

HIGH CONTRAST IN LOW-LEVEL VISION

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ABSTRACT

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Intuitively, many people believe they are aware of all the information available in their surroundings. However, that may not be correct. This paper identifies key visual features that make up the information being shared via television broadcasts. Specifically, this project uses a cognitive science approach to look at the competing hypotheses about the role of motion in attentional capture. The attention literature suggests that attention will switch from one stimulus to another when the second stimulus is either new to the environment or “odd” to the environment. This paper reports on a critical test between three competing hypotheses (new object, unique event, and behavioral urgency) to better understand how to capture attention in a realistic television view setting. Using a within subjects design, subjects viewed video and then were asked if they recognized any of the secondary stimuli manipulations. The new object hypothesis was supported, while the other hypotheses were not.

Keywords: cognitive, communication, inattentional blindness, motion, attentional capture

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HIGH CONTRAST IN LOW-LEVEL VISION

Intuitively, many people believe they are aware of all the information available in their surroundings. However, that may not be correct. For example, drivers who are concentrating on turning tend not to notice other drivers (Simons, 2000), a phenomenon known as inattention blindness (Beanland & Pammer, 2011). Similarly, individuals engaged in group communication may miss important nonverbal cues or television viewers may miss graphic information because they are focused on live action on the screen. Because much of communication relies on the visual information, understanding the process by which people select information from the environment is essential to understanding communication in general.

It has been repeatedly shown in laboratory experiments that people can miss dramatically large objects in their visual field, whether those objects are a woman carrying an umbrella [see Neisser (1979) for a description of several different versions] or even a gorilla (Simon & Chabris, 1999). In the classic Simons & Chabris (1999) study, subjects watched a video where a group of six people, half wearing white and half wearing black, were passing a basketball. Subjects were instructed to count the number of passes made by either the black or white team, or by both teams. At 45 s into the video, a woman dressed in a gorilla costume walked across the screen. A total of 90 subjects (out of a total 196 subjects, 46%) failed to see the gorilla.

Do findings on visual attention from cognitive science laboratory studies transfer to the real world, particularly that of media? This study tests the applicability of a subset of laboratory findings on visual attention to a real world media viewing situation. Specifically, this project will look at the competing hypotheses about the role of motion in attentional capture. The attention literature suggests that attention will switch from one stimulus to another when the second stimulus is either new to the environment or “odd” to the environment. This paper reports on a

critical test between the three competing hypotheses to better understand how to capture attention in a realistic television view setting.

Attention

Attention has been defined as the choice to pursue one task over another (Duncan, 1999). In the case of visual attention, the task is looking. Attention to a stimulus is a prerequisite for any type of processing; if a person does not direct their attention to a stimulus, they cannot process it. There are three attentional networks that assist working memory in selecting external data for processing and two processes by which attention is captured. In this section, I will discuss the types of attentional networks and the two attentional capture processes.

Three attention networks

There are three attention networks: executive, alerting, and orienting. Executive attention controls and manages conflicts in systems. It involves “planning or decision making, error detection, new or not well-learned responses, conditions judged to be difficult or dangerous, regulation of thought and feelings, and the overcoming of habitual actions” (Mezzacappa, 2004; Raz & Buhle, 2006, p. 374). Orienting attention refers to “the ability to select specific information from among multiple sensory stimuli (sometimes known as scanning or selection).” (Rav & Buhle, 2006, p. 372) Thus, orienting attention is focused on stimuli external to the individual and executive attention is focused on stimuli that are internal to the individual. Both types of attention are largely volitional. For example, an individual might focus selective attention on her mother, ignoring all the other people in a crowded mall. Alerting attention is sustained vigilance to the surrounding environment (Posner, 2006); “the ability to increase and maintain response readiness in preparation for an impending stimulus” (Rav & Buhle, 2006, p. 371). Alerting attention can be found in children as young as 3 months of age (Mezzacappa,

2004). This attention serves an evolutionary purpose by drawing attention to peripheral events quickly and automatically (Yantis, 1998; & Barton, 2005).

Orienting and alerting differ in how they operate. Orienting attention concerns spatial precision (Fernandez-Duque & Posner, 1996), allowing an individual to focus on sensory stimuli at a specific physical location. Alerting attention, however, pertains to “a signal to noise ratio over the visual field,” (Fernandez-Duque & Posner, 1996, p. 477). Alerting attention is not spatial located, but constantly monitors the environment for sensory stimuli that stand out from average stimuli. Both orienting and alerting attention are implicated in exogenous (bottom-up) attention. Exogenous attention shift is a reflexive mechanism in which attention is automatically drawn toward a stimulus (as contrasted with endogenous or ‘top-down’ shift in which the individual chooses to shift attention). It is very rapid; peaking at approximately 100–120 ms and then decaying quickly (Barbot, Landy, & Carrasco, 2012). The process represents a shift from orienting attention to a primary stimulus to a secondary stimulus via alerting attention. Initially, orienting attention focuses on some existing stimulus (e.g., the action happening on a television screen). When a friend enters the room, alerting attention identifies the friend as a new and important stimulus because the friend stands out from the environment due to increased magnitude of certain sensory cues (e.g., motion, sound, etc.). Orienting attention then focuses processing resources on the friend as the new stimulus.

Exogenous attention shift

The exogenous (bottom-up) attention shift process is primarily associated with low-level vision (Walther et al., 2004); a type of preattentive visual processing in which a person can identify characteristics of a target (e.g., color, motion), but not an integrated image (Healey & Enns, 2012). Low level vision represents the initial exposure of light to the eye’s two types of

photoreceptor cells: cones which sense color (red, blue, and green) and rods which sense luminance and form (Livingstone et al., 1988). Electrical signals transduced by the rods are processed through magnocellular or the M-path, while signals from the cones are processed through the parvocellular or P-path (Livingstone et al., 1988). These diverging paths serve different purposes. Livingstone and colleagues (1988) explain, “while the magno system is sensitive primarily to the moving objects and carries information about the overall organization of the visual world, the parvo system seems to be important for analyzing the scene in much greater and more leisurely detail” (p. 240). Because the bottom-up approach is a rapid initial impression, signals are primarily processed via the M-path. Therefore, not all features of the stimulus are captured in a bottom-up approach in low-level vision (Livingstone et al., 1988).

How does alerting attention identify a stimulus for exogenous attention shift? As individuals are exposed to an image, they extract low-level vision attributes of the various stimuli as well as the extent to which those stimuli contrast with the other objects and the environment (Koch & Ullman, 1985). The information represented by the various stimulus characteristics is used to form a saliency map (Treisman & Gelade, 1980). A saliency map is defined as a two-dimensional map in which each area is represented on a contrast, gradient scale (Treue, 2003). Coordinates existing within a saliency map compete for the highest contrast in view eliciting a winner-take-all (WTA) network (Walther et al., 2004). WTA means that objects highest in contrast with their environment will attract alerting attention and secondly, trigger the bottom-up attention shift. The WTA effect is greatest when the desired target is in the highest contrast with the environment (Koch & Ullman, 1985). There are stimuli that can fall into the visual field, but fail to alert attention producing what is known as inattention blindness (Simon, 2000). Itti, Koch, and Niebur (1998) argue that a similar contrast mechanism was part of the

early primate visual system for processing visual stimuli at swift rates, allowing early primates to attend to critical stimuli to the exclusion of benign stimuli.

Stimulus characteristics that comprise the saliency map include: color, luminance, size, and motion (Itti & Koch, 2001; Itti, Koch, & Niebur, 1998; Treisman & Gelade's, 1980), as well as a variety of less important characteristics including "length, closure, size, curvature, density, number, hue, luminance, intersections, terminators, 3D depth, flicker, and lighting direction" (Healy & Enns, 2012, p. 3). Because stimulus characteristics are often processed in parallel, humans can see several of these basic features simultaneously (Treisman & Gelade, 1980). These components have received considerable attention in the literature (Giesbrecht, Bischof, & Kingstone, 2004; Healey & Enns, 2012; Most et al., 2001; Treisman & Gelade, 1980; Wolfe, 1998; Xuan et al, 2007).

Attentional Capture

An attentional shift that is involuntary is known as attentional capture. "Explicit attentional capture occurs when a salient and unattended stimulus draws attention, leading to awareness of its presence" (Simons, 2000, p. 147). Capture is triggered when an unattended stimulus in the environment is able to overcome all other stimuli in the saliency map. However, simply outcompeting other stimuli in the WTA network is not necessarily adequate to activate capture. Instead, the unattended stimulus must also overcome attention to the attended stimulus. As Simons explains, "when attention is engaged, the likelihood of capture is reduced" (Simons, 2000, p. 153). In the case of Simon & Chabris' gorilla, the presence of the gorilla was not adequate to overcome the attention to the ball for a subset of the subjects. Further, when subjects given the more demanding attentional task of counting the number of passes by both teams

(45%), were less likely to spot the gorilla than subjects only counting the number of passes of one team (64%).

A stimulus must 'win' a person's attention to evoke the WTA effect. It has been shown that a person is drawn to look at one stimulus over other stimuli based on specific, visual features (Pessoa, 2005). Pessoa (2005) describes the human visual cortex as specific regions that respond in simple ways to visual stimuli. The use of patterns is one example of how to evoke a response using a stimulus (Pessoa, 2005). Commonly recognized characteristics of stimuli include shading, color, size, and movement. These features are: (1) regarded as motivating factors of a stimulus, (2) are considered the driving force behind focused attention to one stimulus over another, (3) and are needed to make a target stimulus the "winner" (Wang et al., 2011).

Color and hue. Koivisto and colleagues (2004) as well as Most, Simons, Scholl, Jimenez, Clifford, and Chabris (2001) results suggest that "bottom-up properties of the stimulus, such as color, contribute to the likelihood of detecting an unexpected stimulus under inattention" (p.3220). Most and colleagues (2001) were interested in examining how color, in an unexpected object, affected inattentional blindness in a selective looking task. They found that, even though inattentional blindness was not completely removed, there was a degree of change in participants' inattentional blindness to the unexpected object from 50% to 28% (Most et al., 2001). Furthermore, if the intended, unexpected target has the same color as the current target then the unexpected target is less likely to be identified (Koivisto et al., 2004). Attractors of the non-target stimulus are most effective when their chromatic distance or hue separation is increased (D'Zmura, 1990; Nagy & Sanchez, 1990). When the target stimulus is yellow, there may not be a quick response when a new orange stimulus is introduced as when a dark blue stimulus is introduced, because blue is in higher contrast with the yellow target and environment

than orange. Furthermore, D’Zmura’s (1990) research on color suggests that color attractors are not just “red-green, yellow-blue and black-white”, but the human brain can see contrasts between other intermediate hues too (p. 951). Nagy and Sanchez (1990) argue that the discrepancy in high and low contrast in color suggests that short- and long-wavelength cones appear to be independent of each other.

The color red may possess additional alerting properties. “Empirical work has begun to emerge showing that exposure to the color red has motivational, as well as symbolic, implications for human perceivers” (Meier et al., 2012). Animals inherently recognize the color red as signifying danger, which in turn, evokes an aversive response (Elliot & Maier, 2007; Meier et al., 2012). Because many potential threats in nature, such as blood or fire, are red, mammals may have evolved an aversive response to the color. Further, Elliot and Maier (2007) argue that the recognition of the color red happens mainly outside of our consciousness; it may be that reactions to red are instinctive and automatic—a characteristic of alerting attention and bottom-up attention shift.

Luminance. Along with color, luminance plays a strong role in attributes of a stimulus. It is due to the contrast of luminance between the stimulus and the environment that a person is able to see the stimulus (Treisman & Gelade, 1980). As mentioned under WTA, the higher the contrast there is between the stimulus and the environment, the quicker the response time will be to the stimulus. Luminance itself allows the viewer to see other parts of the stimulus including color, size, and movement (Cavanagh & Favreau, 1985; Derrington & Badcock, 1985).

Even color varies by luminescence when it is on a dark background versus a light background (Meier et al., 2012). Giesbrecht, Bischof, and Kingstone (2004) have shown that when subjects viewed stimuli under dark and light conditions, perceived understanding of the

image was altered. Early visual responses can be greatly affected by dark and light conditions of viewing that effect low-level vision (Giesbrecht, Bischof, & Kingstone, 2004).

Size. By evolutionary design, an object's size provides important visual cues about how much potential threat is present. Because objects that are distant appear smaller than objects that are near, distant objects are perceived as less of a threat and immediate danger (Ashbridge et al., 2000). Rapid recognition of relative size suggests that size is initially processed in low-level vision, as a function of alerting attention (Ashbridge et al., 2000). In visual searches, "taller, shorter, denser, and sparser pixels can easily be identified" (Healey & Enns, 1999, p.165). Additionally, subjects are able to locate a long line among a group of short lines faster than they can locate medium length lines (Healey & Enns 2012).

Change in stimulus speed and direction. Although not specifically named by Itti and Koch (2001) as a key low-level vision feature, Wolfe (1998) argues that a key stimulus characteristic driving attentional shift is the contrast of motion, defined as a stimulus' change in speed and direction. In one experiment, Wolfe (1998) had participants conduct a visual search and found that objects contrasting in motion were more quickly recognized than those not contrasting in motion. He concluded that a contrast in motion is one of the strongest attention-getting features a stimulus can have.

Motion. According to Abrams and Christ (2003), "the onset of motion captures attention in a bottom-up, stimulus-driven manner" (p. 429). In a series of three experiments, participants were found to be more likely to identify target letters among distractors when the targets had changed from static to moving, as compared to continuously moving targets (Abrams & Christ, 2003). The onset of motion can provide a "substantial additional benefit" for capturing attention because the onset of motion is a cue that the stimulus may be alive (Abrams & Christ, 2005). In

the time since this initial finding, a number of competing hypotheses have emerged to explain the phenomenon of attention capture due to motion (Franconeri & Simons, 2003).

New object hypothesis. In a 2008 article, Christ and Abrams argued that it wasn't the onset of motion that captures attention, but onset of a new object. The "new object hypothesis" states that "new objects have a larger impact on the allocation of attention than new motion" (Christ and Abrams, 2008, p.1). In previous research, Abrams and Christ (2003) used a visual search task where participants were told to identify the location of letters on a display with targets and distractors. Some of the letters were moving and others were stationary (e.g., Abrams & Christ, 2003; Abrams & Christ, 2006; Christ & Abrams, 2008). In their studies, a blank area in the visual field that subsequently gets a letter was considered a "new object" (Abrams & Christ, 2003). The researchers found that subjects were faster to identify the location of a target letter if it occupies a previously empty space than if it was simply moving prior to the change (Abrams & Christ, 2006).

Delayed-signal hypothesis. Another hypothesis posits a temporal component for the onset of motion. The delayed-signal hypothesis predicts that feature changes will be more effective when the change is cued in advance of the display transition (Horstmann, 2002). In one experiment (Horstmann, 2002), subjects were shown twelve small squares arrayed in a circle (as in the face of a clock). After 500ms a letter appeared in each of the 12 squares and stayed there for 53ms before returning to their original color. Subjects were told to identify the location of the letter "U" in the array. All squares were the same color in the conjunction condition, while in the surprise condition, the square that would contain the target letter was a different color than the rest. Subjects were significantly more likely to identify the correct location in the surprise

condition than in the conjunction condition. These findings help to support the delayed-signal hypothesis.

Unique event hypothesis. The delayed signal hypothesis was made even more precise by the introduction of the unique event hypothesis. The unique event hypothesis argues that attention capture will be stronger if feature change occurs just slightly before, or even just after, the display transition. In one study using the same paradigm as Horstmann (2002), Muhlenen, Rempel, and Enns (2005) manipulated the temporal placement of the color change in four conditions: 1000ms prior to the transition, 150ms prior to the transition, simultaneous with the transition (0ms), and 150ms after the transition. They found that response time was significantly faster in the conditions in which color change occurred 150ms prior to or after the transition. They obtained the same results when the unique event signal was motion rather than color change. Muhlenen et al., (2005) argue that these results uniquely support the unique event hypothesis' argument that the visual system is sensitively tuned to change in a number of dimensions. They argue that the new object hypothesis (onset) is not supported because that hypothesis doesn't explain the effectiveness of a brief preview or delay on capture. Furthermore, they argue that the delayed-signal hypothesis is not supported because capture was slow in the 1000ms condition (delayed-signal) and because the delayed-signal hypothesis does not account for capture when color or motion occur after the transition.

Behavior urgency hypothesis. The behavior urgency hypothesis states that attention is drawn to objects in the visual field that have features that suggest threat and may therefore require the viewer to respond (Kawahara, Yanase & Kitazaki, 2012). Kawahara, et al. (2012) tested the behavior urgency hypothesis using top-down and bottom-up attentional capture approaches. Kawahara et al. (2012) was interested in whether top-down or bottom-up controlled

attention for task-irrelevant stimuli (movement of objects outside of the central task). In five optic-flow experiments, subjects were to seek out the target amongst peripheral distractors (Kawahara, Yanase & Kitazaki, 2012). If top-down controlled attention, then peripheral distractors should not have an effect. However, the researchers found that indeed there was an effect such that attention shifted from top-down to bottom-up when motion in the periphery started or stopped and if the motion was expanding (engaged bottom-up) or contracting (did not engage bottom up). Expansion suggested that the dots were approaching the subject and contraction suggesting that the dots were moving away from the viewer. However, attention did not shift to bottom up when the motion changed speed (slowed down or sped up). The researchers concluded that qualitative change mattered (the quality of onset or offset of motion), but quantitative did not matter (the speed). These results support the behavior urgency hypothesis (Kawahara, Yanase & Kitazaki, 2012).

In other feature search task studies supporting the behavior urgency hypothesis, four dynamic events were found to induce high priority: abruptly appearing objects, sudden motion, looming, and “concurrent changes in luminance contrast and contrast polarity” (Franconeri & Simons, 2003; Franconeri, Simons & Junge, 2004; Jonides & Yantis, 1988). The researchers found that all the feature changes, except receding and color, captured attention, lending support to the behavior urgency hypothesis.

In three experiments using visual search tasks, the researchers found that the onset of motion (new object hypothesis), jitter motion (unique event hypothesis), and looming motion (behavioral urgency hypothesis) all were significant in capturing attention (Franconeri & Simons, 2003). This raises the question: how do these hypotheses work in a natural viewing setting when viewers are not searching for the stimuli? In an experiment, Bergen, Grimes, and

Potter (2005) showed that when viewers watched television with two visual focuses competing like a crawl and video on the same screen, they were less likely to retain the information than if there was just one visual focus. This study explained that motion can be a viable way of capturing attention; however, the study did not test what kinds of motion are more likely to attract attention.

Movement is often seen during severe weather events as a crawl on the screen alerting viewers of the oncoming danger or in other formats (Federal Communications Commission, 2007). During a severe weather watch or warning, the government requires official alerts, including graphics, to be immediately broadcast for the maximum safety effect (Federal Communications Commission, 2007). Carter (1996) describes five different types of animation or moving weather graphics used in weather forecasts: point symbols (like raining clouds), line symbols (usually showing flow patterns), raster display sequences (radar loops), 3D clouds (used to show height of the weather system), and areal expansion and contraction (cold or warm air changes). A common graphic used regularly during broadcasts are the point symbols. The motion hypotheses can help to explain the most effective motion features among weather graphics that can then in-turn be used to attract attention.

Hypotheses

From the above hypotheses and studies, along with several others, new object, unique-event, and behavioral urgency hypotheses are commonly supported, where delayed-signal has inconclusive support. With this understanding, it is proposed that there should be a test, in a natural-viewing setting, among the former three hypotheses. This paper compares the three of conflicting accounts: new object hypothesis, unique-event hypothesis, and behavioral urgency

hypothesis. All of these hypotheses advocate that they are superior hypotheses and that all other hypotheses are less effective in capturing visual attention.

New object hypothesis

This hypothesis predicts that the onset of motion encompasses all types of motion.

H1: The onset of motion is sufficient to capture attention, regardless of other characteristics.

H1a: There will be no difference in attention capture between onset and looming conditions.

H1b: There will be no difference in attention capture in onset and jittering conditions.

Unique event hypothesis

This hypothesis predicts that unique motions in objects, like jittering, will be superior to capturing attention that just a new object. Under this hypothesis, a new object is not as effective as a new object that contrasts the environment when trying to gain attention because viewers seek out the “unusual”.

H2: Jittering objects will be more likely to induce attentional capture than the onset of a new object.

This hypothesis directly conflicts with H1b.

Behavioral urgency hypothesis

This hypothesis predicts that threatening motion, like looming, will be more effective at capturing attention than new objects or unique motion.

H3: Looming objects will be more likely to induce attentional capture than the onset of a new object.

This hypothesis directly conflicts with H1a.

H4: Looming objects will be more likely to induce attentional capture than jittering objects.

Method

Participants

Forty-four undergraduate students (28 males, 16 females) from Michigan State University participated in the study. All subjects had normal vision or vision corrected to normal. Subjects were recruited through the Communication Department's subject pool through Experimentrix and participated for course credit. All participants were briefed on their rights as research subjects and signed informed consent approved by the Michigan State Institutional Review Board in advance. The students varied in class level: 25% Freshmen ($n = 11$), 16% Sophomores ($n = 7$), 36% Juniors ($n = 16$), and 23% Seniors ($n = 10$) and were from a variety of colleges including Arts and Letters ($n = 0$; 0%), Business ($n = 8$; 18%), Communication ($n = 23$; 52%), Education ($n = 2$; 5%), Social Science ($n = 2$; 5%), Natural Science ($n = 4$; 9%), Undecided ($n = 3$; 7%), and None of the above ($n = 2$; 5%),

Procedure

Subjects were briefed on the study, told of their rights as research subjects and read and signed informed consent forms. Subjects were then randomly assigned to watch one of two equivalent videos of a meteorological news report (see description below) in a group setting. There were 3-19 subjects simultaneously viewing in each session. Subjects were told, "This study is to understand how people learn information from educational science videos. After watching this brief video, you will be asked to answer a set of questions about the video." After viewing, subjects were tested on recognition memory of graphics that were presented briefly

during the video in three ways: onset, looming, and jittering. The subjects also answered questions on their opinions of the video and some demographic questions. After finishing the instrument, subjects were thanked, given an opportunity to ask questions about the study, and instructed to not discuss the study with anyone for two weeks (end of data collection period).

Materials

Manipulation. A segment of an ABC News national meteorological broadcast on extreme storms was downloaded from the Internet. The video was approximately 3 minutes in duration. Using a professional video guaranteed that the stimulus was of high quality and maintained the cover story of the study being about educational science videos. Because the study was about drawing visual attention in a real-life situation, the cover story was important so that the subjects were not primed to search for graphics. Two black and white weather graphics (see Appendix) were inserted in the lower corners of the video screen, as is commonly found with television program graphics. Black and white graphics were used to eliminate potential confounds caused by attentional capture due to color. The graphics were presented in one of three ways consistent with the hypotheses: onset, looming, or jittering (see Table 1). The manner of presentation was matched to manipulations in experiments described above. *Static* graphics simply appeared, stayed on screen for 2s, and then disappeared. *Looming* graphics zoomed in for 2s and then disappeared from the screen. *Jittering* graphics consisted of oscillatory motion over a small spatial distance (approximately 5 degrees) for 2s and then disappeared from the screen. The stimulus manipulations occurred at 60s, 105s, and 160s into the video. In order to control for spatial effects, two videos were created with location of graphics presentation counterbalanced (see Table 1). Temporal order was not changed because none of the hypotheses supported a cueing effect.

Table 1

Counterbalanced graphic manipulations

Stimulus Video	Screen Location		
	Lower Left/Right Corner	Lower Left/Right Corner	Lower Left/Right Corner
Video 1	(Static/Looming)	(Jittering/Looming)	(Static /Jittering)
Video 2	(Looming/ Static)	(Looming/Jittering)	(Jittering/ Static)

Outcome measure. After viewing the video, participants were immediately given a simple questionnaire consisting of nine questions and three demographic measures (see Appendix). Of specific interest for the hypotheses was question five that tested recognition recall of graphic elements. In addition to the six graphics used in the video, nine distractor graphics were included to test for false recognition. Additional questions tested their general recall of information from the video (numbers 1-4), their recall of the location of the graphics (number 6), and their general rating of the quality of the program (numbers 7-9). Questions 1-4 and 7-9 were used to maintain the cover story and provide information on how well subjects attended to and remembered the video. Finally, three demographic questions were asked for sex, year in the university (freshman-senior), and college that their major is in.

Results

Binomial tests were used to analysis the results of the three manipulations. Only data from viewers saw a single icon in each manipulation was analyzed. Significance was counted at the $p < .05$ level. Hypothesis 1a predicted that there would be no difference in attentional capture between static objects and looming objects, while H3 predicted that looming objects would capture attention more effectively than static objects. The results showed that static objects ($n =$

7) captured attention more than looming objects ($n = 5$), but the difference between the two motion types were not statistically significant, $p = .77$. Therefore, H1a was supported and H3 was rejected (see Table 2).

Hypothesis 2 predicted that jittering objects would capture attention more effectively than static objects, while H1b predicted there was no difference. The results showed that jittering objects ($n = 2$) captured attention more frequently than static objects ($n = 1$), but the difference between the two motion types were not statistically significant, $p = 1.0$. Therefore, H2 was not supported, but H1b was supported (see Table 2).

Hypothesis 4 predicted that looming objects would capture attention more effectively than jittering objects. The result showed that jittering objects ($n = 13$) captured attention more frequently than looming objects ($n = 2$). The difference between the two motion types was statistically significant, $p = .007$, and opposite the prediction of the behavioral urgency hypothesis. Therefore, H4 was rejected and it was concluded that the data supports jittering objects as a more effective way to capture attention than looming objects (see Table 2).

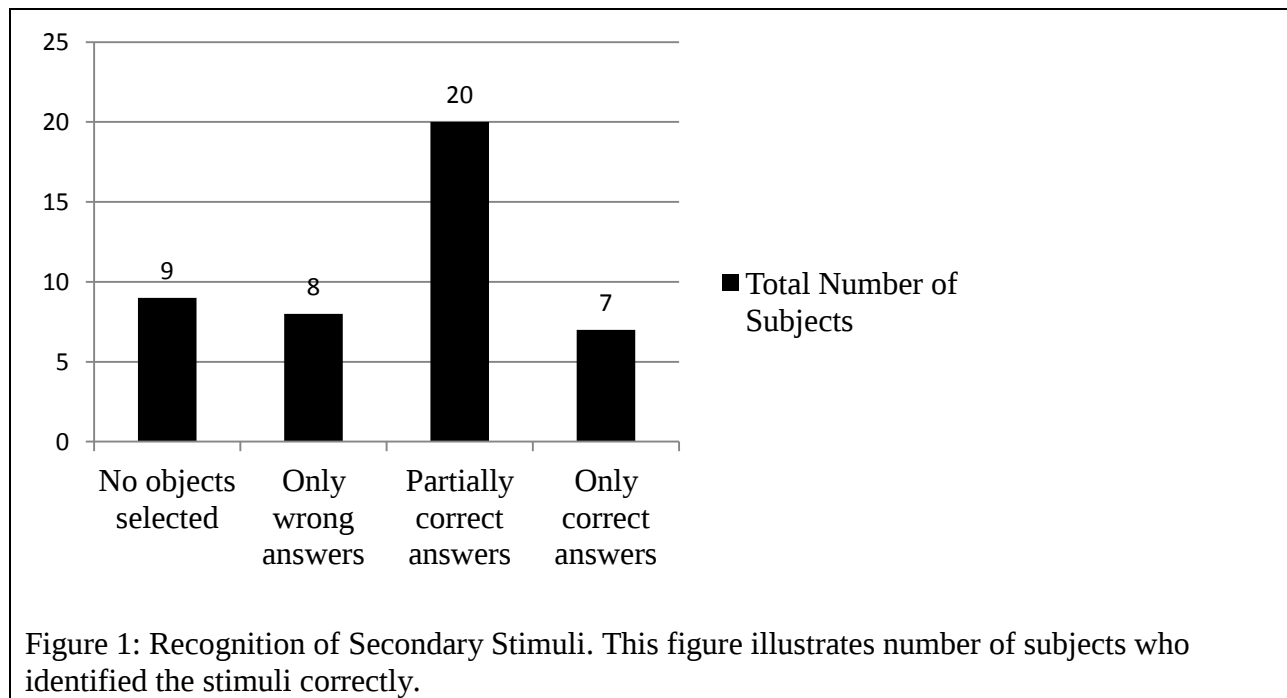
Table 2

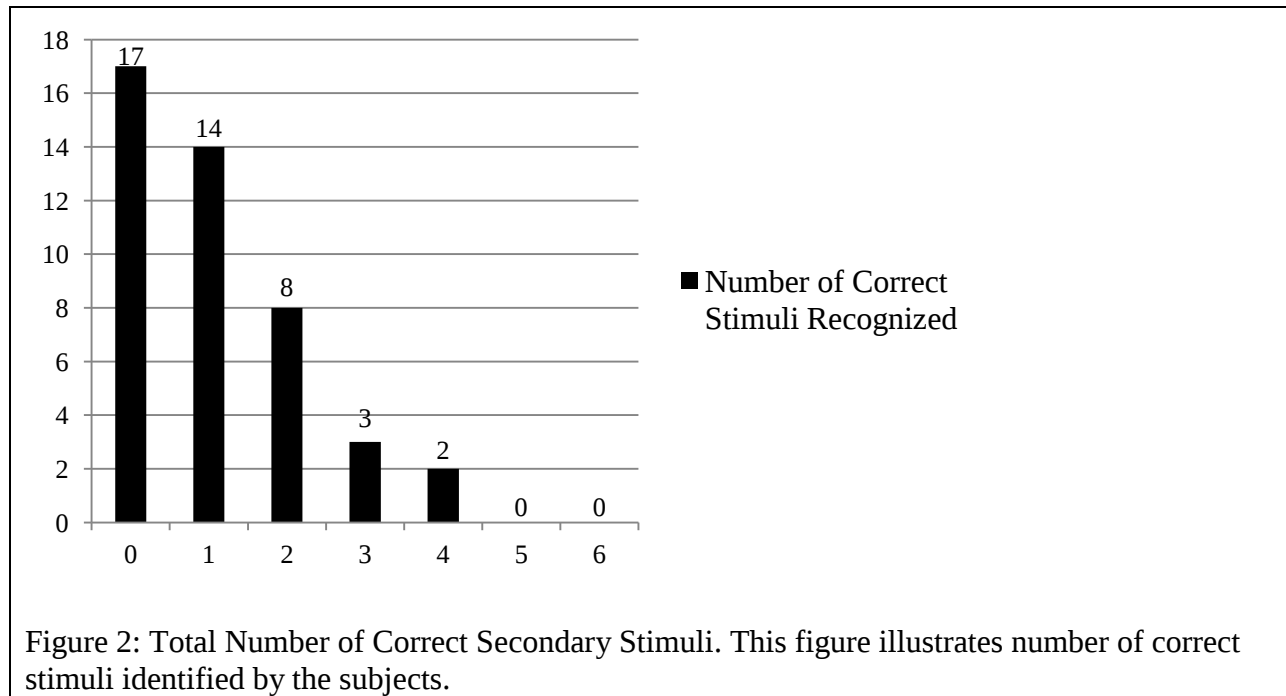
<i>Number of subjects who recognized the stimuli</i>			
Stimuli Type	Recognition ($n = 44$)		
	None	One	Both
(Looming/Static)	30	(5/7)	2
(Jittering/Static)	37	(2/1)	4
(Looming/Jittering)	26	(2/13)	3

Note. One recognition describes the subjects who only saw one object in each manipulation. Each subject had the potential to see anywhere from none to all of the stimuli.

The within subject design indicates that, including all of the manipulations, nine people (20.4%) saw none of the stimuli, eight people (18.2%) saw only incorrect stimuli, 20 people (45.5%) saw partially correct stimuli, and seven people (15.9%) saw only correct stimuli (see Figure 1). Of the correct stimuli seen by viewers, the 17 viewers (36.4%) saw no correct stimuli, 14 viewers (31.8%) saw one correct stimulus, eight viewers (18.2%) saw two correct stimuli, three viewers (6.8%) saw three correct stimuli, two viewers (4.5%) saw four correct stimuli, and no viewers saw five or more correct stimuli (see Figure 2).

The count of the areas in which viewers saw objects/stimuli on the screen showed that sixteen viewers saw the objects in the upper-right-hand corner (see Figure 3), despite exclusive placement of the stimuli in the lower-left-hand and lower-right-hand quadrants, subjects were no more likely to recall seeing the graphics in the correct quadrants than the incorrect quadrants ($p < .05$).





	Left	Center	Right
Upper	10	4	16
Center	6	10	6
Lower	9	7	13

Figure 3: Recognized Screen Location for Stimuli. This figure illustrates the count of identified screen locations for the stimuli.

Discussion

The results of this study failed to replicate some experimental findings in real world conditions. While the basic new object hypotheses were supported, there was no support for more nuanced versions (unique event and behavioral urgency). There are a number of potential explanations for this; most directly that bench cognitive science findings for visual attention do not easily translate to real world mass communication experiences. This conclusion signals caution to media designers who assume that bench findings readily transfer to media production

choices. This is a particularly important caution as media researchers begin to move away from behavioral science approaches and into cognitive science.

There are other possible interpretations of the findings. First, it is important to note the fundamental differences between tasks from the original experiments and this experiment. Prior experiments were concerned with attentional capture in a visual search situation, whereas this study was simply interested in attentional capture in a media viewing situation. It may be that the differences in findings are a function of the visual search task that viewers in the present study did not have. That is, attention capture may be stronger during search than it is during everyday experience, including media viewing. Further, visual attention may be sensitive to more nuanced processes under a focused search task. This makes sense in that a search task likely activates greater alerting attention than is found in day-to-day tasks.

Further, outcome measures are different between the lab search tasks and the recognition tasks. During search tasks, the subject signals as soon as identification occurs; which means that every target must be seen. The recognition task requires that the attention of non-searching subjects be captured by the target and that the subject is able to subsequently recognize the target stimuli on the post-viewing instrument. This may simply be a more difficult cognitive task. However, this is not to say that results from bench experiments cannot transfer to real world experience; Simon and Chabis (1999) demonstrated that some visual attention findings do extend to real world situations.

In Simon and Chabis's study, where the object detection stimulus video was conducted in a natural setting, they found that the likelihood of detecting an object was dependent on the surrounding environment and the task at hand (1999). As previously stated, the study used several people passing a ball and asked the viewer to count the passes (Simon & Chabis, 1999).

It then had a stimulus, a person in a gorilla suit, walk through the ball passing area (Simon & Chabis, 1999). Their study suggested that, like laboratory studies, viewers are drawn to stimuli or ignore stimuli based on the stimuli's features (Simon & Chabis, 1999). This current study, uses the feature of a stimuli, motion, to pick apart what types of motion are more attractive in attention gaining.

Close consideration of the subject population suggests an interesting potential generational confound. Unlike subjects in the Simon and Chabis (1999) study, the subjects in the present study learned to use media during a time when television and video games commonly display multiple simultaneous information streams. For example, CNN often provides 3-4 different streams of information to the viewer at one time including several on the periphery, whereas traditional news contained only 1-2 information streams (a single news reader and a graphic). A typical video game contains progress updates on the edges of the screen in addition to the main action. It may be that subjects from this generational cohort have learned to ignore information in the periphery in order to focus attentional resources on the main program. In the context of this study, it is unlikely that any real threat information would be relayed on peripheral graphics. A follow-up study with older populations or with subjects from single information stream cultures would help clear up the extent to which the subjects in the present study have simply learned to ignore certain streams of information.

During the data analysis phase, a possible confound was detected. One of the weather graphics that was used may have been too closely associated semantically with the main video story. That is, the video story included a section on the negative outcomes of an extreme rain storm and one of the graphics represented a rain storm. Is it possible that subjects chose this graphic primarily because of its semantic association with the story content? This may have

occurred in the jittering (16 viewers) versus looming (five viewers) condition because the measure the jittering graphic was a cloud with raindrops. Furthermore, the recognition of jittering of the partly-sunny icon was drastically different with only six viewers. From these findings, it is possible that many participants assumed they saw objects that fit most closely with the topic of the video playing as the primary stimuli. However, a significant portion of the story was about a snow storm in Vermont and two of the distractor graphic elements on the recall test were for a snow storm. These graphics were less likely to be seen as the jittering rain storm graphic, suggesting jittering when competing against static motion can have a greater attentional capture effect.

A similar phenomenon was found with stimuli screen location. Sixteen viewers, a better than chance amount, incorrectly indicated that they viewed the stimuli in the upper-right-hand corner of the screen (see Figure 3). This is concerning. After reviewing the stimulus video for possible confounds, this paper suspects that there were no confounds in the video in the upper-right-hand corner of the screen, but a natural bias for icon spatial location in television news. There seems to be a bias for screen corners and the center. These locations also happen to be popular places for reporting information on national and local networks. This seems to point out general bias and not actual icon recognition. Perhaps, future studies could explore different spatial locations to see if there is a similar effect.

Although the new object hypotheses were supported, an overwhelming number of subjects in all manipulations missed the objects (see Table 2). This raises the question: why did most subjects not see the stimuli? Perhaps future research should look at increasing the length of time each graphic remains up. Also, manipulations in color or size may also increase the effects of the object's motion. Another, manipulation could be to an auditory direct reference of the

objects. With the current research, there is still much unknown about how motion affects attentional capture in a natural-viewing setting.

Conclusion

This paper tested conflicting hypotheses from the motion and visual attention literature, applying the finding to a real-world media situation. This was accomplished by testing different types of motion, supported by different hypotheses, in a natural television-viewing setting. The findings of this study suggest that there is more research needed in visual motion that is unrelated to viewer's task.

APPENDIX

Science Video Questionnaire

We have a number of questions we would like you to answer about the video you just saw.

Answer all the questions to the best of your ability.

1. What was the news source (circle)?

- | | |
|---------------------|-----------------------------|
| a. Weather Channel | e. CBS News |
| b. NBC News | f. ABC News |
| c. CNN | g. National Weather Service |
| d. Fox News Network | h. PBS News |

2. What was the main topic of the story?

3. Where did the flooding occur?

4. In what state was the snow storm located?

5. Did you see any of the following graphics (circle any you saw)?

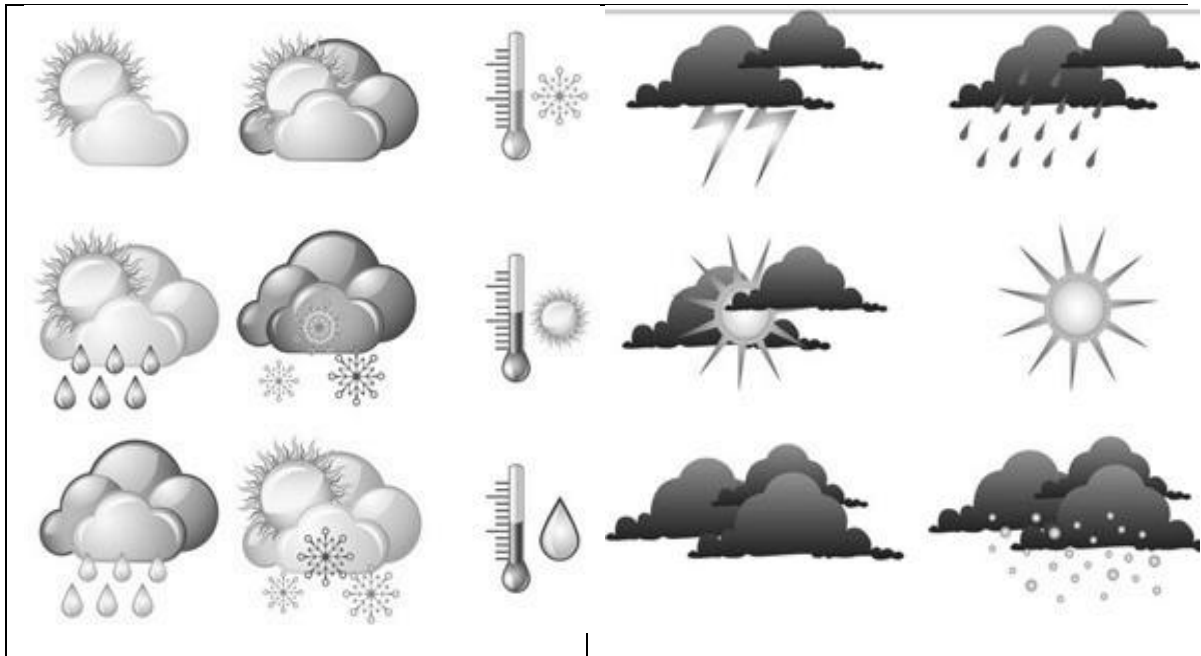


Figure 4: Television Weather Icons.

6. What part of the screen did you see the graphics (circle all that apply)?

1	2	3
4	5	6
7	8	9

Figure 5: Quadrants of the Television Screen.

7. How would you rate your interest in the main story?

1-----2-----3-----4-----5-----6-----7-----8-----9-----10

8. How would you rate your prior understanding of the topic of the main story?

1-----2-----3-----4-----5-----6-----7-----8-----9-----10

9. How would you rate your understanding after watching the video?

1-----2-----3-----4-----5-----6-----7-----8-----9-----10

Demographics

Sex _____ Female	Year _____ Freshman	College _____ Arts & Letters
	_____ Sophomore	_____ Business
_____ Male	_____ Junior	_____ Communication
	_____ Senior	_____ Education
		_____ Social Science
		_____ Natural Science
		_____ Undecided
		_____ None of the above

Thank you for your assistance with this research project

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