, as well as the conditions where search for multiple targets breaks down (Cave, Donnelly, Menneer, & Stroud, 2008).

What makes my research unique from the majority of research in visual search is how search efficiency is operationalized. Efficiency is characterized in two main ways with the first involving classic methodologies that compare reaction times and accuracy between single and dual target searches, while the second is focused on comparing the actual objects that are fixated

during search. In a search for two targets, if objects are fixated that clearly do not resemble either of the targets (consequently resulting in longer search times), search is considered to be inefficient. However, if search for two targets results in the same relative frequency of objects fixated, then search is considered efficient.

(i) Efficient dual target search

My research has found that when two targets share the same color, but differ along the dimension of shape, search is equally efficient compared to conducting two separate searches. The stimuli in this particular set of experiments consisted of abstract representations of guns, knives and bombs, to simulate targets in an x-ray scanner for airport security screeners (Stroud, Menneer, Cave, Donnelly & Rayner, under review). In a more basic research paradigm, I demonstrated similar results when the two targets shared the same shape, but differed slightly along the dimension of color (Cave, Stroud, Menneer & Donnelly, 2008). Taken together, it appears that searching for two targets can be efficient when the two targets differ along the same dimension with no feature values falling between the two targets. These results suggest that when two objects share a similar structure, the objects may be represented as one solitary template in order to guide search efficiently. However, search for dual targets is generally less efficient than conducting two individual searches.

(ii) Breakdowns in dual target search

In the same paradigm involving abstract x-ray displays, a breakdown in search was discovered when the two targets differed along the dimensions of both shape and color. The breakdown was revealed via significantly higher fixations on objects that were very dissimilar to the targets. For example, if the observer was searching for an orange and a blue object, multiple fixations were made on green and purple objects (Cave, Menneer, Stroud, Donnelly, & Rayner, 2006). Utilizing the paradigm that only manipulated the color between the two targets, a similar cost was revealed associated with increasing the separation in color space between the two targets. This 'split-target' cost showed that breakdowns in selectivity are a result of increasing the number of feature values in between the two targets. Once again, this cost was exemplified by a higher frequency of fixations on objects that did not resemble the target color (Stroud, Cave, Menneer, & Donnelly, 2008).

These results suggest that when two objects differ along the same dimension with feature values falling in between, there is considerable difficulty in regard to representation. Rather than efficiently creating a unitary template, a less efficient, *fuzzy* representation may be utilized that contains these intermediate feature values. The overall results of the dual-target research places constraints on current models of visual attention. The breakdown in search efficiency may be attributed to a number of different factors, including interference between the two target templates, a hybrid template consisting of the feature values that fall in between the two targets, or perhaps a decrement associated with cognitive load.

(iii) Selectivity in a visual search

Within this dual target paradigm, I am particularly interested in observers' ability to select specific objects of interest while ignoring a larger set of distractors. My current research explores participants' use of color to guide search. Results have demonstrated that when observers are searching for two targets that are separated by three intervening colors, fixations are directed towards objects approximately 1 – 2 steps from the target colors in color space.

However, vast individual differences were revealed, with one group of subjects ignoring the colors in between the targets, and another group of subjects fixating the intermediate colors with the same frequency as the target colors. It appears that these two targets can be represented as either the two individual targets or perhaps a range of targets encompassing all of the feature values that fall in between the two targets (Stroud, et. al., 2008).

I have also been involved in research regarding search strategies and selectivity in a single target search paradigm. In a search task containing four groups of clusters comprised of two different colors, participants chose to use global target probabilities to guide saccades between groups of objects, while they relied more on the color information within groups to guide search on a more local level (Williams, Pollatsek, Cave, & Stroud, in press).

While my primary interests are grounded in visual cognition and attention, I have conducted research projects that have investigated a number of different theoretical and applied issues in cognitive psychology. One major goal I have is to reconnect with past collaborations to further explore the issues discussed below. I mentored a number of undergraduates in almost every aspect of my research with the hopes of motivating them to engage in original projects of their own.

Theory of Mind

In a paradigm where observers must determine the point of view of an individual, what role does language play? Previous research has shown that participants fail in making false belief judgments based on another's perspective if the participant was engaged in a verbal shadowing task. These results suggest that language is a necessary component in false belief reasoning. I am currently testing individuals in a false belief paradigm to observe if they have an implicit understanding of the false belief. Implicit understanding is measured through eye gaze to one of two possible choices while the subject verbally shadows a message. The results should further reveal the role of language in false belief reasoning.

Reading and Age-related Differences

An abundance of unsubstantiated beliefs exist regarding decrements in abilities associated with age. This line of research attempted to tackle one of these myths with regard to reading behavior. Eye movements were monitored as a valid index of online text processing in normal college aged adults (~21 years old) and elderly adults (~70 years old). The results revealed that older readers adopted a more risky strategy in reading, which involved skipping more words but also making more regressions (revisiting words). This study provided objective evidence regarding the differences between younger and older adults within the domain of reading (Rayner, Reichle, Stroud, Williams, & Pollatsek, 2006).

Metaphorical Graphics

It is well known that chemistry is a difficult subject to manage at the high school and college levels. Textbooks are typically filled with difficult concepts and abstract pictures that contribute to the difficulty in acquiring the necessary information. Metaphors are valuable learning devices that present an unfamiliar concept within the context of a familiar, well-known domain. For example, when someone tells you that the brain is a computer, you are able to acquire some relevant information about the brain in terms of the architecture of a computer. Similarly, graphics convey a wealth of information via pictorial representations that lend to a visual code of the intended information. This results in a reduction of cognitive load freeing up

more resources when attempting to learn a new concept. This research attempted to combine the properties of both metaphors and graphics to give learners an enriched tool for mastering difficult concepts in chemistry. The findings revealed that metaphorical graphics helped learners to develop a deeper understanding of the behavior and reactivity, but not of the physical properties, of fifteen selected chemical elements, compared to the two other traditional methods for presenting chemistry (Stroud & Schwartz, under review; Stroud, Schwartz, & Phelps, 2003). The results suggest that learners are able to construct relevant graphical representations of the elements which create a rich verbal and non-verbal code of the difficult material.

Metaphorical Priming

As mentioned in the previous section, metaphors are powerful devices for conveying difficult concepts. The question evaluated in this line of research was whether or not metaphorical understanding of a concept would transfer to learning in a novel domain. Results revealed deep level comprehension and personal understanding of a novel instructional system and content only for students receiving a relevant metaphorical primer compared to students receiving either a weak metaphorical primer or nothing at all (Schwartz, Stroud, Lee, Scott, & Mcgee, 2006; Schwartz, Stroud, Lee, Scott & Mcgee, 2005). This research suggests that when primed with the appropriate metaphor, transfer of the underlying relationships and structures of the prime can be applied to a new unfamiliar concept.

Future Directions

To summarize, my research interests are multifaceted and touch upon many areas within the broad field of cognitive psychology. I have been involved in research that investigates basic questions, as well as applied issues in a variety of areas. My current research is aimed at answering questions regarding the processes underlying visual attention and visual search through methods of eye movements. Understanding the mechanisms involved in these types of tasks will lead to new or refined theories and models of visual search, as well as restructured guidelines for research in an applied setting. Currently, leading theories of visual search have difficulty accounting for the results of search for multiple targets and need to be adjusted to account for my results. Research focused on theory of mind will explore the suspected role of language in certain reasoning tasks so as to gather a greater understanding of the collective nature of the brain. Finally, I plan on revisiting research on learning, cognition and instruction in order to gain a deeper understanding of the basic issues involved in learning that may be directly applied to educational settings. I am excited to continue forward with the research I have begun in my graduate career, and to begin new lines of inquiry.