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Change Blindness



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Definition

Change blindness is a phenomenon of visual attention in which changes to a visual scene may go unnoticed under certain circumstances, despite being clearly visible and possibly even in an attended location. For example, the appearance of an object might not be noticed if it coincides with a disruption of visual continuity such as a flicker or an eye movement. Change blindness is an example of a striking limitation to visual attention and indicates that visual representations are more sparsely detailed than would sometimes be assumed. The phenomenon can occur under a wide array of circumstances, as well as in multiple sensory modalities, and has been demonstrated in some nonhuman animals.

Introduction

The first experimental investigations of change blindness were of saccade-contingent changes: changes that occur at the same time as eye movements. McConkie and Currie (1996), for example, had human participants view photographic displays on a computer screen while monitoring

their eye movements with eye trackers. During viewing, sudden changes were made to the display and participants were asked to search for them. For example, an object in the scene might change color, change location, or disappear entirely. Changes that happened during an eye saccade were more difficult to detect than those occurring during a fixation. Even prominent changes encompassing a large portion of the screen frequently went unnoticed if they happened while the viewer's eyes were in motion.

Subsequent research using different methods showed that this kind of failure to detect changes is not limited to eye movements; change blindness can occur under a wide variety of conditions and at any time. For example, in the flicker task, one of the most commonly used methods of investigating change blindness, participants search for a difference between two sequentially alternating visual scenes that are identical save for a single feature (Rensink et al. 1997). If the scenes alternate instantaneously, with one image or the other always visible, the change is usually seen quickly and effortlessly. Participants often report that the change “pops out” at them. On the other hand, if a short inter-stimulus interval (ISI) is inserted between each image, during which the screen is blank, the change is much more difficult to identify and requires an active, location-to-location search. Consequently, accuracy is worse, and latency to identify the change is longer. The flicker task is particularly appealing to experimental psychologists because it allows them to easily

isolate and manipulate specific aspects of a change, such as its size, location, or salience. The method also establishes the practical importance of change blindness, by showing that change blindness can occur at virtually any time, regardless of what the participant is doing or where she is looking. The earlier demonstrations of saccade-contingent change blindness constrained it to the short moments of time when the eyes are in motion.

While the flicker task has been the most widely used procedure for studying change blindness, other methods have emerged that show the same pattern of results and illustrate that change blindness can occur under widely varying conditions. For example, one method is similar to the flicker task, in that participants attempt to identify changes in alternating images. However, instead of including an ISI to induce a global visual disruption, a set of small local disturbances (“mudsplashes”) are superimposed onto the image at the moment of change (O’Regan et al. 1999). These mudsplashes are located so as not to obscure the change, but their presence nevertheless makes it more difficult for participants to identify the difference between images. Thus, the procedure illustrates that a global visual disruption (as in the flicker task) is not necessary for change blindness to occur. Yet another method uses gradual changes to produce change blindness. In this method, two images are prepared that are identical save for one feature (such as the presence, location, or color of an object). One image is presented initially, but gradually dissolves into the other over the course of several seconds, and participants are asked to search for and identify the change (Simons et al. 2000). In this case, there is no visual disruption at all, and yet participants often fail to notice the change, especially if the rate of change is slow.

Not only can change blindness be produced by a widely varying collection of laboratory procedures, there appear to be parallels in other sensory modalities. Using parallel methods, researchers have shown that people can be made to fail to detect changes in auditory (Gregg and Samuel 2008), tactile (Gallace et al. 2007), and olfactory (Sela and Sobel 2010) stimuli. While less research

has been done on these nonvisual equivalents of change blindness, their existence would seem to suggest that change blindness could be due to a general nonmodality specific feature of attention.

Research programs on change blindness carry some important implications for cognitive science and our understanding of how we experience the world around us. While our momentary experiences during visual fixation may be quite detailed, very little of that detail is maintained from one view to the next. Instead, the visual memory that persists from moment to moment is quite sparse, consisting of little more than the meaning or gist of a scene (Simons and Levin 1997). Thus, we fail to notice many feature-level changes because the representations of those initial features are transitory and do not persist across the change. Nevertheless, the details that are preserved appear to be sufficient to allow people to interact with a complex world quite successfully, at least under most everyday circumstances.

Change Blindness in Nonhuman Animals

If change blindness is in fact a wide-ranging general consequence of sparsely detailed representations of visual scenes, we might expect to see the same phenomenon in some nonhuman animals that have similar visual systems. Indeed recent research has shown predictable change detection failures in nonhuman animals using methods patterned after those originally developed to investigate change blindness in humans.

Primates, of course, are closely related to humans and have visual abilities that are comparable in many ways. Thus, they make a logical population for initial comparative research into change blindness. Tomonaga and Imura (2015) used a variant of the flicker paradigm to study change blindness in chimpanzees and humans. They presented alternating displays consisting of several line drawings on a CRT monitor in a task inspired by the flicker paradigm. On each trial, one of those line drawings changed between alternating displays by either shifting position, changing shape, or appearing/disappearing, and chimpanzees were trained to touch the location

of the line drawing that changed. As in other implementations of the flicker task, some trials included a blank field that appeared at the time of a change, producing a global disruption of visual continuity. Inclusion of those blank fields led chimpanzees (like humans) to make more errors and to respond more slowly to all three kinds of changes, indicating that change detection was more difficult.

Cavanaugh and Wurtz (2002) used a similar approach to study change blindness for motion change in macaques. Their monkeys viewed several fields of moving dots on a display, one of which could change its direction of movement. Monkeys were then rewarded for making an eye movement in the direction of the field that had changed its direction of movement (or for not making an eye movement if no change had occurred). As with other change blindness tasks, they included a global visual disruption on some trials by presenting a brief blank field at the onset of the change. Change detection accuracy was impaired on those trials that featured a blank field, a standard change blindness effect. Accuracy on blank field trials improved if the location of the change was cued ahead of time, indicating that monkeys were still capable of detecting those changes, and indeed could strategically use information to attenuate the effects of change blindness.

Pigeons are more distantly related to humans, but have excellent visual acuity and have long been used to study visual attention in comparative psychology. Herbranson et al. (2014) used a version of the flicker paradigm to study pigeons' ability to detect changes in a visual display. Birds viewed alternating collections of features (up to eight lines of varying orientations) projected onto three response keys in an operant chamber. One of the line features present on one response key appeared and vanished across presentations, and after observing a required number of iterations, pecks to the location of the change were reinforced. Some trials contained an ISI between successive displays (causing a global visual disruption) and other trials did not. Pigeons were less likely to peck the location of the change if an ISI was present, the same change blindness pattern seen in the flicker task with human

participants. Accuracy remained better than chance however, showing that pigeons were still capable of correctly identifying changes on some ISI trials. Subsequent research in the same lab (Herbranson and Jeffers 2017) used the same methodology to demonstrate change blindness for color changes, a potentially more subtle variety of change. Again, pigeons were less likely to detect a change if an ISI was present. Furthermore, change blindness in pigeons appears to be affected by some of the same factors that affect change blindness in humans and in the same way. Specifically, the magnitude of impairment caused by visual disruption depends on both the duration of an ISI and the salience of the change (Herbranson 2015; Herbranson and Davis 2016).

Whereas the flicker task produces change blindness via a global visual disruption, recall that such a disruption is not necessary in humans, who also show change blindness for gradual changes that involve no visual disruption at all. Haggmann and Cook (2013) showed that this is also the case for pigeons. They trained birds to detect continuous, gradual changes in brightness on a computer display using a go/no-go procedure. Pigeons viewed a colored rectangle that was either constant or continuously changing in brightness. Pecks on constant-brightness trials were reinforced on a VI schedule, and pecks on changing-brightness trials resulted in a timeout. Birds suppressed pecking on changing trials, but took longer to do so when the rate of change was slower. Thus, more gradual changes were more difficult to detect, as they are for humans. Again this shows that changes may go unnoticed, even when there is no disruption of visual continuity to obscure the change. In the context of the previously described comparative research, it also shows that change blindness in pigeons is not tied to one specific laboratory procedure such as the flicker task.

Conclusion

Change blindness has been a topic of considerable interest in cognitive psychology in recent decades. Research on humans indicates that it can occur in a wide variety of situations, and consequently can

be studied using many different procedures. The resulting collection of research tools includes several tasks such as the flicker paradigm that can be readily adapted to study change blindness in non-human animals. While only a small number of species have been tested and only a subset of the developed change blindness tasks have been adapted, the available results show striking parallels with the results produced by humans.

Change blindness research has thrived in part because it presents results that do not match most people's subjective perceptions. Our momentary visual experience appears detailed, even though that detail is transitory and does not persist across views, and most people overestimate their ability to detect changes ("change blindness blindness"; Levin et al. 2000). The existence of change blindness in nonhuman animals might initially seem just as puzzling, given that vigilance and the ability to quickly and accurately detect changes would intuitively seem to have survival value for many animals. Simons and Levin (1997) propose that the sparsely detailed visual representations that give rise to change blindness may serve to provide stability and continuity from moment to moment. Thus, one can have a detailed perceptual experience at any instant, but by preserving only those components that are likely to be important, the relevant features in the next glance can be quickly matched up without the overwhelming task of tracking and linking each and every minute detail. Presumably this logic would apply as well to nonhuman animals, who often have to solve the same perceptual problems as humans, with even more limited neural resources.

Cross-References

- ▶ [Attention](#)
- ▶ [Change Detection](#)
- ▶ [Cognition](#)
- ▶ [Same/Different Learning](#)
- ▶ [Search Image](#)
- ▶ [Short-Term Memory](#)
- ▶ [Visual Perception](#)
- ▶ [Visual Search](#)
- ▶ [Working Memory](#)

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