Research Statement

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With the abundance of objects in the environment, the brain must selectively choose which should be attended for further processing and which should be ignored. For example, a driver must quickly—and perhaps without experience on a road—selectively attend to traffic signals, signs, other cars, and pedestrians, while ignoring distracting objects such as a man wearing a horse mask. Selective attention can be considered the gate' that allows certain relevant objects to be further processed and that prevents other irrelevant objects from interfering with our processing of information. But at the same time, attention can be 'captured' by irrelevant stimuli in the environment. My research focuses on the control of selective attention, and the goal of my research is to advance our understanding of how selective attention works, and what and how different environmental and cognitive factors influence the control of attention.

Scientific Methodology and Philosophy

I am trained as a cognitive-experimental psychologist; however, I hold a Feyerabend-ian (from Paul Feyerabend) view of science, that strict adherence to established method is damaging and can hinder the acquisition of knowledge. Thus, over the past several years I have utilizing different research and analytic methods to study human attention, including individual difference approaches, analyzing data distributions rather than just central tendency, and meta-analysis. My hope is that common findings from across these variegated projects will shed new, but common light on our understanding on the mechanisms and functions of selective attention.

Research

My research initially focused on the capture of attention by salient stimuli and whether this was stimulus-driven or mediated by top-down factors. These studies used *attentional capture* and *spatial cuing paradigms*, in which the presentation of a salient visual property may influence responding. I also examined the relationship between working memory and selective attention as part of my doctoral dissertation; observing that interfering with working memory interfered with attentional control. My current research followed up and extended my initial research on working memory and attention, and I began examining visual field asymmetries to study differences in the shifting and the control of attention, which has implications for underlying cortical processes. I have also spent a great deal of time examining how implicitly encoding object features can influence selective attention and memory retrieval processes in visual search paradigms. Below, is a sampling of some of my research project areas:

Attentional Capture by Static Discontinuities. Presented with a display containing several green shapes and one red shape, individuals assume that the red shape should be attended first, because it is different (*singleton*). Such captures of attention by the red shape may be stimulus-driven and due to its salience, or may be contingent on its similarity to an *attentional set* (Folk, Remington & Johnston, 1992). We showed how a discontinuity at the boundary between perceptual groups (red X's abutted next to green O's) captured attention even though subjects were set to detect a dynamic target (Burnham & Neely, 2008). In a follow up study (Burnham, Neely, Naginsky & Thomas, 2010), we demonstrated this was stimulus-driven and not due to feature similarity between the discontinuity and the target, suggesting boundaries 'automatically' attract attention.

Working Memory and Attention. Working memory is a multicomponent system in which new information is processed and information is retrieved from memory using one of several subsystems that are governed by a *central executive*. As part of this research, I used visual search tasks in which subjects located a target among non-targets while trying to ignore a color singleton distractor. Typically, the presence of the distractor captures attention and slows responding. In one set of experiments (Burnham, 2010), I used a single-task vs. dual-task manipulation of working memory to examine the influence of *working memory load* on the control of attention. I found that attentional capture was greater when verbal working memory load was high compared to low. In a related set of experiments (Burnham, Sabia & Langan, 2014), I found visual working memory load, spatial working memory load, and central executive load produced greater attentional capture, but phonological working memory load did not.

Working Memory Capacity and Attention. In addition to experiments using the single-task vs. dual-task manipulation, we used individual differences approaches to study the relationship between *working memory capacity* and attention. In one study (Burnham, Harris & Suda, 2011), after completing an OSPAN task to measure working memory capacity (Conway, et al., 2005), subjects completed a spatial cuing task in which they located a target that was defined by a specific feature (onset or red) that appeared after a cue that was feature-relevant to the target or feature-irrelevant. We found no relationship between OSPAN and attentional capture for relevant cues, but individuals with less working memory capacity showed larger attentional capture by feature-irrelevant cues. We have also combined the individual differences in working memory capacity approach with the single-task vs. dual-task approach to examine the relationship between working memory and attention. We found both working memory capacity and working memory load were related to the control of attention, but there was no interaction between working memory load, working memory capacity, and attentional control.

Visual Field Asymmetries in Shifting Attention. We became interested in visual hemifield asymmetries in selecting salient visual singletons. Following a study by Du and Abrams (2010), we (Burnham, Rozell, Kasper, Bianco & Delliturri, 2011) found that when targets were presented centrally, a task-irrelevant color singleton in the left hemifield produced a larger attentional capture effect compared to when that same singleton appeared in the right hemifield. We believe this asymmetry reflects a lateralization in the cortical underpinnings of top-down and bottom-up control of attention (Corbetta & Shulman, 2002).

Priming of Popout. During search for a visual singleton that is defined by a variable and unpredictable feature, subjects are faster to respond if the current target's features are congruent with the preceding target's features. Such intertrial repetition or priming is ubiquitous and suggests subjects will implicitly encode task-irrelevant features during visual search. When this is observed during search for a variable-feature singleton ("popout search), a *priming of popout* (PoP) has been observed. Intertrial priming may reflect an automatic priming mechanism that influences selection on the following trial or facilitated memory-retrieval processes when the current target's features match the preceding target's features, and Lamy, Yashar & Ruderman (2010) proposed intertrial priming and PoP reflect both selection and memory retrieval processes. In my lab, we supported Lamy et al.'s dual-stage account of intertrial repetition by combining a PoP task with a go/no-go task, and observed that the decision to respond or not respond on the preceding trial moderated the size of the PoP effects (Burnham, 2013). We have also been using RT distribution analyses to examine the number of processes that contributed to PoP effects. After fitting the Ex-Gaussian function (a convolution of the normal/Gaussian function and an exponential function) to data obtained in PoP tasks, we found PoP was influenced by a difference in both the shift and skew of the underling RT distributions (Burnham, Cilento & Hanley, under review). We believe this suggests two distinct processes underlie intertrial priming effects and we are currently examining this further.

Selective Inhibition to Locations. Lastly, my lab has been examining the extent to which we can selectively ignore locations, and whether featurally-relevant objects appearing in ignored locations capture attention or go unnoticed. In a series of experiments we used the basic Folk et al. (1992) spatial cuing paradigm, in which subjects identified a target that was defined by a specific feature (onset or red), and was preceded by a cue that was feature-relevant or feature-irrelevant to the target. On some trials an arrow pointed toward a location where the target would not appear and subjects were instructed to ignore that location. Even though subjects ignored the arrow-cued location, we found a feature-relevant cue appearing in that ignored location still captured attention (Burnham, 2013, November). We are currently examining this further.

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