Out of Mind, Out of Sight:

An introduction to Change Blindness[1]

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The world we live in is a richly detailed and vivid world. We rarely see the same thing twice. Even when we view a photograph on separate occasions the lighting conditions the orientation of the photograph changes, creating novel stimuli for our senses. Yet there is still a sense of continuity. That photograph is the very same photograph we have seen before and barring abnormal circumstances, we perceive it to be the very same. This continuity is important: without it, the world would fascinate us with its details after every time we blink.

Advances in modern technology have helped us to understand more about the human mind. In the past few decades a new field of study has amalgamated the study of intelligence, the human brain, and the human mind; working with computer models to develop a model of the mind. Cognitive Science has helped promote a renewed interest into the study of sensation and perception. We cannot develop a model that responds to the world it perceives the way we would if we cannot make it perceive the way we do.

Technology makes it possible to test, with incredible accuracy, different sensations and perceptions. Of all the senses, vision has received the most attention. Stimuli that would not be found in the real world can be created in a laboratory setting. Objects in the real world do not change as rapidly as the stimuli we can create in the laboratory. What if we could change an object that someone is perceiving? How much of a change is necessary to make it a noticeable change? By examining the history, the experimental paradigms, and the proposed causes of change blindness, this essay provides the reader with an overview of this field of study.

Cognitive Psychologists have recently been exploring the phenomena they have named Inattentional Blindness. Mack & Rock (1998) accidentally stumbled across an interesting pattern of results when trying to test a hypothesis. They found that participants failed to notice a stimulus when it was presented after an initial stimulus within a certain critical period. Participants' attention was focused elsewhere, making the critical stimulus difficult to perceive.

Mack & Rock (1998) tested using stimuli made of crosses, dots, squares and other geometrical shapes. Would this finding occur in the real world, a world which is not simply geometric shapes? Simons & Chabris (1999) tried to look at inattentional blindness from a real world perspective. Participants counted the number of ball passes between members of a team on a video. During the task a woman in a gorilla suit walked into the scene, beat her chest and walked off. Many participants failed to notice the gorilla, despite the fact that the ball was at times in front of or obstructed by the gorilla.

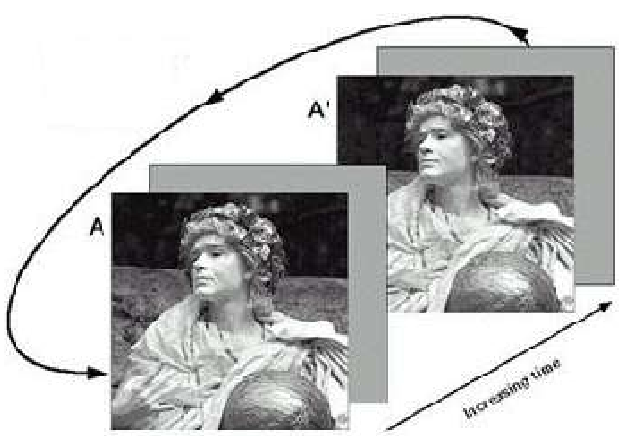
If participants do not notice an object they are not attending to, what would happen if we changed an object they were attending to? Simons & Levin (1998) examined just that. An experimenter asking for directions approached participants in this study. During the conversation a pair of conspirators passed between the participant and experimenter, carrying a large obstruction. With the obstruction in place, the experimenter switched off with one of the obstruction carriers, leaving a new person to finish the conversation. In their first experiment, they noted that participants responded to the change more frequently when the experimenters were in the same peer group. To test what kind of effect this had, they repeated the experiment. This time, all the experimenters were dressed as construction workers.[2]

The distinction between the two previous studies leads us to the distinction between two phenomena. Aptly named, inattentional blindness is where lack of attention leads to momentary blindness to anything that is not the focus of attention. Change

[2] It is interesting to note, however, that while both dressed as construction workers, their clothes were drastically different. For instance: the first experimenter wore a yellow hat; the second wore an orange hat.

blindness, also aptly named, is where a person is blind to the change in an object that they may or may not be attending to. Work with Change Blindness evolved from studies concerned with inattentional blindness. But how can we study Change Blindness?

Different experimental paradigms were developed to study this new phenomenon. These paradigms can be grouped into two major categories: the one change and the repeated change. The one change category is subdivided into a slow change and a rapid change. Participants in a one change study are given ample time to examine the first image before it is changed into the second image. With the slow change an image is slowly morphed into a second image (Simons, 2002). With the rapid change an interruption is necessary, to prevent the perception of motion. These interruptions can come in the form of a "mudsplash" (Rensink, 2000; Rensink, 2002; Rensink, O'Regan, & Clark 2000).[3] The mudsplash technique is also useful in repeated change experiments as well. In the repeated change experiments the images are "flickered" rapidly, with a mask in between.[4] Often subjects will view the two images a hundred times before the change is detected.

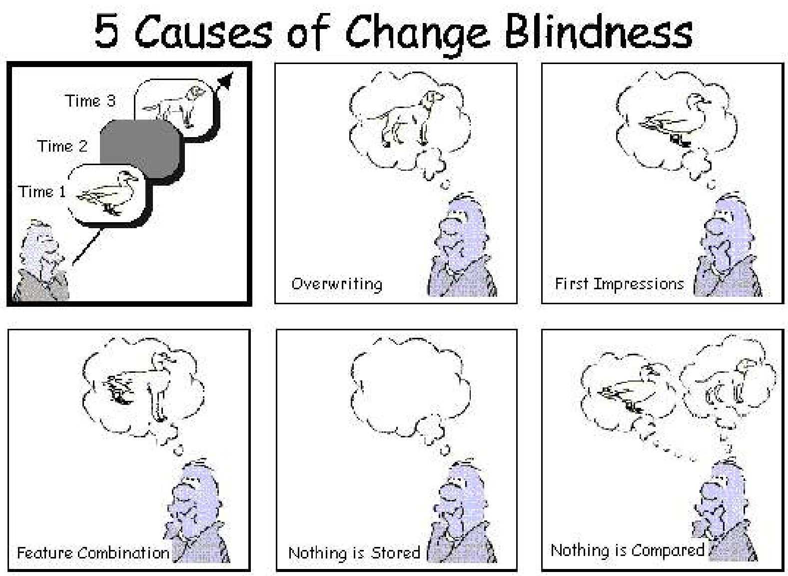


[3] There are several interesting sites on the internet that provide excellent examples of these paradigms. Two of the best ones are:
http://viscog.beckman.uiuc.edu/djs_lab/demos.html
http://www.psych.ubc.ca/~rensink/flicker/download/index.html

[4] A mask is a neutral image, usually a blank screen in these studies.

Understanding what it is that makes us susceptible to Change Blindness will help us understand more about how we perceive the world around us. What causes Change Blindness?

There are five theorized causes of change blindness: overwriting, first impressions, feature combination, nothing is stored, and nothing is compared. The first four are useful in understanding the problems involved in studying change blindness. The last one, nothing is compared, is the best candidate to date for the cause.



[5]

The first suggested cause of change blindness is overwriting. This suggests that the image that is represented in memory is the last image shown to the participant. All of the previously viewed images in that trial are forgotten or replaced in memory by the last image. The overwriting explanation is the one that is most often used and assumed in the current literature on change blindness. Overwriting, though it helps to explain the results found in object masking studies, fails to account for the change blindness phenomenon. When using the flicker paradigm, assuming the overwriting theory is correct, the image

[5] The five causes of change blindness, image taken from Simons (2000). Note that although the figure was taken from Simons (2000) it was altered to reflect the order of discussion in this paper.

the subject represents is being overwritten at a very rapid rate. The representation that would be retrieved at a later time would be the most recent image shown, which might possibly be the mask and not one of the images at all.

The second cause is known as first impressions. First impressions directly contrasts overwriting in that it is not the last image, but the first that is represented. The logic of first impressions is that if the goal of perception is to understand the meaning of a scene then the details will be irrelevant once that goal is achieved. (Simons, 2000) In other words, once we have viewed the first scene, we tend to overlook the details in the second scene because we have already grasped the meaning of the first one. Levin and Simons' (1997) results supported the first impressions theory, when the subjects where asked to describe the actor in the film where an actor answers the phone the most frequent description matched the first actor more accurately.

Feature combination is the third cause. Advocates of the feature combination approach believe that it is neither the first nor the second image that is represented, but a hybrid of the two. In the present study one of the images shown had an image of a man, in the original image the man had a handkerchief hanging out of his breast pocket, in the second image the handkerchief was gone. Feature combination theory would suggest that a subject would remember either part of the handkerchief or a faded version. (The image had a white handkerchief contrasted with a black suit; the subject may have represented a gray handkerchief)

It is also possible that the subject would remember all or nothing of the handkerchief because the subject represents parts of each image to create the whole image, the handkerchief may or may not have been in the image that was contributing to the final representation. When this happens it becomes either the first or the second image that is remembered. Occam's Razor states that one should believe only the simplest explanation for an event unless there is some reason to believe otherwise (Brook & Stainton, 2001). This means that if a pair of images consistently lends itself to having the first (or second) image represented, the theory that would best apply would not be a feature combination theory, but either first impressions or overwriting as the case may be.

This model was used to explain other visual phenomenon, and was widely debunked in the 1980s (Simons, 2000). One of the conditions of the feature combination theory is that the features when combined must be coherent. For instance in the feature combination illustration shown above, the result is a cross between a dog and a duck, this would never happen in the real world and is not something that is coherent, and thus would not be a plausible representation.

What if the subject does not have any representation of the scene? There is a school of philosophical thought that promotes the idea that "the world is it's own best representation." Why do people need to represent the world when it is right there? These philosophers might believe in the nothing is stored cause. As the name suggests this cause states that there is no representation formed of the images. This is not an all or nothing theory as it may appear. This can be looked at as a continuum, along which a point exists (or many points) where the subject represents the scene but in a low mental resolution. The subject may not remember any details of an image, and yet have a representation of the image at a more general level. In the study where two experimenters dressed as construction workers approached people on campus to ask for directions, many of the subjects may have only represented the experimenter as a construction worker and not represented any of the details. (Simons & Levin, 1998) This would account for the inattentional blindness that later ensued. Having never encoded the details of height, weight, color of shirt and sound of voice distinguishing between the two different experimenters became difficult.

Nothing is compared is the most plausible cause. This theory suggests that the subjects represent both the original and the altered image, but do not compare the two to find the differences. Studies that provide evidence for almost all the other causes can provide evidence for nothing is compared. The example of the construction workers could also be used as an example of nothing is compared and not nothing is stored. It is possible that the subjects represented accurately both experimenters, however, it did not occur to them to compare the two, because things do not often change like that in the real world. Since things in the real world are relatively stable and can not just change into other things the way that images on a computer can change, comparison between representations over such a brief period of time has not been necessary. One of the subjects in the construction worker study even commented that she had just seen a construction worker and had not coded the properties of the individual. (Simons & Levin, 1998)

Change Blindness is not a "common sense" issue. Many people find the results of these studies to be counter-intuitive. Levin (2002) showed how few people realized that a change might be difficult to detect. First year psychology students were asked whether or not they would be able to detect a change in a video or real world setting. Different types of changes were considered, one of them was a change in an actor's attire across cuts in a motion picture. Most of the students, 90.5% of them, decided that they would be able to notice whether a scarf that was there in one scene disappeared in the next. The average confidence rating for this change (on a scale of 0-5, 5 being the most confident) was 3.98. The actual success for this change detection was 0% in Levin & Simons (1997). With this startling "Change Blindness Blindness" it becomes clear that people modeling the human mind, must work with Cognitive Psychologists to learn more about our perception. A common sense approach to how the mind works falls short.

Research into the causes of Change Blindness will help us come to a more complete understanding of how people encode, store and retrieve information about a scene. Each of the five causes lead us to different conclusions about how our mind works. Through further research in the area it will become clearer to us how well (or not) we understand our perceptual process. Once we understand our own perception better, we will be in a better position to model the process, developing a more accurate model of the mind.

References

Brook A. and Stainton R. (2000). *Knowledge and Mind: A philosophical introduction*. Cambridge, MA: MIT Press.

Levin D. (2002). Change Blindness Blindness as visual metacognition. *Journal of Consciousness Studies, 9*(5/6), 111-130.

Levin D. and Simons D. (1997). Failure to detect changes to attended objects in motion pictures. *Psychonomic Bulletin and Review, 4*(4), 501-506.

Mack A. and Rock I. (1998). *Inattentional Blindness.* Cambridge, MA: MIT Press.

Rensink R.A. (2000). Seeing, Sensing and Scrutinizing. *Vision Research, 40,* 1469-1487.

Rensink R.A. (2002). Change Detection. *Annual Review of Psychology, 53,* 245-277.

Rensink R.A. (2004). Viewable/Downloadable Examples of Change Blindness. Retrieved April 15, 2004, from http://www.psych.ubc.ca/~rensink/flicker/download/index.html

Rensink R.A, O'Regan J.K, and Clark J.J. (2000). On the Failure to Detect Changes in Scenes Across Brief Interruptions. *Visual Cognition, 7,* 127-145.

Simons D. (2000). Current Approaches to Change Blindness. *Visual Cognition, 7*(1/2/3), 1-5.

Simons D. (2004). Visual Cognition Lab: Demos and Stimuli. Retrieved April 15, 2004, from http://viscog.beckman.uiuc.edu/djs_lab/demos.html

Simons D. and Chabris C.F. (1999). Gorillas in our midst: sustained inattentional blindness for dynamic events. *Perception, 28,* 1059-1074.

Simons D. and Levin D. (1998). Failure to detect changes to people during a real-world interaction. *Psychonomic Bulletin and Review, 5*(4), 644-649.