

## Inattentional or Change Blindness

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### Abstract

This article explores why sometimes we don't see or hear things that should be obvious to us. It supplements the material presented in the Situational Awareness section of the Human Factors: Threat & Error Management course.

As you will see situational awareness is extremely complex and affected by many things. I hope this article gives you more insight into the complexities of the brain and its role in processing information.

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Inattentional blindness is also known as perceptual blindness and is the phenomenon of not being able to see things that are actually there. This can be a result of having no internal frame of reference to perceive the unseen objects, or it can be the result of the mental focus or attention which causes mental distractions.

The phenomenon is due to how our minds see and process information. Closely related to the subject of change blindness, it is an observed phenomenon of the inability to perceive features in a visual scene when the observer is not attending to them. In other words humans have a limited capacity for attention which limits the amount of information processed at any particular time. Any other important feature within the visual field will not be observed if not processed by attention.

*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 medical cart. She looks at the label, fills the syringe and then injects the patient. The patient receives the wrong drug and dies.*

*Item: A sonar operator reported to the Captain that there were no ships in the area. The 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 airline 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.*

All these real accidents and many 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 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 inattentive blindness, a condition that all people exhibit periodically. 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 it is one of the major causes of accidents and human error.

To understand how inattentive 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 inattentive 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. Inattentive 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 inattentive 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:

1. Uniqueness of the Stimulus
2. Mental Workload
3. Expectation
4. Capacity

## **1. Uniqueness of the Stimulus**

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

### ***Sensory Uniqueness Factors***

There are two general types of factors which determine uniqueness. One is sensory uniqueness, 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 harder to notice at night. We also are more likely to notice objects which are large and which move or flicker. That's why school busses, police cars, ambulances, and railroad crossings and so on all use flickering light.

### ***Cognitive Uniqueness Factors***

There is more to uniqueness that just sensory quality. "Cognitive uniqueness" 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 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 "new" even if they are not in the area that I am examining. The reason is that I'm from New York, so the "new" has a special meaning 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 attention 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.

But 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 attention 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 "auto-pilot" when performing highly practiced 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 an autopilot, it is often "set it and forget it." The pilots of the Eastern 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. 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."

### 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 inattentiously blind to it because it is uninformative. Nothing new ever happens, so attention filters away the sensation to conserve mental processing.

Errors often occur when there is a new and unusual combination of circumstances in a highly familiar circumstance. 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***

One of the ironies of inattentive blindness is that highly skilled and highly practiced "experts" are more susceptible than 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:*** We look for things to confirm what we expect or believe.

The human tendency toward confirmation bias strengthens expectancy effects. Humans who hold a belief or expectation tend to seek evidence which confirms, and they 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 undoubtedly 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 1,500 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 crewmember appears to have imagined a buoy being in the "right place" even though it wasn't 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, and is eroded by drugs, alcohol, fatigue and age. Under these conditions, the 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 enough 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. (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. But 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 flames. 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

Inattentive blindness accidents are usually caused by a combination of factors: low uniqueness, 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.