2017

Change Detection of Emotional Information Across the Adult Lifespan

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CHANGE DETECTION OF EMOTIONAL INFORMATION ACROSS THE ADULT LIFESPAN

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May 2009

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August 2011

submitted in partial fulfillment of requirements for the degree

DOCTOR OF PHILOSOPHY OF ADULT DEVELOPMENT AND AGING

at the

CLEVELAND STATE UNIVERSITY

August 2017

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DEDICATION

To my husband Jeff Misener, and my children, Alyssa and Luke, for their love, patience, and unending support. To my parents, Linda and Randy Donaldson, who have always encouraged me to work hard and pursue my dreams. To my dissertation advisor Dr. Eric Allard, for his instrumental support, the incredible time he dedicated to this project, and for welcoming me into the Aging, Cognition, and Emotion Laboratory. To Dr. Naohide Yamamoto, for his continued guidance during my graduate student career. To my committee members, Dr. Philip Allen, Dr. Conor McLennan, and Dr. Jennifer Stanley for their valuable feedback and encouragement. Last but not least, to Dr. Sara Incera, Dr. Evan Shelton, and the other cherished friendships I have formed in the last 5 years.

ACKNOWLEDGMENT

I would like to thank my committee chair, Dr. Eric Allard for his support and helpful feedback on stimuli, design, and earlier drafts of this manuscript. I would like to thank the members of my committee, Dr. Philip Allen, Dr. Conor McLennan, Dr. Jennifer Stanley, and Dr. Naohide Yamamoto. In particular, I would like to thank Dr. Jennifer Stanley for her helpful input on experimental design which led to a better understanding of how Trial type and Valence variables used in Experiment 1 should be conceptualized. I would also especially like to thank Dr. Conor McLennan for his feedback on the proposal of this project that led to the development of Experiment 2. I would like to thank the Office of Research, who granted me the Dissertation Research Award, which provided financial support for this project. I would like to thank Elizabeth Antol for her assistance with Photoshop. Finally, I would like to thank my research assistant, Mollie Ballew, and the other members of the Aging, Cognition, and Emotion laboratory, for helping with pilot study development, participant recruitment, and data collection.

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ABSTRACT

Visual change detection ability is necessary for successful interaction with the environment, yet few studies have been conducted on change detection with older adults, and whether their use of top-down and bottom-up processing differs from younger adults, especially with emotional processing. Emotions can be motivating and guide the scope of attention using top-down processing and can capture attention in an automatic, bottom-up fashion. Theories of socioemotional aging suggest that younger and older adults may be differentially motivated to process positive and/or negative aspects of the environment, and these tendencies may have implications for age-related trajectories in well-being. Change detection efficacy in older adulthood may be influenced by whether individuals process salient and motivationally relevant emotional stimuli. To address the impact of age and emotional information processing on change detection performance, two experiments were conducted. Experiment 1 addressed whether individuals differ in their detection of neutral and emotional object changes and whether such differences are influenced by age. Participants were instructed to detect the appearance or disappearance of positive, negative, and neutral objects to understand how these factors impact change detection ability. Positive preferences were noted for both age groups, with enhanced processing for positive onsets and negative offsets. The focus of Experiment 2 was to investigate the influence of four top-down motivations, prioritizing each visual change and valence on change detection by creating contexts in which the target may be initially non-emotional, but the target acquires emotional meaning based on the situation. The strength of Experiment 2 was to assess the role of explicit top-down motivations on how emotional goals and contextual features may impact change detection for younger and older adults, which could not be assessed in Experiment 1. Overall, negativity effects emerged in Experiment 2, wherein both younger and older adults prioritized processing of negative onsets in the threat condition, contrary to Experiment 1. The present research revealed many age similarities in change detection ability. Participants' attention was commanded more heavily toward positive targets in the absence of a specific motivation, but when provided with explicit top-down motivation, participants' attention was most sensitive for detection of threat.

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CHAPTER I

INTRODUCTION

The human attentional system constantly processes a remarkable amount of information. We live in a dynamic world, and there are multiple demands on our attention at any given time (Malcolm & Shomstein, 2015). Attentional capacity is finite. We simply cannot constantly attend to every aspect of our visual field, and any attempts to do so would be overwhelming. Thus, human cognition is adept at prioritizing salient visual events. Maintenance of attentional prioritization and related abilities are critical across the lifespan, and there is active debate surrounding preservation of attentional faculties across adulthood and old age (Costello, Madden, Shepler, Mitroff, & Leber, 2010; Knight, Seymour, Gaunt, Baker, Nesmith, & Mather, 2007). Attention is a multi-faceted process; some facets of which tend to decline as we age and others that remain intact across older adulthood. Specifically, Costello and colleagues (2010) maintain that there is evidence of top-down attentional control being preserved across the adult lifespan. In this regard, when an older adult has a particular goal in mind, he or she is able to accomplish this goal by maintaining attentional focus on facets of the environment congruent with his or her intentions. Conversely, older adults may have difficulty inhibiting distraction, so even if their top-down attentional resources are actively seeking out goal-relevant information in the environment, they may have difficulty tuning out extraneous visual information (Rodrigues & Pandeirada, 2015).

Intact attentional abilities are critical to many facets of life, including driving, independent living, and detection of threat and danger. Findings from studies assessing a variety of attentional domains indicate age-related declines in processing speed (Salthouse, 1996), reduced useful field of view (UFOV; Wood & Owsley, 2014), and decreased spatial location ability (Scialfa & Kline, 1988). Because all of these processes affect attentional faculties, which enable us to successfully navigate our environments and make sense of the world, it is logical to examine how these processes interact as we age.

Mechanisms Underlying Attention

Individuals use both top-down and bottom-up processing resources to successfully engage with the environment on a daily basis. When top-down processing is used, prior knowledge, experience, and motivations guide our perceptions, in a potentially goal-oriented manner. Bottom-up processing is data-driven and occurs when a stimulus, or features of a stimulus, in the environment command attention, often very quickly (Nothdurft, 2000). According to Nothdurft, attentional capture via bottom-up or exogenous means generally occurs because the object or event ultimately commanding attention is distinct from the surrounding environment through size, color, luminance, or other salient features. Top-down control enables people to overtly seek out particular information in the visual world, depending on observers' behavioral goals and/or prior knowledge (Walther & Koch, 2007). For example, a building surveyor assessing a skyscraper on a busy street is able to attend only to the visual information that is necessary to complete his or her job (i.e., appearance of windows, the foundation, and upper levels). S/he can successfully inhibit the noise of street traffic, vendors, or birds flying. Exogenous and endogenous attentional systems function in concert with one another. That is, if someone shouted for help, or a bus were driving toward him/her, bottom-up processing resources would likely be activated. When bottom-up driven attentional activation occurs, s/he has effectively "paused" his/her survey, and s/he can quickly react to a call for help or avoid the bus. In this sense, when we use top-down processing resources, we can volitionally interact with aspects of the environment that fit with our current behavioral goals and deprioritize other aspects that are not goal-relevant. However, since bottom-up processing often operates in the background, we can rapidly use these resources to react to events in need of our immediate attention.

From an evolutionary point of view, the interplay between top-down control and bottom-up informational processing is advantageous. Both top-down and bottom-up processing resources are used in typical attentional processing tasks, such as a visual search task. Although bottom-up processing mechanisms are particularly useful when targets are distinct from background noise and distractors, or when targets represent a distinct visual event (i.e., onset of a new object), these types of situations rarely occur in natural environments. Moreover, most natural environments are imbued with emotional content. Much prior work assessing the role of exogenous and endogenous attentional control has been conducted using neutral stimuli, with less of a focus on emotionally evocative information.

Typically, visual search and attentional tasks involve attentional capture via the "pop out" or onset of an object through exogenous or bottom-up processing means. Attentional capture by other types of visual events, such as offsets, or the disappearance of previously viewed stimuli, likely occur through endogenous or top-down processing means, as this form of capture is typically construed as being more dependent on prior knowledge and goal-relevant motives (Walther & Koch, 2007). However, when emotional information is introduced, as in the present experiments, valence affects both endogenous and exogenous attentional streams. Negative, and especially threatening, events that appear in a visual array are likely to be efficiently and prioritized due to bottom-up/exogenous salience (Mather & Sutherland, 2011). Attentional capture by negative or threatening stimuli is detected in early visual areas (Theeuwes, 2004), and is processed quickly through the ventral component of the frontoparietal network, in a stimulus-driven, or exogenous, manner. This form of attentional capture temporarily dampens attention guided by behavioral goals and motivations so that we can efficiently process and react to negative and salient events for survival. Furthermore, attentional guidance toward positive events can be motivated by top-down or endogenous means, especially when these are relevant to observers' behavioral goals (Mather & Sutherland). Attentional guidance toward positive events is especially relevant for older adults who have a more limited future time perspective, and so are cognitively motivated to seek out positive information (Carstensen, Isaacowitz, & Charles, 1999). Because positively valenced stimuli typically does not entail a threat component, it is processed in the dorsal component of the frontoparietal network (Cabeza, 2002) and other higher order cortical areas later in the processing stream (Connor, Egeth, & Yantis, 2004) because guiding attention toward self-relevant goals may be an ongoing process, not one that must occur instantaneously. Thus, in order to fully appreciate the role of emotion on attentional capture, emotion must be examined within an interplay of endogenous and exogenous processing streams, as both forms of attentional processing of emotional information are likely to be encountered regularly in naturalistic settings within our environment.

Some evidence suggests that bottom-up processing may be impaired in older adulthood, and perceptual changes may be more difficult to detect in a bottom-up manner, especially if visual changes are neutral or irrelevant to one's behavioral goals (Porter, Wright, Tales, & Gilchrist, 2012). However, considerable evidence supports the preservation of top-down processing abilities as we age (Madden, Whiting, Spaniol, & Bucur, 2005), such that older adults are capable of volitionally engaging with certain aspects of the environment. This ability promotes inhibition of distracting and irrelevant stimuli, which contributes to more efficient search strategies and attentional control (Peterson & Kramer, 2001). In addition, more recent evidence suggests that older adults are as capable as younger adults at inhibiting distracting stimuli when informative cues are present; however, attentional capture of irrelevant information is more likely for older adults compared to younger adults when informative cues are unavailable (Whiting, Madden, & Babcock, 2007). Although top-down attentional control is largely preserved, there are some age-related declines in maintenance of attentional guidance that can affect the efficiency and success of visual search (e.g., Colcombe et al., 2003). Notably, age-related reductions in working memory capacity may contribute to difficulties with cognitive control during visual search tasks (Redick & Engle, 2011), and older adults may experience particular difficulty with inhibiting distracting information (Hsieh, Wu, & Tang, 2016), which may prolong the time it takes to detect targets during a visual search.

Through the interaction of both forms of processing, individuals are able to volitionally interact with the environment because bottom-up processing resources, which often run in the background, can override top-down processing control if stimuli that are in need of immediate attention (i.e., something threatening) emerge (Yantis, 2005). A frontoparietal network is implicated during visual search and other attentional tasks (Kastner, 2004). The dorsal component of this network promotes attentional guidance via top-down processing (Cabeza, 2002). Because of age-related increases in frontal lobe activity during cognitive processing, older adults may rely more heavily on top-down processing resources compared to younger adults (Cabeza, 2002). Conversely, information that could signal threat and danger rapidly attracts attention and is guided by bottom-up processing faculties through the ventral component of the frontoparietal network (Madden, 2007). Here, attentional resources are quickly deployed away from one's behavioral goals and toward these salient events when informed by stimulus-driven processes in our perceptual systems (Theeuwes, 2004). Thus, it is logical that attentional capture through stimulus-driven means occurs rapidly, as early visual areas process this information (Theeuwes, 2004). Conversely, top-down attentional control requires the activation of higher order cortical processing and occurs later in the processing stream (Connor, Egeth, & Yantis, 2004). Theeuwes (2004) maintains that top-down attentional control will always be overridden by bottom-up processing if a threat arises, or some other visual event in the environment requires immediate attention. Additionally, top-down attentional control is likely to dominate when demands for bottom-up processing are low (Rolls, 2008). Thus, when observers do not need to be vigilant to potential threats, attention is more likely to be guided by top-down motivational cues. However, once the situation changes such that vigilance and quick responses to visual events are again relevant, the attentional system can minimize the top-down system and prioritize attentional capture through bottom-up processing means. Current research supports an ongoing interplay between top-down and bottom-up processing for both younger and older adults. This relationship can be modulated depending on the demands of the situation and the goals of the individual, so as to ensure successful interactions with the environment (Yantis, 2005).

Attentional Prioritization

Generally, the human attentional system is adept at directing attention to further process salient information within our environment. Given the complex nature of our visual environment, it is expected that not all visual events will be processed with equitable efficiency. The specific aspects of the visual world that command attention differ across environments and age groups, and even within individuals, as motivations and abilities vary. In this manner, we are remarkably capable of using attentional resources efficiently. However, sometimes, as will be covered thoroughly later, salient visual events fail to attract attention adaptively (Simons & Rensink, 2005). Because of these occurrences, it is necessary to better understand the circumstances surrounding instances when our attentional systems fail to prioritize important visual events and how to minimize the frequency of these instances (Malcolm & Shomstein, 2015).

Scene processing. Considerations of how organisms visually process a scene or environment reveal that not all features receive equal attention. For instance, when an observer initially approaches a room, if each table or floor tile received as much consideration as more relevant and informative stimuli (e.g., peoples' faces, a dangerous object/weapon), scene processing would be highly inefficient, navigation within this environment would be impaired, and our survival could be compromised. By efficiently prioritizing visual events in the environment, humans (and several non-human species) automatically allocate attentional resources toward other individuals, and potential threats are attended to prior to engaging with more mundane visual features (e.g., Parasuraman & Galster, 2013).

Visual search. As mentioned earlier, an area of visual attentional research relevant to a discussion of attentional prioritization is visual search. Visual search paradigms that focus on attentional capture are helpful in order to evaluate how the prioritization of visual events unfolds. In a typical visual search study, participants are instructed to look for a pre-specified target stimulus among other distractor symbols, shapes, or letters within a visual array. Generally, the array is continuously presented until the target is located; thus, this task assesses attentional functioning without strong demands on memory ability (Yantis & Jonides, 1984). Here, the type of target stimulus and distractors are task-dependent, but target characteristics can also influence how effectively the target is located.

As we age, declines in sensory abilities, executive function, and selective attention can impact visual search ability, particularly for more challenging visual searches (i.e., larger search arrays, less distinction between targets and distractors), which can result from age-related reductions in brain volume in dorsal frontoparietal regions (Müller-Oehring, Schulte, Rohlfing, Pfefferbaum, & Sullivan, 2013). However, there is evidence for maintained selective attention ability in cases of top-down control (Costello, Madden, Shepler, Mitroff, & Leber, 2010). In other words, older adults can maintain attention or direct attention toward visual events, consistent with their behavioral goals, and away from distractors using top-down processing mechanisms. To illustrate, if an older individual is watching a movie with some sad elements, but their behavioral goal is to maintain a positive mood, he or she may selectively attend to the non-negative aspects of the movie and ignore scenes or elements that are sad and thereby undermine the experience of any pleasant feelings. Relatedly, there is research suggesting that within certain memory and attention tasks, presenting information that is either in line with older adults' motivational goals or is imbued with personal relevance (e.g., themes such as grandparenthood and retirement), performance is more successful (Mather & Carstensen, 2005). Thus, perhaps observations of age-related deficits in visual search could at least be partially mitigated by providing older adults with motivationally-relevant stimuli.

Change detection and blindness. Change detection is another domain of attention wherein prioritization of changing visual events over static ones becomes critical. Next time a basketball game is on, watch how often the players move up and down the court, change orientations, and adjust the movements and positions of their bodies. In most complex environments, many items will change moment to moment: cars will travel along a road, traffic signals change, animals move about. Other objects, such as sidewalks and buildings, remain static. However, with limited attentional resources available, people typically do not focus on unchanging features of the environment.

Rather, it is important to dedicate attentional resources to the objects that change, as these objects may be very informative and may necessitate an adaptive response (i.e., for personal safety/survival).

In some cases, despite attempting to maintain vigilance to our surroundings, people fail to notice large visual changes in their environment, a phenomenon referred to as *change blindness* (Simons & Rensink, 2005). Although it is ideal to respond to visual changes as quickly as possible, particularly if such changes represent a potential threat, in some cases, the visual event goes unnoticed. Change blindness may occur more frequently if the environment is particularly complex, there are too many facets of the environment to attend to adequately, or if people are experiencing stress or trying to manage too many internal tasks (Simons & Rensink, 2005).

Change blindness was first demonstrated in the laboratory by using an experimental technique known as the flicker paradigm, which is intended to simulate what happens during an eye movement (i.e., saccade; Rensink, O'Regan, & Clark, 1997). In this paradigm, two images that are identical to one another, except that one of the objects in the image changes to another object (e.g., a stapler in one image is replaced by a ruler in the other image), "flicker" over one another in an alternating pattern until the change is located. Rensink et al. observed that an unexpectedly long duration (5 seconds on average if the change is in a central interest location, and 10 seconds on average if the change is in a marginal interest location) was required for successful detection of the difference between the images. In other words, basic change detection may not be particularly efficient. This occurrence has been demonstrated both within (Bubic, 2008) and outside a laboratory environment (Simons & Levin, 2004).

Simons and Rensink (2005) posit that although change blindness is a common occurrence, it does not happen randomly. Susceptibility to change blindness may differ for different kinds of visual events, for people of different ages, and for different qualities of a visual scene (e.g., perceptual salience and/or motivational importance). Change blindness can occur in normal everyday situations. For example, movie viewers may miss the presence of bloopers and other mistakes editors may have overlooked. Additionally, a distracted driver may fail to notice another vehicle on a road. As illustrated by these examples, although it may appear that we are vigilant to our surroundings, attend to details in the environment, and notice the people around us, attention is not an unlimited resource (Simons & Rensink, 2005). Aspects of typical activities in our daily lives may not capture attention, but more critically, people fail to notice visual changes in complex high-risk environments (Levin & Varakin, 2004). Failure to notice such visual changes can lead to grave consequences.

Noticing when changes occur in the environment can be challenging and taxing. In our daily lives, we encounter situations where it is necessary to recognize the replacement of objects (e.g., one customer from another at a food service counter), object onsets (e.g., another vehicle merging ahead on a highway), and object offsets (e.g., missing merchandise in a retail store). The priority given to each of these visual events is largely a product of the salience and urgency that the events represent, as well as the context in which they are situated (e.g., missing child versus missing merchandise). Maintaining successful change detection ability is advantageous in all domains, but since attention is a finite resource, attending to everything in the environment is overwhelming and untenable.

The particular psychological mechanisms influencing whether or not visual changes are successfully detected have been the subject of active debate in the selective attention literature; researchers generally agree that change blindness occurs in conjunction with the deployment of observers' attention (Bubic, 2008). Overall, the human attentional system is able to detect and react to salient stimuli with remarkable speed and efficiency. As mentioned earlier, since attentional capacity is finite, it is maladaptive to allocate limited resources to objects or features that are stable and unchanging. Instead, even when focusing or attending to something in the environment, people allocate more attentional resources to novel or distinct components (Yantis, 2005). This form of attentional deployment transpires regardless of observers' goals, indicating this process occurs as an extension of bottom-up processing (Beck & Kastner, 2005). However, salient stimuli can also contain motivational value (e.g., emotional stimuli that signal the presence of a threat or danger that should be avoided), or a sudden onset, offset, or change in a stimulus may be informative to the viewer because he or she may have to respond to the stimulus in some way (e.g., move lanes to avoid a merging vehicle). As such, change detection of salient stimuli can occur without voluntary intent, so attentional deployment can be beneficial to our survival (Rauschenberger, 2003).

Change detection and aging. Early work on change detection ability in older adults has not yet fully explained how mechanisms underlying attentional processing operate later in life. Preliminary evidence supports the preservation of some bottom-up and top-down processing resources (Madden, Whiting, Spaniol, & Bucur, 2005; Costello, Madden, Shepler, Mitroff, & Leber, 2010), but whether and how these mechanisms alter change detection ability as people age is not fully understood, given that change detection relies on a successful interaction of bottom-up and top-down components.

Within a standard change detection paradigm, both bottom-up and top-down processing resources can be utilized depending on the nature of the change. As outlined in more detail below, the detection of a new object entering one's field of view is assumed to engage bottom-up processing resources (i.e., due to the novelty and perceptual salience of an object onset). Conversely, the detection of objects being removed from a scene may rely more heavily on top-down processing resources since the observer must use their memory of the preceding scene/environment to accurately detect the change. Research on change detection from a developmental framework is crucial to informing the debate about attentional preservation across the lifespan, particularly because intact visual change detection abilities promote successful interaction with our environment. In general, little is known regarding particular changes (declines, improvement, maintenance) in change detection ability across the adult lifespan. Previous work on change detection ability in older adults has yielded somewhat mixed findings, further complicated by the use of different types of tasks, stimuli, and conceptualizations of change paradigms.

In one previous study, Costello and colleagues (2010) found that older adults were less efficient at change detection and, thus, were more susceptible to change blindness because older adults exhibited lower accuracy and required more cycles within a flicker paradigm to locate a change. Declines in processing speed may have compounded these deficits in visual attention, especially when the target is unknown and/or a computer-generated abstract symbol, as is the case with standard change detection tasks (Costello, Madden, Mitroff, & Whiting, 2010). In another study, older adults took more time to detect changes in driving-related photographs (Pringle, Irwin, Kramer, & Atchley, 2001). Pringle et al. posited that an additional time consideration (i.e., speed of search) for the specified target or change might compound the amount of time older adults needed to locate the change (Humphrey & Kramer, 1977). However, Veiel, Storandt, and Abrams (2006) pointed out that Pringle and colleagues failed to control for known age-related declines in processing speed ability when using an older adult sample.

Veiel, Storandt, and Abrams (2006) further addressed age-related differences in change detection performance using eye-tracking to demonstrate predictive relationships between near-real time visual attention metrics and change detection ability. Veiel and colleagues observed that age differences in change detection ability could be explained by age-related reductions in processing speed and a reduced useful field of view (UFOV). Additionally, their data also indicated that older adults rechecked the location of the change, perhaps due to stricter criteria for making detection decisions. For example, an older individual may only indicate that he or she has found the change by returning to the correct location to confirm the detection. A younger adult may be more comfortable with some degree of uncertainty. Thus, older adults may exhibit slower reaction times than younger adults because older adults report the change when they are sure, rather than when they first detect it.

To fully appreciate age-related differences and context-dependent declines in change detection ability, researchers must also consider related faculties known to diminish with age. For example, spatial localization ability is known to decrease with age, a resource used in scene processing; thus, this perceptual component may also hinder older adults' change detection ability (Scialfa & Kline, 1988). Furthermore, Veiel and colleagues (2006) found that older adults' change detection ability, compared to younger adults, was compromised above and beyond what would be predicted by processing speed theories alone. Current findings in the literature point to greater change blindness for older adults compared to younger adults (Costello, Madden, Mitroff, & Whiting, 2010; Veiel, Storandt, & Abrams, 2006), although this shift may represent a multifaceted process attributable to difficulty with inhibition and general age-related declines in attention.

Mechanisms underlying change detection performance: onset primacy. Attentional mechanisms underlying age differences in change detection can differ as a function of experience, motivation, behavioral goals, and the type of visual change that occurs. Early studies on change detection and change blindness included instances of unexpected object replacement, both in the laboratory (e.g., office supplies changing to other office supplies; Levin & Varakin, 2004) and in more natural settings outside the lab (e.g., the exchange of one conversation partner by another; Simons & Levin, 2004). Change blindness research has more recently focused on other types of visual changes to further understand the circumstances under which awareness is hampered. In one type of task, participants are required to identify an abrupt change in the search display, wherein the target stimulus is either the appearance of a new object (object onset) or the disappearance of a previously viewed object (object offset). Results from studies using these types of tasks have consistently revealed that onsets are detected with greater speed and accuracy than object offsets (Yantis & Jonides, 1984). Yantis and Jonides described this phenomenon as *onset primacy*. Brockmole and Henderson (2005) used eye-tracking to investigate the role of transients, which are changes in visual properties that co-occur with object onsets. These researchers found that participants could attend to a non-transient onset if the participants had an opportunity to develop some memory for a visual scene prior to the onset. However, attentional capture in this manner is driven by top-down means, rather than attentional capture by onsets accompanied by visual transients, which occur in a bottom-up fashion. In this sense, attentional mechanisms can adapt to various types of onsets, but this form of attentional capture has a strong memorial component (Brockmole & Henderson, 2005). In addition to transients, other changes in visual properties, such as luminance, quantity, and color, are also produced during the onset of a new object; however, evidence from the visual search literature indicates that the object onset itself, rather than other concomitant visual changes, ultimately captures an observer's attention (Jonides & Yantis, 1988; but see also Hollingworth, Simons, & Franconeri, 2010).

Because there are instances where we must identify missing objects or recognize that something has been added to our field of view, more research has been dedicated to onsets and offsets compared to other types of visual change events (e.g., Cole, Liversedge, & Simon, 2006; Cole, Kentridge, & Heywood, 2004). Thus, support for onset primacy has also been noted in change blindness paradigms. Cole et al. (2003) used a one-shot flicker paradigm, in which two images are presented in succession, separated by a gray screen, for only one cycle. Cole and colleagues found that observers were more resistant to change blindness when experiencing object onsets than offsets, presumably due to onset primacy. Using three-dimensional scenes with naturally occurring visual cues in a one-shot flicker paradigm, Donaldson and Yamamoto (2012) replicated Cole et al.'s (2003) findings, providing further evidence that onset primacy exists in a change blindness context. In sum, research indicates that the prioritization of relevant visual events, and specifically onset primacy, is a robust occurrence applicable to many domains of visual attention.

Change detection and attentional flexibility. It is likely that onset primacy occurs for its evolutionary value. By attending to - and evaluating - the importance of new objects entering into one's environment, observer's increase the likelihood of reacting appropriately, which thereby promotes survival (Cole et al., 2003). Until an onset succeeds in capturing attention, it is unknown to the observer if it is necessary to react in a particular way. Thus, new objects are generally processed rapidly to optimize survival. Yet, as Cole et al. and Donaldson and Yamamoto (2012) have demonstrated, it is not the case that offsets are missed entirely. Successful detection of all types of visual changes probably has some survival utility (Donaldson & Yamamoto, 2016); thus, change detection ability should extend beyond the scope of onset primacy. Take lifeguarding for example. Here, the processing advantage likely shifts from onset detection to offset detection for purposes of loss prevention. For instance, a lifeguard must be able to recognize when a swimmer has disappeared from view (i.e., has gone underwater) and take appropriate action in that scenario. Thus, detection of offset events is just as important (if not more so) as onset primacy in that context. Relatedly, Donaldson and Yamamoto (2016) pitted two hypotheses, the *default mode hypothesis* (i.e., bias for detecting onsets both more rapidly and more accurately) and the *attention modulation hypothesis* (i.e., flexibility with detecting offsets more efficiently under situations where this is favorable), against one another to determine if onset primacy persists in environments prioritizing offset detection. In other words, the default mode refers to the tendency to be more vigilant to onset detection using bottom-up processing resources, whereas attentional modulation allows for flexible detection of offsets when task and motivational manipulations are provided that promote offset prioritization using top-down processing resources. If support were found for the default mode hypothesis, then onset primacy would still be observed in experimental conditions favoring offset advantage. However, under the attention modulation hypothesis, although it may be the case that the human attentional system is programmed toward onset primacy, as it may indeed be advantageous in most situations, if a scenario arose favoring an offset advantage, we should be able to flexibly adapt to offsets. Thus, we sought to answer whether onset primacy is a hard and fast rule or whether it could be overridden if the environment, and behavioral goals of the observer are congruent with an offset advantage.

In this study, participants were randomly divided into one of four conditions. All participants viewed a training block and a testing block. The testing block contained equal amounts of onset and offset trials and was identical for all participants. The difference between conditions was the structure of the training trials. One condition provided no specific instruction for favoring onsets or offsets, and an equal number of onset and offset trials were presented; another condition induced offset bias by having participants receive a disproportionate percentage of offset relative to onset trials during the training block (80% vs. 20%); another condition gave participants explicit instructions to focus on offset trials, but there were an equal proportion of onset and offset trials; and finally, a condition had participants explicitly focus on offset trials and provided a disproportionate number of offset to onset trials (80% to 20%). Participants viewed image pairs that represented either an onset or an offset. Images were presented using a one-shot flicker paradigm. Participants completed a left-right judgment task to indicate the side of the screen on which the change occurred. Participants were able to respond following the appearance of the second image, at which point, participants had viewed both photographs and could judge which object had been removed or added. Reaction time and accuracy were recorded when a button press occurred.

Results based on the training block data for younger adults revealed significantly shorter reaction times to onset trials compared to offset trials when no offset instructions were presented and there were an equal number of onset and offset trials. However, significantly shorter reaction times were observed for offset trials compared to onset trials in the condition where offset instructions were given and the trial where the majority of trials were offsets. These results suggest that implicitly exposing participants to additional offset trials without an instruction, or giving them equal amounts of onsets and offset trials with an instruction to attend with greater priority to offsets, was sufficient for reducing onset primacy. However, when these two manipulations were combined, offset bias was actually promoted. These results carried over successfully into a testing block but only when the number of training trials was doubled. Results from this study indicate that attentional modulation to promote detection of offsets can occur when individuals are provided sufficient motivation, but the strongest effect emerges when both bottom-up (80% offset trials, 20% onset trials) and top-down (verbal instruction) processing cues are provided.

Attentional flexibility in aging. Age differences in the speed of change detection may be expected when investigating attention across the adult life span; however, reductions in the speed of detection are less interesting than understanding how the mechanisms guiding change detection may unfold as we age. When the Donaldson and Yamamoto (2016) attentional flexibility paradigm was applied to an older adult sample, results revealed a significant interaction between trial type and condition on reaction time, such that onset primacy was eliminated for participants who received both the additional offset trials during a first block and an instruction to attend more during offset trials. Additionally, a marginally significant interaction between trial type and condition indicated higher accuracy on offset trials for participants provided with both manipulations. These results offer additional evidence for attentional flexibility whereby offset biases successfully emerge through the dynamic interplay of both bottom-up and top-down processing mechanisms, suggesting that both components may be integral to supporting older adults' successful change detection performance.

There is additional evidence that both bottom-up and top-down manipulations impact older adults' performance on attentional tasks, which is beneficial for older adults so that they can engage volitionally with a scene while remaining vigilant to salient events (Connor, Egeth, & Yantis, 2004). Results from the younger adult sample in Donaldson and Yamamoto (2016) suggest that the human visual system is particularly tuned to the detection of object onsets; however, data from the older adult sample provides evidence that the human attentional system can adaptively and flexibly adjust to detect non-onset events. Since older adults likely have a longer history of exposure to many different types of visual experiences, they may be more in tune with detection of non-onset events than younger adults. Alternatively, onsets and offsets may represent two fundamentally distinct forms of visual events. Without attending to an onset, it is unknown whether it is benign or may pose a threat; since offsets are deletions of previously viewed aspects of the environment, their occurrence may not command attention with such immediacy as onsets. However, it is unclear if this discrepancy between the noticeability of onsets and offsets will hold for all types of stimuli or objects. Previous change detection paradigms have relied on basic objects, which are neutral in nature, presented within situations where participants may not be overly motivated to attend to these visual stimuli in a particular way. However, most scenarios that necessitate adaptive change detection in our day-to-day lives likely have an emotional quality, providing interesting test cases for age-related trajectories in change detection abilities in more realistic contexts. Emotional information can be highly salient and processed with high priority for individuals of all ages (Carstensen & Turk-Charles, 1994). Furthermore, many natural examples of onset (avoiding colliding with a merging vehicle) and offset (a lifeguard needing to notice swimmers that go underwater) detection represent situations that are imbued with emotional value.

Aging and Emotional Attention

In our daily lives, people encounter both positive and negative information, in personal experiences of affect, as well as in facial expressions and images. Emotional information can help guide our cognition and behavior in a variety of situations. Emotionally valenced stimuli are often very noticeable, and humans have a natural tendency to deploy attentional resources toward the processing of emotional information in the environment (Carretié, 2014). Diverse emotionality is central to the human experience, and recognition of emotional valence informs how people should respond to their environment and help shape current and future behavior.

The way in which people attend to - and process - emotional information may change as a function of age. Sociemotional Selectivity Theory (Carstensen, Isaacaowitz, & Charles, 1999) provides a motivational account, based on an individual's future time perspective, for how younger and older adults may differentially process emotional information. For instance, with advancing age, older adults may become acutely aware of limits to future time left in life. This awareness may cause a shift in motivational focus toward goals that would be beneficial in the here-in-now, such as feeling good and being happy. Conversely, younger adults likely have a more expansive time perspective, facilitating a focus on information gathering goals that can be applied in the future. These shifts in goal prioritization may be reflected in how individuals preferentially process emotional information in their environment. For instance, older adults' motivation toward present-oriented well-being goals may lead to preferential engagement toward positive, and/or the avoidance of negative, information (in comparison to younger adults) in the environment. This preferential positive focus in emotional information processing has been termed a *positivity effect* (Carstensen, Mathers, & Mikels, 2006; Reed & Carstensen, 2012).

Evidence for the positivity effect has been observed across several studies and research paradigms, including assessments of visual attention. Specifically, previous studies have revealed older adults' preferential attention toward positive and/or away from negative stimuli (i.e., facial expressions, images, and words) using a variety of attentional measures, including dot probe (Mather & Carstensen, 2003) and eye-tracking tasks (Isaacowitz, Toner, Goren, & Wilson, 2008; Isaacowitz Wadlinger, Goren, & Wilson, 2006; Knight, Seymour, Gaunt, Baker, Nesmith, & Mather, 2007). In a recent meta-analysis, Reed, Chan, and Mikels (2014) observed that positivity effects in visual attention are more likely to emerge under consciously controlled processing conditions and when attentional resources are least restricted. Thus, older adults' positive emotional preferences likely necessitate top-down processing networks that actively seek out information that facilitates positive affective goals in the moment.

While supported by a substantial literature, age-related positivity effects are not ubiquitous across studies; hence, there are likely boundary conditions as to when positivity effects do and do not emerge. For example, when given sufficient explicit motivation (Samanez-Larkin et al., 2009) or instructions to attend to specific or non-emotional aspects of a stimulus, positivity effects can be overridden (Reed & Carstensen, 2012). Additionally, Noh and Isaacowitz (2015) found that when distractors impede control of visual attention, positivity effects are not observed. Finally, another study assessed older and younger adults' attention toward both negative and positive targets in the presence of distractors that were neutral or of the opposite valence of the target (Ziaei, von Hippel, Henry, & Becker, 2015). Older adult participants were just as capable as younger adults at resisting attentional capture from positively valenced distractors when encoding negatively valenced targets. Thus, positivity effects may not be observed in scenarios where bottom-up assessments of visual attention are examined, or at least within a time course that commands attention via bottom-up mechanisms. This later point is evidenced by a previous study that had participants view a series of positive-neutral and negative-neutral face pairs. Age-related positivity effects did not emerge until 500 ms post-stimulus onset and were strongest after 2,000-3,000 ms (Isaacowitz, Allard, Murphy, & Schlangel, 2009). Knight and colleagues (2007) also observed a lack of valence preferences in older adults' visual attention within early fixation measures (i.e., first fixation deployment) when employing an eye-tracking divided attention paradigm. Thus, perhaps both positive and negative visual events confer bottom-up salience above and beyond top-down motivational importance within assessments of early attention.

While substantial research documents advantages with having an age-related positivity bias, failure to attend to negative information can have undesirable, maladaptive consequences. However, it may be more appropriate to conceptualize this trend as a default attentional strategy intended to bolster positive affect. In visual search tasks, older adults engage with negative information just as efficiently as younger adults when instructed to do so (Lundqvist, Svärd, & Fischer, 2013). Hence, even if positivity effects indicate a preference or a default strategy, such preferences do not necessarily reflect older adults' inability to attend effectively to negative information.

Threatening visual events represent a special class of negative stimuli due to their highly arousing nature and need for more immediate attention, and older adults are able to adequately deploy attention toward arousing negative stimuli (Hahn, Carlson, Gronlund, & Singer, 2005). Additionally, older adults respond to high arousing images just as quickly as younger adults (Leclerc & Kensinger, 2008). Thus, along with a potential top-down, goal driven default preference for the positive, older adults can rapidly deploy attention toward salient negative inputs (Mather & Carstensen, 2005; Mather & Knight, 2006, Isaacowitz, Allard, Murphy, & Schlangel, 2009; Hahn et al., 2006). For instance, Mather and Knight (2006) observed that older adults were able to rapidly identify angry faces relative to joyful faces, suggesting maintenance of negative salience in old age. Ruffman, Ng, and Jenkin (2009) also found that while older adults may be less adept at providing labels for particular emotional facial expressions (i.e., anger), older adults are able to attend and respond quickly to these stimuli. Thus, although positivity effects represent a motivational shift, when such a preference would be less pressing or maladaptive, older adults are able to deploy resources toward the negative.

Change Detection of Emotional Information

Typical change detection paradigms tend to employ non-emotional stimuli/images within visual arrays; however, the ability to detect changes to emotional objects/scenes may be more important for determining an individual's true change detection efficacy (Michael & Gálvez-García, 2011). Neutral or mundane objects may be less informative, less motivationally relevant, and require less immediacy in comparison to emotional stimuli/objects. Michael and Gálvez-García suggest that one strategy individuals use in visual search tasks is to move from the most to the least salient object when finding a target. In this manner, observers may naturally gravitate to the most arousing or salient aspects of a scene before surveying aspects of the array that are least arousing or salient. Only a few studies have addressed how change detection ability may operate as a function of emotionality, and these studies have yielded mixed findings. For instance, Liang and Yu (2012) found that positive stimuli facilitated, and negative stimuli reduced, change detection performance; however, the facilitation effect for positive stimuli only occurred during cognitively demanding tasks. Thus, when task difficulty is high, controlled cognitive resources may be necessary to process positive events (Liang & Yu, 2012). Typically, attention to salient or arousing visual events occurs automatically without conscious intent. It seems unusual that change detection would be impaired when viewing negative stimuli in Liang and Yu's study because previous literature on threat detection and bottom-up processing would predict that negative visual events should attract attention in a stimulus-driven fashion (LoBue, Matthews, Harvey, & Stark, 2014). It seems this finding could be partially reconciled by the possibility that the negative images used in Liang and Yu's experiment did not elicit sufficient arousal to be perceived as threatening. Additionally, Loranel (2008) indicated that differences in change detection occur as a function of different emotions, but their results did not form a clear interpretable pattern.

More work is needed to uncover patterns in how emotion affects change detection ability for informing current theories. Work on change detection for emotional stimuli is still quite new, and much research is needed in this area. However, as work on change detection and emotional processing continues to develop, it is likely that less change blindness will occur when the change carries emotional weight, compared to changes that are neutral. One explanation for this prediction is that it is advantageous to notice an emotional change because such events may require a particular reaction. Conversely, if a visual change is neutral, successful change detection may be less important.

As exemplified by research on emotion and attentional processes, it would be incomplete to develop theories on aging and attention without investigating the role of emotion on various attentional processes, as emotion is relevant to understanding cognition in old age. Predictions from Socioemotional Selectivity Theory and the positivity effect would suggest that positive emotional stimuli are more likely to capture older adults' attention through top-down processing due to the importance of emotion regulation goal priorities in old age (Carstensen, Mikels, & Mather, 2006). Furthermore, negative stimuli may confer automatic saliency and be detected using bottom-up resources (Lundqvist, Svärd, & Fischer, 2013). Thus, it is probable that older adults' change detection performance will be aided by exposure to emotional information, given that top-down and bottom-up processing could be adequately engaged when older adults are exposed to positive and negative stimuli.

Older adults' performance on change detection tasks within situations that are familiar, self-relevant, or in line with behavioral goals could be superior compared to performance on standard change detection tasks. Older adults' processing of emotional information could be linked to motivational priority when stimuli are positive (top-down) or confer automatic salience when stimuli are negative (bottom-up). Thus, older adults' change detection performance may be aided by scenarios that are emotional and/or self-relevant. Objects that successfully capture attention differ between individuals and across age groups due to varied goals. Thus, it is likely that change detection ability is relevant to developmental trajectories of attentional processing.

Some attention theorists posit that change blindness occurs because of our tendency to ignore the details of our visual field that are irrelevant to our goals, as well as the absence of active attention toward salient objects in the environment (Triesch, Ballard, Mayhoe, & Sullivan, 2003). Following Triesch and colleagues' line of reasoning, older adults may be more susceptible to change blindness for neutral events because these details may not be inherently motivating (i.e., positive affective goals) or signal immediacy (i.e., threat detection). However, older adults may exhibit less change blindness for emotional stimuli due to the more robust top-down and bottom-up salience of such information.

In sum, older adults' attentional foci are guided by motivationally relevant stimuli and environments, including finding positive aspects to maintain a positive mood (Carstensen, Fung, & Charles, 2003) or adaptive reactivity when danger arises (Carretié, 2014). Since many day-to-day scenarios that require rapid change detection consist of an emotional component, it is sensible to hypothesize that older adults' change detection ability may be less encumbered when emotional images or scenarios are employed in comparison to less evocative situations.

CHAPTER II

PRESENT STUDY

Results from current work on change detection, paired with theories of emotional processing in later life, indicate a need for research on how emotional processing operates within the realm of change detection scenarios. Change detection paradigms have bottom-up and top-down components, both of which guide emotional information processing. Few studies have assessed change detection with emotional information, and this is the first study to assess change detection of emotional information from an adult lifespan perspective. By adding an emotional component to a change detection task with a focus on aging, we can assess the following: 1.) whether top-down motivational relevance will facilitate change detection for positive stimuli for older adults (based on SST predictions) and/or 2.) whether bottom-up salience of negative emotional information is more influential in promoting change detection abilities in old age. In this manner, the inclusion of an emotional component could help us better understand age-related trajectories in change detection abilities, inform socioemotional theories on aging, and inform theories regarding detection as a function of change type (i.e., onset vs. offset). Thus, by assessing younger and older adults' change detection performance in response to emotional and neutral onsets and offsets, we can independently and conjunctively test these effects.

The aim of the present study is to uncover how younger and older adults may differentially attend to emotionally valenced visual events within a change detection paradigm. Given that adequate change detection abilities are essential for survival, and many instances in which change detection competency is needed in our daily lives involve emotional situations, it is possible that older adults' change detection performance will be aided by an emotional component. Evidence for improved change detection ability within emotional scenarios could be broadly extended toward understanding age-related attentional functioning across other domains (i.e., in the context of driving efficacy, etc.).

The present study will include two experiments. In Experiment 1, participants will be instructed to detect visual changes (the onset or offset of a positive, negative, or neutral object) as quickly and as accurately as possible. For each trial, participants will be presented with a fixation cross for 1,000 ms, followed by two images - each displayed for 1,200 ms in succession, separated by a gray mask screen for 100 ms. One object (positive, negative, or neutral) will have changed (onset or offset) between the two images. Using a combination of neutral and emotional objects and different types of visual events, we can gain a better perspective regarding how top-down (i.e., SST motivations) and bottom-up (general emotional salience) processing impact change detection ability, and what facets ultimately capture attention, within a more naturalistic environment. Because the detectability of a visual change may be based both on the valence of the changed object itself and whether it is appearing or disappearing from participants' field of view, a second paradigm will be used to separately assess how emotionality is represented by the type of change and its ascribed emotional value as compared to the inherent emotionality of the object. Importantly, the design of Experiment 2 affords the ability to directly assess the influence of top-down goals on change detection ability. Experiment 1 is structured only to infer motivational mechanisms through Socioemotional Selectivity Theory based predictions (Carstensen, Isaacowitz, & Charles, 1999), but participants will not receive instructions beyond maintaining both speed and accuracy. Thus, in Experiment 2, the role of explicit motivation can be evaluated as a function of both valence and context. This design has the added benefit of rectifying the ambiguity surrounding top-down factors for offset trials and bottom-up factors for onset trials (Madden, Whiting, Spaniol, & Bucur, 2005; Costello, Madden, Shepler, Mitroff, & Leber, 2010), because each type of change has a different motivational value depending on whether the target represents something positive or negative. Thus, in Experiment 2, the procedure and presentation times will be identical as in the first experiment; however, the stimuli will be neutral, and emotionality will be manipulated by placing affective value onto the objects based on the type of change event (i.e., onset vs. offset). In this manner, a positive onset and negative offset are imbued with a "pleasant" affective value while positive offsets and negative onsets have an "unpleasant" affective value. Thus, emotionality, rather than being inherent to a particular object, is the product of the initially non-emotional object combined with its relation to the observer. Using these paradigms, we should be able to demonstrate how sustained attentional flexibility across adulthood may function as an adaptive tool during change detection processing.

CHAPTER III

EXPERIMENT 1

Method

In Experiment 1, older and younger adult participants were instructed to detect a changed object (positive, negative, or neutral; onset and offset) within a naturalistic scene with neutral distractors. Participants were instructed to detect the change as quickly and as accurately as possible, regardless of target valence or change type. That is, participants were not given explicit motivational instructions or asked to behave differently as a function of target valence.

Predictions

Based on the aforementioned literature (Donaldson & Yamamoto, 2012; Yantis & Jonides, 1984), it is likely that both age groups will detect onsets with faster reaction times and higher accuracy compared to offsets; however, such an onset advantage may depend on object valence. Furthermore, it is also expected that older adults will be slower than younger adults at detecting changes, but a main effect of age is not the focus of interest. There are several plausible patterns of results that may emerge in terms of emotional effects.

Positivity effects. Given the extensive literature on positivity effects, findings from this study may provide evidence in support of positivity effects derived from Socioemotional Selectivity Theory. With evidence of positivity effects emerging within an early time course (starting at 500 ms), we might observe positivity effects in the present paradigm of 1,200 ms (Isaacowitz, Allard, Murphy, & Schlangel, 2009). While positivity effects often do not emerge until later on in processing, it is possible that such effects could emerge in the tasks used in the present study due to the memorial component of a change detection paradigm. Conversely, younger adults may be more vigilant to negative objects. As SST predicts that younger adults are likely more information-oriented, rather than positive-focused like older adults, younger adults often display a bias for negative relative to positive information (Rozin & Rozyman, 2001). Overall, an Age x Emotion interaction would likely be reflected in older adults exhibiting faster reaction times and higher accuracy on positive trials (here, positive trials could reflect a positive onset and/or a negative offset) compared to neutral or negative trials, and possibly younger adults exhibiting faster reaction times and higher accuracy to negative trials (which could be reflected in negative onsets and/or positive offsets) compared to neutral or positive trials.

Negativity effects. Given the nature of a change detection task, failing to observe positivity effects would not be particularly surprising because the goal of the task is to detect the changed object as efficiently as possible. Reed and Carstensen (2012) argue that positivity effects are most robust when no additional goal processes are relevant to the task, and no particular attentional instructions are given. Specifically, these researchers argue that positivity effects may not emerge if another behavioral goal overrides the SST-inspired goal of feeling as good as possible. Thus, it is possible that evidence for a negativity bias for both age groups could be revealed (i.e., reflected in response to negative onsets and/or positive offsets). The short presentation times and salience of negative items may support this possibility. Here, we could observe faster reaction times and higher accuracy for negative trials compared to neutral or positive trials due to the bottom-up saliency of negative information (Rauschenberger, 2003; Beck & Kastner, 2005). Additionally, locating a negative object alongside neutral distractors contributes to particularly efficient visual search, which could aid both younger and older adults in having faster reaction times and high accuracy on negative trials (Hahn, Carlson, Gronlund, & Singer, 2005; Mather & Knight, 2006).

General emotional prioritization. Instead of a specific focus on positivity or negativity, a pattern of results could reflect general emotional salience that does not discriminate by valence. An emotional enhancement effect would mean a co-activation of bottom-up processing resources to detect negative salience and top-down processing resources to motivationally identify the positive (Carstensen & Turk-Charles, 1994). The time interval in the present study is sufficient for emotional prioritization to be observed (Isaacowitz, Allard, Murphy, & Schlangel, 2009). In this case, older adults could demonstrate a general facilitation of emotional change detection compared to their performance on neutral trials. Although both age groups may perform better on emotional trials compared to neutral ones, there could be within-group improvement by older adults

(Fung & Carstensen, 2003; Samanez-Larkin, Robertson, Mikels, Carstensen, & Gotlib, 2009).

Pilot Study

The purpose of the pilot study was to ensure that ratings of positivity, negativity, and neutrality of the emotional objects were comparably evaluated by younger and older adults. Participants were presented with 75 objects (25 positive, 25 negative, 25 neutral) (see Appendix A for list of objects) and a corresponding ratings sheet. For each object, participants rated how positive, negative, and neutral the object was on a scale of 1-9 with 1 indicating very negative, five indicating neutral, and 9 indicating very positive. Five older adults with an average age of 69.8 years from the Cleveland State University community and greater Cleveland area and five younger adults with an average age of 18.4 years were recruited to participate in the pilot study. Older adults received monetary compensation at the rate of $5 per half hour, and younger adults received partial course credit at the rate of .5 credits for each half hour of participation. All participants had normal or corrected-to-normal vision.

A 2 (Age: younger or older) x 3 (Valence: positive, negative, or neutral) mixed analysis of variance (ANOVA) was conducted on ratings in the pilot study. The main effect of age was not significant, F (1, 8) = .64, p = .446, η_p^2 = .074, indicating that older and younger adults did not differ significantly in their ratings of objects used in the main experiment. There was a main effect of Valence, F (2, 16), p < .001, η_p^2 = .958. A Bonferroni-corrected post hoc analysis on this effect revealed that mean ratings of positive, negative, and neutral objects all differed significantly from each other. Positive objects received an overall mean rating of 7.03, ($M_{younger}$ = 7.15, M_{older} = 6.90), which differed significantly from both negative, $t(9) = 14.58$, $p < .001$, $d = 6.629$ and neutral objects, $t(9) = 9.31$, $p < .001$, $d = 2.822$. Negative objects had an overall mean rating of 2.40, ($M_{younger} = 2.14$, $M_{older} = 2.67$), and neutral objects had an overall mean rating of 5.54 ($M_{younger} = 5.42$, $M_{older} = 5.74$), and negative and neutral differed significantly from each other as well, $t(9) = 14.75$, $p < .001$, $d = 5.055$. A paired samples t-test was also conducted on the difference scores of ratings of neutral objects compared to negative objects and positive objects compared to neutral objects to determine if the magnitude of intensity ratings differed significantly for positive and negative objects in comparison to neutral objects. The paired samples t-test indicated that ratings for negative objects compared to neutral objects ($M = 2.75$, $SD = .56$) were significantly more intense than positive objects were compared to neutral objects ($M = 1.97$, $SD = .73$), $t(9) = 3.23$, $p = .010$, $d = 1.040$. Because positive objects overall were less intense on the positive scale than negative objects on the negative scale, the five objects with the lowest positive ratings were excluded from the experiment, as were the five neutral objects with the highest ratings and the 5 negative objects with the lowest ratings. Neutral objects excluded from the experiment had an overall mean rating of 6.60 ($M_{younger} = 6.56$, $M_{older} = 6.64$), positive objects excluded from the experiment had an overall mean rating of 5.96 ($M_{younger} = 5.92$, $M_{older} = 6.00$), and negative objects excluded from the experiment had an overall mean rating of 1.68 ($M_{younger} = 1.28$, $M_{older} = 2.08$). No significant interactions emerged for the ratings data.

Main Experiment

Participants. Twenty older adults ranging in age from 60 to 87 ($M = 68.3$, $SD = 6.55$) from the Cleveland State University community and greater Cleveland area and 20 younger adults ranging in age from 18 to 30 (M = 20.4, SD = 3.45) were recruited to participate in this study. In a preliminary study, an a priori power analysis was conducted based on an effect size of .172 for the interaction of Trial Type and Instructional Condition (Donaldson & Yamamoto, 2016). By setting an alpha level of .05 and power of .8 to .95, 16 to 23 participants were needed per group. Thus, recruitment of 20 participants per age group for the present study should have been sufficient (Donaldson & Yamamoto, 2016).

Participants' demographic information was also collected. The older adult sample consisted of seven men and 13 women. For older adults, 30% were African American, 65% were Caucasian, and 5% were Hispanic. For handedness, 85% of older adults reported right hand dominance, 10% reported left hand dominance, and 5% were ambidextrous. The average years of formal education for the older adults was 16.05 years, which approximately corresponds to attainment of a Bachelor's degree. The younger adult sample also consisted of seven men and 13 women. For younger adults, 15% were African American, 25% were Asian or Middle Eastern, 40% were Caucasian, 15% were Hispanic, and 10% chose not to provide this information. In the younger adult sample, 100% of participants reported right hand dominance. The average years of formal education for the younger adults was 13.75 years, which corresponds approximately to the second year of college.

Participants completed a series of mood and cognitive measures to assess whether scores on mood and cognitive inventories accounted for age differences on our main variables of interest. The Positive and Negative Affect Schedule (PANAS, Watson, Clark, & Tellegan, 1988) was used to assess positive and negative affect prior to the experimental tasks; the Center for Epidemiological Studies Depression (CESD-D; Radloff, 1977) scale was used to asses symptoms of depression; the trait subscale of the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) was proctored to examine anxiety symptomology; and the SLUMS inventory (SLUMS; Tariq, Tumosa, Chibnall, Perry, & Morley, 2006) was administered to gauge basic cognitive functioning. A cognitive battery designed to assess frontal lobe functioning, consisting of the FAS generative task, mental arithmetic, backward digit span task, and mental control task was also administered (Glisky, Polster, & Routhieaux, 1995), as well as the Shipley vocabulary test (Zachary, 1986). Cognitive questionnaires were administered prior to the affective questionnaires in order to prevent potential activation of cognitive ability from negatively influencing participants' performance on the main tasks. Older adults received monetary compensation of $5 per half hour of participation, and younger adults received .5 research credits per half hour of participation. All participants had normal or corrected-to-normal vision.

Materials. Experimental stimuli were color digital photographs depicting kitchen scenes, as this environment is commonly encountered by individuals of all age groups. Six different kitchen scenes were used an equal number of times to avoid habituation effects that may occur if the same scene was used for 120 trials. A positive scene, for example, consisted of the appearance of a dessert tray or the disappearance of rotting food; a negative scene, for example, consisted of the appearance of rotting food or the disappearance of a dessert tray; and a neutral scene consisted of the appearance or disappearance of a kitchen utensil. All non-target items were neutrally valanced. Stimuli were created using Adobe Photoshop and presented using ePrime 3.0 (Psychology

Software Tools, Pittsburgh, PA). Each scene contained objects typically found in a kitchen environment, and the set size varied from six to 15 objects to avoid predictability of whether the trial consisted of an onset or an offset. The objects were arranged such that half were on the left side of the scene and half were on the right side.

Figure 1a. This is an example of a stimulus trial for Experiment 1 that contains a positive target. Here, the plate of eclairs on the right of this image is the target.

Figure 1b. This is an example of a stimulus trial for Experiment 1 that contains a negative target. Here, the spider on the right of this image is the target.

Figure 1c. This is an example of a stimulus trial for Experiment 1 that contains a neutral target. Here, the umbrella on the left of this image is the target.

Images were presented on a 22-inch computer monitor. The screen was positioned vertically in front of the participant. The distance between the participant and the screen was approximately 60 cm. The images were presented so as to occupy the entire screen. When presented on the screen, the center of the scene was approximately at the center of the screen so that the left and right halves of the scene corresponded to those of the screen (see the appendix for the objects used in this Experiment).

Design. Participants began with a short practice session of 16 trials. Stimuli used in the practice session were unique photographs that were not repeated in subsequent blocks. These manipulations ensured that participants were not influenced by any adventitious priming effects resulting from seeing particular objects or configurations in photographs more frequently (e.g., Chun & Jiang, 1998).

Following the practice session, participants were presented with a block of 120 trials, each depicting a series of photograph pairs. The two photographs of each pair depicted the same object configuration, but one change occurred between them—a new object appeared in the second photograph (onset), or one of the objects in the first photograph disappeared going into the second photograph (offset). One onset trial and one offset trial were created from the same two photographs by reversing the order of their presentation. This manipulation ensured that the identical visual characteristics were present for both onset and offset trials. The onset and offset trials were randomly intermixed. Each object was used the same number of times to create an onset trial or an offset trial throughout the experiment (i.e., all objects were presented an equal number of times throughout the experiment).

The task was to detect the change between the photographs as accurately and quickly as possible by indicating with a button press whether the change occurred on the right half or the left half of the scene. The location of the change was counterbalanced such that the changed object occurred on the left and right side of the scene an equal number of times. There were 40 positive trials, 40 negative trials, and 40 neutral trials. There were 40 trials with a low set size, 40 trials with a medium set size, and 40 trials with a high set size. The objects and side of the screen on which the change occurred was also counterbalanced.

Procedure. This experiment used the same procedure as in Donaldson and Yamamoto (2012), which adopted the one-shot flicker paradigm developed by Cole et al. (2003). Participants sat in front of a computer screen, centered in front of a keyboard. The participants were told that they would view a series of photograph pairs in which an object would change between two images of each pair. Participants were instructed that the change would be either an onset of a new object or an offset of an existing object. Participants were instructed to press either the “F” key if the change occurs on the left or the “J” key if the change occurs on the right side of the screen. Participants used their left index finger to press the left button and their right index finger to press the right button. Participants did not have to report whether the trial represented an onset or an offset trial. Participants were cautioned to be as quick, but as accurate as possible.

During each trial, participants first viewed a fixation cross for 1,000 ms that was presented at the center of the screen. Participants were instructed to keep fixating on the cross while it was displayed and maintain their fixation around the same area after the cross disappeared. Participants then viewed a first image for 1,200 ms. This image was followed by a 100-ms gray screen that produced a one-shot flicker of the scene. The second image was then displayed for 1,200 ms. At the onset of the second image, participants were allowed to make a button press indicating on which side of the screen they believe the change occurred if they had noticed it. Following the presentation of the second image, the second gray screen was displayed and remained on the screen until the participant made his or her response or until 3,000 ms has passed. Reaction time was recorded between the appearance of the second image and the participant's button press. Accuracy in the left/right judgment was also measured based on participants' button press response. When the participant made an error in the left/right judgment, reaction time from such a trial was not included in the reaction time analysis.

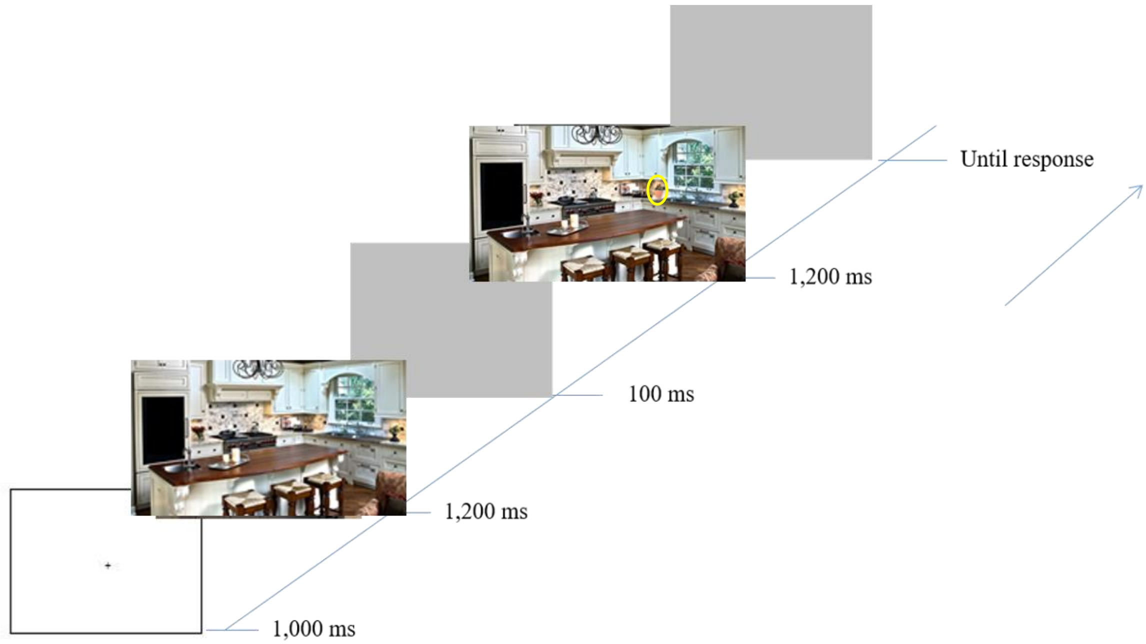

Figure 2. The trial sequence for Experiment 1. This represents a positive onset trial, in which the flowerpot (positive target) appears on the right in the second image. By reversing the order of the presentation, the same image pair could represent a negative offset trial.

Data analyses. Data were analyzed via a 2 (Age: younger or older) x 3 (Valence: positive, negative, or neutral) x 2 (Trial type: onset or offset) mixed ANOVA, in which age was a between participant factor and valence and trial type were within participant factors. Although we controlled for set size, set size was not included in the main analysis, because the function of set size was only to eliminate attentional capture by trial type predictability, and was not of central interest. Separate analyses were conducted for reaction time and accuracy.

Results

No participants were excluded from the analyses for having mean accuracy in the left/right judgment task for either onset or offset trials more than three standard deviations from the mean of all participants. However, aberrant reaction times were removed at the trial level for each participant that exceeded three standard deviations from the mean for that participant. This method of outlier analysis was used in previous studies (e.g. Donaldson & Yamamoto, 2016) and less than 1-2% of trials in 11 younger adults, and less than 1-2% of trials in 14 older adults were removed in the present study. Analyses did not differ substantially with or without outliers.

Covariates. On the Positive Affect Schedule, older adults (M = 39.25, SD = 4.42) reported significantly higher positive affect compared to younger adults (M = 34.10, SD = 6.91), $t(38) = -2.81$, $p = .008$, and on the Negative Affect Schedule, older adults (M = 12.90, SD = 2.77) reported significantly lower negative affect than younger adults (M = 16.35, SD = 5.37), $t(38) = 2.55$, $p = .015$ (PANAS, Watson, Clark, & Tellegan, 1988). On the CESD-D, older adults (M = 5.60, SD = 4.75) reported significantly lower depressive symptomology than younger adults (M = 14.30, SD = 10.18), $t(38) = 3.46$, $p = .001$

(CESD-D; Radloff, 1977). On the STAI, older adults (*M* = 29.40, *SD* = 5.09) reported significantly lower anxiety compared to younger adults (*M* = 37.30, *SD* = 8.43), $t(38) = 3.59$, $p = .001$ (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). Older adults (*M* = 25.65, *SD* = 2.96) and younger adults (*M* = 25.20, *SD* = 3.25) did not differ significantly on the SLUMS inventory for basic cognitive functioning, $t(38) = -.46$, $p = .650$ (SLUMS; Tariq, Tumosa, Chibnall, Perry, & Morley, 2006). On the Shipley vocabulary test, older adults (*M* = 34.50, *SD* = 5.15) scored significantly higher than younger adults (*M* = 26.95, *SD* = 3.63), $t(38) = -5.36$, $p < .001$. Older adults (*M* = -.08, *SD* = 1.55) did not differ significantly from younger adults (*M* = -.35, *SD* = 1.39) on composite front lobe cognitive functioning scores, $t(38) = -.58$, $p = .565$ (Glisky, Polster, & Routhieaux, 1995). Thus, younger and older adults from this sample had comparable cognitive capacities, which given the level of education and nature of this experiment, is in line with what would be expected from this older adult sample. Results of these analyses indicate what is generally expected in the literature on emotion and cognition in terms of age profiles on these variables. Importantly, when included as covariates in the main analyses, STAI, CESD-D, Shipley, PA, and NA scores had no significant effect on the main dependent variables of interest.

Reaction time data. There was a main effect of Age, such that reaction times for younger adults were significantly quicker than for older adults, $F\ (1, 38) = 15.59$, $p < .001$, $\eta_p^2 = .291$. There was also a significant main effect of Trial type, $F\ (1, 38) = 44.99$, $p < .001$, $\eta_p^2 = -\ .542$, wherein reaction times for offsets were significantly quicker than reaction times for onset trials, suggesting greater offset primacy. The sphericity assumption was not met for Valance, $X^2(2) = 17.17$, $p < .001$, so the Greenhouse-Geisser correction was used for this variable. There was a significant main effect of Valence, F (1.458, 76) = 7.04, p = .005, η_p^2 = .156. Bonferroni-corrected post hoc analyses revealed that reaction times for positive trials were significantly quicker than reaction times for both negative, $t(38) = 2.812$, $p = .023$, $d = 1.540$, and neutral trials, $t(38) = 3.032$, $p = .013$, $d = 1.483$, and negative and neutral trials did not differ significantly from each other, $t(38) = .888$, $p = 1.000$, $d = .321$. The main effect of Valence was qualified by a marginally significant interaction between Valence and Trial type, $F(2, 76) = 2.823$, $p = .066$, η_p^2 = .069. A simple effects analysis revealed that for onset trials, positive trials were detected more quickly than either negative, $t(38) = 4.88$, $p < .001$, $d = 2.520$, or neutral trials, $t(38) = 4.46$, $p < .001$, $d = 1.653$, but negative and neutral trials did not differ significantly from each other, $t(38) = 2.24$, $p = .093$, $d = .804$. For offset trials, positive, negative, and neutral trials did not differ significantly from each other. No other main effects or interactions were significant.

As noted in the Predictions section, a positive trial could either be construed as a positive onset or a negative offset, while a negative trial could either be construed as a negative onset or a positive offset. Thus, to provide a more sensitive assessment of positivity vs. negativity preferences, variables were created to further interrogate the interplay between participant Valence and Trial type variables. A 2 (Age: young vs. old) x 3 (Valence/Trial type: positive onset/ negative offset, negative onset/ positive offset, neutral) Analysis of Variance was conducted separately for reaction time and accuracy data. For reaction time, there was still a main effect of Age, F (1, 38) = 15.59, $p < .001$, η_p^2 = .291. There was also a main effect of Valence as well, F (2, 76) = 4.10, $p = .020$,

η_p^2 = .097, whereby positive trials, both positive onsets and negative offsets, were detected more quickly than neutral trials, *t*(38) = 2.96, *p* = .016, *d* = .890. Negative trials did not differ significantly from positive trials or neutral trials. See Figure 3a for reaction time data for the main ANOVA and Figure 3b for the follow up analysis.

Accuracy data. There was a main effect of Age, such that younger adults exhibited significantly higher accuracy than older adults, F (1, 38) = 22.88, p < .001, η_p^2 = .376. No other main effects or interactions were significant. Furthermore, there was no evidence of any speed-accuracy trade-offs. The same follow up analysis used to understand the interplay between Trial type and Valence variables was conducted for accuracy as well. Again, a main effect of Age emerged whereby younger adults were significantly more accurate than older adults, F (1, 38) = 22.88, p < .001, η_p^2 = .376, but no other main effects or interactions were significant. See Figure 3c for accuracy data.

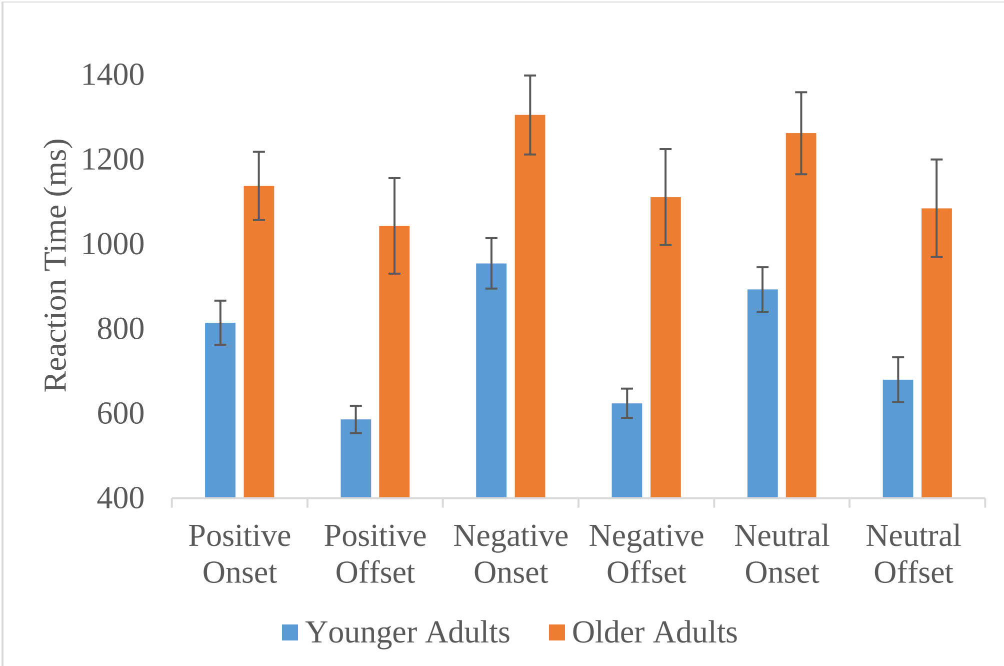

Figure 3a. Reaction time data for Experiment 1. Error bars represent standard errors of the mean.

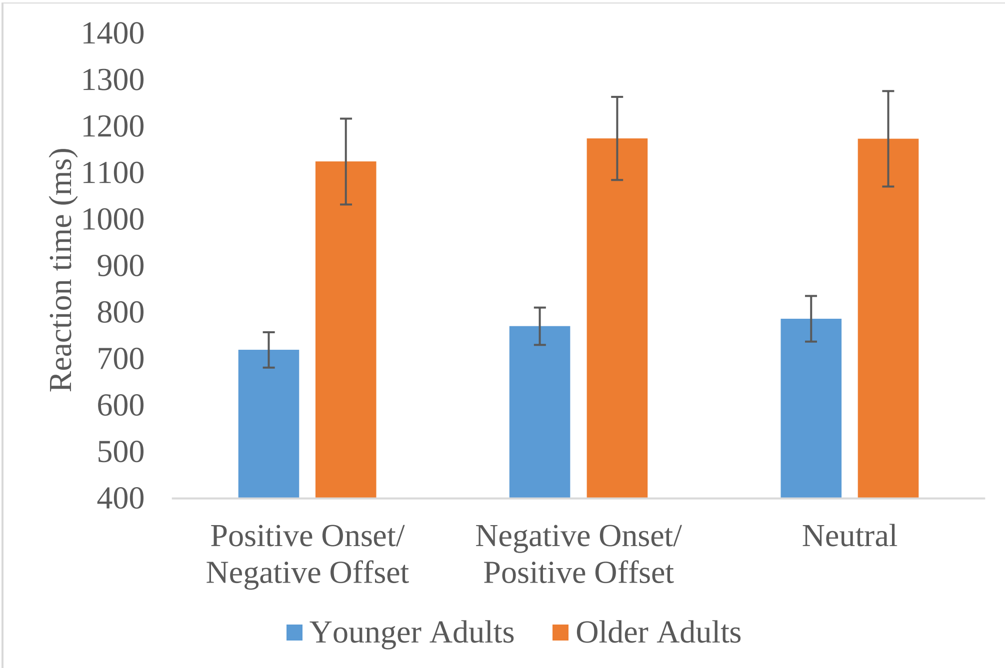

Figure 3b. Reaction time data for Experiment 1 in which positive trials are comprised of positive onsets and negative offsets and negative trials are comprised of negative onsets and positive offsets. Error bars represent standard errors of the mean.

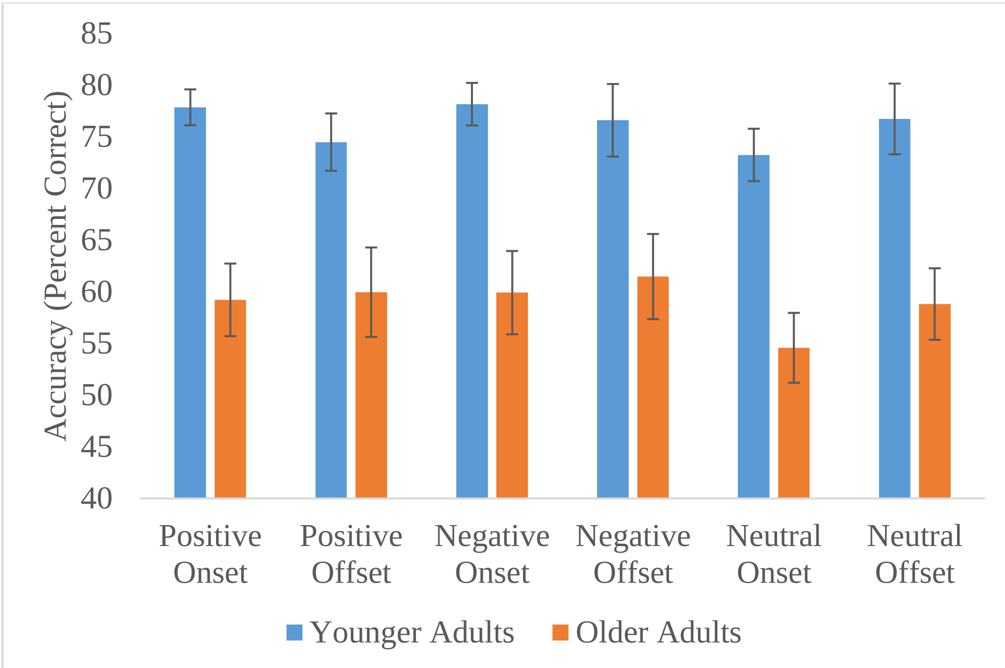

Figure 3c. Accuracy data for Experiment 1. Error bars represent standard errors of the mean.

Experiment 1 Discussion

Results of Experiment 1 highlight two main findings. First, given the extensive literature on age-related positivity effects, it was possible that findings from this study could have provided evidence in support of Socioemotional Selectivity Theory given the time course for the stimulus presentations used (i.e., within 1,200 ms; see Isaacowitz et al., 2009). While positivity effects often do not emerge until later on in processing, such effects could have emerged in the tasks used in the present study due to the memorial component of a change detection paradigm. However, in order for findings from the present study to support positivity effects as predicted by Socioemotional Selectivity (Carstensen, Isaacowitz, & Charles, 1999), an Age x Valance interaction, in which older adults exhibited faster reaction times and/or higher accuracy on positive trials (here, positive trials could reflect a positive onset and/or a negative offset) compared to neutral or negative trials, or possibly in which younger adults exhibited quicker reaction times and/or higher accuracy to negative trials (which could be reflected in negative onsets and/or positive offsets) compared to neutral or positive trials was not observed in the present study. In fact, we found evidence of greater positive preferences across the entire sample, as both younger and older adults were much faster at detecting positive targets, relative to negative and neutral targets.

Older adults may have a cognitively motivated desire to optimize well-being (Mather & Carstensen, 2003); thus, the enhanced positive preferences observed are somewhat in line with SST predictions. However, SST would also predict that younger adults would be less positive focused due to the supposition that younger adults are likely more information-oriented and vigilant toward the negative (Rozin & Rozyman, 2001); this did not appear to be the case based on the present results.

There are two possible explanations for this pattern of results in which positive preferences emerged for both younger and older adults. One possibility is that we recruited a particularly happy and emotionally well-adjusted sample of younger adults. However, the PANAS, STAI, and CES-D data obtained from the present sample would indicate that both our young adult and older adult sample were representative of what would be expected for both age groups, with older adults demonstrating higher levels of PA, and lower levels of NA, depressive symptomology, and anxiety symptomology in comparison to the younger adult sample (Carstensen et al., 2011).

The second potential explanation, then, is to consider the stimuli that were used in this experiment, as well as how they were employed. To review, stimuli used in the pilot study for Experiment 1 were chosen as potential objects that could feasibly exist in a typical kitchen environment but that had some affective component (aside from the neutral objects). We did not control for size, contrast, or luminance, as these naturally vary with objects that occur in naturalistic scenes. Thus, some objects were larger and more colorful than others. This may have contributed to the noticeability of some objects over and above other objects. However, the important constraint was the believability of the object for the purpose of assessing how observers respond to changes in a more natural change detection paradigm. In that respect, objects were also only placed in parts of the scene where they could theoretically exist. For example, a water bottle cannot float, so it was placed on the kitchen counter.

Interestingly, in the pilot study, positive objects were actually rated as less intense on the positive scale, compared to negative objects on the negative scale. Despite this potential limitation, the onset of a positive object was particularly noticeable, as revealed in the Valence by Trial type interaction. Perceptual features of positive objects may have been particularly salient when appearing in the scene; positive object color and size compared to the negative may have enhanced the noticeability of positive objects during onset trials.

Importantly, in the main ANOVA, an overwhelming offset advantage also emerged. To fully understand the processing advantage of positive onsets, it is critical to concomitantly consider the other main finding from Experiment 1 concerning the main effect of Trial type. Despite considerable research supporting onset primacy (e.g. Brockmole & Henderson, 2005; Cole, Kentridge, Gellatly, & Heywood; Donaldson & Yamamoto, 2012), overall, offsets were detected with quicker reaction times in the present study. Donaldson and Yamamoto (2016) found that despite providing participants with both implicit and explicit manipulations in order to activate both top-down and bottom-up processing resources, onset primacy is a rather robust phenomenon, and it was only with the combination of top-down and bottom-up processing that an onset advantage disappeared. However, a true offset primacy never emerged. One possible explanation I propose for the pattern of results obtained in the Donaldson and Yamamoto study was that the objects were all neutrally valenced and the instructions given were purely attentional. In contrast, in the present study, the only instruction given was to respond both as quickly and as accurately as possible, but the objects differed in emotional quality. Thus, with neither an explicit nor implicit attentional motivation, an offset primacy emerged given the emotional nature of this task.

In the supplementary analysis that was conducted in which positive trials were comprised of positive onsets and negative offsets and negative trials were comprised of negative onsets and positive offsets, another processing advantage was for “positive” trials relative to neutral ones. That is, both younger and older adults were paying particular attention to the onset of a positive object and the offset of a negative object. Although the overall processing advantage was for offset trials, as indicated by faster reaction times, the main effect of Trial type also appears to be driven by positivity upon consideration of the supplementary analysis results.

Importantly, the change detection paradigm used in this study allows for this disentanglement of emotion not only being inherent to an object but also a product of what that object represents. Attentional capture by positive onsets and negative offsets occur as a function of different underlying mechanisms, so it is actually quite interesting how dominating positivity was in the present study. This point actually speaks to the preservation of an interaction between bottom-up and top-down processing resources in later life (Yantis, 2005), given the lack of age interactions. Processing emotional information involves both exogenous and endogenous attentional control. In typical change detection paradigms, onset detection is largely a product of exogenous attentional streams, as attention can quickly be commanded by bottom-up processing resources to new and potentially salient visual events (Theeuwes, 2004). During emotional object change detection, exogenous attentional capture is a distinct possibly, especially in cases of threat. However, when demands for attention are low, people can volitionally engage with the environment, and emotions could guide this interaction via exogenous control (Connor, Egeth, & Yantis, 2004; Rolls, 2008). Detection of a positive onset may be partially driven by a motivated desire to maintain positive affect and regulate emotions for older adults (Carstensen, Isaacowitz, & Charles, 1999), so there may be some degree of top-down processing involved; however, because younger adults showed the same pattern of results, for onset trials, detection may also largely be dependent on bottom-up processing resources. In past research, the newness of an onset has a processing advantage because until it is attended, it is unclear whether or not that event will require us to react in some important, adaptive way (Cole, Kentridge, & Heywood, 2004). Rapid detection of positive onsets would be more in line with the pattern of results typically seen in past change detection studies because the new positive object pops out in the second image. However, negative offsets operate differently, even though the valence categorization within these two trial types is equivalent. Detection of negative offsets commands bottom-up processing because negative objects tend to be salient; thus, participants' attentional resources may have made them quickly aware of the presence of a negative object in the first image (Theeuwes, 2004). Even though in this trial type the negative object was not the ultimate target (rather the space in the second image where the negative object was initially located) its temporary presence may have still commanded observers' attention in a meaningful way. The challenging part of this task is the memorial component involved with offset trials, which makes any kind of offset advantage rather impressive. Yet, in this study, there was a robust offset advantage. One mechanism typically driving onset primacy observed in the visual attention literature is the "pop out" effect in which the target differs from non-target distractors on details such as size, orientation, or luminance (Nothdurft, 2000). Because of efforts to control for object "belongingness" within the kitchen scenes, it may be the case that the traditional bottom-up pop-out effect associated with onsets was dampened in this paradigm. If onsets were less noticeable than typical, detection of offsets may have been more noticeable than usual. Regardless, offset detection can still be quite challenging. Participants must remember the arrangement of the previous display, and correctly identify the location of the screen where the target was located during the first image. In this way, this task also requires intact top-down processing resources, which was demonstrated by both the younger and older adult sample, due to the lack of an observed Age x Trial type interaction.

Results of this experiment demonstrate that one way to activate (or motivate) our attentional system is through emotion, even without an explicit motivational instruction. The lack of predictability from the first image to the second image was a strength in the sense that this design more closely resembles naturally occurring change detection scenarios people may encounter. However, this also made for a rather challenging task. We were able to observe successful maintenance of older adults' flexible use of bottom-up and top-down processing resources to facilitate change detection ability. However, without seeing meaningful age effects regarding positive preferences, the true effect of emotion and visual trial type on change detection ability is not resolved following this initial experiment. Thus, in Experiment 2, we more carefully addressed the role of emotion on change detection ability by not only considering the combined effects of Valence and Trial type (i.e., the similar valence of a positive onset and negative), but also the effect of a top-down emotional motivational instructions on participants' performance.

CHAPTER IV

EXPERIMENT 2

Method

Experiment 1 investigated how the emotionality of objects may differentially impact older and younger adults' ability to detect onset and offset changes in scenes. Results indicated that older and younger adults were both particularly adept at processing positive-oriented trials. In contrast to assessing change detection of objects imbued with emotional value, emotionality can also be ascribed to a scene based on what a particular object represents. For instance, objects (e.g., store merchandise) may not have inherent emotional value, but when they disappear (e.g., shoplifted from a store), their offset could be emotionally evocative (i.e., distressing). In Experiment 1, we were able to assess this implied effect of positivity and negativity crossed between onset and offset; however, in Experiment 2, we made this interaction between Valence and Trial type explicit to participants. If all the changes are imbued with top-down affective components, we can further interrogate the motivational nature of change detection abilities for younger and older adults in this type of paradigm.

Thus, considering the emotional context of scenes is critical to understanding how individuals behave with change detection in their daily lives. The purpose of Experiment 2 was to delineate how an emotional component may motivate behavior, and if the motivation differs between younger and older adults. Many occasions requiring change detection in our everyday environment are infused with emotional relevance. The object that must be detected in those instances may not convey emotionality in isolation, but within the context, its detection is critical. For example, a trash can, in essence, likely would not convey emotional meaning on its own. However, if it rolls onto the sidewalk in front of your child, who is riding a bike, that object now becomes highly emotionally relevant. Noticing and reacting to that stimulus becomes critical to ensuring the child's safety.

Most situations involving change detection represent one of four different scenarios. If an object with a positive salience (e.g., new puppy) is an onset, this situation is construed as pleasant. If a positive object (e.g., new puppy) disappears from a scene, this could be distressing. A negative object entering a scene (e.g., aggressive dog) may illustrate a threat; and lastly, a negative object disappearing from a scene (e.g., aggressive dog) could represent relief. Thus, in a change detection paradigm, the same object could be valued as either positive or negative depending on situational factors; similarly, the same visual event could carry either positive or negative salience depending on the value of the object. In the present study, we tested four motivational scenarios to represent each type of visual event. Determining which of these scenarios has the greatest influence on performance in this task should provide us with a better understanding of what affective events are prioritized within specific affective contexts.

Predictions

Positivity effects. If there is evidence for positivity effects, there may be faster reaction times and higher accuracy for pleasant and relief conditions compared to distress, threat, and control conditions for older adults, similar to what was observed for Experiment 1. Alternatively, younger adults may exhibit faster reaction times and higher accuracy for distress and threat conditions compared to pleasant, relief, and control conditions. In Experiment 1, both younger and older adults displayed positive preferences, as demonstrated by faster reaction times on positive onset and negative offset trials. Even though younger adults exhibited positive preferences in Experiment 1, by providing the explicit emotional motivations to participants in Experiment 2 and using different stimuli, it is still possible that younger adults may have an age-related negativity bias.

Negativity effects. Given the short presentation times, a negativity bias may emerge for both younger and older adults. In this case, reaction times will be faster and accuracy higher for distress and threat conditions, compared to pleasant, relief, and neutral conditions. Even though Experiment 1 contained negative objects that either appeared (negative onset) or disappeared (positive offset), the overall context of the kitchen scene in which these changes occurred might not have fully conveyed a threatening or relieving environment. By using top-down emotional motivations to represent the different affective and attentional scenarios, we may be more likely to observe negativity effects for both age groups in the present study

General emotional prioritization. If an emotional preference is observed, then reaction times will be faster and accuracy higher for pleasant, relief, distress, and threat conditions compared the baseline condition. This emotional preference could be observed for younger and older adults. Even though a general emotional preference was not observed in Experiment 1, the different stimuli, and changing emotional context used in Experiment 2, could alter the processing of these objects in a manner different from what was noted in Experiment 1.

Pilot Study

The purpose of the pilot study was to choose the most motivating emotional context scenarios for Experiment 2. Participants were presented with 5 scenarios that were potentially pleasant (positive onset), 5 that were potentially distressing (positive offset), 5 that represented potential threat (negative onset), and 5 that represented potential relief (negative offset). Participants completed the task individually. Participants were instructed to order the 5 scenarios within each type of change from most motivating to least motivating. Each scenario naturally had the potential for both onsets and offsets, but for that situation, it was clear whether onsets or offsets were more crucial to notice. The scenario that was most commonly motivating for each type of change across age groups was used in Experiment 2. A stargazing situation in which the goal was to notice a shooting star entering the sky was chosen for the pleasant scenario (M_{young} = 4.4, SD_{young} = .89; M_{old} = 4.4, SD_{old} = .55). Participants rated a driving situation, in which the goal was to detect new cars appearing on the road that may endanger safety, as most evocative for the threat scenario, (M_{young} = 5.0, SD_{young} = .00; M_{old} = 4.8, SD_{old} = .45). A description of maintaining vigilance over children at a daycare center in case one of the children goes missing was chosen for the distress situation (M_{young} = 4.2, SD_{young} = .84; M_{old} = *4.4*, SD_{old} = .55). Lastly, an armed intruder scenario was rated as most evocative for the relief scenario, as the goal was to notice that the intruder had left the scene (M_{young} = 5.0, SD_{young} = .00; M_{old} = *4.6*, SD_{old} = .55). A 2 (Age: younger or older) x 4 (Scenario: pleasant, threat, distress, or relief) analysis of variance (ANOVA) was conducted on ratings data in which age was a between participants factor and scenario was a within participants factor. The main effect of age was not significant, $F(1, 8) = .27$, $p = .620$, $\eta_p^2 = .032$, suggesting that these scenarios were rated as equivalently motivating across age groups. The main effect of scenario was not significant, $F(3, 24) = 2.81$, $p = .061$, $\eta_p^2 = .260$, suggesting that the scenarios were equally motivating. The interaction of age and scenario was also not significant, $F\ (3, 24) = .54$, $p = .659$, $\eta_p^2 = .063$. Descriptions of the scenarios used in Experiment 2 can be found in the Appendix.

Main Experiment

Participants. The participant sample for Experiment 2 was identical to that of Experiment 1. The order of experiments was counterbalanced across participants to account for potential carryover effects following completion of the mood and cognitive questionnaires.

Materials. Experimental stimuli were colored, 2-dimensional shapes on a solid grey background (see Figure 4 for example stimuli). These stimuli were created using Microsoft PowerPoint, and were presented using ePrime 3.0 (Psychology Software Tools, Pittsburgh, PA). The set size varied from six dots to 11 shapes. In this manner, participants were not able to predict whether an onset or offset occurred during the trial simply by the number of dots present on the screen. Shapes appeared in each color an equal number of times, were present on each side of the screen an equal number of times, and were the target an equal number of times. The shapes were arranged such that half were on the right side of the screen, and half were on the left side of the screen. Images were presented on a 22-inch liquid crystal display and occupied the entire screen. The screen was positioned vertically in front of the participant. The distance between the participant and the screen was approximately 60 cm.

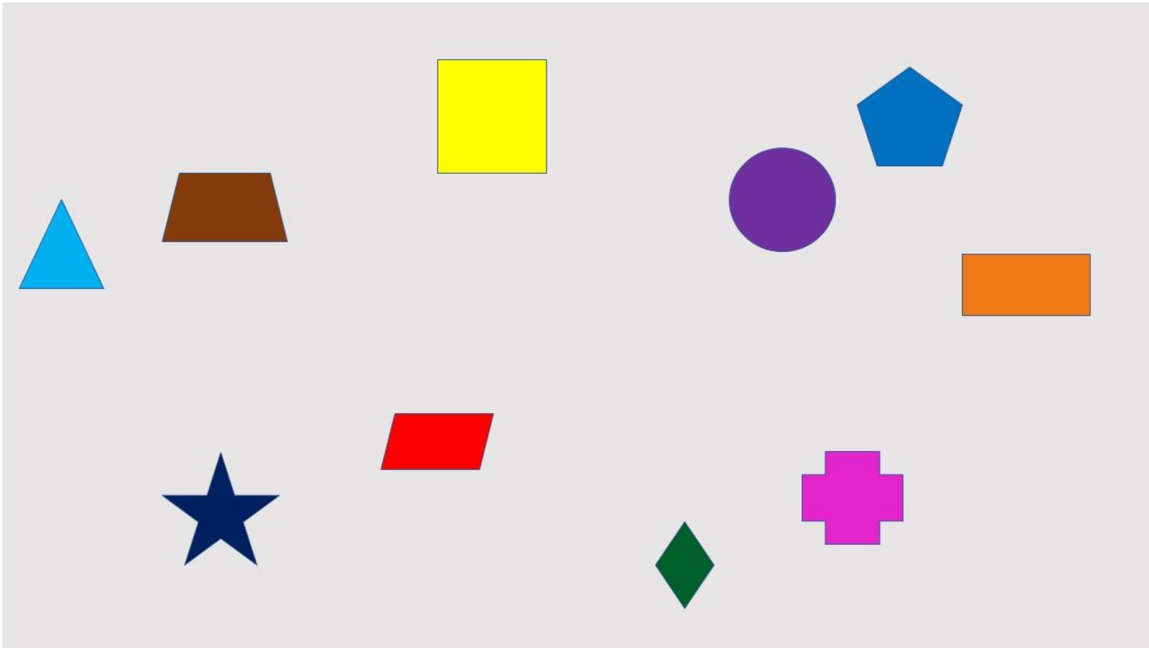

Figure 4. This image represents sample stimuli for Experiment 2. This image contains 10 objects. It is possible that the next image may have either 9 or 11 objects, thereby eliminating the risk of change detection simply by counting the number of objects present in the array.

Design. Participants were exposed to all four change detection scenarios (one scenario per block); however they were randomly assigned to one of four counterbalanced orders, so that we could assess how different emotional contexts would motivate behavior for each participant. A Latin Square design was used to develop the four counterbalanced orders: 1. Pleasant, Threat, Distress, Relief; 2. Threat, Relief, Pleasant, Distress; 3. Distress, Pleasant, Relief, Threat; 4. Relief, Distress, Threat, Pleasant. All experimental sessions began with a short practice session of 16 trials (eight onsets, eight offsets) in which no contextual motivation was given. This was to ensure that participants were able to notice an onset and offset in this paradigm. Stimuli used in the practice session were different from stimuli used in the actual experimental conditions.

Following the practice session, participants completed a baseline control condition in which their only instruction was to respond as quickly and accurately as possible to onsets and offsets. The baseline control condition was the same length as the other four experimental blocks and was used as a comparison against the other four blocks. Following this condition, participants then went through each of the four conditions, the order of which was counterbalanced. Each condition began with a scenario describing how the shapes should be conceptualized for that block of trials. Participants completed the same 60 trials (30 onsets and 30 offsets) for each of 4 blocks (and the control block), for a total of 300 trials. The same 60 trials were used in each of the blocks, but the order was randomized across participants and within each block. Other studies (i.e., Veiel, Storandt, & Abrams, 2006) have used 100-200 trials per condition, but given the emotional nature of this task and to avoid participant fatigue, this number of trials should have been sufficient. The context determining how they respond to these blocks, however, was different. In each trial, participants viewed a pair of images presented in succession, depicting a shape display. One change occurred between them—a new shape appeared in the second image (onset), or one of the shapes in the first photograph disappeared in the second image (offset). One onset trial and one offset trial were created from the same two images by reversing the order of their presentation. This manipulation ensured that the identical visual characteristics were present during both onset and offset trials. The onset and offset trials were randomly intermixed. At the onset of each new block of 60 trials, participants were presented with one of four instructions, based on the results of the pilot study to orient them to the emotional context of the environment. These represented the four combinations of negative and positive valence with onset and offset trials.

The task was to detect the change between the shape displays as accurately and quickly as possible by indicating whether the change occurred in the right half or the left half of the scene. The location of the change was counterbalanced such that the changed object occurred on the left and right side of the scene an equal number of times.

Procedure. Participants sat in front of a computer screen, centered in front of a keyboard. Participants were then told that they would view a series of image pairs in which a shape would either be added (onset) to the second image, or deleted (offset) from the first image. In the neutral control block, participants were not given a motivational instruction to respond in a particular way. However, in each of the four subsequent experimental blocks, participants were given a motivational instruction indicating how onsets and offsets should be conceptualized for those trials. Importantly, both onsets and offsets were plausible for each of these stimuli, but one trial type carries more affective weight than the other type of change in each context. Participants were instructed to press either the “F” key if the change occurred on the left or the “J” key if the change occurred on the right side of the screen. Participants used their left index finger to press the left button and their right index finger to press the right button. They were cautioned to be as quick, but as accurate as possible. Participants did not have to report whether the change was an onset or an offset.

For each trial, participants first viewed a fixation cross for 1,000 ms that was presented at the center of the screen. Participants were instructed to keep fixating on the cross while it was displayed and maintain their fixation around the same area after the cross disappeared. Participants then viewed a first image for 1,200 ms. This image was followed by a 100-ms gray screen that produced a one-shot flicker of the scene. The second image was then displayed for 1,200 ms. At the onset of the second image, participants could make a button press indicating on which side of the screen they believe the change occurred. Following the presentation of the second image, if a response had not yet been made, a second gray screen was displayed and remained on the screen until the participant made his or her response or until 3,000 ms had passed. Reaction time was recorded between the appearance of the second image and the participant’s button press. Accuracy for the left/right judgment was also measured based on participants’ button press response. When the participant made an error in the left/right judgment, reaction time for that trial was not included in the analyses.

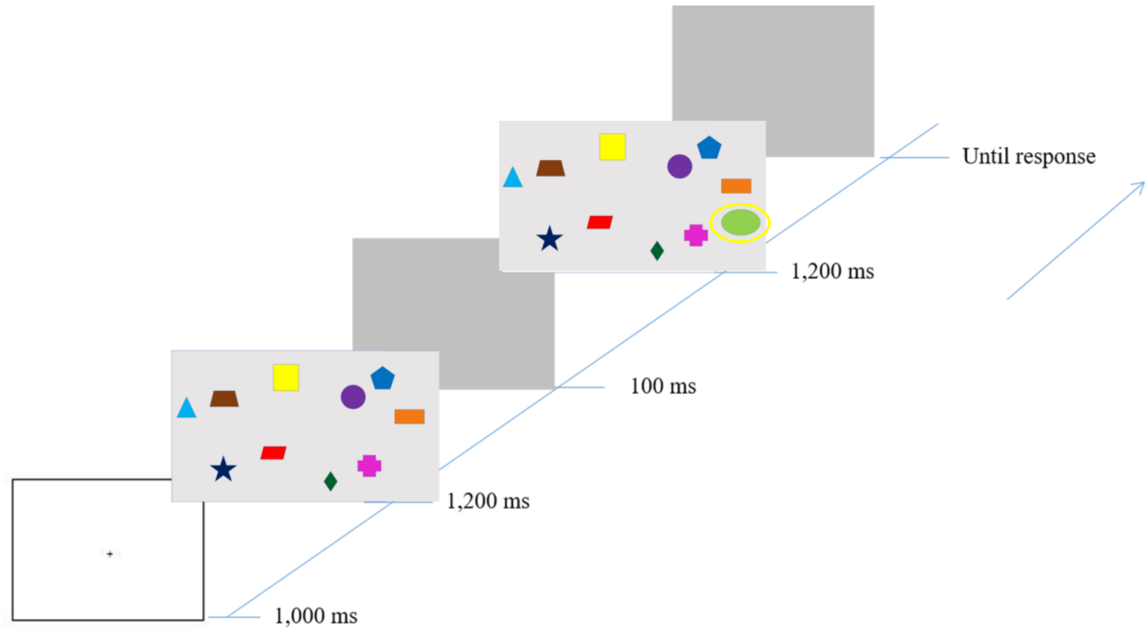

Figure 5. The trial sequence for Experiment 2. This example represents an onset trial, in which the green oval appears on the right in the second image. By reversing the order of the presentation, the same image pair could represent an offset trial. The valence of this image depends on the motivational scenario that is provided for that block of trials.

Data analyses. Data were analyzed via a 2 (Age: younger or older) x 2 (Trial type: onset or offset) x 5 (Scenario: baseline, pleasant, distress, threat, relief) mixed analysis of variance (ANOVA) in which Age was a between participant factor and Trial type and Scenario were within participant factors. Set size was used to eliminate the prediction of trial type based on the number of objects in a scene but was not included in the omnibus ANOVA. Separate ANOVAs were conducted for reaction time and accuracy.

Results

No participants were excluded from the analyses using listwise deletion for having a mean accuracy in the left/right judgment task for either onset or offset trials more than three standard deviations away from the mean of all participants. Aberrant reaction times for each participant were removed at the trial level exceeding three standard deviations away from the mean for each individual participant. This method of outlier analysis removed less than 1-2% of trials in seven younger adults, and less than 1-2% of trials in nine older adults (Donaldson & Yamamoto, 2016).

Covariates. Again, analyses of the affective and cognitive measures indicated what is generally expected in the literature on emotion and cognition in terms of age profiles on these variables. Importantly, when included as covariates in the main analyses, STAI, CESD-D, Shipley, PA, and NA had no significant effect on the dependent variables.

Reaction time data. There was a main effect of Age, such that older adults had significantly slower reaction times compared to younger adults, $F(1, 38) = 52.48$, $p < .001$, $\eta_p^2 = .580$. The sphericity assumption was not met for the Scenario effect, $X^2(9) =$

22.77, p = .007, nor the Scenario x Trial type interaction, $X^2(9) = 19.79$, p = .019; thus, the Greenhouse-Geisser correction was used for these effects. There was a main effect of Trial type, F (1, 152) = 39.82, p < .001, η_p^2 = .512, in which onsets were detected significantly faster than offsets. There was a main effect of Scenario, F(3.159, 152) = 5.37, p = .001, η_p^2 = .124. Follow-up analyses revealed that the threat scenario yielded significantly quicker reaction times compared to the baseline condition, p = .005, but not compared to pleasant, p = .896, distress, p = .664, or relief, p = 1.000. The interaction of Scenario and Trial type was significant, F (3.112, 152) = 3.94, p = .009. Simple effects analyses of the Scenario and Trial type interaction revealed that for offset trials, reaction time was significantly faster in the threat condition compared to baseline, p = .002 and in the relief condition compared to baseline, p = .003, but not for pleasant, p = .057, or distress, p = .075, compared to baseline. Based on simple effects, the motivational scenarios did not differ amongst each other, p = 1.000. Furthermore, simple effects analyses of the Scenario and Trial type interaction revealed that onsets were detected significantly faster than offset trials in the baseline condition, p <.001, pleasant condition, p = .001, and threat condition, p < .001, but there were no significant differences between onset and offset trials in the distress, p = .115, and relief condition, p = .450. No other interactions were significant.

A 2 (Age: younger or older) x 4 (Order: 1, 2, 3, 4) x 5 (Scenario: baseline, pleasant, distress, threat, relief) mixed analysis of variance (ANOVA) was conducted on reaction time data to determine if order effects were significant, in which age and order were between participant factors, and scenario was a within participant factors. The main effect of order was not significant, F(3, 32) = .19, p = .905, η_p^2 = .017. The interaction of age and order was also not significant, $F(3, 32) = .14$, $p = .936$, $\eta_p^2 = .013$, indicating that order did not affect participants differently depending on age. See Figure 6a for a graph of reaction time results.

Accuracy data. There were no significant differences in accuracy between younger and older adults, $F(1, 38) = .12$, $p = .737$, $\eta_p^2 = .003$. The main effect of Scenario was not significant, $F(4, 152) = 2.09$, $p = .084$, $\eta_p^2 = .052$. The main effect of trial type was significant, $F(1, 38) = 17.12$, $p < .001$, $\eta_p^2 = .311$, in which participants were significantly more accurate on offset trials compared to onset trials. A 2 (Age: younger or older) x 4 (Order: 1, 2, 3, 4) x 5 (Scenario: baseline, pleasant, distress, threat, relief) mixed analysis of variance (ANOVA) was conducted on accuracy data as well to determine if order effects were significant, in which age and order were between participant factors and scenario was a within participant factor. The main effect of order was not significant, $F(3, 32) = 2.42$, $p = .084$, $\eta_p^2 = .185$. The interaction of age and order, however, was significant, $F(3, 32) = 3.26$, $p = .034$, $\eta_p^2 = .234$. Simple effects analyses revealed that for order 2, younger adults were significantly more accurate than were older adults, $t(8) = 2.86$, $p = .007$, $d = .425$. Because this order effect was found for only one order, and there were only five participants in each order for each age group, it is likely that this is a spurious finding. It is improbable that this order effect will have any bearing on results ultimately derived from this experiment. Overall, there was no evidence of speed-accuracy tradeoffs. See Figure 6b for a graph of accuracy results.

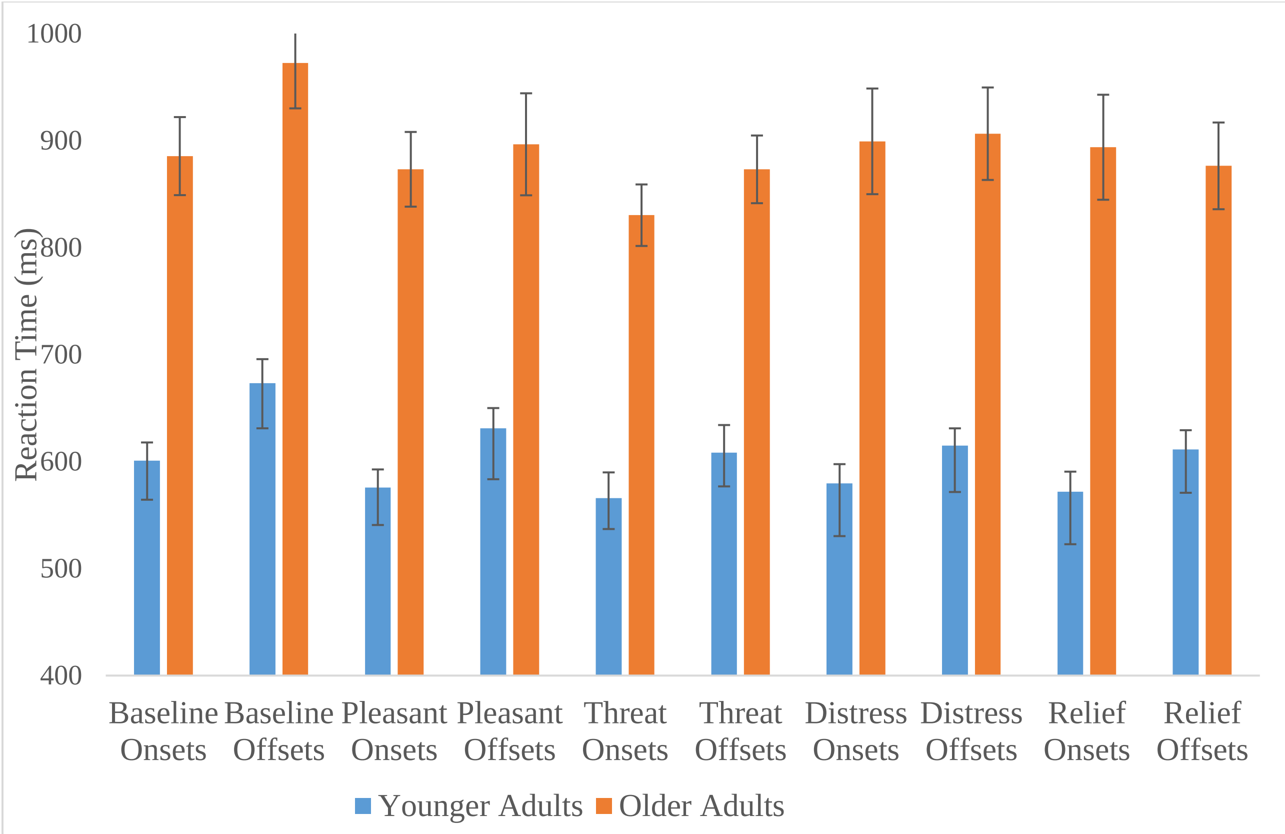

Figure 6a. Reaction time data for Experiment 2. Error bars represent standard errors of the mean.

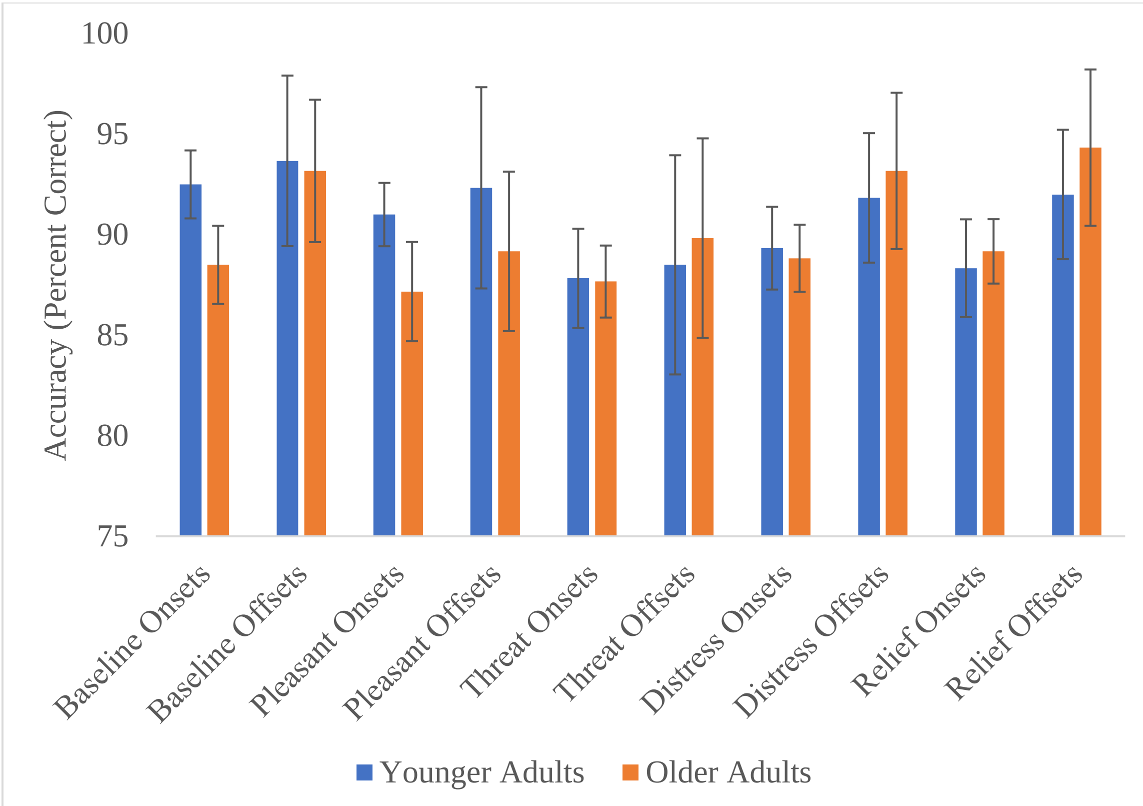

Figure 6b. Accuracy data for Experiment 2. Error bars represent standard errors of the mean.

Experiment 2 Discussion

In Experiment 1, the emotionality of the changed object was a product of the valence of the object itself, as well as the trial type (appearance or disappearance). In other words, something negative or positive appearing is qualitatively different than when the same target disappears. For this reason, Experiment 2 was designed to isolate the role of top-down motivation on change detection of onsets and offsets in four different emotionally structured scenarios. Experiment 2 used four motivational scenarios to represent the four trial types in a naturalistic manner, and eliminated within-object valence possibilities by using non-emotional shape stimuli.

The main finding for Experiment 2 was that reaction times for onset trials compared to offset trials were quicker for both younger and older adults during the baseline, pleasant, and threat scenarios. This is sensible for the baseline condition, which most resembles a standard change detection task employing neutral items; without any specific emotional motivation, onsets typically confer a processing advantage well known in the visual attention literature (e.g. Brockmole & Henderson, 2005; Cole, Kentridge, Gellatly, & Heywood, 2003; Donaldson & Yamamoto, 2012, Jonides & Yantis, 1988). In the pleasant scenario, participants were instructed to conceptualize shapes appearing on the array as shooting stars as they viewed the night sky, and in the threat scenario, participants were instructed to imagine driving and maintaining vigilance of potential new objects appearing on the road that might jeopardize their safety. Although participants were not explicitly told to prioritize onset trials rather than offset trials, these scenarios naturally motivated participants to prioritize onset detection because of the emotional value of an onset in those situations. The two other scenarios were designed to naturally prioritize offset detection in a similar manner. In the distress condition, participants were instructed to conceptualize objects leaving the array as children in their care wandering out of sight, and in the relief condition, objects disappearing were to represent an armed intruder having left one's workplace. In these scenarios, in which an offset advantage was expected, although a true offset primacy did not emerge, onset trials were de-emphasized, as there were no differences in response times to onset and offset trials. Overall accuracy was higher for offsets across all scenarios. This may be evidence for a de-emphasized onset prioritization in the distress and relief conditions. Perhaps the evocative nature of this change detection task enabled participants to be more cognizant of offset trials, thus enabling higher accuracy therein.

Experiment 2 allowed for the examination of the interaction between valence and trial type, as well as furthering our understanding as to how explicit top-down motivational instructions impact how we may view, interact with, and respond to changes in a visual environment. Changes in this task operated differently than in Experiment 1 because the combination of one particular emotion with one particular trial type were combined and examined in isolation of the other three potential combinations within each scenario block. Thus, in Experiment 2, we cannot conceptualize positive and negative events within the same block of trials in quite the same manner as in Experiment 1. Each scenario was specifically designed to prioritize only one of these combinations. That is, for example, participants were instructed to view new shapes entering into the array as oncoming cars that may pose a threat, but they were not instructed to treat cars disappearing from the array during offset trials as signaling something relieving. In many scenarios, such as driving, one trial type is naturally prioritized. Importantly, although it is possible, it is not necessarily the case that threat is simply the inverse of relief. Future work should investigate scenarios in which onsets and offsets are equally motivating within the same block of trials to examine how these valence effects may operate in a variety of scenarios.

Other ways in which results of this experiment could be extended would be to improve the quality of the stimuli and motivations. The stimuli consisted of neutral objects in a two-dimensional array. A strength of Experiment 1 was to simulate change detection experience in naturalistic settings. However, use of neutral objects on a plain background was necessary for Experiment 2 in order to isolate the influence of top-down motivational manipulations and control for perceptual features of the objects. Given the simplicity of the images, it may have been difficult for some participants to implement the motivational instructions as efficiently as possible. Future work may consider using more naturalistic arrays that still control for as many perceptual features as possible. The other obstacle participants may have encountered in Experiment 2 may have been the motivations themselves. Thus, even though these scenarios were most motivating based on results of the pilot study, there may have been individual difference factors leading to how well participants were able to implement the particular motivations used in this study.

Regardless of these potential areas of improvement, results of Experiment 2 demonstrated attentional flexibility. Of course, there are benefits of positivity effects, such as lower cardiovascular reactivity and better emotion regulation ability (Labouvie-Vief & Medler, 2002), however there are also benefits to demonstrating enhanced vigilance toward negative and threatening events because attention to negativity is adaptive (e.g., Isaacowitz, Allard, Murphy, & Schlangel, 2009; Mather & Knight, 2006). Importantly, emotional stimuli can command attention both exogenously and endogenously. Emotional stimuli are often salient and noticeable (e.g., fast oncoming cars), and in these instances, it is likely that exogenous features of the environment will suppress an endogenous motive to react adaptively. However, humans can also be emotionally motivated internally in a meaningful way by way of endogenous attention, as demonstrated by how the top-down scenarios used in Experiment 2 altered how participants viewed the array. By observing evidence of onset primacy in the pleasant and threat conditions, and a de-emphasis of onset prioritization in the distress and relief conditions, participants (regardless of age) were able to adjust their attentional prioritization depending on their current behavioral goals and the demands of the present environment. This suggests that emotion is a crucial domain in for investigating the successful interplay of endogenous and exogenous elements of attentional processing.

Additionally, Reed and Carstensen (2012) argue that positivity effects are most robust when no additional goal processes are relevant to the task, and no particular attentional instructions are given, yet positive preferences were observed in Experiment 1, in which speed and accuracy were attentional goals. The pattern of results obtained in Experiment 1 would correspond to a robust processing advantage for relief and pleasant scenarios in Experiment 2, but that is not what was observed. Reed and Carstensen argue that positivity effects may not emerge if another behavioral goal (such as the motivational instructions or instruction to respond both as quickly and as accurately as possible) overrides the SST-inspired goal of feeling as good as possible, yet at least for Experiment 1, this attentional instruction did not override positive preferences. It is more likely that the salience of the top-down manipulations for these evocative scenarios allowed participants to demonstrate attentional flexibility in unique ways.

One more important finding from Experiment 2 was that there were no age interactions for accuracy data, so other than older adults being slower than younger adults, their change detection ability was comparable to that of younger adults. Some previous work (e.g., Madden, Whiting, Spaniol, & Bucur, 2005; Colcome et al., 2003) has found that although older adults can maintain top-down control, they are more susceptible to attentional capture by distractors or difficulty with inhibition compared to younger adults. In the present study, all of the scenarios were imbued with top-down motivation. Within each motivational context, older adults were just as accurate as younger adults. Overall, older adults exhibited slower reaction times. However, slower speed may be due to distractibility, a different criterion for determinining the target location, or a motor impairment issue. However, accuracy data at least provide preliminary support for the preservation of top-down control for older adults in this type of emotional change detection task.

These data indicate evidence of attentional flexibility across the adult lifespan when performing emotional change detection tasks. Older adults in this experiment, as with Experiment 1, exhibited largely preserved change detection ability. Experiment 1 highlights successful interaction of top-down and bottom-up processing resources with an overwhelming processing advantage for positive trials. In the present experiment, there is support for attentional flexibility. Even though these patterns of results do not necessarily fit nicely with SST predictions, they are informative for general attentional processing theories.

CHAPTER V

GENERAL DISCUSSION

The present experiments were designed to gain insight into change detection ability across the adult lifespan by investigating how younger and older adults may differentially engage with and respond to positive, negative, and neutral visual events as they enter and exit the visual field. Results of Experiment 1 provided support for positive preferences for both younger and older adults. The effect of positive preferences was noted both for positive onset trials and for negative offset trials, suggesting that both top-down and bottom-up processing resources are intact in across age groups. For instance, detection of positive onset trials may have been guided by the perceptual salience (e.g., size or color) of positive objects when they appear in the second photograph, as these factors may have contributed to their noticeability, through bottom-up processing means. The other portion of the positivity preference observed in Experiment 1 involved a processing advantage for detection of negative offsets. This finding may represent superior detection of a negative item in the first scene, a process driven by bottom-up means, followed by maintenance of that item in memory, and a quick response when that object is recognized to be the target. In this manner, an integration of top-down processing resources is also necessary in this task. Although Experiment 1 allows for the disentanglement of Trial type from Valence, the only goal participants were mindful of while completing this task was to be accurate and quick. The design of Experiment 2 enabled the particular isolation of top-down motives, specifically, by analyzing how emotional motivation influences attentional performance in different affective scenarios. Overall, results of Experiment 2 provided support for attentional flexibility, as onset primacy was noted in the two conditions favoring an onset advantage (pleasant and threat), and the onset advantage did not emerge in the two conditions that would prioritize an offset advantage (relief and distress).

On the surface, there appears to be some incongruence with results from the two experiments. However, in neither experiment was there evidence of any Age x Valence interaction; thus, younger and older adults were behaving similarly in both experiments. Overall, reaction time and accuracy data, as well as the lack of speed-accuracy trade-offs, support the preservation of change detection ability in later life based on these experiments. One of the main goals of these studies was to investigate the possibility of attentional flexibility as a product of both internal goals and external features of the environment as we age. It is clear through these experiments that different aspects of the environment were prioritized, and individuals from both age groups flexibly adjusted their attentional systems appropriately. For the positive preferences noted in Experiment 1, participants had to efficiently process two different types of changes equivalently.

Positive onsets and negative offsets are fundamentally different visual events in that the target is appearing in one and disappearing in another; offsets entail a memorial component, whereas onsets do not. Finally, the target differed in emotional quality as a function of onset and offset. Because these trial types were chosen specifically as visual events we could plausibly encounter in our daily lives, this finding is critical for understanding the maintenance of attentional flexibility across the adult life span.

In Experiment 2, the crucial difference, again, was the implementation of a motivational instruction to understand the influence of motivational endogenous effects on attention, over and above the top-down effects elicited from the emotional component. Both age groups were able to maintain attentional control throughout the paradigm, as demonstrated through high accuracy. The same explanation that could be aiding the positive preferences noted in Experiment 1 (e.g. perceptual features such as size of positive objects during onset trials and/or salience and memory for negative objects during offset trials) are not applicable to Experiment 2, in which two-dimensional neutral shapes were used as stimuli. One theory potentially useful for understanding the pattern of results that emerged in Experiment 2 is the Arousal-Biased Competition (ABC) model (Mather & Sutherland, 2011). According to the ABC model, arousal applies to emotional information processing in two ways. First, arousal enables prioritization of emotional information for its saliency. Emotional information is salient both due to bottom-up pop-out effects in which emotional objects are perceptually different than neutral objects, as well as through top-down processing because of the meaning or value we ascribe to emotional objects based on prior experience and situational factors (Mather & Sutherland). Secondly, arousal enhances prioritization of goal-relevant and high priority information. Above and beyond explaining that onsets were both goal relevant and naturally prioritized in the threat and pleasant conditions, and a compelling feature of visual attention literature, in these scenarios, according to ABC, onsets are also more arousing, and therefore more noticeable. Arousal magnifies the chance participants would efficiently detect onsets in the threat and pleasant conditions given the design of the emotional change detection task. Due to a lack of visual clutter and the simplicity of the object arrays, onsets were likely to be amplified in these conditions. While a full offset bias was not observed in the relief and distress conditions, there was a de-emphasis of onsets, in that onsets and offsets were detected with equivalent efficiency. Generally, offsets represent a fundamentally different type of visual event than object onsets. Even though offsets should have been prioritized and were goal relevant in the relief and distress conditions, factors including relevance of the scenarios and design of the stimuli, may have lead them to be less arousing.

It is important to note that the attentional flexibility observed for differences in trial type between the affective scenarios are particularly impressive because the target and the distractors were all neutrally valenced. Past research has indicated that locating a negative object alongside neutral distractors contributes to particularly efficient visual search, which could aid both younger and older adults in having faster reaction times and high accuracy during these negative trials (Hahn, Carlson, Gronlund, & Singer, 2005; Mather & Knight, 2006). In the present experiment, though, the only factor contributing to the “salience” of the target was participants’ ability to visualize the object as a threat because, visually, the objects shared similar perceptual properties to the distractors. This finding lends credence to older adults’ continued ability to maintain top-down control in attention-demanding situations (Costello, Madden, Shepler, Mitroff, & Leber, 2010). They were slower than younger adults, however they still completed the task with high accuracy. Many instances of change detection that we could encounter in our daily lives entail affective components, which older adults could be particularly adept at handling (Mather & Carstensen, 2005). In Experiment 2, older adults' pattern of results was very comparable to that of younger adults.

It is worth reiterating that scenarios used in the main experiment were chosen from the pilot study, and that both younger and older adult raters deemed these scenarios equally motivating. In addition to the stimuli making it difficult to implement the various motivational manipulations, it is also possible that the scenarios used were not self-relevant to be fully motivating. Thus, a limitation of Experiment 2 could be the style of the pilot study. A future pilot study might instead involve a generative task, wherein, a sample of participants could be provided with a description of the four types of changes, and then come up with some scenarios that fit those descriptions that are motivating for them. The difficulty in generating these scenarios is that one visual event, either onset or offset, should naturally be prioritized. Using a coding procedure, if the same scenario emerges multiple times, that may signal a situation that would be worth investigating as a motivation. In Experiment 2, not all scenarios differed from baseline, and even the threat scenario did not differ significantly from the other affective scenarios. Future work could potentially include even more self-relevant scenarios in which individuals devise their own. Here, once a certain number of options had been generated for each scenario, participants could choose among those during the actual experiment.

Moreover, the method of motivation could be altered. For example, as listed in the appendix, the motivations used in Experiment 2 were presented as written descriptions. Instead, a photograph of a busy street, or children playing, could have been used alongside the description to make the task seem less abstract, especially given the nature of the stimuli.

Additional limitations could be addressed in regards to Experiment 1. Again, although the images were chosen for the pilot study as objects that could feasibly appear in a kitchen scene, as well as being large enough for detection in this type of a task, the images were not perfect. Despite the positive preferences we observed, positive objects were rated as less intense on the positive scale compared to negative objects on the negative scale. Having a larger repertoire of objects to rate in the pilot study may have been one way of handling this critique. Another possibility is to have participants rate how likely each object was to be present in a kitchen scene, and then somehow control for this "belongingness" factor. This was partially controlled for in Experiment 1, but future work should more carefully control for it. For example, a pan and spatula are very typical for a kitchen, whereas mice and balloons, although feasible, probably arise less often. Within each valence, ratings for "belongingness" or typicality probably exist on a continuum. Objects that do not belong may represent a type of newness, which may attract observers' attention. This attentional attraction may be life- saving in the case of a weapon being present, or a surprise if an uncommon positive object (e.g. anniversary present) is detected. Given that positive preferences were indicated both by the appearance of positive objects and the disappearance of negative objects in Experiment 1, this limitation should not override conclusions drawn from the present study; nevertheless, implementing these changes could be valuable in future work.

A strength of Experiment 1 was the simulation of a more naturalistic change detection experience, and the images were designed to uphold this goal. However, this aim also introduced two important limitations. The first limitation was the potential for a "belonginess" confound, that could be handled in future studies by having participants rate the belonginess of each object to the scene used on a continuum and then including this factor as a covariate. The second limitation of this design is the task difficulty. Importantly, this task was not intended to be so difficult; however, by examining the present data and careful consideration of the images used, it is clear that the task used in Experiment 1 was considerably more challenging relative to Experiment 2.

One theory that could potentially account for the task difficulty of Experiment 1 is the clutter theory of attention. Clutter theory, applied to visual attention, defines clutter as visual noise, that can detract from performance, either through reductions in speed or accuracy, when set size increases with more objects present in a visual array (Wolfe, 1998). Wolfe has conducted considerable research to understand how size should be determined, and the resulting effects. Researchers tend to agree that clutter impacts search efficiency. For example, Henderson (2009) demonstrated that clutter correlated negatively with search efficiency in real world scenes, such that search efficiency was higher with lower clutter and lower with higher clutter. Specifically, Ho, Scialfa, Caird, & Graw (2001) found that although younger adults' performance was better on a visual search task compared to older adults, and performance for participants of both age groups declined as clutter increased, older adults' performance with clutter was not disproportionately worse relative to their younger counterparts. Ho et al.'s (2001) findings are reminiscent of results from Experiment 1. Older adults demonstrated lower accuracy and slower speed overall, but their performance was still quite high considering the task difficulty. More recent work on clutter has found that spatial and object working memory impacts performance more severely when more naturalistic scenes are used compared to stimuli used in more traditional search tasks (Ren & Sun, 2014). Because the images used in Experiment 1 were intended to be naturalistic, they likely contained a more cluttered array than would be encountered in a typical change detection experiment.

The images used in Experiment 1 depicted 6 different kitchen scenes to avoid habituation to the background environment, which may have reduced the overall valence of the targets. Even though the set sizes used were approximately equal, there were additional elements, such as cupboards and counters, which added to scene complexity (e.g., along with texture gradients and depth that are present in most visual environments). Thus, it would be advantageous for participants to ignore fixed objects these scene features. However, if the visual environment is too cluttered, it is possible that extraneous features capture attention, leading to inefficient change detection, which then could account for the lower accuracy observed in Experiment 1 compared to Experiment 2.

This theory may also help explain the emergence of the overarching offset advantage noted in Experiment 1. In a more cluttered array, it may be easier for observers to notice the disappearance of a previously viewed object rather than the onset of a new object. In Experiment 1, many visual characteristics, such as set size, depth, and complexity were accounted for, but as a byproduct, these considerations may have detracted from the valence of the objects in the array. Thus, it may also be important to experiment with depth of field to maximize the size of objects, relative to other items in the array. Using photographs of kitchen scenes limited object placement to mainly countertops and kitchen islands; thus, to make placement of the objects believable within these scenes, some of the objects were not very large. Future work should consider using other scenes, such as an outdoor environment, or indoor scenes with more natural surfaces on which to place objects, with a simpler background. This may enable objects to appear larger, if they can be placed in the foreground, as well as in the background, and this manipulation may make them easier to spot in the scene as well as increase the salience of emotional objects. Future work should seek to create images that are less complex and cluttered, but are still naturalistic, so that valence effects are more salient.

It is not necessarily a limitation that the stimuli used in Experiment 2 were intentionally created to be two-dimensional and non-emotional because this design allowed for the isolation of top down effects of motivation on change detection. Most instances of change detection are inherently motivating and occur in naturalistic environments; however, combining the top-down motivational component of Experiment 2 would not allow this effect to be isolated from the investigation of Trial type and Valence.

Conclusion

Investigating the effect of emotion and types of visual changes are particularly important across the adult lifespan because adequate change detection ability can be important for adaptation and survival. A main goal of the experiments was to determine how studying change detection from an aging perspective is critical both for informing theories on aging, theories on emotional processing, and theories regarding the role of top-down and bottom-up processing on attention. The main aging theory of interest for the present study was Socioemotional Selectivity Theory (Carstensen, Isaacowitz, & Charles, 1999). However, observed results did not fully support this theory. Experiment 1 exhibited general positive preferences that were not age specific, and Experiment 2 revealed support for threat effects. However, these findings do support maintenance of an interaction of top-down and bottom-up processing resources in attention in later life (Yantis, 2005). Furthermore, results of the present experiments help delineate factors (e.g., target valence, motivational goals of observer, type of visual event) that impact attentional capture and how observers respond to emotional information. In Experiment 1, a processing advantage was observed across age groups for positive onsets and negative offsets, as well as for offset detection overall, and in Experiment 2, with the addition of a salient top-down motivational component, onset prioritization was noted in the pleasant and threat conditions favoring onset detection, and onsets were de-emphasized in distress and relief conditions that naturally should have prioritized offset detection. These results contribute to our understanding of cognitive emotional information processing in aging because older adults can flexibly adapt attention in order to detect different types of visual events, much like younger adults. Older adults are adept at processing visual changes with varying emotional salience, similar to younger adults, and can maintain top-down control when stimuli are sufficiently self-relevant. Attention is a multi-faceted process and should be thoroughly considered in an aging framework to understand how attentional faculties, such as change detection, develop across the lifespan.

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APPENDIX

A. PANAS

The words listed below describe different feelings and emotions. Read each item and then, in the space next to that word, indicate the extent to which you **GENERALLY** feel that way; that is, how you feel on average.

1	2	3	4	5
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

_____ Interested

_____ Distressed

_____ Excited

_____ Upset

_____ Strong

_____ Guilty

_____ Scared

_____ Hostile

_____ Enthusiastic

_____ Proud

_____ Irritable

_____ Alert

_____ Ashamed

_____ Inspired

_____ Nervous

_____ Determined

_____ Attentive

_____ Jittery

_____ Active

_____ Afraid

B. CES-D

Below is a list of ways you might have felt or behaved. Please indicate how often you have felt this way during the past week by circling the number at the end of each statement corresponding to the four numbered statements listed between the lines below.

During the Past week	0. Rarely or none of the time (less than 1 day) 1. Some or a little of the time (1-2 days) 2. Occasionally or a moderate amount of time (3-4 days) 3. Most or all of the time (5-7 days)

1. I was bothered by things that usually don't bother me.	0	1	2	3
2. I did not feel like eating; my appetite was poor.	0	1	2	3
3. I felt that I could not shake off the blues, even with help from my family and friends	0	1	2	3
4. I felt that I was just as good as other people.	0	1	2	3
5. I had trouble keeping my mind on what I was doing.	0	1	2	3
6. I felt depressed.	0	1	2	3
7. I felt that everything I did was an effort.	0	1	2	3
8. I felt hopeful about the future.	0	1	2	3
9. I thought my life had been a failure.	0	1	2	3
10. I felt fearful.	0	1	2	3
11. My sleep was restless	0	1	2	3
12. I was happy.	0	1	2	3
13. I talked less than usual.	0	1	2	3
14. I felt lonely.	0	1	2	3
15. People were unfriendly.	0	1	2	3
16. I enjoyed life.	0	1	2	3
17. I had crying spells.	0	1	2	3
18. I felt sad.	0	1	2	3
19. I felt that people disliked me.	0	1	2	3
20. I could not get "going."	0	1	2	3

C. STAI

A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to indicate how you generally feel. There are no right or wrong answers. Do not spend too much time on any one statement, but give the answer that seems to describe how you **generally** feel.

Generally:	1. Almost Never 2. Sometimes 3. Often 4. Almost always

1. I feel pleasant.	1	2	3	4
2. I feel nervous and restless.	1	2	3	4
3. I feel satisfied with myself	1	2	3	4
4. I wish I could be as happy as others seem to be	1	2	3	4
5. I feel like a failure	1	2	3	4
6. I feel rested	1	2	3	4
7. I am "calm, cool, and collected."	1	2	3	4
8. I feel that difficulties are piling up and I cannot overcome them.	1	2	3	4
9. I worry too much about something that really doesn't matter.	1	2	3	4
10. I am happy.	1	2	3	4
11. I have disturbing thoughts.	1	2	3	4
12. I lack self-confidence.	1	2	3	4
13. I feel insecure	1	2	3	4
14. I make decisions easily.	1	2	3	4
15. I feel inadequate.	1	2	3	4
16. I am content.	1	2	3	4
17. Some unimportant thought runs through my mind and bothers me.	1	2	3	4
18. I take disappointments so keenly that I can't put them out of my mind.	1	2	3	4
19. I am a steady person.	1	2	3	4
20. I get in a state of tension or turmoil as I think over my recent concerns and interests	1	2	3	4

VAMC
SLUMS Examination

Questions about this assessment tool? E-mail aging@slu.edu

Name________________________________ Age______________

Is the patient alert?______________ Level of education______________________

__/1 (1) 1. **What day of the week is it?**

__/1 (1) 2. **What is the year?**

__/1 (1) 3. **What state are we in?**

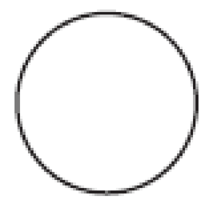
4. **Please remember these five objects. I will ask you what they are later.**
   Apple Pen Tie House Car

5. **You have $100 and you go to the store and buy a dozen apples for $3 and a tricycle for $20.**
   (1) **How much did you spend?**
   __/3 (2) **How much do you have left?**

6. **Please name as many animals as you can in one minute.**
   __/3 (0) 0-4 animals (1) 5-9 animals (2) 10-14 animals (3) 15+ animals

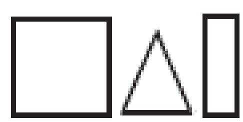
__/5 7. **What were the five objects I asked you to remember? 1 point for each one correct.**

8. **I am going to give you a series of numbers and I would like you to give them to me backwards. For example, if I say 42, you would say 24.**
   __/2 (0) 87 (1) 648 (1) 8537



9. **This is a clock face. Please put in the hour markers and the time at ten minutes to eleven o'clock.**
   (2) Hour markers okay
   __/4 (2) Time correct

(1) 10. **Please place an X in the triangle.**



__/2 (1) **Which of the above figures is largest?**

11. **I am going to tell you a story. Please listen carefully because afterwards, I'm going to ask you some questions about it.**
    Jill was a very successful stockbroker. She made a lot of money on the stock market. She then met Jack, a devastatingly handsome man. She married him and had three children. They lived in Chicago. She then stopped work and stayed at home to bring up her children. When they were teenagers, she went back to work. She and Jack lived happily ever after.
    (2) **What was the female's name?** (2) **What work did she do?**
    __/8 (2) **When did she go back to work?** (2) **What state did she live in?**

_______ **TOTAL SCORE**

SCORING		
High School Education		Less than High School Education
27-30	Normal	25-30
21-26	Mild Neurocognitive Disorder	20-24
1-20	Dementia	1-19

CLINICIAN'S SIGNATURE ______________ DATE ______________ TIME ______________

E. Shipley Vocabulary Test

In the test below, the first word in each line is printed in capital letters. Opposite it are four other words. Circle the one word that means the same thing, or nearly the same thing, as the first word. If you don't know, guess. Be sure to circle the one word in each line that means the same thing as the first word.

1. TALK:	draw	eat	speak	sleep
2. PERMIT:	allow	sew	cut	drive
3. PARDON:	forgive	pound	divide	tell
4. COUCH:	pin	eraser	sofa	glass
5. REMEMBER:	swim	recall	number	defy
6. TUMBLE:	drink	dress	fall	think
7. HIDEOUS:	silvery	tilted	young	dreadful
8. CORDIAL:	swift	muddy	leafy	hearty
9. EVIDENT:	green	obvious	skeptical	afraid
10. IMPOSTOR:	conductor	officer	book	pretender
11. MERIT:	deserve	distrust	fight	separate
12. FASCINATE:	welcome	fix	stir	enchant
13. INDICATE:	defy	excite	signify	bicker
14. IGNORANT:	red	sharp	uninformed	precise
15. FORTIFY:	submerge	strengthen	vent	deaden
16. RENOWN:	length	head	fame	loyalty
17. NARRATE:	yield	buy	associate	tell
18. MASSIVE:	bright	large	speedy	low
19. MILITANCY:	laughter	speed	grace	malice
20. SMIRCHED:	stolen	pointed	remade	soiled
21. SQUANDER:	tease	belittle	out	waste
22. CAPTION:	drum	ballast	heading	ape
23. FACILITATE:	help	turn	strip	bewilder
24. JOCOSE:	humorous	paltry	fervid	plain
25. APPRISE:	reduce	strew	inform	delight
26. RUE:	eat	lament	dominate	cure
27. DENIZEN:	senator	inhabitant	fish	atom
28. DIVEST:	dispossess	intrude	rally	pledge
29. AMULET:	charm	orphan	dingo	pond
30. INEXORABLE:	untidy	involatile	rigid	sparse
31. SERRATED:	dried	notched	armed	blunt
32. LISSOM:	moldy	loose	supple	convex
33. MOLLIFY:	mitigate	direct	pertain	abuse
34. PLAGIARIZE:	appropriate	intend	revoke	maintain
35. ORIFICE:	brush	hole	building	lute
36. QUERULOUS:	maniacal	curious	devout	complaining
37. PARIAH:	outcast	priest	lentil	locker
38. ABET:	waken	ensue	incite	placate
39. TEMERITY:	rashness	timidity	desire	kindness
40. PRISTINE:	vain	sound	first	level

must read these slowly. If repeat it, keep the timer going. can only repeat once.

6. Arithmetic

DISCONTINUE IF EXCEEDS THIS

Problem	Time Limit	Completion Time in Seconds	Correct Response	Response	Score (0 or 1)	Problem	Time Limit	Completion Time in Seconds	Correct Response	Response	Score (0 or 1)
1.	15"		3		1	11.	30"		$10.50		
2.	15"		7		1	12.	60"		30¢		
3.	15"		5		1	13.	60"		$185.00		
4.	15"		2		1	14.	60"		10		
5.	15"		$9.00			15.	60"		$600.00		
6.	15"		$4.00			16.	60"		43		
7.	30"		5			17.	60"		$51.00		
8.	30"		$1.50			18.	60"		$49.50		
9.	30"		8			19.	60"		1 of 4 or 5 of 20		0 1 2
10.	30"		$3.60			20.	120"		96		0 1 2

Total Raw Score (Maximum = 22)

5. How much is 4 dollars plus 5 dollars?

6. If you buy 6 dollars' worth of gasoline and pay for it with a 10-dollar bill, how much change should you get back?

7. Soft drinks are sold 6 cans to a package. If you want 30 cans, how many packages must you buy?

8. Chewing gum costs 25 cents per pack. How much would it cost to buy 6 packs?

9. How many hours will it take a person to walk 24 miles at the rate of 3 miles an hour?

10. If you buy 7 20-cent mints and give the clerk 5 dollars, how much change should you get back?

11. If you have 18 dollars and spend 7 dollars and 50 cents, how much will you have left?

12. Jesse bought 6 pieces of chocolate for $1.60. An additional 20 cents sales tax was added to this price. How much did he pay for each chocolate including sales tax?

13. The price of shirts is 2 for 31 dollars. What is the price of 1 dozen shirts?

14. What is the average of these numbers: 10, 5, and 15?

15. A family bought some secondhand furniture for two-thirds of what it cost new. They paid 400 dollars for it. How much did it cost new?

16. A family drove 215 miles in 5 hours. What was their average speed in miles per hour?

17. A coat that normally sells for 60 dollars is reduced by 15 percent during a sale. What is the price of the coat during the sale?

18. Chris has two times as much money as Robert. Chris has ninety-nine dollars. How much money does Robert have?

19. Linda had 8 yellow paper clips, 5 green paper clips, and 7 orange paper clips. She picked out one paper clip without looking. What was her chance of picking out a green paper clip?

20. If 8 machines are needed to finish a job in 6 days, how many machines would be needed to finish the job in one-half day?

Cognitive Measures: Mental Control Task

Time responses to the series of information below	Response Time	# of Errors	Accuracy Score	Bonus Points	Score (0-5)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20		2 → 1 → 0 →	0 1 2	7+’ 5-6’ 4’ 1-3’ 0 1 2 3	
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z		2 → 1 → 0 →	0 1 2	7+’ 5-6’ 4’ 1-3’ 0 1 2 3	
Sun Mon Tue Wed Thur Fri Sat		2 → 1 → 0 →	0 1 2	4+’ 2-3’ 1’ 0 2 3	
Jan Feb March April May June July Aug Sept Oct Nov Dec		2 → 1 → 0 →	0 1 2	5+’ 4’ 1-3’ 0 2 3	
20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1		2 → 1 → 0 →	0 1 2	11+’ 8-10’ 6-7’ 1-5’ 0 1 2 3	
Sat Fri Thur Wed Tue Mon Sun		2 → 1 → 0 →	0 1 2	6+’ 5’ 4’ 1-3’ 0 1 2 3	
Dec Nov Oct Sept Aug July June May April March Feb Jan		2 → 1 → 0 →	0 1 2	17+’ 12-16’ 10-11’ 1-9’ 0 1 2 3	
(0) Sun (6) Mon (12) Tue (18) Wed (24) Thur (30) Fri (36) Sat		2 → 1 → 0 →	0 1 2	21+’ 16-20’ 13-15’ 1-12’ 0 1 2 3	

INSTRUCTIONS: “I want you to state a series of information to me as quickly as possible. These series will include numbers, days of week, months of the year, etc. You will be timed during this task.”

Cognitive Measures: Generative Naming (FAS)

Word Fluency Measure

Instructions: I am going to say a letter of the alphabet and I would like you to name as many words as you can think of that begin with that letter. For example, let’s take the letter B. I could name the words ball, bar, beer, brick, baby. Can you think of some other words that being with that letter? (have the subject practice the task)

Now I will say another letter and I’m going to time you for one minute. I cannot count numbers or names of people or places and do not repeat words with different endings like please, pleasing, pleasingly. Now, name as many words as you can think of that begin with the following letters:

(Time the subject for one minute. Be sure to record every response and UNDERLINE ANY ERRORS.)

F	A	S
Total # F =	Total #A =	Total #S =
Total # Correct Responses = (F+A+S)		

Cognitive Measures: Backwards Digit Span

Item		Correct Response	Score 0 or 1
1	Trial 1	2-4 (4-2)	
	Trial 2	5-7 (7-5)	
2	Trial 1	6-2-9 (9-2-6)	
	Trial 2	4-1-5 (5-1-4)	
3	Trial 1	3-2-7-9 (9-7-2-3)	
	Trial 2	4-9-8-6 (6-8-9-4)	
4	Trial 1	1-5-2-8-6 (6-8-2-5-1)	
	Trial 2	6-1-8-4-3 (3-4-8-1-6)	
5	Trial 1	5-3-9-4-1-8 (8-1-4-9-3-5)	
	Trial 2	7-2-4-8-5-6 (6-5-8-4-2-7)	
6	Trial 1	8-1-2-9-3-6-5 (5-6-3-9-2-1-8)	
	Trial 2	4-7-3-9-1-2-8 (8-2-1-9-3-7-4)	
7	Trial 1	9-4-3-7-6-2-5-8 (8-5-2-6-7-3-4-9)	
	Trial 2	7-2-8-1-9-6-5-3 (3-5-6-9-1-8-2-7)	

INSTRUCTIONS: “I am going to say a series of numbers out loud to you. Please repeat these numbers back to me in REVERSE order. For instance, if I said the numbers 3-6; you would say _______.”

Note: Discontinue the task once the subject misses both trials within the same item. Each trial is worth one point. Tabulate the number of points (out of a possible 14) at the end of the task.

G. Experiment 1 Stimuli

Positive Objects	Negative Objects	Neutral Objects
Milkshake	Bomb	Blender
Latte	Stained mug*	Clipboard
Strawberry	Bloody knife	Water bottle*
Wine stopper	Spilled coffee	Pan
Ice cream	Dagger*	Dice
Flowerpot	Knife	Hole punch
Cookie jar	Gun	Goggles
Award	Needle	Glasses*
Cake	Ash tray	Pencil
Dessert tray	Bee	Napkin
Cappuccino	Mace	Kettle
Gold watch*	Pistol	Spatula
Broach*	Poison	Waffle press*
Money	Spider	Whistle
Cupcake	Skull	Towel
Pie*	Dirty dishes*	Umbrella
Slinky*	Apple core*	Headphones
Orchid	Dirty plate	Coffee pot*
Sundae	Mouse	Notebook*
Wine glass	Cockroach	Gravy boat
Trophy*	Rotten banana	Muffin pan
Rings	Flies on waffle*	Book
Flower bouquet	Rotten peach	Placemat
Balloon	Spilled milk	Coffee in mug
Cinnamon roll	Shiny insect	Rolling pin

Note. The items with an asterisk were not used in the main experiment.

H. Experiment 2 Motivational Scenario Instructions

Pleasant (positive onset)- For this block of trials, imagine you are outside stargazing on a clear night. As you view the objects in these trials, imagine that each object represents a star in the night sky. In addition to the typical constellations of stars, you are paying close attention to new stars that appear in the night sky because these might be shooting stars.

Threat (negative onset)- For this block of trials, imagine you are driving a car. As you view the objects in these trials, imagine that each object represents another care on the road. You must pay close attention to new cars that appear on the road to maintain your own safety.

Distress (positive offset)- For this block of trials, imagine you work at a daycare. As you view the objects in these trials, imagine that each object represents a child in your care. After all the children have been dropped off, you supervise the kids while they play at an outdoor playground. Your goal is to remain vigilant to the location of the children and pay close attention of an object (child) disappears.

Relief (negative offset)- For this block of trials, imagine you are in a particularly frightening situation in which an armed individual might be in the building where you work. The objects represent other people. Your goal is to remain vigilant to objects that may disappear, as this would signal that the intruder has left and your workplace is safe once again.