# Interview with Dr. Otto H. MacLin on Visual Perception

**LLF:** Hello Dr. Mac Lin. As a recognized and experienced specialist in Perception, I would like to interview you on issues related to Visual Aesthetics and Perception. Forgive me for my lack of knowledge on the matter.

Let's begin by your studies on Perception, and your findings

**Otto:** I was trained in perception by Dr. Mike Webster who is a color vision scientist. Dr. Robert L. Solso trained me in cognition. My area of speciality is face recognition (both cognitive and perceptual aspects) and I have been focusing on forensic issues involving eyewitness identification. An interesting perceptual phenomenon we discovered is that changing subtle attributes on a face such as hair can radically alter how we perceive and process the face. Specifically, when we change the hair style on a face, the hair functions as a racial marker which in turn changes what race the person appears to be. When the race of the face is perceived as that of different from one's own, the face is processed more superficially making it difficult to later recognize the face. This goes towards explaining what is called the cross-race effect which is of course a big problem within our legal system. The problem is that most if not all of the processing is done automatically and we are not consciously aware of these processes.

We also have examined how simply being exposed to one face radically alters the perception of another face. Perception scientists have studied how adapting to colors or to movement changes the perception of similar experiences. Adaptation was originally thought to be a low lever perceptual phenomenon (working only with things like colors and movement). The research community was entirely surprised when we demonstrated that higher order processing, such as that for faces, could be affected by adaptation.

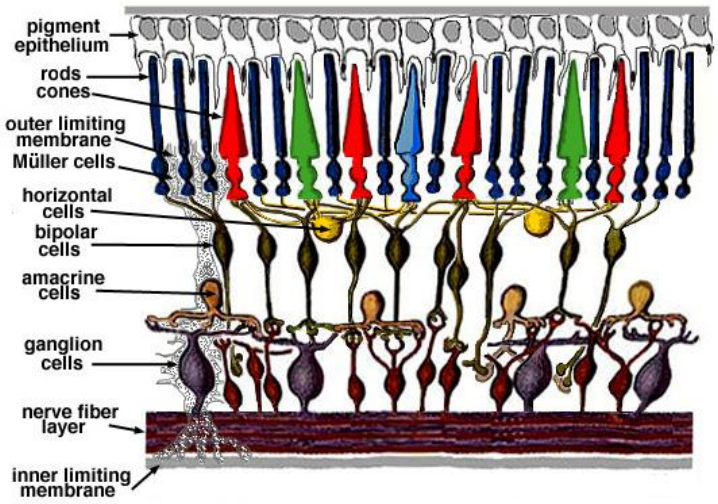
**LLF:** In relation to visual perception would you like to comment on the following sentence? "We see with our brain and not with our eyes."

**Otto:** I had a question on one of my perception exams this semester asking the students to discuss problems with the eye (for example color blindness). A couple of the students discussed prosopagnosia (the inability to recognize individual faces). This is incorrect because prosopgnosia occurs from damage to the temporal lobe of the brain, not the eye proper. I asked one of the students why they gave that answer and she said, "when I first started the

class I saw the eye as something totally separate from the brain, but as I learn more about the visual system, I realize that the eye and the brain are inseparable." I gave the student partial credit because I agree that the visual system relies on its many parts, to function as a whole. Remove one part and the entire system breaks down.

I like the question you ask because it is a good conversation starter and can be addressed on many levels. Another way to look at the question is to ask yourself, what does it mean to see? Clearly, many people have full functioning visual systems, yet they don't appear to see much at all or they see only select aspects of the world. Some people are blind at birth but are capable of seeing (http://www.sciencedaily.com/releases/2010/10/101006131203.htm) to the extent that they use parts of their visual cortex to 'see.'

The other cool thing is that our eyes are not just cameras that capture light and convert it into electrical impulses. There is a considerable amount of information processing going on at the retinal/eye level. Check out this schematic of the retina:




http://www.rvscny.com/simple_retina2.jpg

Notice how some cells run vertical while other run horizontal. There is a considerable amount of 'cross-talk' going on long before the light patterns even leave the eyeball. Each cell needs to know what the other cells are "seeing," this is what the horizontal cells are doing; they are looking at cluster of light patterns. From these cluster patterns we can perceive/see lines and edges (as you know are important in art); they also 'see' motion.

We have three receptors that respond to different light/electromagnetic wave lengths. But they do not see red, blue or green. The cells need to know what its neighbouring cells see before it can tell what color the light is. This is getting a bit deep but because the way the receptors work some wave lengths can be interpreted several different ways.

These are called metamers (http://en.wikipedia.org/wiki/Metamerism_(color)) but since the responses of the individual receptors are examined in a cluster, the eye can sort it out before the information is passed along the visual system.

So I guess I'll take the fun out of your question and say that we see with our eyes **and** with our brain.

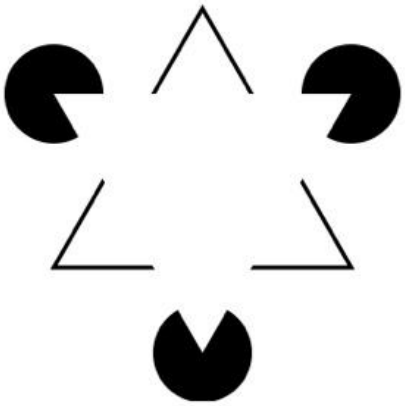
**LLF:** Thanks for your explanation. I have also a series of questions that were inspired by Dr. Solso's book *Cognition and the Visual Arts (1996)* who said that "Different styles of art affect people differently" (pg. 231). Do you want to comment on this?

**Otto:** I can see why Bob said that. Some brains like complex figures, other brains like simple figures. Just like some people like complex tasks, while others are OK with simple mundane tasks. This is why they have aptitude tests to help screen out the individual differences. The same would apply to abstract and realistic art.

**LLF:** Interesting. I think I am the type of person who likes to look at complex figures and who likes to complicate simple figures. Well, in the same book Solso mentions that abstract and experimental art which is more complex than 'realistic art' is by nature a 'cerebral art', a top-down process where the viewer (trained or untrained) has to apply his or her intellect in order to appreciate it fully.

My question is when we do not have an easy, referential point to associate old information to what we are seeing, what type of patterns, neural synaptic connections does the reader-viewer use in order to interpret what he or she sees?

**Otto:** Abstract art has a greater amount of ambiguity than realist art. So let's talk about how the brain resolves ambiguity. The brain uses what we call heuristics to interpret the world. Heuristics are rules of thumb that usually lead to the right conclusion. Compare this to algorithms (such as 2 + 2) which always lead us to the right conclusion. Check out this illusion:



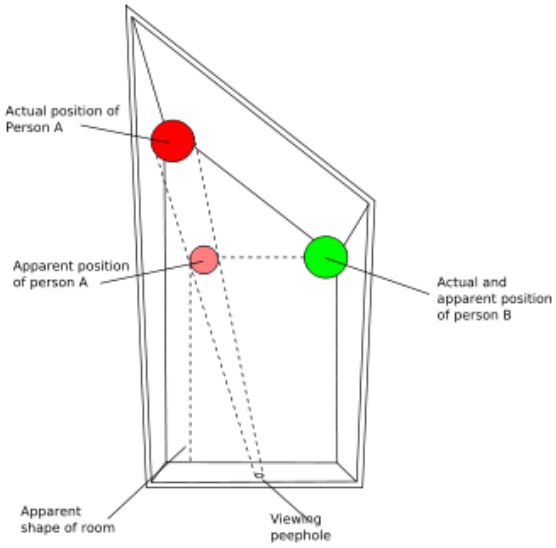
http://chartshapes.files.wordpress.com/2010/08/12-kanizsatriangle.jpg

The brain sees this pattern of shapes and has to determine what it is. The conclusion is that there is a white triangle floating in front of three circles and above another triangle. Depth is perceived. Not only does the brain see a white triangle, the triangle looks whiter than the background even though it is exactly the same pixel value. This occurs because the brain needs to see the lines of the triangle. Why would this be? What is the probability of three Pac Man shapes in the world compared to the probability of three circles in the world? It is a higher probability that they are circles. If they are circles, something must be occluding them. What is more probable, 3 small triangles covering the circles just so, or one larger triangle occluding the three circles? This is why we see the triangle. Our brain knows about occlusion. Closer things cover things that are further away. Since the circles are covered they appear further back, etc.

Here is an example of how expectations (probability) alter our perceptions. The Ames room:

http://nickshell1983.files.wordpress.com/2010/12/ames-room-2.jpg

We expect that the room is a normal room with right angles (top down processing due to all of your experience with rooms). But it is not:




http://www.illusionism.org/media/ames-room.png

So we are forced to interpret the visual image as one person being smaller than the other, when in actuality they are simply farther away (something called size constancy).

The brain is constantly guessing using heuristics. It uses context and probability (how likely is it?) to resolve ambiguity.

**LLF:** In addition, following Solso again and in relation to the 2D, 3D problem, it seems that our brain sees in 3-D and beyond (the 3-D world is recorded by a two dimensional eye and then interpreted in 3-D) and when we view a 2-D object our brain sees depth. How do we transform the 2 D object in a 3 D experience?

**Otto:** Artists have already learned how to do this and they teach this to other artists. They learn by trial and error, the rules our brain automatically uses to perceive depth, occlusion, and linear perspective, for example, by putting something higher (on the paper) in the background, to make an object appear farther away, and by using less pattern detail in the 'distance' to mimic what our mind sees). That is why we call them pictorial depth cues.

There are many heuristics the brain uses for perceiving depth. Some are monocular (pictorial cues) and others are binocular (http://en.wikipedia.org/wiki/Depth_perception).

When my son was a baby he would watch these short videos with people speaking and singing in foreign languages. They would also show objects while naming them. When he was old enough to be able to stand and get to the television, he tried to grab the objects as they appeared. Another time he tried to grab flowers printed on the wallpaper. It is as though we expect the world to be 3D and have to learn about 2D.

Perhaps the question is how do we transform a 3D experience into a 2D experience...?

**LLF:** I am intrigued by the idea that (visual) information processing occurs mostly at the subconscious levels of the brain. For instance, if we are looking at a visual work of art can visual information processing occur automatically, on a subconscious level?

**Otto:** The short answer is Yes.

Much of the processing we do is at the subconscious level and this is a good thing since most processes are more efficient when automated. I recall first learning how to drive a car. I had to look at all the gauges, pay attention to the mirrors, listen to the engine to know when I had to shift, keep in mind which peddle was the brake and which was the accelerator so as not to get the two confused. I had to watch out for the parked cars and the cars passing from the opposite direction as well as those ahead and behind. I imagine learning to walk was equally difficult and far from automatic/subconscious, however I have no recollection of those early days. Back to the car, I have been driving so long and the process is now so automatic/subconscious, that I often get lost in thought while driving and at times end up travelling somewhere unintended such as accidently heading towards work on the weekend. So, if driving a car demands so much attention initially, imagine operating a human body (including the brain). Imagine constantly feeling the pressure of the seat, below me, the feeling of my socks, all of the sounds in the room (music, coughing noise, clicking of the keyboard), etc. Seeing each and every piece of clutter on my desk, the rims of my glasses, my nose (yes, we see it all the time and it actually takes up a considerable amount of visual space—but our brain nicely 'subtracts' it from conscious awareness).

One way we can deal with this overload problem is to have an automatic system for attention, where attention is directed to the relevant information in the world (just as you most likely started paying attention to your nose when I brought that up earlier). There are many other systems and heuristics the brain uses to automate our cognitive processing. There is strong evidence that we have multiple visual pathways, some that we are consciously aware of such as the one you used to look at your nose, and some that we are totally unaware of yet deliver visual information to the brain nonetheless. These visual systems are not monitored consciously.

Can we grasp the whole picture without being consciously aware of it?

I don't think we can ever grasp the whole picture at all unless perhaps it is a very simple (but even then I am not sure). Consciously or unconsciously, our brain's job is to construct a representation of the world and to persuade us that it is a complete representation. I can argue this more but perhaps an example or two will do. We experience the world in a very specific manner such that it allows us to go about our human business. We see the world at a specific size or resolution. Due to technological advances we now have the ability to see a snowflake as it really is using powerful microscopes:
http://www.psychologicalscience.com/perception/2011/04/snowflakes-up-close-a-small-fragile-world.html

What is the whole picture when it comes to a snow flake? Is the whole picture only what our eyes/brain can see? Can we even grasp the whole picture of a water splash when our brain is limited to a specific temporal resolution speed?
http://www.metacafe.com/watch/1592637/high_speed_camera/

My question to you is why would we want to grasp the whole picture anyway? I enjoy going back over a book and seeing something different in it. I enjoy going back to the theatre or museum and seeing something entirely new that completely changes or even contradicts what I thought I saw before. I like to watch movies. With many movies, not only can I guess the ending, I can guess the next line; they are highly predictable perhaps because I can grasp the whole picture. The best movies for me are those that defy my ability to form a whole picture. I have little room for predictable art as well when it tells me little about the world or about myself no matter how many times I see it or for how long. But then I guess I take a certain delight on the days my brain surprises me by taking me to work rather than my proper destination. Because, like good art it reminds that I am human and that I am only aware of a thin slice of the picture at any given time.

**LLF:** Thanks for those insights. They certainly help us to appreciate the richness and at the same time the 'imperfectness' of our interpretations in life and in a work of art.