EFFECTS OF CHRONIC AND SITUATIONAL ACCESSIBILITY ON INATTENTIONAL BLINDNESS

by

HOLEN ELIZABETH KATZ

B.A., Bryn Mawr College, 2005

M.A., University of Colorado Boulder, 2010

A thesis submitted to the

Faculty of the Graduate School of the

University of Colorado in partial fulfillment

of the requirement for the degree of

Doctor of Philosophy

Department of Psychology and Neuroscience

2012

This thesis entitled:
Effects of Chronic and Situational Accessibility on Inattentional Blindness
written by Holen Elizabeth Katz
has been approved for the Department of Psychology and Neuroscience

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Irene V. Blair

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Angela Bryan

Date_____

The final copy of this thesis has been examined by the signatories, and we
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IRB protocol # 11-0685 & # 0204.1

Katz, Holen Elizabeth (Ph.D., Social Psychology)

Effects of Chronic and Situational Accessibility on Inattentional Blindess

Thesis directed by Associate Professor Irene V. Blair

Inattentional Blindness (IB) refers to the phenomenon that people often fail to notice unexpected, yet obvious, events when they are focused on another task. The consequences of IB can be deadly when it contributes to attentional error in high-risk situations.

In this research, four studies investigated strategies for increasing noticing of unexpected events, specifically through enhancing the chronic and situational accessibility of those events. Studies 1 – 3 explored the degree to which priming unexpected events increased the likelihood that they would be noticed. Study 4 employed different types of warning to situationally increase attention to the unexpected. In addition, all four studies manipulated chronic accessibility of the unexpected event and examined the relationship between increased chronic and situational accessibility.

The results of the four studies indicate that events that are more chronically accessible are significantly more likely to be noticed than events that are not chronically accessible. Explicitly warning individuals that something unexpected was to appear also increased the likelihood that it would be noticed, whereas more subtle warnings were ineffective. Finally, the priming techniques used in this research generally did not increase noticing of unexpected events. The implication of these findings are discussed in the context of how they might apply to reducing attentional error in health care settings.

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CHAPTER I

INTRODUCTION

There are numerous instances when people fail to notice important events in their everyday environments. Imagine an automobile driver focused on oncoming traffic while making a turn and hitting a bicyclist, a parent cooking dinner and failing to notice a child slice her finger while helping to chop vegetables, or a surgeon focused on a successful surgery who misses seeing a surgical sponge left in a patient's chest cavity. When such events result in a serious, adverse outcome the clarity of hindsight makes the situation seem avoidable and tragic. How might such events be avoided?

The motivation for the current research stems from a specific applied research problem: how can inattention to unexpected events be avoided in health care contexts? As an example of how inattention in health care can lead to severe consequences, consider the case study of a patient with a guide wire in her body, inadvertently left behind following a medical procedure (Lum, Fairbanks, Pennington, & Zwemer, 2005). The patient was admitted to the intensive care unit for a serious medical condition and multiple teams of health care providers examined the patient and her chest x-ray multiple times, yet, not one person noticed the misplaced guide wire for five days. The guide wire was obviously visible in x-rays, even to the untrained eye. This type of error can lead to patient death, thus, understanding how attention to the unexpected can be increased in health care contexts is an important component of improving patient care. This research will investigate strategies to increase attention to the unexpected in the context of an otherwise busy environment, with the intention that this research will eventually lead to informing health care practices.

Inattentional Blindness

Prior research has provided much insight into the cognitive factors involved in people's inattention to seemingly obvious events, what has been termed "inattentional blindness" (IB) (Chabris & Simons, 2010; Mack & Rock, 1998; Neisser, 1979; Simons & Chabris, 1999). In the most well known study, "Gorillas in our Midst" (Simons & Chabris, 1999), participants watched a video of two teams passing a basketball. Participants were instructed to count the number of passes that players on one team made. In the middle of the video, a person wearing a gorilla costume walked through the scene, thumped her chest and continued walking. Though the gorilla was on the screen for 9 seconds during the 30-second video, only 42% of participants noticed the anomaly. Demonstrations of IB are surprising, so much so that in a recent, nationally representative survey of 1,500 adults 75% were confident that they would notice an event such as a gorilla walking across their visual display (Chabris & Simons, 2010). Laboratory studies show however, that a significant number of people fail to notice such events when they are engaged in another task (Chabris & Simons, 2010; Mack & Rock, 1998; Mack et al., 2001; Neisser, 1979; Simons & Chabris, 1999).

Why Does IB Occur?

Inattentional blindness is a unique form of error because it does not arise from a lack of attention, but rather as a result of intent, focused attention on one's primary task. Returning the example above of the patient with an unnoticed guide wire left in her body (Lum, et al., 2005), the medical team missed seeing the wire, not because they weren't paying intense attention to the patient. Instead the error was made because, presumably, the health care teams' focus of attention was not at all on the guide wire, an unexpected element of the patient's overall health care.

Research explains that inattentional blindness occurs because "there is no perception without attention" (Chabris, Weinberg, Fontaine, & Simons, 2011; Mack 2003; Mack & Rock, 1998). In other words, events go unperceived because they fail to capture the perceiver's attention. The degree to which an event will capture a perceiver's attention depends on several factors (Koivisto & Revonsuo, 2007; Mack, Pappas, Silverman, & Gay, 2002; Mack & Rock, 1998; Most, Scholl, Clifford, & Simons, 2005; Most, Simons, Scholl, Jimenez, Clifford, & Chabris, 2001). Unexpected objects that are more similar to the attended-to-objects are more likely to be noticed, whereas, objects more similar to objects that are actively being ignored are less likely to be noticed (Most et al., 2001). This is because when individuals are intentionally trying to ignore similar objects to the unexpected object, the unexpected is less likely to break through the attentional filter.

Increasing Chronic and Situational Accessibility to Reduce IB Effects

Increasing the salience of an unexpected event is one strategy for increasing the likelihood that it will be noticed (reducing IB). Social psychological research has shown items that are more accessible are more likely to capture attention (Bruner, 1957) and that both chronic accessibility and the situational accessibility influence perception (Bargh, Lombardi, & Higgins, 1988; Bargh, Lombardi, Tota; 1986). For the purpose of this research, I will refer to chronic accessibility as objects or events that are perpetually salient to all people, regardless of context. For example, a person continually hears his or her name throughout the course of his or her lifetime as a signal to pay attention. Thus, if a person hears his or her name, even out of context, that name should be particularly salient as compared to other names. Prior research indicates that chronically accessible items are less susceptible to IB. For example, unexpected objects that are familiar such as a person's name or a smiley face (Becker & Leinenger, 2011; Mack & Rock,

1998; Mack et al., 2002) or an unexpected object that is goal relevant (e.g., from the same conceptual category as the attended objects; Koivisto & Revonsuo, 2007; Most et al., 2005) are more likely to be noticed on an IB task.

Given that prior research suggests that the chronic accessibility of an unexpected event increases noticing of that event (Becker & Leinenger, 2011; Koivisto & Revonsuo, 2007; Mack & Rock, 1998; Mack et al., 2002; Most et al., 2005), what other strategies might successfully moderate IB? Increased situational accessibility of an unexpected event might be one strategy. Situational accessibility refers to an increase in salience as the result of a specific event. Social perception literature demonstrates that recent experiences have an influence on subsequent experiences, attention and behavior. For example, people who recently thought about positive or negative traits subsequently used those traits in forming an impression about another person, both in their description of the person and in their evaluation of how much they liked the person (Higgins, Rholes, & Jones, 1977). In other words, enhanced accessibility to those traits acted like a filter through which additional information about a person was processed. Analogous to effects of chronic accessibility on IB, I hypothesize that concepts that are made situationally accessible should more readily break individuals' attentional filters, and thus be less susceptible to IB.

Priming Increases Situational Accessibility: Does it Reduce IB? Priming, a strategy for increasing situational accessibility, is the effect that exposure to a stimulus that is conceptually related to later stimuli facilitates response to those stimuli (Meyer & Schvaneveldt, 1971; Neely, 1977; Posner & Snyder, 1975; Schvaneveldt & Meyer, 1973). For example, participants primed with the word "doctor" are faster to identify the word "nurse" (Meyer & Schvaneveldt, 1971). Priming can influence goals, thoughts and behavior (Bargh, Chen & Burrows, 1996; Dijksterhuis & Bargh, 2001; Williams & Bargh, 2008). In other words, priming

increases the accessibility of primed concepts and subsequently can strongly influence how individuals interact with their environment. Because IB arises as the result of selective attention, facilitating accessibility and thus ease of processing through priming is hypothesized to increase noticing of unexpected events.

The use of priming to increase noticing in IB tasks has only been tested in two known studies (Becker and Leinenger, 2011; Rattan and Eberhardt, 2010). One study has suggested that relevant social cues can prime or facilitate attention to the unexpected object in an IB task. Specifically, Rattan and Eberhardt (2010) exposed participants to stereotypically African American names or stereotypically white American names. After seeing the names, participants completed Simons and Chabris' (1999) Gorillas in our Midst task. The African American names were expected to prime the concept of gorilla because prior research has indicated that there is an implicit association between African Americans and apes (Goff, Eberhardt, Williams & Jackson, 2008). Of the participants who were primed with African American names 70% saw the unexpected gorilla, whereas of participants who were primed with a white American name only 45% saw the gorilla.

In a similar study, Becker and Leinenger (2011) tested the idea that attention to unexpected stimuli can be increased when the content of the stimuli are consistent with the mood of the observer. In their study Becker and Leinenger induced a happy or a sad mood for participants who then completed a widely used IB task (Most et al., 2001). Participants who had been primed with a happy mood were significantly more likely to notice and unexpected happy face appear on the screen than the frowny face and visa versa; participants who were primed with a sad mood were significantly more likely to notice a frowny face.

Priming requires relatively low cognitive resources and can be executed subliminally (e.g., Bargh et al., 1996), with significant effects. For this reason, priming is the type of strategy that has the possibility to easily increase noticing of unexpected events in a variety of settings, even outside the laboratory. This research will attempt to replicate and extend the findings of Rattan and Eberhardt (2010) and Becker and Leinenger (2011) both by replicating the effect of priming on noticing unexpected events and through examination of the effects of both chronic and situational accessibility, simultaneously.

The Interaction Between Chronic and Situational Accessibility. The degree to which increased chronic vs. situational accessibility is more effective and whether or not there is an interaction between chronic and situational accessibility is an area of research in demand of more attention. Social psychological research suggests that chronic and situational accessibility have additive effects in person perception (Bargh, et al., 1988; Bargh, et al., 1986). For example, traits that are both chronically and situationally accessible will both guide impression formation of another person. The current research will address issues of chronic and situational accessibility of an unexpected object by manipulating both the context in with the IB task occurs (situational accessibility) and the unexpected object itself (chronic accessibility) with the hypothesis that events that are made both chronically and situationally accessible should be most readily noticed.

The Current Research

The current research will test three main hypotheses: 1) Unexpected events that are more chronically accessible will be more readily noticed. 2) Unexpected events that are made more situationally accessible will be more readily noticed. 3) Chronic and situational accessibility will interact such that unexpected events that are made both chronically and situationally accessible will be most be most readily noticed.

Priming Studies. The research presented in this paper will investigate three priming strategies for increasing situational accessibility and the likelihood that an unexpected event will be noticed. Expanding on limited existing research on the role of priming in reducing IB (Becker and Leinenger, 2011; Rattan and Eberhardt, 2010) Studies 1 – 3 will further examine the effectiveness of priming in attention to unexpected events. In these studies, the chronic accessibility of the unexpected event will also be manipulated.

Warning Study. Study 4 will test the effectiveness of warning on increasing the likelihood that unexpected event will be noticed. Understanding how warnings influence IB is a significant component of fully understanding the best strategies for reducing IB, particularly in applied settings. The content of the warnings and how they are delivered may influence the degree to which they are successful. Again, chronic accessibility of the unexpected event will be manipulated in Study 4.

Tradeoffs in Attention on Primary Attention Task and Noticing the Unexpected.

Finally, IB tasks require attention on a primary task and on a secondary task (noticing an unexpected event). This research will investigate both types of attention. Prior research suggests that there may be tradeoffs in IB tasks such that noticing an unexpected event comes at the cost of reduced attention on the primary task (Becker and Leinenger, 2011, Mack et al., 2005), while other research suggests that under certain circumstance, noticing an unexpected event is correlated with better performance on a primary task (Bressan & Pizzighello, 2008). Although in some settings it may not matter if there are tradeoffs in attention for a primary task, it is particularly important to fully understand the costs of noticing unexpected events for applied settings. It would be important to know if noticing an unexpected event comes at a high cost to attention in a setting such as health care, for example, because compromised attention on a

primary task could also result in serious adverse outcomes. This research will examine tradeoffs in attention on IB tasks when they occur in the context of priming or warnings.

CHAPTER II

PILOT STUDIES

The IB task used in this research was modeled on a task developed by Most et al. (2001). In this task, participants complete 15-second attention trials during which sets of objects move in random patterns around the screen. As the objects move across the visual display they "bounce" off the edges of the display and then continue moving in another direction. Participants' task is to track one set of objects and count the number of times those objects bounce on the edge of the display. The first two trials are *practice trials* – objects from the two sets are the only items to appear on the display. The third trial is the *first critical trial* – in this trial, an unexpected object moves horizontally from right to left across the visual display, remaining visible for 5 seconds (1/3) of the trial. Following the first critical trial, participants are prompted to report whether or not they noticed an unexpected object during the trial and if so, to describe what it was they saw. Following the first critical trial a *second critical trial,* the same as the first critical trial, is also completed. The final trial is an *attention check*. In this trial participants are instructed to simply watch the screen without counting bounces and report what they saw, with the expectation that all participants should see the unexpected object under these conditions.

I conducted two pilot studies to adapt Most et al.'s (2001) task to be in line with the goals of the present research. The first goal was to create a task in which only 10 – 20 % of participants noticed the unexpected event – a rate low enough to be able to determine whether or not priming manipulations would increase the percentage of individuals who would see the event. The second goal was for the IB task to have an unexpected event that a) could be semantically and visually primed and b) for which chronic accessibility could be manipulated. I decided that the appearance of an object related to either the concept "stop" or "go" would be used because

stop and go are simple constructs, that ought to be easily primed, and differ in chronic accessibility. I hypothesized that the concept stop would be more chronically accessible than the concept go. This hypothesis was formed based on prior research that suggests that the word stop is a highly salient object and less susceptible to IB (Mack & Rock 1998), and because stop signs are a more frequently used symbol used in everyday life (e.g., stop signs are more common on roadways than signs that say go).

Pilot Study 1

Twenty-two students (17 females) at the University of Colorado Boulder participated in the first Pilot. The average age of the participants was 19.32 years. All participants completed an IB task with 2 practice trials 2 critical trials and an attention check, modified from Most et al. (2001). The visual array contained numbers printed in either red, green or white and participants' task was to count the number of times the numbers printed in white bounced off the edges of the display (16 – 18 times per trial). The unexpected object was either a red circle (thought to be associated with stop) or a green circle (thought to be associated with go). Screen shots of the task can be seen in Appendix 1.

Fourteen of the 22 participants saw the unexpected object on the first critical trial, a notice rate of 64%. There was not a significant difference in attention rates between the red circle and the green circle (40% vs. 34%, $\chi^2(1) = 0.39$, $p = 0.53$). Because a 64% notice rate was much higher than the target 10 -20% notice rate, the IB task was modified and re-piloted.

Pilot Study 2

Twenty-four students (13 females) at the University of Colorado Boulder participated in the second pilot study. The average age of the participants was 18.91 years. The same IB task from Pilot 1 was used with the following modifications: 1) Instead of numbers participants

counted Xs and Os were the background distractor. Xs and Os were used because Os are similar in shape to solid circles (the unexpected object) and thus encourage lack of attention to solid circles. 2) Instead of the distractors being both red and green the distractors were either red if the unexpected object was to be red and green if the unexpected object was to be green, again increasing the similarity between the unexpected object and the distractors and thus the difficulty of the task. 3) The unexpected object moved horizontally from right to left across the bottom third of the screen to make it less obvious. 4) The number of times the Xs bounced was increased to 23 -24 times, making the primary attention task more difficult and decreasing the likelihood that the unexpected event would be noticed. Screen shots of the task can be seen in Appendix 1.

Only one participant (4%) saw the unexpected object on the first critical trial and only 32% noticed it on the second critical trial. These results indicate that the IB task used in Pilot 2 was very difficult, and most likely too difficult to use paired with a priming procedure.

Based on what I learned from the first two pilot studies, I developed a third IB task in which the unexpected objects were either stop or go signs. This task produced the desired notice rate of 10 – 20% and will be discussed in full in Study 1.

CHAPTER III

STUDY 1

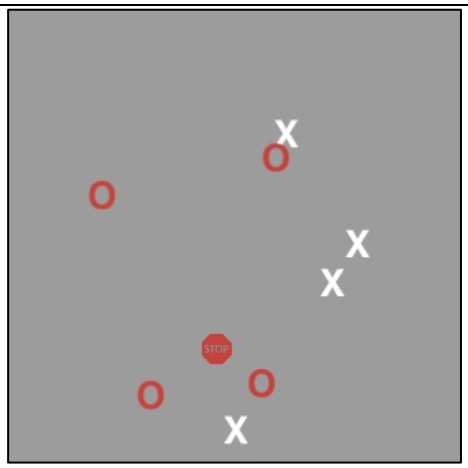
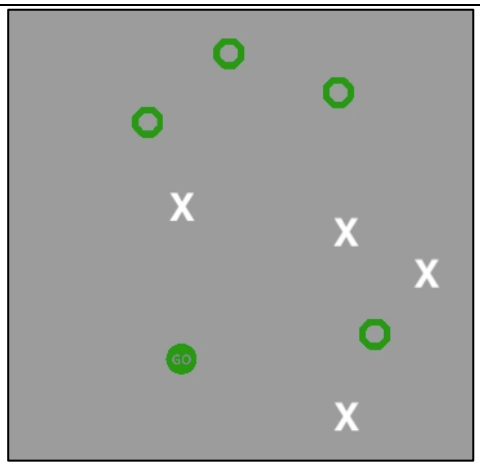
The purpose of Study 1 was to test the effect of semantic priming on noticing an unexpected stop sign or go sign. I hypothesized that activation of the concept stop or go via a semantic priming procedure would make the concept more situationally accessible and thus more likely to be noticed. Of additional interest was the interaction between chronic and situational accessibility on noticing, participants' accuracy on the primary task, and tradeoffs in attention between accuracy and noticing an unexpected event.

Method

Participants. Twenty-nine students (14 females) at the University of Colorado Boulder were recruited from the Psychology 1001 subject pool to participate in Study 1. The average age of the participants was 19.31 years.

IB Measure. The IB task was nearly identical to that used in Pilot 2 except that the unexpected objects were a stop sign and a go sign, randomly assigned between subjects. Previous research has indicated that unexpected events that carry meaning, such as the word stop, are more readily noticed (Mack & Rock, 1998), so I expected that the notice rate would be higher than in Pilot 2 and closer to the target 10 – 20% notice rate. A screen shot of trials with the stop and go sign appearing are in Figure 1.

Figure 1. Screen Shots of Pilot Study 1 Trials

Unexpected Red Circle	Unexpected Green Circle
	

Priming Manipulation. Participants completed a go-priming or a stop-priming manipulation, randomly assigned between participants and fully crossed with the IB measure conditions. The priming task was a semantic priming procedure in which participants unscrambled sentences with meaning either related to "go" or "stop". Participants were each given 11 sets of five words that they had to unscramble into 11 four-word sentences by omitting one word. For example, "train middle here the stop" would be unscrambled as "Stop the train here." Unscrambling sentences is a classic priming procedure that has been used effectively in other research (e.g., Srull & Wyer, 1979). The sentences used in the unscramble task are in Appendix 2.

Procedure. Participants completed the sentence unscramble measure with paper and pencil. When they finished the sentence unscramble they completed the IB task following the same procedure as in the pilot studies.

Results

Accuracy on Primary Task. To assess accuracy on the primary counting task, I calculated the absolute value of the difference between the correct number of bounces on each

trial and the number of bounces that participants reported counting. Thus, higher scores indicate less accuracy and lower scores indicate greater levels of accuracy. Participants were fairly accurate in counting bounces except in the first practice trial when they were learning the task. An analysis of the average accuracy across both critical trials showed that there was no condition differences – main effects or interactions – in participants' accuracy, all F's < 1.5, p > .05. See Table 1 for a full report of accuracy and notice scores by condition for each trial.

Table 1. Accuracy, Notice Rate and Correlation Between Accuracy & Noticing for Study 1

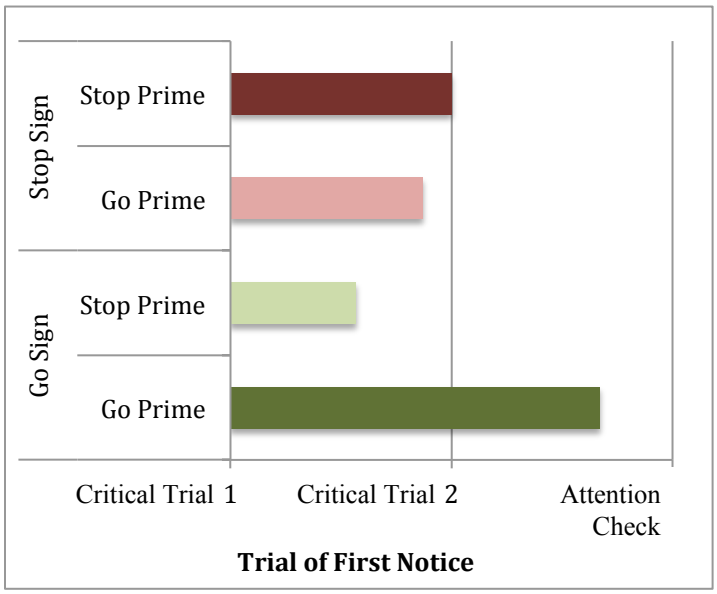
			First Critical Trial	**Second Critical Trial**
Stop Sign	Stop Prime	Accuracy	2.12	3.62
		Notice	13%	88%
		r	-0.06	0.17
	Go Prime	Accuracy	1.25	5
		Notice	13%	100%
		r	-0.11	1
Go Sign	Stop Prime	Accuracy	1.71	2.71
		Notice	57%	86%
		r	-0.24	0.80*
	Go Prime	Accuracy	2.83	3.33
		Notice	0%	33 %
		r	-	0.65

*Denotes significant correlation, p <0.05

Effects of Situational and Chronic Accessibility on IB. Study 1 successfully produced the desired notice rate of 20% on the first critical trial. To assess the combined effects of increased situational accessibility through priming, a "notice score" was created for each participant for when they first noticed the unexpected object. Participants who saw the unexpected object on the first critical trial scored a 1, participants who noticed the unexpected object on the fourth trial scored a 2, and participants who did not notice the unexpected object until the attention check scored a 3. Lower notice scores indicate that participants saw the unexpected object on earlier trials. Higher notice scores indicate that participants saw the

unexpected object later in the task (either on the second critical trial, or not until the attention check). Notice scores by condition are presented in Figure 2.

Figure 2. Average Notice Score x Condition for Study 1



I regressed the notice time variable on prime type (stop vs. go) and object type (stop sign vs. go sign) to determine whether there were differences between conditions in how readily participants saw the unexpected event. There was a significant main effect of prime type, $F(1, 28) = 5.31$, $p = 0.02$ such that participants in the stop priming condition were more likely to notice the unexpected event. There was not a main effect of object type, $F(1, 28) = 0.74$, $p = 0.40$. There was a significant interaction between prime type and object type $F(1, 28) = 8.40$, $p < 0.01$.[1] Simple comparison tests revealed that the interaction was driven by participants in the go prime/go sign condition, who took significantly longer than participants in all other conditions to see the unexpected object, all *t*s >2.0, p <.05 (See Figure 2 for comparison).

[1] The regression models reported do not control for participants' accuracy on the counting task. I also ran the regression analyses controlling for participants' counting accuracy and the effects in the model remain the same. This was true for all studies reported in this paper. Thus, all studies report models that do not control for participants' accuracy in counting, though the effects would remain the same if they did.

Tradeoffs in Attention. Of additional interest was the relationship between noticing the unexpected object and participants' accuracy in the primary counting task. Collapsing across conditions, on the first critical trial, there was not a significant relationship between accuracy and noticing, $r = -.22$, $p = 0.26$. Interestingly, there was a positive correlation between accuracy and noticing the unexpected object on the second critical trial, $r = 0.53$, $p < 0.01$. That is, participants were more accurate at counting the bounces of the Xs when they noticed the unexpected event.

Discussion

In Study 1, activating the concept stop through priming made participants more vigilant overall of both the appearance of an unexpected stop sign and go sign. However, the finding that participants in the go prime/go sign condition were significantly less likely than participants in any other condition to see the unexpected event is surprising and difficult to explain. Priming theory indicates that priming a concept should make it more accessible and thus I hypothesized that, if anything, the priming of the concept go should make go signs more readily noticed. An additional surprising finding was that chronic accessibility (stop vs. go sign) of the unexpected object did not determine the degree to which it was noticed. This effect may indicate that stop signs are no more chronically accessible than the go signs, or simply that in in the context of this particular task the difference between the two items could not be observed. To better understand these effects I conducted a new study to determine whether or not they would replicate.

CHAPTER IV

STUDY 2

Study 2 aimed to provide another test of the potential for chronic and situational accessibility to influence noticing. That is, I manipulated both chronic and situational accessibility of an unexpected event with the hypothesis that events made more accessible would be more readily noticed. Participants in this study evaluated t-shirts with words and images related to stop or go prior to completing the IB task. I theorized that stop and go images would strongly prime the concepts of stop and go and that priming through images (as opposed to sentence unscrambling) may be a technique more readily implemented in applied, real world settings.

Method

Participants. Fifty-six students at the University of Colorado Boulder were recruited from the Psychology 1001 subject pool to participate in Study 2. Of the 56 recruited participants, two were dropped from the analyses. One participant reported colorblindness and never saw the unexpected object, even on the attention check. The other participant also failed the attention check. The final data set included 54 participants (26 females) with an average age of 18.85 years.

IB Measure. In order to conduct a more in depth analysis of the effects of prime type and object type on *when* participants noticed the unexpected object, two additional critical trials were added to the IB task used in Study 1. Just as in the previous studies, participants completed two practice trials in which no unexpected object appear. Participants then completed *four* critical trials where the unexpected object appeared and a final attention check trial.

Priming Manipulation. The priming manipulation in Study 2 was designed to be more involving. In this task participants rated t-shirt designs that were gathered from popular t-shirt websites. Participants rated each of nine shirts on a 7-point likert scale on these two questions: 1) "Overall how much do you like this shirt?" and 2) "If you saw this shirt in a store how likely would you be to purchase the shirt?" In the stop priming condition three of the t-shirts that participants rated had vivid stop symbols and language and in the go priming condition three of the shirts had vivid go symbols and language. The stop and go related t-shirts that participants rated can be seen in Appendix 3. The t-shirts meant to prime the concepts stop and go were rated first, fourth, and last, with neutral t-shirts rated in between.

Results

Accuracy on Primary Task. See Table 2 for accuracy scores, notice scores and the correlation between the two for Study 2. Participants were fairly accurate on the primary task, with some decline in accuracy on the third critical trial. This trial had more bounces (25) for participants to count and appeared to be more difficult than the other trials. It should be noted that there was one significant condition difference in counting accuracy. Participants in the stop prime condition were significantly more accurate at counting bounces on the critical trials than participants in the go prime condition $F(1, 53) = 4.17$, $p = 0.05$. All other condition differences (object and the interaction between object and prime) were not significant, all $Fs < 3.1$, $p > 0.05$.

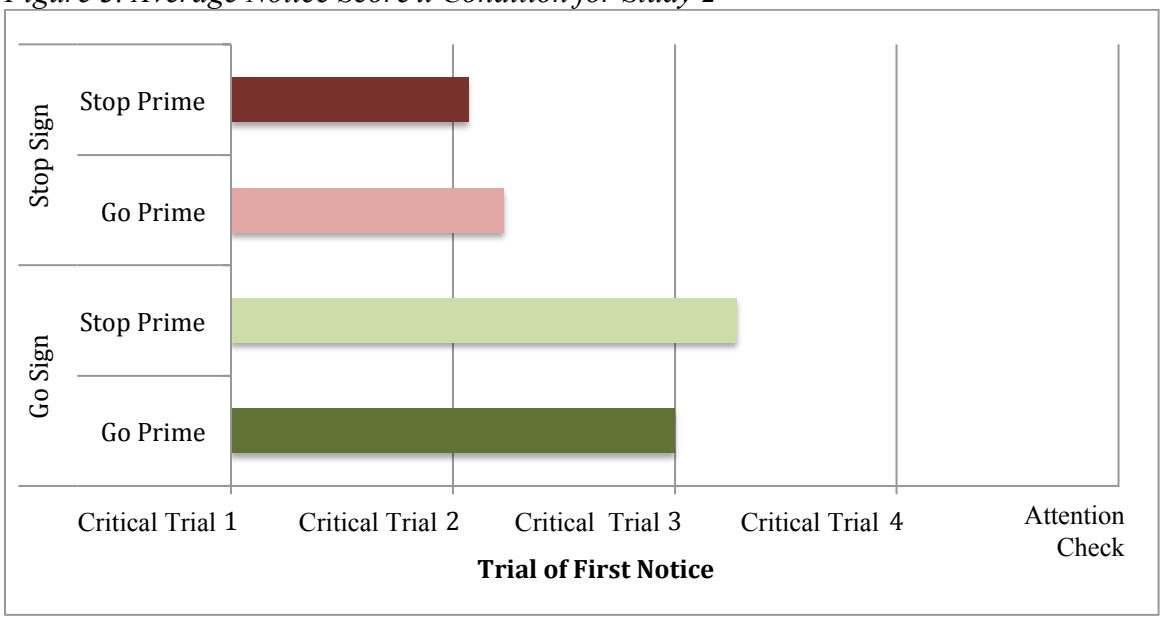
Table 2. Accuracy, Notice Rate and Correlation Between Accuracy & Noticing for Study 2

			First Critical Trial	**Second Critical Trial**	**Third Critical Trial**	**Fourth Critical Trial**
Stop Sign	Stop Prime	Accuracy	1.69	3.84	5.69	2.77
		Notice	0%	92 %	62%	77%
		r	-	0.39	-0.07	-0.22
	Go Prime	Accuracy	1.54	3.85	6.61	3.07
		Notice	0%	85%	85%	85%
		r	-	-0.16	-0.22	0.02
Go Sign	Stop Prime	Accuracy	2.21	3.57	5.78	3
		Notice	0%	50%	50%	57%
		r	-	0.17	0.09	-0.8
	Go Prime	Accuracy	2.78	4.86	7.07	5.64
		Notice	7%	36%	64%	64%
		r	-0.47	0.16	-0.24	0.14

Effects of Situational and Chronic Accessibility on IB. Only one participant (2%) noticed the unexpected object on the first critical trial. However, there was a large increase in the percentage of participants who saw the unexpected object on the second critical trial trial (65%) and in subsequent trials. As before, I calculated a notice score for each participant based on when they first noticed the unexpected object (first critical trial = 1, second critical trial = 2, etc.).

I regressed the notice score on prime type and object type to examine main effects of prime, object type and their interaction. Contrary to the hypothesis that priming would increase noticing, there was no effect of prime type on noticing, $F(1, 53) = 0.07$, $p = 0.79$. There was, however, a main effect of object type such that participants in the stop sign object condition noticed the unexpected object sooner than participants in the go sign object condition $F(1, 53) = 13.16$, $p < 0.001$. There was no interaction observed between prime type and object type $F(1, 53) = 0.65$, $p = 0.42$ (see Figure 3).

Figure 3. Average Notice Score x Condition for Study 2



Tradeoffs in Attention. There were no significant correlations between accuracy and noticing for the critical trials, rs = -0.16, 0.06, 0.04, -0.02 (for the first through fourth critical trials, respectively). Participants did not demonstrate a significant decrease or increase in attention on the primary task when they noticed the unexpected object.

Discussion

Study 2 provided support for the hypothesis that stop signs are more chronically accessible than go signs and that chronically accessible objects are more readily noticed than non-chronically accessible objects. However, the results of Study 2 did not replicate the priming effects of Study 1, with no differences observed in noticing between stop priming and go priming conditions. The effect of priming on noticing may not have been replicable or the effect of priming of noticing may only observed under semantic priming conditions. To test this theory, in Study 3 I returned to a semantic priming procedure to investigate the effects of chronic and situational accessibility on IB.

CHAPTER V

STUDY 3

The purpose of Study 3 was to test a more naturalistic semantic priming manipulation that could be imbedded into the IB task. I wanted to use a procedure that employed semantic priming techniques and that might also be more similar to strategies that could be used in applied settings. Thus, participants received instructions for the IB task that contained language that was semantically consistent with the content of the unexpected object. The idea behind this strategy being that instructions for tasks in applied settings might include language that could prime individuals to be more vigilant for possible unexpected events. Study 3 also expanded the participant population to include both participants from the University of Colorado Boulder and participants recruited from a broader population.

Method

Participants.

Recruited Via Mechanical Turk. One hundred participants were recruited from Amazon Mechanical Turk to participate in this study. Amazon Mechanical Turk is an online "market place" where individuals can complete assignments in exchange for payment. Amazon Mechanical Turk has been used widely in social psychological research and has yielded reliable research findings (Paolocci, Chandler, & Ipeirotis, 2010). Four participants were removed from the data set because they had the same IP address. These participants may have come from the same household and shared information about the nature of the study, thus invalidating their results. Two additional participants were removed from the data set because they failed the final attention check. The reported results included data from 94 participants (56 females) recruited from Mechanical Turk. The average age of the participants in this sample was 34.39 years.

Recruited Via Subject Pool. Fifty-three students (25 females) at the University of Colorado, Boulder were recruited from the Psychology 1001 subject pool to participate in Study 3. The average participant age was 18.90 years.

IB Measure. The IB task was identical to that used in Study 2.

Priming Manipulation. Priming was built directly into the instructions of the task. All participants were told at the beginning of the task:

> "In this session you will complete a series of visual tracking tests. Although these tests may seem simple, research shows that performance on them is a good indicator of how well you can integrate complex information under demanding conditions. Doing well on these tests would suggest that you are the kind of person who can think on your feet, problem solve in stressful situations, and notice details that others may not. These are important skills for being highly successful in life!"

The next set of instructions was designed to prime and increase the accessibility of the concepts stop and go. In the stop priming conditions, participants read:

> Increasing Your Chances of Success:
> Similar to how you would handle other difficult tasks, your best strategy here is to take your time and follow a deliberate strategy. Try calming your mind and pausing before you begin each test; block out all other distractions. Think to yourself about a strategy of stopping, being thoughtful and avoiding mistakes.
> You have plenty of time to complete the tests, so be careful and use as much time as you need. At the end of each test, stop to think about what you did and what you could do better.

Additionally, before each trial, participants in the stop priming condition were reminded, "The next test will begin as soon as you click NEXT, so stop to think about counting the Xs before you click it."

Analogously, in the go priming condition, participants read:

> Increasing Your Chances of Success:
> Similar to how you would handle other difficult tasks, your best strategy here is to keep yourself at a high level of readiness. Try focusing your mind and imagine getting a shot of energy before you begin each test; just go for it. Think to yourself about a strategy of being confident and going for your best.
> You have plenty of time to complete the tests, so take the time you need to keep your

> energy high for each test. At the start of each test, focus on what you are going to do and how you can do better.

Participants were also reminded before each test, "The next test will begin as soon as you click the NEXT button, so go ahead and get ready to count the Xs before you click it."

Procedure.

Mechanical Turk. Participants were invited to complete the study via the Amazon Mechanical Turk work request. Participants were provided with informed consent, completed all of the study measures online and were provided with a written debriefing and contact information if they wished to follow up with further questions about the research. Completion of the study measures took approximately 10 minutes. Once participants had completed the study measures they received $0.50 for their participation.

Laboratory. The laboratory procedure was the same as for the first two studies, except that instead of reporting bounce counts on paper, participants reported their bounce counts and other responses electronically in the same program as the IB task.

Results

There was not a significant difference in notice scores between participants recruited from the University of Colorado Boulder and Mechanical Turk, $F(1, 146) = 1.03$, $p = 0.31$. Thus, the reported results included data from both populations for a total of 147 participants (81 females).

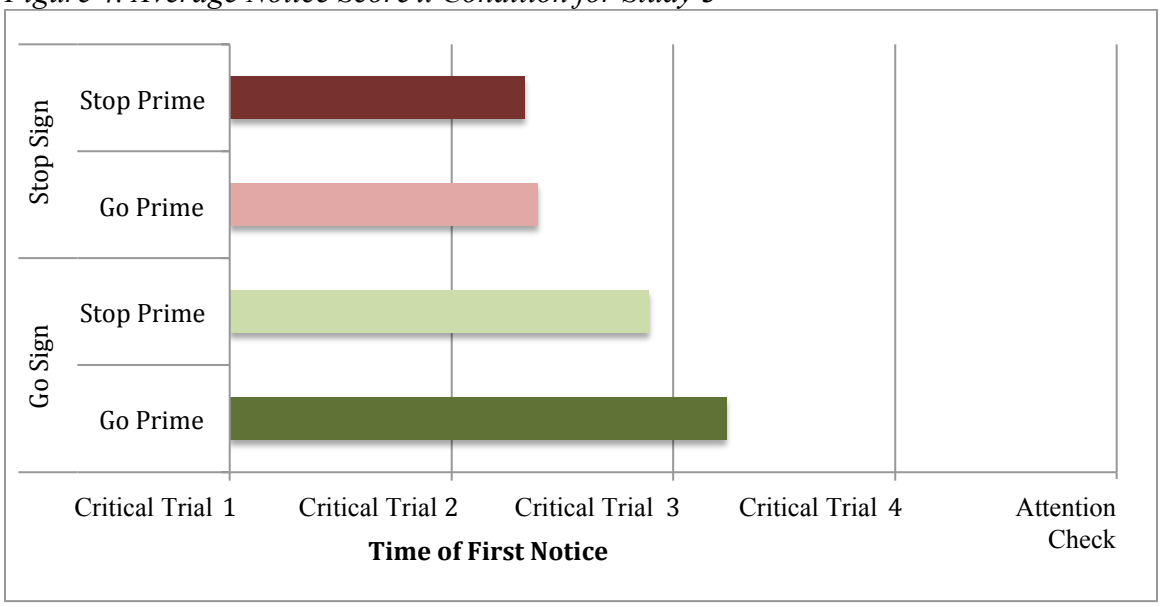
Accuracy on Primary Task. Participants' accuracy in counting scores on all trials, along with whether or not they noticed the unexpected event and the correlation between the two can be seen in Table 3. The accuracy scores are similar to those in previous studies. An analysis of the average accuracy across all critical trials showed that there was no condition differences – main effects or interactions – in participants' accuracy, all F's < 1.5, $p > .05$.

Table 3. Accuracy, Notice Rate and Correlation Between Accuracy & Noticing for Study 3

			First Critical Trial	**Second Critical Trial**	**Third Critical Trial**	**Fourth Critical Trial**
Stop Sign	Stop Prime	Accuracy	1.97	2.86	6.57	3.89
		Notice	8%	69%	64%	64%
		r	-0.15	0.22	-0.28	-0.06
	Go Prime	Accuracy	1.81	3.44	7.13	4.55
		Notice	9%	73%	61%	67%
		r	-0.25	0.2	-0.09	0.07
Go Sign	Stop Prime	Accuracy	1.54	3.91	6.5	3.75
		Notice	10%	42%	61%	58%
		r	-0.14	0.33	0.09	0.1
	Go Prime	Accuracy	1.9	4.1	5.36	3.74
		Notice	8%	30%	49%	49%
		r	<0.00	0.23	0.26	0.1

Effects of Situational and Chronic Accessibility IB. A small percentage of participants (8.84%) noticed the unexpected object on the first critical trial. I calculated a notice score, exactly as in Study 2, across all four critical trials and the attention check to assess the effects of increased situational accessibility via priming, chronic accessibility through the object and the and interaction of these effects. There was a significant effect of object on noticing, such that participants noticed the stop sign sooner than the go sign, $F(1, 146) = 13.22$, $p = <0.001$. There was not a significant effect of priming, $F(1, 146) = 1.11$, $p = 0.29$, nor a significant interaction between object and prime, $F(1, 146) = 0.55$, $p = 0.46$. See Figure 4. These results directly replicated the findings of Study 2.

Figure 4. Average Notice Score x Condition for Study 3



Tradeoffs in Attention. There was a significant positive relationship between accuracy and noticing the unexpected object on the second critical trial, $r = 0.30$, $p < 0.001$, but not on the other other critical trials, $rs = -0.13$ to 0.05.

Discussion

The results of Study 3 directly replicated the results of Study 2. I observed a significant effect of object such that participants noticed the appearance of a stop sign more readily than a go sign. Although the priming manipulation was arguably the most engaging of the three attempts at priming, there was no effect of priming on noticing an unexpected event in this study. While priming may be effective at increasing noticing of unexpected events under some conditions, the combined results of Studies 1 – 3 suggest that priming is not an overwhelming strong technique for reducing IB.

CHAPTER VI

STUDY 4 PILOT

The priming manipulations explored in Studies 1 – 3 were not successful at situationally increasing noticing of unexpected events. Though Study 1 offered some suggestion that stop priming was an effective strategy for IB reduction, this effect was not replicated. Thus, I decided to explore an alternative strategy for reducing IB.

The pilot to Study 4 was a test of whether or not explicitly warning individuals that something unexpected was to occur would reduce IB. This may seem like an obvious approach to increasing attention to the unexpected – of course people will see something if they are told it is about to appear– but there is also reason to believe that a straightforward warning may not always be sufficient for facilitating attention to unexpected events. For example, hospitals are full of warning signs, yet errors in attention in hospitals still occur. If people do not know what they are supposed to be looking for and are also engaged in another cognitively demanding task, they might still not see the unexpected event. Understanding the degree to which explicit warnings are effective is an important step in better understanding how attention to unexpected events can be increased.

Method

Thirty-five participants (20 females) were recruited from Amazon Mechanical Turk to participate in this study. The average age of participants was 40.31. Participants completed the same IB task used in Study 1 (with only two critical trials) except that preceding both critical trials, participants were warned: "WARNING: Something unexpected is going to appear in the next test! In the next test your task is to count the Xs, as before. You will also be asked about the unexpected event at the end of the test."

Results

Accuracy on Primary Task. Table 4 displays the accuracy scores, noticing rates and the correlation between the two for Study 4. Participants' average accuracy was similar to the prior studies.

Table 4. Accuracy, Notice Rate and Correlation Between Accuracy & Noticing for Study 4 Pilot

		First Critical Trial	Second Critical Trial
Stop Sign	Accuracy	2.47	3.76
	Notice	71%	76%
	r	-0.13	-0.35
Go Sign	Accuracy	2.61	3.77
	Notice	50%	78%
	r	0.03	0.2

Effect of Warning on IB. As the notice rates in Table 4 show, participants in both the stop sign and the go sign condition had higher rates of noticing with the explicit warning, as compared to previous studies. Since there was no control condition for comparison for this pilot study, I calculated the average notice rate on the first critical trial across Studies 1 – 3 (8.4%). This notice rate was significantly lower than the notice rate on the first critical trial in Study 4 (60% overall), χ^2 (1) = 33.30, p <0.001. Participants who received warning were significantly more likely to notice the unexpected event on the first critical trial than participants who did not receive warning in previous studies.

To examine differences in noticing of the stop sign vs. the go sign I calculated a notice score based on the first time participants noticed the unexpected event (first critical trial = 1, second critical trial = 2, attention check = 3) and regressed the notice score on object type. Participants who were warned of an unexpected event were no more likely to see the stop sign (mean notice score = 1.5) than the go sign (mean notice score = 1.3), F(1, 34) = 1.03, p = 0.32.

Tradeoffs in Attention. There was not a significant relationship between accuracy and noticing for either the first or second critical trial, $r = -0.05$, and $r = -0.07$.

CHAPTER VII

STUDY 4

Knowing that explicit warning successfully produced high rates of noticing on an IB task, Study 4 explored explicit warnings and warnings conveyed through "cautionary stories" as strategies for moderating IB. The purpose for using cautionary stories was to introduce warnings of the unexpected that more closely mimic strategies that are issued in real world situations. Outside of the laboratory it is impossible to issue warnings before unexpected events occur, because such events are unknown. However, cautionary stories can be used as a tool to teach people about the possibility of unexpected events in the hope that such stories will help people to be more vigilant in the future. Participants in Study 4 learned about a scenario in which an obvious medical error resulted in the loss of a patient's life. The story was conveyed as a warning that unexpected events can happen when attention is diverted elsewhere.

Social Information

An added factor in this study was the social information conveyed about the patient in the warning story. The character was either highly similar to the participants in the study (e.g., ingroup member) or dissimilar to the participants in the study (e.g., outgroup member).

Understanding how situational cues might differ in their effectiveness as a function of social group membership associated with those cues is important because in real world contexts people differ in ethnicity/race, gender, age, SES, religion or culture and along many other social dimensions. In health care, for example, there is a great deal of evidence that members of minority groups have disparate outcomes from the white majority (also the majority of health care providers), attributed to many social factors including stereotypes and prejudice (Burgess, van Ryn, Dovidio, & Saha, 2007; Dovidio, Penner, Albrecht, et al. 2008; Green, Carney, Pallin,

et al., 2007; Penner, Dovidio, West, et al., 2010; Smedley, Stith, & Nelson, 2003; van Ryn & Fu, 2003). Laboratory research shows that when interacting with members of outgroups, individuals are more cognitively taxed, experience anxiety, demonstrate less liking, pay less attention, and are more likely to rely on stereotypes (e.g., Blascovich, Mendes, Hunter, Lickel, & Kowai-Bell, 2001; Gaertner & Dovidio, 1986; Gaertner & Dovidio, 2000; Richeson & Shelton, 2003). Information about social group membership could be distracting from the main message of the cautionary story, when that information is about a member of a social outgroup.

Therefore, in Study 4, I compared the effectiveness of two cautionary stories about a patient who died as the result of an attention error during surgery. The two patient stories contained nearly identical content, except for the information about the patient herself. In one story the patient was very similar to the participants in the story (e.g., student entering college, 18 years old, athlete, stereotypical White name) and in the other story the patient had was dissimilar from participants (e.g., drug addict, no job, 45-years old, Latina sounding name).

Proximity of Warning

An additional factor of this study was when the explicit warning or cautionary story occurred relative to when the unexpected event occurred. I was interested to know whether such manipulations must occur immediately prior to the unexpected event, or whether the explicit warning or cautionary story would have a lasting effect over subsequent trials. Having information about the effectiveness of less proximal warnings has important implications for applied contexts. In medical training, for example, cautionary stories may be told, but not necessarily immediately prior to another unexpected event. Thus, in this study participants completed two critical trials, just as in prior studies, then two *filler trials* in which nothing unexpected appear and a *final critical trial* in which the same unexpected event appeared again.

See Table 5 for the sequence of manipulations for Study 4. This design allowed me to test the effect of explicit warnings and cautionary stories when some time had passed since the warning or story was issued.

Method

Participants. One hundred-sixty participants (96 females) were recruited from the Psychology 1001 subject pool to participate in Study 4. The mean age of the participants was 19.38. One hundred-thirty of the participants self identified their race as White, 19 Asian, 4 Hispanic, 1 Native American, 3 mixed-race, and 3 other.

IB Measure. The IB task used in this study was very similar to the IB task used in Studies 1 – 4, however, there were a few key differences, outlined in Table 5. First, participants were all provided with an applied rationale for why they were completing the IB task. It was explained to participants that high levels of attention are needed in medical contexts and that by better understanding attention, we as researchers might be able to help doctors improve medical care for patients. The full study materials are included in Appendix 4.

Following the background explanation of the task, participants completed the two practice trials of the IB task, where nothing unexpected appeared. Participants then received some additional information, contingent on condition (see condition information below), and then continued with the first critical trial in which an unexpected object appeared. The unexpected object appeared again in the second critical trial, did not appear for two filler trials and then appeared again for the final critical trial. There was no attention check trial. Changing the nature of the filler trials by not having the unexpected object appear allowed for testing of the proximity of warning on increasing attention to the unexpected.

Table 5. Sequence of Manipulations and Trials for Study 4

1. Applied rationale & explanation of IB task	2. Two practice trials	3. Experimental context manipulation, between subjects: 1. Control 2. Explicit Warning 3. Ingroup Cautionary Story 4. Outgroup Cautionary Story	4. First & second critical trials, object manipulation (stop sign or go sign) assigned between subjects	5. Two filler trials (no unexpected object)	6. Final critical trial

Control Condition. The control condition was the simplest version of the IB task. Participants received no additional information after reading about the applied rationale for the task. Appendix 4 contains the information that participants saw in the control condition leading up to the first critical trial.

Explicit Warning. Participants in the warning condition received all of the same information as participants in the control condition with the additional explicit warning before the first critical trial that something unexpected was going to occur. This was the only explicit warning that was issued.

Ingroup Cautionary Story. Participants in the ingroup cautionary story condition read a story about a patient who had undergone surgery to correct an abnormality in the lung. During the surgery a large retractor was left in the patient's chest cavity due to inattention to the retractor, causing the patient to die. All participants were provided with an image of an x-ray depicting the retractor that had been left in the patient's chest. The story was developed based on real stories of medical error (Hyman, Van Boven, Katz, Visscher, & Hemmelgarn, 2011; Murano, 2009). The ingroup character in the story was an 18 year-old woman planning to attend her freshman year at Harvard University and run on the track team. She was given a stereotypically

White name. The characteristics of this character were meant to be highly similar to the student participants in this study. The full ingroup patient story is in Appendix 4. Participants were told that they should keep the messages of the story in mind in their upcoming attention task.

Outgroup cautionary story. Participants in the outgroup cautionary story condition read the identical story to participants in the ingroup story condition except that the character in the story was 45 years old, a drug addict, unemployed and was given a stereotypically Latina sounding name. See Appendix 4.

Results

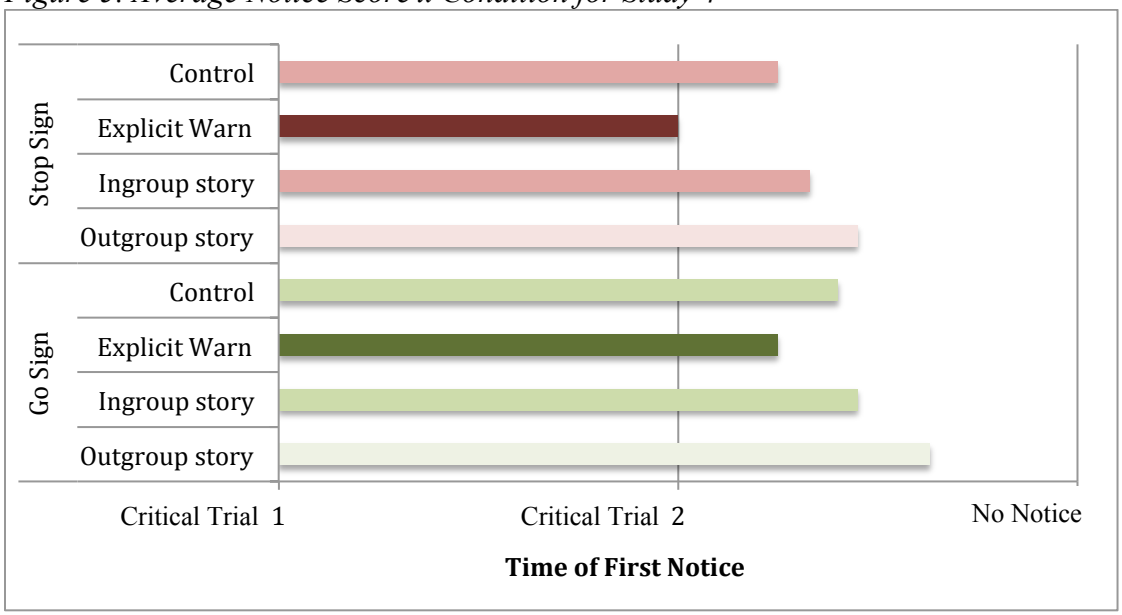
Accuracy on Primary Task. Table 6 displays the results from Study 4. Accuracy was similar to previous studies. An analysis of the average accuracy across all critical trials showed that there was no condition differences – main effects or interactions – in participants' accuracy, all F's < 1.5, $p > .05$.

Table 6. Accuracy, Notice Rate and Correlation Between Accuracy & Noticing for Study 4

			First Critical Trial	Second Critical Trial	Filler Trial 1	Filler Trial 2	Final Critical Trial
Stop Sign	*Control*	*Accuracy*	2.35	4.79	2.45	1.3	3.6
		Notice	15%	70%	-	-	90%
		r	<0.01	0.13	-	-	-0.37
	Explicit Warning	*Accuracy*	3.35	4.65	1.95	1.65	3.1
		Notice	55%	85%	-	-	95%
		r	0.14	0.12	-	-	0.12
	Ingroup Cautionary Story	*Accuracy*	2.09	3.38	2.66	1.38	3.95
		Notice	14%	57%	-	-	86%
		r	0.26	0.18	-	-	0.11
	Outgroup Cautionary Story	*Accuracy*	1.95	4.05	2.5	1.4	3.15
		Notice	5%	55%	-	-	55%
		r	0.17	0.27	-	-	0.02
Go Sign	*Control*	*Accuracy*	2.65	5.5	1.89	1.35	2.15
		Notice	20%	50%	-	-	35%
		r	0.04	0.26	-	-	0.2
	Explicit Warning	*Accuracy*	3.25	5.55	2.8	2.2	2.8
		Notice	50%	55%	-	-	55%
		r	0.47	-0.05	-	-	0.05
	Ingroup Cautionary Story	*Accuracy*	2.45	5	2.2	1.8	2.75
		Notice	15%	45%	-	-	20%
		r	-0.27	0.05	-	-	0.21
	Outgroup Cautionary Story	*Accuracy*	3	4.84	1.47	1.68	2.37
		Notice	0%	36%	-	-	21%
		r	-	0.22	-	-	-0.12

Effects of Warning and Chronic Accessibility on IB. To test differences between conditions on whether or not participants noticed the unexpected event, I again created a notice score based on the first two critical trials (first critical trial = 1, second critical trial = 2, no notice on first two critical trials =3). I did not include noticing on the final critical trial in this notice score because the degree to which participants notice on the final critical trial is conceptually different than whether or not participants noticed on the first two critical trials.

Figure 5. Average Notice Score x Condition for Study 4

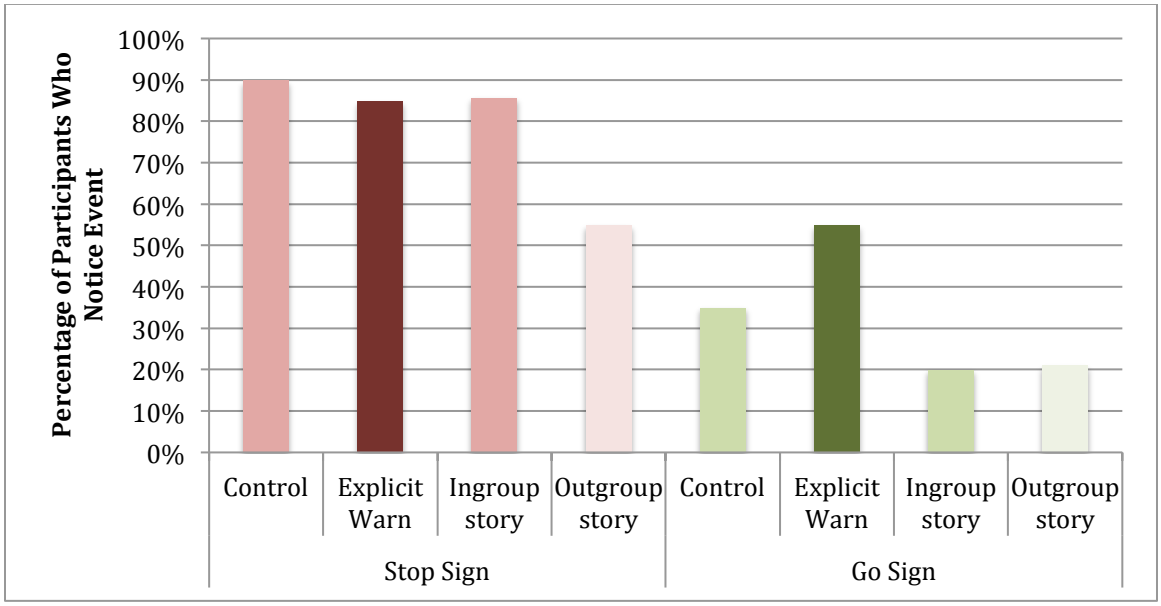


*Note: Notice score calculated based on first and second critical trial only. Data from the final critical trial is presented in Figure 6.

I regressed the notice score on object type and context (control vs. explicit warning vs. ingroup cautionary story vs. outgroup cautionary story). The results revealed a significant effect of object type $F(1, 159) = 5.92$, $p = 0.02$ such that participants were more likely to notice the stop sign than the go sign, replicating the effect of chronic accessibility found in the previous studies. There was also a significant effect of context $F(3, 157) = 5.73$, $p < 0.01$. I created four sets of orthogonal contrast codes to test the simple effects of context, specifically to compare each of the experimental manipulations to the control condition. As shown in Figure 5, only participants in the explicit warning condition noticed the unexpected object sooner as compared to participants in the control condition, $t(159) = 1.97$, $p = 0.05$. Neither of the cautionary stories increased noticing sooner over the control condition, and indeed, the outgroup cautionary story actually *increased* the number of trials it took participants to notice the object below the control condition, $t(159) = 2.11$, $p = 0.04$. The observed effects of object and context did not interact $F(3, 157) = 0.16$, $p = 0.92$.

Proximity Effects of Warning and Chronic Accessibility. I turned next to an analysis of the final critical trial that occurred after two filler trials and without any additional warning or reminder of the cautionary story. This analysis allowed for examination of the effects of explicit warning and cautionary stories over time. To analyze these findings, I performed a logistic regression procedure, regressing the likelihood that participants noticed the unexpected event on the critical trial on four orthogonal sets of contrast codes. The orthogonal contrast codes were designed to test each of the context manipulations against the control condition and to test the object effect. The percentage of participants who noticed the unexpected object in each condition is presented in Figure 6.

Figure 6. Percentage of Participants Who Notice Unexpected Event on Final Critical Trial x Condition



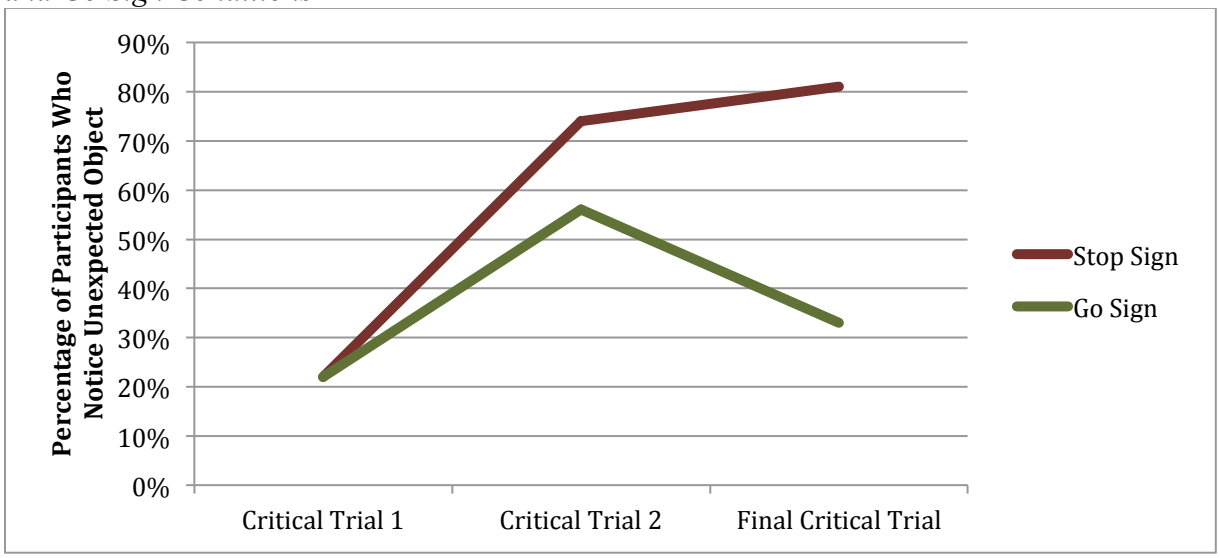
The effects in the final critical trial largely mirrored the effects of noticing on the first two critical trials. There was not a significant difference on the individual contrast level between warning and control on the final critical trial $\chi^2(1) = 0.003$, $p = 0.96$, however, a comparison designed to test the explicit warning condition against all other conditions, simultaneously, revealed that participants in the warning condition were significantly more likely to see the

unexpected event on the final critical trial as compared to all other conditions combined, χ^2 (1) = 5.53, p = 0.02.

There was also a significant difference between participants in the outgroup cautionary story condition and control condition such that participants in the outgroup cautionary story condition were significantly less likely to notice the unexpected event χ^2 (1) = 5.63, p = 0.02.

A particularly striking effect is the significant difference between noticing of the stop sign and go sign on the final critical trial, χ^2 (1) = 32.39, p <0.001, with participants more likely to notice the stop sign. Figure 7 displays the percentage of participants who notice the stop sign and go sign on each critical trial, collapsing across other between subject context conditions. The change in participants who notice the stop sign between the second critical trial and the final critical trial (+7%) is significantly different than the change in participants who notice the go sign (-13%), χ^2 (2) = 15.86, p < 0.001. The object effect over time became particularly pronounced, providing further support for the idea that chronically accessible objects are more likely to be noticed.

Figure 7. Percentage of Participants Who Notice Unexpected Event on Critical Trials, By Stop and Go Sign Conditions



Tradeoffs in Attention. There was a significant positive correlation between counting accuracy and noticing the unexpected event on the first critical trial, $r = 0.22$, $p = 0.01$ and on the final critical trial, $r = 0.16$, $p = 0.04$. The relationship between accuracy and noticing was positive on the second critical trial but not significant, $r = 0.13$.

Discussion

Study 4 demonstrated that increased chronic accessibility and explicit warnings effectively increased noticing of unexpected events. However, cautionary stories in this study did not increase attention to the unexpected, and may in fact have harmed it.

Some interesting effects emerged in this study. First, the effect of chronic accessibility was again strongly apparent in these results. Participants were significantly more likely to see the stop sign than the go sign, both immediately following the explicit warning and cautionary stories and also in the final critical trial. In fact, the chronic accessibility of the object appeared to be particularly important over time, with the difference in notice rates between stop and go sign increasing over time.

Second, the effect of explicit warning on IB lasted over time. Participants who had been explicitly warned of an unexpected event prior to the first critical trial were significantly more likely than participants in other conditions to notice the unexpected event on the final critical trial. It would be impossible to predict from this study alone how long lasting the effects of an explicit warning really are, but these results are a small indication that explicit warnings have a powerful effect on individuals' vigilance for the unexpected.

Finally, participants in the outgroup cautionary story condition were significantly less likely than participants in the control condition to notice the unexpected event. It is unclear exactly why this effect emerged, but nonetheless it provides interesting insight into the effects of group status

on information processing. It is possible that participants' in the outgroup cautionary story condition were more cognitively taxed because of their simulated encounter with an outgroup individual and thus were unable to devote the cognitive resources needed to noticing the unexpected on the IB task. However, it should be noted that since there were not condition differences in participant's overall counting accuracy the outgroup patient story information at least did not detract from participants' primary focus of attention.

CHAPTER VIII

GENERAL DISCUSSION

The goal of the current research was to examine the effects of chronic and situational accessibility on IB. I presented data from four studies designed to increase the likelihood that individuals would notice an unexpected event during an inattentional blindness task. Based on accessibility theory, I hypothesized that increasing the situational or chronic accessibility (or both) of an object would increase the likelihood that individuals would notice that object when it appeared unexpectedly. In these studies, chronic accessibility was consistently manipulated by the content of the unexpected event; the appearance of either a stop or go sign. Situational accessibility was manipulated through various means in each study.

The clearest finding across all of the studies was that increasing the chronic accessibility of an unexpected event increased noticing of that event. In Studies 2 - 4 participants were significantly more likely to notice a stop sign than a go sign. This finding indicates that if an event has features that are strongly salient and chronically activated for individuals, it will be more likely noticed. This finding is consistent with prior research (Becker & Leinenger, 2011; Mack & Rock, 1998; Mack et al., 2002).

In Studies 1 – 3, situational accessibility was manipulated through semantic and visual priming techniques. These studies did not produce a reliable effect on IB. Because situational accessibility did not reliably influence IB in the first three studies, Study 4 investigated how warnings – both explicit and through a cautionary story – would influence individuals' ability to see an unexpected event. I found that explicit warning was an effective technique. People explicitly warned that something unexpected was to appear were much more successful at noticing the event than participants who were not explicitly warned. Warning was not effective,

however, when it was delivered indirectly, through a cautionary story. Participants who read a cautionary story that was intended to teach them about the possibility that unexpected things can occur and lead to adverse events did not translate the message of the story into their primary IB task. In fact, participants who read a cautionary story about an outgroup member were significantly less likely to notice the unexpected event, indicating that the content of the story may have prevented participants from being successful at noticing the unexpected event.

Implications

The overarching implication from the current work is that chronic accessibility and explicit warnings effectively increase noticing of unexpected events. Additionally, though some research has indicated that priming is a successful strategy for IB moderation (Becker and Leinenger, 2011; Rattan and Eberhardt, 2010), the current work suggests that priming is limited in its capacity to reduce IB, at least as implemented in this research.

At the onset of this research, I was confident that increased situational accessibility via priming would successfully moderate IB, given prior priming literature that has shown big effects on cognition and behavior using small priming manipulations (e.g., Bargh, Chen & Burrows, 1996; Dijksterhuis & Bargh, 2001; Williams & Bargh, 2008). Thus, the finding that priming did not increase noticing in these studies was somewhat surprising. One explanation for this finding could be that the strength of the priming manipulations simply was not enough to override the effects of attention on the primary task. Priming may have even increased accessibility of the unexpected object at an unconscious level, but not sufficiently to break through participants' attentional barrier. Indeed, some research indicates that unexpected objects that go un-noticed during IB tasks do get processed at an unconscious level (Mack, 2003; Mack & Rock, 1998). While it would be interesting to know whether or not the priming techniques

used in this study increased unconscious awareness of the unexpected events, ultimately for IB reduction strategies to be useful in applied settings, they need to be strong enough such that the unexpected breaks through the barrier of focused attention elsewhere.

Applied Implications. The original motivation for this research stemmed from an applied research problem: reducing error due to inattention in health care settings. More specifically, I was interested to know more about the effectiveness of training sessions designed to help reduce medical error. For example, in a training designed to reduce patient error, used at the Children's Hospital of Colorado (SBAR and Assertion Model Training Module), health care providers are trained to use specific language in their communication with one another to signal warning about the potential for error with their patients. Such language includes key phrases, such as: "I'm concerned" or "this situation is unsafe." Does such language prime individuals to be more vigilant to subsequent unusual and unexpected medical events?

Studies 1 and 3 used specific language related to the concept stop in order to experimentally replicate this type of training. Most similarly, in Study 3, the stop priming language was directly embedded into the instructions of the task, much like the language taught in the Children's Hospital training is meant to be embedded into the language that providers use with one another. These studies suggest that priming does not have the intended effect of making individuals more likely to notice the unexpected (i.e., an error). In many ways the studies designed in this research were a conservative test of the effect of priming because the content of the priming was directly related to the content of the unexpected event (e.g., stop priming for stop signs). It is possible that in less controlled settings, priming may be even less useful.

Training used to raise awareness and reduce medical error also inspired the design of Study 4. At a medical error conference that I attended (Hyman et al., 2011) family members of

patients who had died as the result of attentional errors told their stories, the details leading up to the errors and the fatalities that resulted from the error. I wanted to know more about the effect of these stories and whether or not their message of warning could be carried forward and used as an example to help avoid future errors. Study 4 attempted to replicate this type of scenario by providing participants with either explicit warnings about unexpected events or stories that conveyed messages of warning about unexpected events. The results of Study 4 indicate that warnings must be explicit in order to have an effect on IB. This finding should be considered in the context of developing training designed to reduce attention error.

Individual Differences in Attention. A question of interest that was not central to the current research but can be answered using these data is the degree to which individual differences in ability on the primary attention task predict participants' ability to notice the unexpected event. To test this question, for each study I created an accuracy score based on the participants' counting accuracy on the practice trials. During the practice trials, no unexpected event occurs, thus this accuracy score provides a baseline attention score for all participants. For each study, I then used the accuracy score to predict participants' notice score (based on which trial they first noticed the unexpected event). Across all 4 studies, participants' accuracy on the practice trials did not predict their ability to notice the unexpected event, all rs $<.05$. This finding indicates that noticing an unexpected event is not an individual difference that can be predicted from people's ability to pay attention on a primary task.

Limitations and Future Directions

There are several limitations of this research, which also indicate areas ripe for future research. This research only tested the effects of chronic and situational accessibility with one task and one set of objects. Although there was no effect of situational accessibility observed, I

can only conclude that priming was ineffective for increasing attention to stop and go signs, and in this particular context. Similarly, the effect of chronic accessibility on IB was only observed for stop signs and not for any other type of object. In future research, I would continue investigations of chronic accessibility with a wider set of events. For example, are events that are emotionally salient less susceptible to IB? At least one study (Becker and Leinenger, 2011) suggests that mood congruent stimuli are more likely to be noticed. Are events that provoke approach or avoidance tendencies more likely to be noticed?

In addition to a limited set of stimuli, the IB task used in this research was purposefully designed to produce an attention rate of 10 – 20%. For this reason the IB task was quite difficult and the primary task of counting Xs and ignoring all other objects may have been too demanding to observe any effect of priming. The priming manipulations used in this research were also fairly basic. In future research it would be interesting to test more intensive priming manipulations and less difficult IB tasks in order to fully explore the effects of priming on IB. Specifically, the background distractors in this task were designed to be very similar to the unexpected event (e.g., red Os look very similar to a stop sign when they are the same size). In a context where participants were working hard to ignore red (or green) circular background distractors, the priming may simply not have been strong enough to over-ride the tendency to ignore anything red (or green) and circular, despite the specific content of the unexpected object (e.g., stop sign). Because there are indications from other research that priming does have an effect on IB (Becker and Leinenger, 2011; Rattan and Eberhardt, 2010), this is a paradigm that is worth additional exploration.

In this research, I developed stories that were meant to convey a message about warning to participants. I also attempted to relate the cautionary stories to the IB task by providing

participants with a strong rationale for their participation in the research (i.e., an explanation that understanding attention in medical contexts is important). The cautionary stories did not produce the desired effect of increased noticing of an unexpected event. However, I do not have any information about the extent to which participants understood the messages of the story to be actual warnings or the degree to which participants viewed the cautionary stories as related to the IB task. It would not be reasonable to conclude that stories that convey messages of warning are ineffective at improving attention to unexpected events. In future research it will be worthwhile to continue to examine how stories of warning are told and the specific content of such stories to fully understand the degree to which warning stories can be used as a training tool.

Finally, the participants recruited for this research do not represent trained medical professionals (or professionals in any other field where the costs of inattention are high). It is probable that participants did not attend to the IB task in exactly the same manner that a trained professional would attend to a task in which he/she had expertise. The degree to which these results would extend into uncontrolled settings where there are many more attentional requirements and distractions, yet presumably high levels of motivation, is unknown. In future research it will be important to extend into real world contexts to better understand how inattention operates more naturalistically.

Conclusions

Despite its limitations, this research provides useful insight into the factors that most readily increase noticing of unexpected events. Namely, I found that both the chronic accessibility of an unexpected event and explicit warnings successfully moderated IB. Future research will continue to investigate strategies for IB moderation that could be implemented in applied settings.

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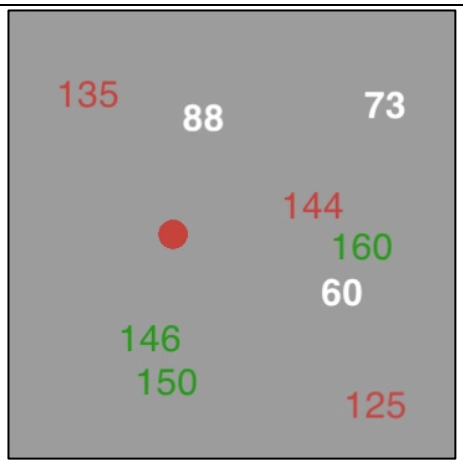
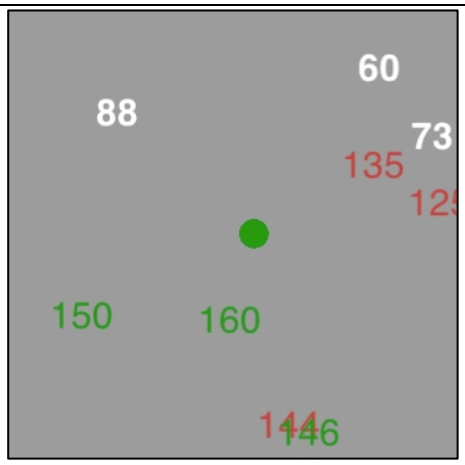
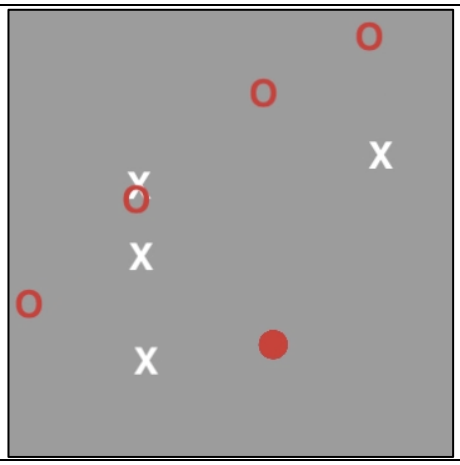
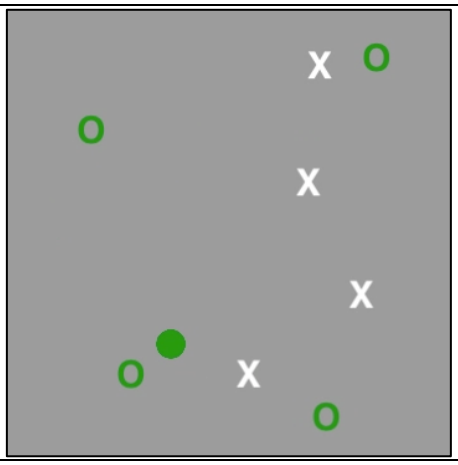
APPENDIX 1:
Screen Shots of Trials From Pilot Studies

Screen Shots of Pilot 1 Trials

Unexpected Red Circle	Unexpected Green Circle
	

Screen Shots of Pilot 2 Trials

Unexpected Red Circle	Unexpected Green Circle
	

APPENDIX II:
Sentence Unscramble Task

Condition: Stop	**Sentence**	**+ Extra Word**	**Scrambled**
1. stop	stop the train here	middle	train middle here the stop
2. halted	the kids' parade halted	over	halted parade kids' the over
3. stay	stay where you are	salt	are where you stay salt
4. pause	pause before you eat	pencil	before eat pause pencil you
5. slowly	do the work slowly	moss	slowly the do moss work
6. end	the brick path ended	batteries	batteries ended the path brick
7. cease	the hissing noise ceased	color	the noise color ceased hissing
8. block	trees block the wind	lotion	block trees lotion the wind
9. interrupt	interrupt the annoying speaker	nine	nine speaker interrupt annoying the
10. standstill	come to a standstill	floor	a floor to come standstill
11. finish	finish writing the story	sweater	story finish writing the sweater
condition: go			
1. go	go to the train	middle	train middle the to go
2. started	the kids' parade started	over	started parade kids' the over
3. continue	continue the game now	salt	the now continue game salt
4. begin	begin eating your food	pencil	eating begin food pencil your
5. quickly	do the work quickly	moss	quickly the moss work do
6. activate	the machine was activated	batteries	batteries activated was the machine
7. advance	advance forward one space	color	forward space color one advance
8. launch	people launched the rocket	lotion	launched people lotion the rocket
9. move	move the annoying plant	nine	nine plant annoying move the
10. skip/leap	leap over the bucket	floor	the floor over bucket leap
11. proceed	proceed with your purchase	sweater	purchase with proceed sweater your

APPENDIX III:
Stop and Go T-Shirts Rated in Study 2

STOP	GO
	
	
	

APPENDIX IV:
Study 4 Materials for all 4 Between Subjects Condition

Between subjects conditions:
1. Control
2. Explicit Warning
3. Ingroup Cautionary Story
4. Outgroup Cautionary Story

INTRO SCREEN – (All conditions receive this information)

This study is about visual attention and the errors that occur when attention is low or mis-directed. Consider the problem of medical error, for example. Approximately 200,000 people die each year in the United States as the result of medical errors, much of it traceable to problems of attention.

Although we are not studying medical errors directly in this study, we are attempting to create conditions that are similar to what doctors face in the medical setting: You will be asked to pay attention to a lot of changing information with a high chance of error.

You will perform a task in this study that has been developed to simulate the kind of attention that is needed for complex tasks in real world environments. Treat this task seriously and imagine that severe consequences could occur as the result of errors in attention.

The results of this study will be shared with medical professionals in the hope that what we learn will ultimately help to save lives by reducing errors in medicine.

INTRO SCREEN – (All conditions receive this information)

Your task is to track objects on the computer screen, over a series of tests.

Each of the tests will proceed as follows:

You will see Xs and Os printed in different colors moving around a grey box. These objects will bounce off the edges of the box. Your task is to count the number of times the Xs bounce, just as a doctor might have to track a patient's rapidly changing vital statistics. This is not complicated, but it is difficult because the objects move very quickly. At the end of each test you will be asked to report the number of times the Xs bounced and you will receive feedback on your performance.

INTRO SCREEN – (All conditions receive this information)

To give you an idea for what the tests are like, you will now complete two practice tests.

Remember: You need to count the number of times the Xs bounce off the edges of the grey box.

The first test will begin as soon as you click NEXT, so be ready to count the Xs before you click it.

2 PRACTICE TESTS – (All conditions do practice tests)

Practice Trial 1 &2 = no unexpected object

INFO SCREEN– (All conditions receive this information)

The tests you just completed may seem simple, but the careful attention that they require closely resembles what doctors must do when caring for patients. A missed detail could lead to an error that puts a patient's life at risk.

PATIENT STORY – (Ingroup Cautionary Story Condition Only)

To give you an example of how attention to detail can affect a person's life, consider the following story that is based on real events:

17-year-old Jessica Scanlon was a high school senior with a full scholarship to Harvard when she learned that she had a rare, but curable lung condition. Jessica was healthy and in good shape. She was a top runner on her high school track team and had been recruited to run at Harvard. With the support of her family, Jessica decided to have surgery on her lungs the summer after high school so that she would recover in time to start college.

Jessica's surgeons assured her and her family that the surgery was routine and that they did not expect any complications. Jessica could expect a six-week recovery period, after which she would be able to begin slowly training again.

Surgeries like Jessica's are routine but require a great deal of attention due to the number of important factors involved with opening a patient's chest. Jessica's highly skilled surgery team completed the surgery, paying careful attention that no detail involved with the lung repair was missed.

The surgeons informed Jessica's family that the procedure had been very successful. They were able to repair Jessica's lungs and were certain that they had not missed a single detail. However, just days after Jessica returned home to recover, her vital signs began to fail. Rapidly she crashed and was rushed back to the hospital.

An X-ray (displayed in the image) quickly revealed the problem: a 13-inch steel retractor had been left in Jessica's chest from the surgery. Her body was rejecting the retractor, the reason why her body could not recover. By the time the surgeons realized that they had missed the retractor, it was too late. Jessica died from the error.

The hospital blamed human error in attention for the mistake that cost Jessica her life and a full investigation was conducted. In an interview, the head surgeon stated: "It is still hard for me to understand how my team made such an obvious mistake. We follow a strict protocol in surgery and pay very close attention to every detail. We don't expect the unexpected to happen. We are very sorry for this mistake and the loss suffered by Ms. Scanlon's family."

PATIENT STORY – (Outgroup Cautionary Story Condition Only)

To give you an example of how attention to detail can affect a person's life, consider the following story that is based on real events:

45-year-old Jésica Santillán had been unemployed and homeless for several years, sometimes staying with friends and sometimes living on the streets. After a recent visit to the emergency room, Jésica learned that she had a rare, but curable lung condition, the result of years of drug abuse and untreated medical problems. Although nervous about the surgery, Jésica decided that it was worth spending some time in the hospital with Medicaid paying for her stay.

Jésica's surgeons assured her that the surgery was routine and that they did not expect any complications. Jésica could expect a six-week recovery period, after which she would be able to return to her normal life.

Surgeries like Jésica's are routine but require a great deal of attention due to the number of important factors involved with opening a patient's chest. Jésica's highly skilled surgery team completed the surgery, paying careful attention that no detail involved with the lung repair was missed.

The surgeons informed Jésica that the procedure had been very successful. They were able to repair Jésica's lungs and were certain that they had not missed a single detail. However, just days after Jésica returned home to recover, her vital signs began to fail. Rapidly she crashed and was rushed back to the hospital.

An X-ray (displayed in the image) quickly revealed the problem: a 13-inch steel retractor had been left in Jésica's chest from the surgery. Her body was rejecting the retractor, the reason why her body could not recover. By the time the surgeons realized that they had missed the retractor, it was too late. Jésica died from the error.

The hospital blamed human error in attention for the mistake that cost Jésica her life and a full investigation was conducted. In an interview, the head surgeon stated: "It is still hard for me to understand how my team made such an obvious mistake. We follow a strict protocol in surgery and pay very close attention to every detail. We don't expect the unexpected to happen. We are very sorry for this mistake and the loss suffered by Ms. Santillán's family."

INFO SCREEN - (Cautionary Story Conditions Only)

The doctors in Jessica (Jésica)'s story were so busy ensuring that the lung surgery was successful that they failed to notice an obvious object left behind. Keep this in mind as you continue with the study.

You will now complete the remaining visual tracking tests.

INFO SCREEN - (Control Condition Only)

Keep this in mind as you continue with the study.

You will now complete the remaining visual tracking tests.

INFO SCREEN - (Explicit Warning Condition Only)

Keep this in mind as you continue with the study.

You will now complete the remaining visual tracking tests.

WARNING! In the next test, something unexpected will appear. You will be asked to report what you saw.

CRITICAL TRIALS – (All conditions)
Stop sign vs. go sign = between subjects

Critical Trials 1 & 2 = unexpected object
Filler Trials 1 & 2 = no unexpected object
Final Critical Trial = unexpected object