Perception and Poetics of VR Documentaries

By Michael Grabowski

Michael Grabowski at the ZDOK documentary conference in Zurich, March 30, 2017

Since VPL Research co-founder Jaron Lanier popularized the term 'Virtual Reality' (VR) in the 1980's, the phrase has reemerged to describe visually immersive environments that include 360-degree recorded video, live feeds of stereoscopic video, computer-generated imagery and videogames, and avatars in collaborative workspaces.[1] Like the Internet, VR can be described as a meta-medium, or a medium that encompasses many media, technologies and processes through which people can communicate, share content, information, and communicate.

Because media are pervasive, their effects often are invisible; *i.e.,* they are a part of the ground, not the figure. When the linguist and media critic Neil Postman founded a graduate program in 1971 at New York University to study media, he drew parallels to the ecology movement. Ecology is the study of biological environments; it argues that adding or removing an organism creates a systematic change in that environment. Likewise, introducing a new medium to a culture does not have an additive effect, but systematically changes an entire symbolic environment. The change is ecological, and Postman named his program Media Ecology.[2] Postman had been a student of Marshall McLuhan, who understood media as extensions of our nervous system (1994). Like McLuhan, Postman was concerned with how dominant media within a culture change relationships of senses in unnoticed ways.

1 For an early take on the history and promise of virtual reality, see Rheingold (1992).

2 For a history and intellectual tradition of media ecology, see Lum (2005).

While this perspective is useful for understanding how new media influence cultures and human relationships, it does not adequately explain the physiological and psychological effects of using media. McLuhan discussed at length aural and visual media and explored the concept of the sensorium, but he did not have the benefit we have from advances in the neuroscience of perception.

These days, collaborations between film and media scholars, psychologists, and neuroscientists have begun to answer some of these questions. Theorists like David Bordwell (1985, 2008) and Noël Carroll (2003, 2008) have contributed to our understanding of the interaction of media and our senses, generating the field known as cognitive cinema studies.

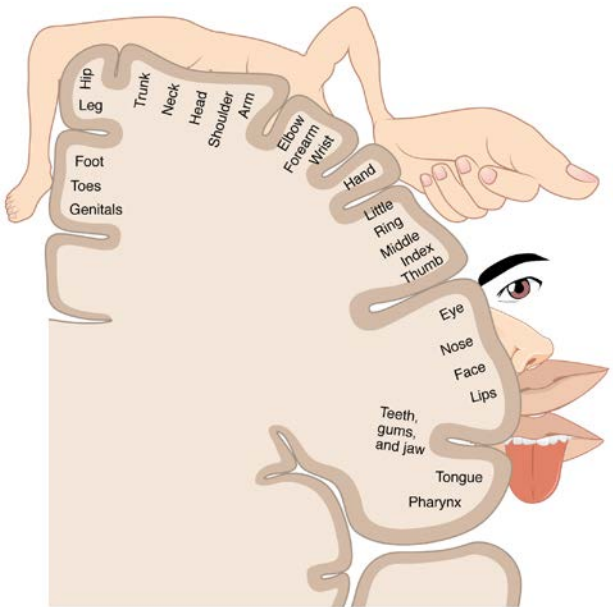
More recently, Uri Hasson, who coined the term 'neurocinematics,' has used fMRI data to show how directed film sequences produce more synchronous brain activity among viewers (Hasson et al., 2008). Directors, like storytellers in other media, are to some degree mind controllers. Daniel Simons and Christopher Chabris (1999, 2010) and Daniel Levin (2002) have shown that we attend to only a fraction of what we perceive, and if our mental attention is drawn to a specific task, we often miss and never remember significant visual information. What film editors call unnoticed continuity errors, psychologists have labeled change blindness. Tim Smith (2012) tracks viewers' eye movements to show exactly where viewers direct their focus on an image, and when they shift after a transition to a new shot or scene. Faces, specifically the eyes and mouth, draw viewers' attention, and visual attention plays a large part in establishing cinematic continuity. Vittorio Gallese and Michele Guerra (2012) have used films to understand the human mirroring system, in which neural networks generate the same activity when someone watches an action as when they perform that same action themselves. Their Embodied Simulation theory argues that representations of the body in the film image tap into the mirroring mechanism, using viewers' own premotor networks to project and predict the movements of characters in a film.

These examples, and many more, make up what has become known as cognitive film theory. I find this approach, how we perceive and build mental models of film, and by extension all media, a fruitful way of exploring their use and effects. Moreover, media ecology and cognitive media studies can help us understand how our perception of media, including documentaries, differs from our perception of our real environment. In effect, filmmakers have appropriated a sensory system that had evolved over millennia within a natural environment. It is a system tuned to help us survive within social groups, obtain food and shelter, avoid predators and other dangers, and identify friend from foe.

When referring to the poetics of VR, I mean 'poetics' in the way David Bordwell uses the term in *The Poetics of Cinema* (2008). It is closely related to aesthetics, but it is more than an evaluation of a work's beauty or the stylistic traditions of a school of art. Bordwell borrows the term from the tradition stretching back to Aristotle. He understands cinema as a constructed artifact, situated in an aesthetic tradition, employing a practice of style, and produced to be consumed

by others. According to Bordwell, the study of poetics consists of three approaches: 1) the aesthetics of film narrative, including the form and style of the medium, 2) aesthetic traditions, including a historical examination of how industry practices and relationships shaped the conventions of a particular tradition, and 3) a perceptual/cognitive/affective explanation for how viewers experience a particular film aesthetic.[3] Given that, at this writing, the industry is in the incunabular stage of VR practices, it is difficult to examine the historical traditions and established style of the medium. However, in order to discuss the experience of perceiving VR, one must first understand how people sense our natural environment.

Popular assumptions about human senses are incomplete; the human brain makes use of more than the five commonly known senses of sight, hearing (aural), smell (olfactory), taste, and touch (haptic). For instance, the vestibular sense, or sense of balance, originates from the semicircular canals in the inner ear. It provides feedback on the body's orientation within the environment. One part of this system consists of the otolithic organs, two small structures between the cochlea and semicircular canals that sense linear acceleration and head orientation. Humans also have the sense of proprioception, or the sense of the location of the body in space. Feedback from sensory receptors in striated muscles, tendons, and joints are sent to the cerebellum to give the brain a map of the position and movement of each part of one's body (Goldstein, 2010).

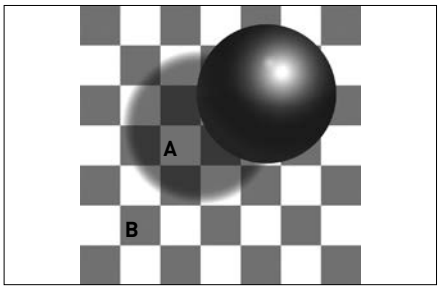


A sensory homunculus represents a map of brain areas dedicated to sensory processing for different anatomical divisions of the body.

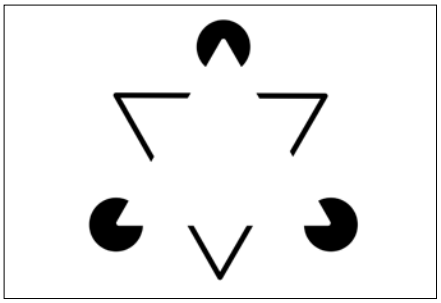
The sense of touch is in fact several distinct sensations, and different neural receptors are responsible for gathering these stimuli. Mechanoreceptors like Merkel receptors and Meissner corpuscles respond to pressure and fine details of haptic sensations. Ruffini cylinders and Pacinian corpuscles sense vibrations and stretching of the skin. These mechanoreceptors send information to the somatosensory cortex in the parietal lobe of the brain. While this cortex maps each area of the body to a particular region, it is also somewhat plastic, and parts of the body that get more use tend to occupy more brain region (Goldstein, 2010, pp. 331-334).

Thermoception provides both an absolute and relative sense of temperature. Transient receptor potential channels (TRPC) provide continuous feedback of warm, cool, and cold sensations, while thermal pain receptors activate at temperatures under 5 degrees and over 45 degrees Celsius. The experience of pain, or nociception, seems to be located not in these receptors, but in the brain itself (Hensel & Craig, n.d.). Researchers have shown that pain can be intensified or reduced depending on

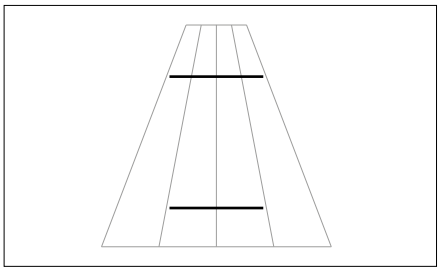
3 Bordwell provides a useful summary of this approach within his blog.



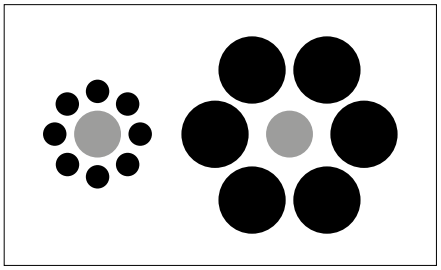
The squares marked A and B are the same shade of gray.



The white triangle (which is not really there) may appear brighter than the background.



Is the length of the horizontal lines equal?



Which of the two centre circles is bigger?

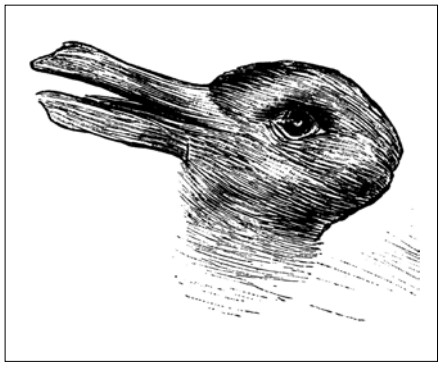
the attention paid to it. In the case of phantom limb syndrome, amputees experience intense pain located within an arm or leg that does not exist (Ramachandran & Blakeslee, 1999).

Even the senses we are familiar with sometimes act in non-intuitive ways. As an evolutionary survival strategy, we are much more sensitive to changes in our environment than in absolute measurements of it. In the case of our visual sense, optical illusions reveal where our perceived reality differs from physical reality. For instance, in the checker shadow illusion, the two squares A and B appear to be lighter and darker because of the contextual cue of the shadow, but in fact the two squares are the same shade. Likewise, the infamous Dress Color Illusion became a viral sensation in 2015, as some argued the dress was blue and black, while others were convinced it was white and gold. This is a result of chromatic bias shift, where our vision adjusts to the overall color temperature of white light.[4] Cinematographers know that daylight has a much bluer color temperature, around 5600 degrees Kelvin, than incandescent light, at a color temperature of 3200 degrees Kelvin (Burum, 2009, p. 124). Cameras display this difference, but our brains remove the colorcast. I think it is important to ask why this became a viral sensation in 2015. If seeing is believing, then a person seeing the dress believes it to be a certain color. Their own eyes tell them so. To have someone else argue just as forcefully that the dress is a different color, the social truth conflicts with perceptual truth. As a precursor to the current debate about fake news, this incident may foretell future controversies in VR.

Size and depth also are perceived in relation to their context. The Ponzo illusion uses depth cues to create the impression that the top line is longer than the bottom, when they are both the same length. Similarly, the Ebbinghaus illusion shows two circles of the same size, though the circle surrounded by smaller circles may appear larger than the same-sized circle surrounded by larger circles.

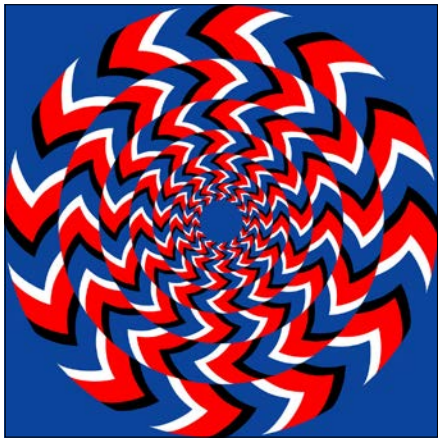
The human brain attempts to infer objects from incomplete information. One can imagine how this would help primates surviving on the savannah. Seeing a glimpse of a cheetah's tail rising through the grass, humans would not wait until they saw the complete animal to seek safety. Gaetano Kanizsa's Square and Triangle illusions demonstrate the law of closure from incomplete visual information. Many people see the outline of a white square, and complete triangles, even though no figures exist. Attempts to make sense of visual information can be tested with

4 Pascal Wallisch (2017) provides a thorough explaination and survey data for this phenomenon.



Do you see a duck or a rabbit?

Do you see the profiles of two heads or a vase?



Color alone can create the illusion of movement.

ambiguous figures, like Joseph Jastrow's 1899 duck/rabbit illustration, and with figure/ground illusions like the vase or face and Schroeder's stairs.

The technology of moving images, from flip books to film and video, relies on the illusion of apparent motion. When an object is presented in two locations in quick sensation, it appears to move from the first to second location (Dawson, 1991). The color phi phenomenon occurs with different colored objects, creating the illusion that the color continuously changes as it seems to move between two positions. Color alone can create the illusion of movement, as with color dependent anomalous motion (Kitaoka, 2014). In this case, the perception of color borders as the eyes saccade across the image produce the illusion of movement in peripheral vision. One may conclude from the illusions above that human visual perception of the physical environment does not, and cannot, produce a perfect map of that environment.

One last point about perception is that it is, in its essence, multimodal and multisensory. People do not use their senses in isolation, but perceive their environment using multiple senses. Stimulating one sense may change the perception of another sense. One can experience multisensory perception with the McGurk effect. Pairing the sound of someone saying 'ba, ba' with the moving image of a mouth uttering a different sound changes the perception of the sound itself. We rely on multisensory perception to navigate our world, and conflicts often produce negative reactions. Motion sickness results from conflicts between the visual and vestibular senses, generating a feeling of nausea. Earlier, I mentioned the phenomenon of phantom limb syndrome. Neuroscientist V. S. Ramachandran developed a treatment for phantom pain by constructing a mirror box. When amputees insert one arm into the box, they create the visual illusion of seeing two arms. Once the visual and proprioceptive senses are no longer in conflict, the patient's pain subsides (Ramachandran & Blakeslee, 1999, pp. 46-48).

Neuroscientists are beginning to explore multisensory perception. They know that both the visual and haptic senses have neurons that synapse in the Thalamus (Komura, Tamura, Uwano, Nishijo, & Ono, 2005; Ghazanfar & Schroeder, 2006), and visual and auditory information is integrated in the superior colliculus (Meredith & Stein, 1983). Luis Antunes (2016) has written about multisensory perception in film, specifically how directors have used visual information such as framing, color, and observed actions to create sensations of nociception, thermoception, and the vestibular. The point here is that, not only do the audio

and visual components of a film reinforce each other, but they also generate and change other senses, including one's sense of balance, temperature, and body position. Meanwhile, those senses feedback to the audiovisual senses and may change what is seen and heard.

Filmmakers already know about multisensory perception in an intuitive way, and they make use of it every day in their work. Playing sound with video that was recorded simultaneously produces a sense of realism. The reinforcing nature of the sound and video resembles the perception of the natural environment, and audiences are more likely to accept the footage as a document of a particular moment. When sound from a different time or place is used, or when non-diagetic sound, like music, is added, audiences must work harder to make sense of the multisensory conflict. When a connection is found, viewers experience joy at solving the meaning puzzle, and an aesthetic is born.

After outlining some ways in which perception works, we may now turn to the perception of VR. This discussion puts aside augmented reality and VR interactive gaming and instead focuses on 360-degree video viewed within a VR headset. The goal for many developers is to achieve a full visual immersion, a photo-realistic 3D, 360-degree view. Two obstacles to achieving this end are pixel density, so that viewers see not a screen of dots but the illusion of physical objects, and latency reduction, so that the image updates immediately when the viewer turns her head (Russell, 2015). Current 360-degree capture technologies, like these Go Pro rigs, use multiple digital video sources and stitching software to assemble a 360-degree image, but the resulting video may or may not be stereoscopic, depending on the rig. Like traditional video, 360 VR plays in a linear sequence, which distinguishes it from VR gaming.

Owlchemy Labs' JOB SIMULATOR

Crytek's THE CLIMB

Beyond immersive video, the sensory experience of VR differs from cinema in other important ways. Because viewers must turn their heads to see the full range of video, they engage the vestibular sense that works in concert with the visual sense, contributing to the feeling of immersion. However, visual representations of the rest of the body usually are not present, causing a conflict between the proprioceptive and visual senses(Caddy, 2016). Players of some VR games have described out-of-body experiences because of this conflict (Valdes, 2016). Games that use haptic controls, like Owlchemy Labs' JOB SIMULATOR and Crytek's THE CLIMB, generate virtual hands to represent players' own bodies in order to avoid that feeling.

One issue with immersion in 360 video is the accompanying sound. Like binocular vision, humans have binaural hearing. When turning one's head, slight

changes in the timing and loudness of sound indicate its directionality. Some VR videos take this into consideration, developing spatial sound mixes that change direction when viewers' heads turn. However, sound in the natural environment is not only heard but also felt. The fact that headphones often feed the soundtrack to VR videos precludes the ability to feel the sound. The point one in 5.1 surround sound is the subwoofer, a speaker designed to produce subsonic vibrations that are felt as much as they are heard. Some devices, like the Subpac M2, transfer low-frequency sounds directly to the body via a wearable vest. As developers build haptic devices for VR, they should take into consideration the haptic properties of sound.

Edison's Kinetoscope vs. Lumière Brothers' Cinematographe

Unlike traditional cinema and video, VR is an individual experience. Audiences can be together only in the virtual sense, like SECOND LIFE or characters in *Ready Player One*. We can appreciate the historical approach of poetics by remembering the birth of cinema. Two competing formats, Edison's Kinetoscope, and the Lumière Brothers' Cinematographe, had two very different ideas about how film should be experienced. Edison's model envisioned the Nickelodeon, where each customer could see their own choice, while the Cinematographe was inherently a group experience. Though cinema won out, VR has retrieved the tradition of the kinetoscope, and we would do well not to attempt to force cinematic metaphors and practices onto this individually experienced medium.

View from the International Space Station.

This early period of VR mimics early film travelogues, which showed audiences far-off places they otherwise would not see.[5] 360 video allows viewers to experience a firefight in Fallujah, the view from the International Space Station, under the ocean's surface, or the top of the World Trade Center. Concert promoters and sports venues advertise front row VR seats, and 360-VR documentaries promise connection to other people and places.

Another trend in VR is allowing viewers to experience visceral experiences from the safe distance of VR goggles. While the sensation of extreme experiences can be more real in VR than on a video screen, viewers still are able to separate VR experiences from real life. Therapists are using VR for cognitive behavioral therapy to treat psychological conditions. For instance, simulating an out-of-body experience has been shown to reduce the fear of death (Bourdin, Barberia, Olivia, Slater & Buckingham, 2017), and researchers at the University of Washington treat arachnophobia by having patients play the VR game SPIDERS! Artists are using the medium to explore our relationship to violence. Jordan Wolfson, who is known

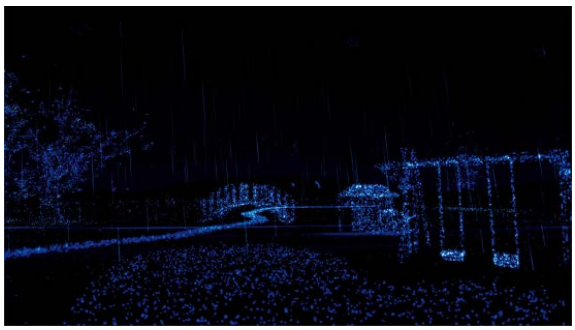
5 Jennifer Peterson (2013) provides a vivid history of early film travelogues.

Viewers watch Jordan Wolfson's REAL VIOLENCE

for creating works that implicate viewers in violent acts, is showing the VR work REAL VIOLENCE at this year's Whitney Biennial in New York. In the short 2.5-minute 360 video, the artist approaches a kneeling man and hits his head with a baseball bat, then kicks and beats the man until blood spurts out. The *New Yorker*'s Alexandra Schwartz (2017) describes her first reaction as 'disgust, repulsion, anger at being made to watch an atrocity' but, by her third viewing, she says, 'my narrative brain had invented a counterpoint scenario.' She continues: 'Fiction is a morally plastic force; point of view can determine much.'

HUNGER IN L.A.

In 2012, Nonny de la Peña created the VR experience HUNGER IN L.A. which uses audio recorded at a food bank at the First Unitarian Church in Los Angeles. De la Peña said that her goal was to: 'Take a story about people who are hungry, who I felt were invisible, and make them visible in a way that was so compelling that people would really get what the f--- was going on out there' (Goodman, 2012). During the recording, someone waiting in line has a seizure, and volunteers struggle to restore order while others begin to rush and grab food. The visceral audio is paired with a VR computer animation of the scene. Unlike 360 video, this VR experience uses motion tracking to allow viewers to walk through the scene. Even so, viewers cannot interact or influence the linear playing out of the narrative. Viewers complained that the animated figures fell into the uncanny valley, the point at which people look almost photorealistic but not quite, which creates an unsettling feeling.[6] Pairing the animation with sound that includes artifacts of recording, including background noise and off-mic voices, reinforces this aesthetic.



NOTES ON BLINDNESS

The impressionistic style of NOTES ON BLINDNESS avoids the uncanny valley and creates a multisensory experience that simulates the emotional cues John Hull experiences as he loses his sight. This VR experience pairs recorded audio with an animated 360 image, but one that is somewhat interactive. The sound of the tape recorder hissing and clicking on and off foregrounds the means of production, cueing the audience that what they are hearing is Hull's own words as he intentionally recorded them. The image consists of pixelated impressions of objects, as if the

6 A description of how virtual characters fall into the uncanny valley, and how to design characters to avoid this psychological effect, can be found in Tinwell, Grimshaw, Nabi & Williams (2011).

audience were using a form of sonar to visualize the environment. The idea that sound is creating the image is reinforced by the background sounds mixed in to Hull's recordings: the wind, the choir, and sounds of children playing in a park. Viewers interact by turning their heads to a particular location and by using a device to click on certain objects. This greater control, combined with the multi-sensory simulation of using sound to see, contributes to the theme of finding power and peace after losing a dominant means of perception.

MAN ON SPIRE

Looking back at the police helicopter, viewers can see the operator holding the VR camera mount out the window.

The pattern of documentation artifacts leads me to one last comparison. The *New York Times* VR short MAN ON SPIRE strives to create an immersive experience. The VR documentary shows professional climber and photographer Jimmy Chin ascending the top spire of the newly built 1 World Trade Center tower. The video was produced at Koncept VR, and editors there painstakingly painted out the VR camera mount and blended the seams of the image to generate a truly spherical VR image. No matter where one looks, one sees the environment and no means of production. Contrast this with the VR footage of the police helicopter hovering over the city of Oslo. Looking back at the helicopter, viewers can see the operator holding the VR camera mount out the window.

Once again, a historical approach to poetics can illuminate and project traditions for the new medium of VR. The Direct Cinema movement derived a portion of its power from foregrounding the technologies of production as evidence of documentation. Over-exposed flashes of film, handheld camera movement, and the sound of the microphones bumping or rubbing against objects delivered perceptual cues that the documentaries were engaged in the act of documenting, and audiences are seeing the artifact of that recording. VR documentarians must choose whether their goal is to create a seamless VR experience or to communicate to audiences that what has been recorded is not the truth, but the truth as documented. The challenge is that the presentation through VR can manipulate this truth, and that manipulation becomes that much harder to discern. If seeing is believing, then experiencing with multisensory perception is believing that much more.

While this paper has explored the perceptual experience of VR documentaries, what it has left unaddressed are the social and political dimensions of VR. As a student of Neil Postman, I feel an obligation to bring up the questions he would ask about any new media technology:

1) What is the problem that this technology solves?
2) Whose problem is it?
3) What new problems might the new technology create?

4) Which people and institutions might gain economic and political power once this new technology is put to use?
5) Which people and institutions might be harmed by the introduction and use of this new technology?
6) What changes in language and social organization might occur with this new technology?
(Postman, 2000, pp. 42-53)

In his book *Technopoly* (1993), Postman referred to the loving resistance fighter. This figure is not, as many assume, a Luddite who rejects technology out of hand. Rather, the loving resistance fighter is someone who foregrounds dominant media technologies, asks questions of them, and is aware of their effects. An often-stated purpose of documentaries is to make viewers aware of problems of the powerless and overlooked, and to encourage action to address those problems. As we think about how VR immerses audiences in these experiences, we either can ask how to control the development of VR and establish traditions of production and perception that are beneficial to those without power, or we can ignore its biases and allow the medium to become environmental, ceding that control and becoming unaware of its effects upon us. As John Hull concludes Notes on Blindness, 'After all, being human is not seeing, it's loving.'

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