Positive Uses of Gradual Change Blindness through the STEGC Algorithms

By Emily Tyszka, Boston University Academy

August 29th, 2013

Abstract:

Gradual change blindness is defined as the failure to detect extremely slow changes in a scene. This is one of many common failures of human perception, in which the brain fails to perceive important details of its environment. Change imagery utilizing the Subthreshold Extreme Gradual Change (STEGC) can be used to develop attentional and perceptive abilities. Testing of perceptive abilities with STEGC could also possibly give rise to perceptive training programs for drivers, members of the military who depend upon recognizing subtle changes in threatening environments, diagnosis and treatment for neurology, and others for whom perceptive acumen is a necessity.

Change blindness is defined as the induced failure to detect major changes in an image. This is caused by a lack of "visual attention," as well as by a disconnect between low-level and high-level vision. A viewer's perception of a scene is developed through a combination of visual attention, eye movements, and memory.[1] Visual attention is a form of selective attention, relating to what the viewer is focusing on at a moment in time[2]. When looking at a scene, a viewer cannot see all details at once and therefore must give their visual attention to parts of the image.

The human eye makes around three movements per second while examining an image. During this time, not all parts of the scene are examined equally, as areas of stimuli (color, contrast, and orientation) attract the viewer's visual attention.[3] Areas that attract little attention are not realized as easily when they undergo a visual change.

[1] Goldstein, E. Bruce. "Chapter Six: Visual Attention." *Sensation and Perception*. Vol. 7. N.p.: n.p., n.d. N. pag. *Psychology 333*. University of Washington. Web. 29 Aug. 2013.
[2] Ibid
[3] Ibid.

When a viewer perceives an image, Conceptual Short-Term Memory (CSTM) is used to quickly interpret elements of the scene. This form of memory enables the viewer to perceive meaningful patterns and structures in a scene, allowing them to later recognize the objects portrayed. CSTM processes meaningful stimuli and relates them to concepts in the viewer's long-term memory.[4] When remembering the shape or details of an object, a preexisting mental image is used.[5] According to the reality simulation principle (RSP), mental imagery is used to generate a scene, in which the viewer places himself. By examining the scene, the viewer registers details from within the memory.[6]

"Low-level vision" and "high-level vision" are differing extents to which such a scene's details are registered. Low-level vision concerns the "geometric and photometric properties" [7] of a scene, while high-level vision uses "abstract knowledge of the physical and semantic properties of the world."[8] Since parts of an image can be interpreted to differing extents, changes in an image may occur without causing a change signal to the brain. A "disconnect" between these two types of vision would then occur with changes that produce a change signal large enough to be seen, but not to draw attention.[9]

Within the concept of change blindness, changes in a scene can remain unperceived in two differing ways. These are defined by the time taken for the unnoticed change to occur, with "quick" and "gradual" changes as the names for the two forms of change blindness.[10] As suggested by their respective titles, one form, "quick-change blindness," takes place over

[4] Potter, Mary C. "Conceptual Short Term Memory in Perception and Thought." *Frontiersin.org*. Frontiers in Psychology, 3 May 2012. Web. 11 Aug. 2013.
[5] Gluck, M.A., J.R. Anderson, and S.M. Kosslyn. "Chapter Seven: Remembering Images."*Memory and Mind: A Festschrift for Gordon H. Bower*. N.p.: n.p., n.d. 93-109.*William James Hall*. Harvard University. Web. 29 Aug. 2013.
[6] Ibid.
[7] Rensink, Ronald A. "Chapter Nine: Change Blindness: Implications for the Nature of Visual Attention." *Vision & Attention*. New York: Springer, 2001. 169-88. *Percepts and Concepts Laboratory*. Indiana University. Web. 29 Aug. 2013.
[8] Ibid.
[9] Simons, Daniel J., Steven L. Franconeri, and Rebecca L. Reimer. "Change Blindness in the Absence of Visual Disruption." Diss. Harvard University, 2000. *Mark Wexler Library*. Harvard University Department of Psychology. Web.
[10] Science Museum of Minnesota. "Low Life Labs: Blindness." *Low Life Labs: Blindness*. Science Museum of Minnesota, 2009. Web. 29 Aug. 2013.

intervals of less than one second, while “gradual change blindness” can occur over much longer periods of time typically of one minute or more.

"In order to "see" such a slow change, one must classify (encode) the new situation and judge it to be different from the previously encoded situation." This implies that training with gradual changes improves ability to spot changes and differences in an image. However, gradual changes are more subtle and therefore require the viewer to understand the scene to its minute details. This involves memory and visual attention by inviting the viewer to use CSTM to interpret the scene and later follow the RSP as a way to examine its details.

For the viewer to recognize a quick change, visual stimuli must cause a change signal to be sent to the brain. For gradual changes, however, there is no stimulus to register a change signal, but rather differences are noticed consciously. Because of this, gradual change blindness can be decreased by increasing the viewer’s ability to consciously perceive differences in their surroundings.

Errors in perception are common occurrences. Among these, errors in observation during vehicle operation pose a hazard to drivers, who can fail to recognize changes in traffic lights, signs, and other vehicles’ signals. In courtrooms, eyewitness testimonies are dependent on the viewer’s ability to observe the situation, so those with lower perceptive skills are more likely to give inaccurate accounts of important situations. Members of the military may be similarly affected, with their ability to process a scene being important in battle. Methods of perception training are therefore necessary to decrease the occurrences of such problems. Recognition of subtle cues can be of benefit in improving the viewer’s visual attention and ability to detect changes in a scene.

TransLumen’s Subthreshold Extreme Gradual Change (STEGC) algorithms are used in the delivery of images, allowing changes to occur, unperceivable to the human eye.[11] STEGC

[11] Siefken, Douglas R. *TransLumen Technologies*. Rep. Translumen Technologies, July 2008. Web. 29 Aug. 2013.

utilizes gradual change blindness in this way and the algorithms have been found to have implications for perception training, using practice with gradual changes to improve one's ability to notice changes in a scene. In this way, gradual change blindness can be seen positively, as it is possible to use this phenomenon to increase one's perceptive abilities.

STEGC has been used in sensitivity training, where viewers attempted to recognize slowly changing details in an image. This training program worked by showing viewers a scene, in which the silhouette of a sniper slowly appeared, and the viewer's task was to discern the change. A US Naval Research Laboratory (NRL) study[12] found that STEGC's sensitivity training increased the perceptual skills of its users. This means that training with STEGC's slow changes has the capability to increase perceptiveness and therefore decrease the occurrence of perceptive error and susceptibility to the effects of change blindness.

Another possible use for incorporating these algorithms lies in perceptiveness testing. Ability to perceive changes in the sensitivity training environment can be measured. By determining the typical perceptive ability of persons of specific demographic groups, it is may be possible to use such software to detect deficiencies such as for traumatic brain injuries in those who score lower than what is considered normal. The development of such a program, however, would require the widespread testing of peoples differing in age, gender, etc.

Conclusion:

Although all types of change blindness are typically considered negative phenomena, TransLumen's objective is to utilize gradual change blindness as a way to test, identify cognitive levels and train to increase perceptual ability. Through STEGC, methodologies can be applied to train people to have better skills in awareness and observation, and consequently experience fewer instances of perceptive errors. Testing and training through STEGC algorithms is currently being evaluated for its usefulness in memory and observational training.

[12] Ibid

Definitions

Change Blindness: The induced failure to detect a change in a scene, caused by a lack of visual attention.

Conceptual Short-Term Memory: A form of short-term memory that processes stimuli into meaningful structures and forms in the viewer's mind.

Gradual Change Blindness: Change blindness occurring in changes that take up to a minute or more.

High Level Vision: Vision concerning abstract concepts and interpretation of an object.

Low Level Vision: Vision concerning the basic visual attributes of an object, such as color, size, and shape.

Quick Change Blindness: Change blindness occurring in changes of less than a second.

Reality Simulation Principle: The concept of placing oneself in a visual scene in order to better observe and understand it

Subthreshold Extreme Change (STEGC) Algorithms: Patent #6,580,466. Methods for generating image set or series with imperceptibly different images, systems therefor and applications thereof.

Visual Attention: A form of selective attention concerning the focus of the eyes on an object at any one time.

Works Cited

Gluck, M.A., J.R. Anderson, and S.M. Kosslyn. "Chapter Seven: Remembering Images." *Memory and Mind: A Festschrift for Gordon H. Bower*. N.p.: n.p., n.d. 93-109. *William James Hall*. Harvard University. Web. 29 Aug. 2013.

Goldstein, E. Bruce. "Chapter Six: Visual Attention." *Sensation and Perception*. Vol. 7. N.p.: n.p., n.d. N. pag. *Psychology 333*. University of Washington. Web. 29 Aug. 2013.

Indiana University. "Change Blindness." *Change Blindness*. Indiana University, 2005. Web. 29 Aug. 2013.

Jenkin, Michael, and Laurence Harris. *Vision and Attention*. New York: Springer, 2001. *Google Books*. Web. 29 Aug. 2013.

Moore, Cathleen M. *Inattentional Blindness*. Rep. University of Iowa, n.d. Web. 29 Aug. 2013.

Potter, Mary C. "Conceptual Short Term Memory in Perception and Though." *Frontiersin.org*. Frontiers in Psychology, 3 May 2012. Web. 11 Aug. 2013.

Rensink, Ronald A. *Change Blindness*. Rep. University of British Columbia, n.d. Web. 29 Aug. 2013.

Rensink, Ronald A. "Chapter Nine: Change Blindness: Implications for the Nature of Visual Attention." *Vision & Attention*. New York: Springer, 2001. 169-88. *Percepts and Concepts Laboratory*. Indiana University. Web. 29 Aug. 2013.

Science Museum of Minnesota. "Low Life Labs: Blindness." *Low Life Labs: Blindness*. Science Museum of Minnesota, 2009. Web. 29 Aug. 2013.

Siefken, Douglas R. *Applying STEGC to Perceptual Training*. Rep. TransLumen Technologies, July 2008. Web. 1 Sept. 2013.

Siefken, Douglas R. *TransLumen Technologies*. Rep. TransLumen Technologies, July 2008. Web. 29 Aug. 2013.

Simons, Daniel J. *Current Approaches to Change Blindness*. Rep. Harvard University, n.d. Web. 29 Aug. 2013.

Simons, Daniel J., Steven L. Franconeri, and Rebecca L. Reimer. "Change Blindness in the Absence of Visual Disruption." Diss. Harvard University, 2000. *Mark Wexler Library*. Harvard University Department of Psychology. Web.

US Patent & Trademark Office, Patent Full Text and Image Database. "United States Patent: 6,580,466." *United States Patent and Trademark Office*. Department of Commerce, 17 June 2003. Web. 1 Sept. 2013.