



## "Inattentional Blindness" & Conspicuity

**Note added 4 Jan 2011.** I wrote this article several years ago and have found it frequently cited. Unfortunately, many people don't get the message. Inattentional blindness is not a mental aberration; it is the norm. Conscious perception is the abnormality.

The eye is not a passive device that automatically converts images of the world into conscious perceptions. Very little of the sensory information registered by the eyes (or ears, or touch receptors or proprioceptors, etc.) contributes to perception, with most going unnoticed. Everyone is inattententially blind to almost everything during every single moment of every day. Most people falsely believe that they seldom experience inattentional blindness because they are unaware of being unaware. (See [this page](#) or [Forensic Vision: With Applications To Highway Safety](#) for further discussion concerning the commonplace fallacies about seeing.)

Lastly, inattentional blindness should be viewed as generally a good thing. It is the price we pay for the gift of attention. Paying attention to one thing means that we don't pay attention to everything else. Without this ability to block out the irrelevant, we could not function. I am saying nothing new here. It has been stated and restated by people who study the problem for 120 years. E. g.: "Only those items which I notice shape my mind - without selective interest, experience is utter chaos"; "The function of ignoring, of inattention, is as vital a factor in mental progress as the function of attention itself." (William James, 1890).

"In essence, trying to eliminate inattentional blindness would be like asking people to try to fly by flapping their arms really rapidly. The structure of the human body doesn't permit us to fly, just as the structure of the mind doesn't permit us to consciously perceive everything around.... Focused attention allows us to use our limited resources more effectively; we don't want to be distracted by everything else around us. Most drivers follow the rules of the road., most doctors don't leave guidewires in patients. Unexpected events are unexpected for a good reason. They are rare." (Chabris and Simon, 2010).

**Item:** *An automobile driver looks left down a sidewalk and pulls forward into a driveway. She hears a thud, looks down and sees a bicyclist on the ground near her left front fender. The bicyclist is seriously injured.*

**Item:** *A nurse pulls a vial from a medication cart. She looks at the label, fills the syringe and then injects the patient. The patient receives the wrong drug and dies.*

**Item:** *A submarine commander looks through his periscope and sees no ships nearby. He orders the ballast blown and the submarine to surface. He then hears the clank of a ship hitting his deck and realizes that he has surfaced with another ship directly overhead. The ship overturns, killing 9 people aboard.*

**Item:** *An Eastern airlines pilot and his fellow officers see a bulb flash on the control panel. They become so concerned with the cause, that they don't notice the plane approaching the ground or hear the alarm. The crash kills over 100 people.*

## "Inattentional Blindness"

All of these real accidents and a large number of others occur under strikingly similar circumstances: someone performing a task simply fails to see what should have been plainly visible. Afterwards, the person cannot explain the lapse.

The person making the error is likely to be held negligent. While assigning blame and deeming someone as stupid or careless might provide emotional catharsis, it does little to explain why such accidents are so commonplace. Why do intelligent, diligent and thorough people so often fail to see the obvious?

The answer lies in inattentional blindness, a condition that all people unknowingly exhibit every waking moment of their lives. As the name implies, it is the failure to see an object because attention is not focused on it. Although the phenomenon has long been known, recent evidence shows that it is much more pervasive than anyone had imagined and that it is one of the major causes of accidents and human error.

To understand how inattentional blindness occurs, it is necessary to accept a very unintuitive idea: most of our perceptual processing occurs outside of conscious awareness. Our senses are bombarded with such a large amount of input, sights, sounds, smells, etc., that our minds cannot fully process it all. The overload becomes even worse when we recall information from memory and engage in deep thought.

To cope with the problem, we have evolved a mechanism called attention, which acts as a filter that quickly examines sensory input and selects a small percentage for full processing and for conscious perception. The remaining information is lost, unnoticed and unremembered - we are inattentively blind to it since it never reached consciousness. This all happens without our awareness, so it is not a behavior which people can bring under conscious control.

The limitations of attention are well known to those of us in the field of "human factors," which examines human interaction with buildings, machines and other aspects of the environment. Many lab and real-world studies have documented the failures of human attention. There are thousands of studies that have investigated the criteria used by our attentional filter to decide what should be permitted into consciousness and what should be rejected.

This research is critical for understanding why accidents occur. Inattentional blindness causes accidents when attention mistakenly filters away important information. Learning the way attention separates the important from the unimportant is the first step in understanding inattentional blindness. If we understand why the lapses occur, then perhaps we can take steps to reduce them. Research suggests that attentional blindness is affected by four factors, conspicuity, mental workload, expectation and capacity.

### 1. Conspicuity

When we are just casually looking around, sometimes an object will jump out of the background. The term "conspicuity" refers to this ability to capture attention. Since getting people to notice information can literally be "a matter of life and death," many studies have examined the factors that underlie conspicuity.

#### **Sensory Conspicuity Factors**

There are two general types of factors which determine conspicuity. One is sensory conspicuity, the physical properties of the object.



The most important sensory factor is contrast. We see objects, not because of their absolute brightness, but by their contrast with the background. When there is higher contrast, objects are more conspicuous.

For example, black cars are involved in many more accidents, presumably because they are harder to notice at night. We are more likely to notice objects which are large and which move or flicker.

That's why school buses, police cars, ambulances, railroad crossings and so on all use flickering light. Recent research has shown, however, factors such as bright colors, movement and flicker do not ensure conspicuity. For example, Britain experienced a rash of accidents where drivers struck police cars parked on road shoulders. In order to reduce the accidents, the entire police car rears were painted the "highly conspicuous" chevron pattern as shown in the figure. Although the cars might now seem conspicuous, the rate of these accidents actually increased.

### ***Cognitive Conspicuity Factors***

There is more to conspicuity than just sensory quality. "Cognitive conspicuity" is equally or more important for drawing attention. We are much more likely to notice things which are relevant to us in some way. The classic example is the cocktail party phenomenon. You are at a cocktail party and having a conversation with someone. You understand the words of your partner and may or may not also be aware of the buzz of other, unintelligible conversations. We are so fast at interpreting speech sounds, that we are generally unaware that detecting the sounds and interpreting them are separate mental processes. The buzz sounds are coded for pitch and loudness, but you do not have the capacity to interpret both your partner's "sounds" as well as those of other conversations in the room. Attention limits us to one conversation at a time.

You can scan the room and switch your attention to someone else and can then understand that conversation but your partner's words become a meaningless buzz. The stream of consciousness is unitary, so you can consciously follow only one conversation at a time.

Now, suppose someone behind you says your name. This automatically attracts your attention to the other conversation because your name is meaningful. This happens visually as well. When I'm reading a newspaper, I frequently find my attention automatically drawn to the combination letters "pitt" even if they are not in the area that I am examining. The reason is that I'm from Pittsburgh, so the "pitt" has a special meaningfulness to me.

## **2. Mental Workload and Task Interference**

Since attention is roughly fixed, the more attention we focus on one task, the less there is for others. Inattentive blindness often occurs because part of our attention is devoted to some secondary task. In theory, for example, speaking on a cell phone, adjusting a radio, or carrying on a conversation with someone in the back seat can absorb some attentional capacity and lead to inattentive blindness. Any mental workload, such as just thinking about what to make for dinner, can also reduce available attention. In some situations, such as driving along an open road on a bright day with no traffic, for example, there may be enough attention available to engage in all behaviors. But if the situation becomes more complicated (dense traffic, poor weather, etc.) there may not be enough attention for all tasks such as cell phone use<sup>1</sup>.

However, it is not always so simple. The notion that attentional capacity is constant is only approximately true. There is ample evidence that visual and auditory senses employ partially independent attentional pools. That means that an auditory task (listening to the radio) will interfere less with a visual task (seeing a pedestrian) than would a second visual task (focusing narrowly on the car up head).

### ***Low Work Load and the Effects of Automation***

Ironically, inattentive blindness can be caused by too little mental load. When confronted with a monitoring task where the chance of an important event is low, people become bored, and they cease paying close attention. Arousal level drops and attention wanders. People may also go on "autopilot" when performing highly practised tasks, such as driving.

The advent of sophisticated computer technology has increased the problem. Pilots, machine operators and others who "control" powerful equipment spend more and more time as spectators, merely watching as computers do the actual work. They become increasingly reliant on the technology and are less likely to notice an abnormal event. A Continental flight barely avoided disaster when it plunged 12,000 feet due to wing icing. Prior to the incident, the captain was sitting with his foot up on the console. With autopilot, it is often "set it and forget it."

The pilots of the Eastern Airline flight were so interested in the panel light that they failed to notice the plane going down. The automatic pilot should have prevented this occurrence, but there was a subtle flaw in it<sup>2</sup>. The pilots came to depend so greatly on technology, that they quit using their own senses. As one aviation authority said, "The burning question of the near future will not be how much work a man can do safely, but how little" (Human Factors, 1980, p176).

### **3. Expectation**

Past experience exerts a strong control on attention because it teaches us what is and isn't relevant. For example, think about your breathing. You can now sense the movement of your chest. Of course, the movement was always there but you were inattentionally blind to it because it is highly uninformative. Nothing new ever happens, so attention filters away the sensation to conserve mental processing.

Expectation has a powerful effect on our ability to see and to notice. When my wife and I go to the mall, we sometimes separate to perform errands. When I go to look for her, I usually recall her coat and search for someone wearing the right color. At first, I did this unconsciously, but after a while I realized that I was adopting an attentional set on purpose. Color blobs (a coat) are far easier to scan and search than are the finer details of facial features<sup>3</sup>. This strategy usually works, but once in a while I'll have forgotten which coat she wore that day and expect to see the other color. On those occasions, I've walked right by her, completely blind to the other features, all highly familiar, which should have attracted attention to my wife.

Errors often occur when there is a new and unusual combination of circumstances in a highly familiar setting. The driver who hit the bicyclist had pulled into the same driveway every workday for a year and had never seen anyone. She had unconsciously learned that there wasn't anything important to see down the sidewalk. The submarine captain had learned that if there were no blips on the sonar, then there should be no ships in view. The nurse was used to picking out the same size and shape bottle that contained a different drug.

#### ***The Cost of Being an Expert***

It is one of the ironies of inattentional blindness that highly skilled and highly practised "experts" are more susceptible than are beginners. In fact, when we say someone is skilled and experienced, we usually mean that he has developed expectations which allow fast and accurate prediction and behavior. The submarine captain was highly skilled and experienced detecting other ships using his sonar. In this case, his expectation was in error and the tragedy occurred.

#### ***Confirmation Bias***

The human tendency toward confirmation bias strengthens expectancy effects. Humans who hold a belief or expectation tend to seek evidence which confirms and ignore or avoid evidence which refutes. For example, people who favor one political candidate will listen to his/her speeches but immediately turn off the TV if someone starts extolling the virtues of the opponent. The same effect occurs unconsciously. The submarine captain doubtless peered through the periscope unconsciously looking for evidence to confirm the sonar reading that there were no ships in the near vicinity.

There are some amazing instances of confirmation bias in accident cases. A ship carrying 1500 people ran aground because the GPS was in the wrong mode, and the crew, for 34 hours, failed to notice that the screen contained the wrong information. Moreover, they simply ignored the presence of lights and buoys located in the wrong places. One crew member appears to have imagined a buoy being in the "right place" even though it wasn't really there - just because he expected it to be there. Expectation not only makes us miss what is there, but it can make us see what is not.

### **4. Capacity**

Attentional capacity varies from person to person and from time to time. It is lessened by drugs, alcohol, fatigue and age. Under these conditions, likelihood of noticing important events declines. Attentional capacity is also a function of experience. A pianist learning a new piece might have to think about every note he hits on the keyboard and cannot let his mind wander. After sufficient practice, the pianist can play while holding a conversation or using his attention for other matters. "Muscle memory" has taken over and the fingers know just where to go for the piano task. When we learn to perform tasks "automatically," we seemingly need no longer pay attention to them and can

focus on other matters. (In reality, however, we still monitor what we are doing with a small, unconscious portion of our attention.)

However, automatic response can also lead to disastrous results. Recently, the pilot of an airliner was operating an aircraft very similar, but not identical to one that he usually flew.

A fire started in one of the engines, so he flipped the switch to cut the fuel supply. However, this new plane had a slightly different switch. The same physical motion which set the switch to "off" in his old plane caused the fuel flow to *increase* in his new one. Naturally, the engine burst into a massive fire. A beginner, who would have to think about the switch and read the settings, would probably not make that error. A beginner might make a "rule-based error" (what rule to follow in a particular situation) but not a "skill-based error."

## Conclusion

Inattentional blindness accidents are usual caused by a combination of factors: low conspicuity, divided attention and high expectation or lower arousal. There is doubtless a tradeoff in the role of these factors. In any specific situation, an accident could be due to any or all.

Inattentional blindness is a natural consequence of our adaptive mental wiring. We are able to consciously perceive a small percentage of the available information that flows into our senses and are blind to the rest. The rules used by the filter, meaningfulness, conspicuity and expectation, are adaptive and usually work very well. Given the number of decisions made and actions performed by a large population of people, however, mistakes are bound to occur. Fortunately, they are generally benign. Sometimes, however, they lead to tragedy.

It is difficult to reduce errors due to inattentional blindness. One reason is that people are unaware of the blindness. Training mainly affects conscious, voluntary behavior, so it helps little. You can tell a driver to be sure to check the oncoming lane before turning, but the advice will do little good if the driver is looking for a specific address, is in a hurry and in an unfamiliar part of town. There was a case where a paramedic became involved in a fatal accident because he was confused about directions and failed to see a pickup truck coming toward him down the opposite lane. *He had just come off a training course on driving the ambulance.*

## Footnotes

<sup>1</sup> see Green, M. (2001) Do Mobile Phones Pose An Unacceptable Risk? A Complete Look at the Adequacy of the Evidence, *Risk Management*, in press.; Green, M. (2000) Human Error in Road Accidents. *Swiss Reinsurance Canada Review*, September, p 1-14.

<sup>2</sup> A control for the automatic pilot was located just below the yoke. If the pilot leaned forward slightly and turned, he could inadvertently bump the control with his knee, switching off the automatic pilot. This is apparently what happened.

<sup>3</sup> This is an example of "cue generalization." People shift from complex to more easily distinguishable cues when making a decision. A nurse for example, might quit reading the label on a medicine bottle and simply select the bottle with the right color or shape.

<http://www.visualexpert.com/Resources/inattentionalblindness.html>