Science Education Collection

Binocular Rivalry

URL: http://www.jove.com/science-education/10065

Overview

Source: Laboratory of Jonathan Flombaum—Johns Hopkins University

Why do people have two forward-facing eyes? By presenting the brain with two ever so slightly different images it becomes possible to comprehend visual problems that are far more difficult to process through a single eye. Chief among these is the problem of 3-D perception, seeing the world in three dimensions, despite retinal inputs in only two dimensions.

What happens if each eye receives two completely different images? That does not happen in nature, to be sure, but it can be contrived in the laboratory in a set-up called binocular rivalry.

Binocular rivalry is a common laboratory paradigm for investigating the ways that the brain integrates information from two eyes, and in recent years, the mechanisms responsible for producing conscious experience.

Procedure

1. Equipment

1. To easily produce binocular rivalry, use a pair of red-cyan glasses **(Figure 1)**.

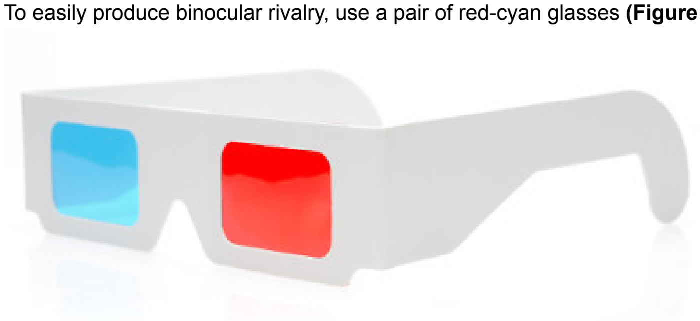

Figure 1. A pair of red-cyan rivalry glasses. The glasses make it possible to present two overlaid images such that only one arrives to each eye. The red lens will filter out all but red light before it reaches a viewer's eye, and the cyan lens will filter out all but blue light. This means that a blue tinted image won't make it to the eye with the red lens, and a red tinted image won't make it to the eye behind the blue lens

2. A stopwatch will also be necessary.

2. Stimulus

1. An easy demonstration having to do with rivalry involves nonsense words superimposed on something meaningful.
2. In PowerPoint©, create a slide with the word 'Hello' written in blue, and on top of it write the letters 'Cfbal' written in red. Make the word on top 50% transparent. It will look like this (**Figure 2**).

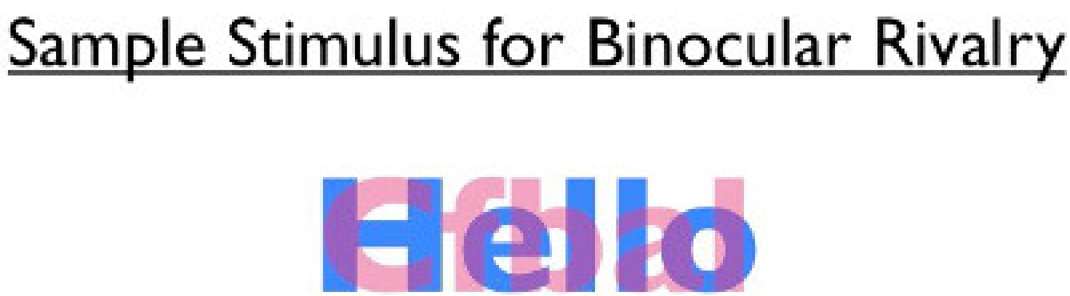

Figure 2. Sample stimulus for a demonstration of binocular rivalry. The word 'Hello' is written in blue, and in a 50% transparent red, the nonsense letters 'Cfbal' are written on top.

3. Running the Experiment

1. Print the slide on a piece of white paper. Seat a participant in front of the paper and ask them to put on the glasses.

2. Set the stopwatch to countdown 120 seconds.
3. Instruct the participant that every ten seconds they will be asked to report what they see, and that they should answer in one of three ways, ‘Hello,’ ‘Cfbal,’ or ‘Mixed / Unclear’.
4. Begin the count, and every ten seconds, ask the participant what they see. Mark down the responses.

Results

The results can be graphed by plotting the raw data (**Figure 3)**, which is what the participant reported seeing as a function of time.

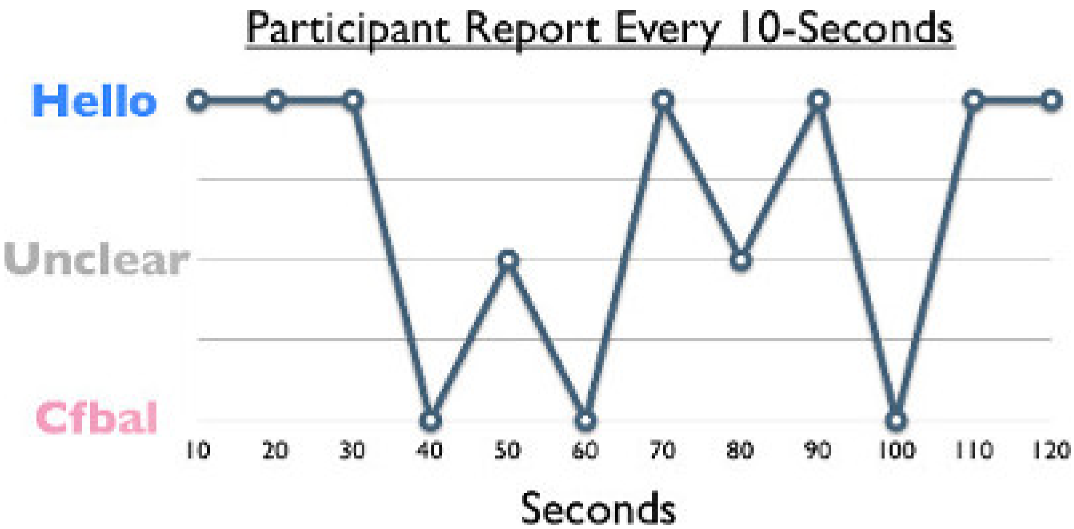

Figure 3. Participants reports what he sees every 10-seconds. The majority of reports involve the coherent word ‘Hello.’ But critically, the object the participant is aware of changes frequently, and can change rapidly.

One thing that should be clear is that the participant tends to only be aware of one of the words at a time. The one they are aware of at any given moment can change quickly and frequently though. This suggests that the brain recognizes that something is not right, and it tries to present a stable image to the observer—only here, the brain can’t decide what the right stable image is.

From these raw data, the proportion of each report type can also be graphed (**Figure 4)**.

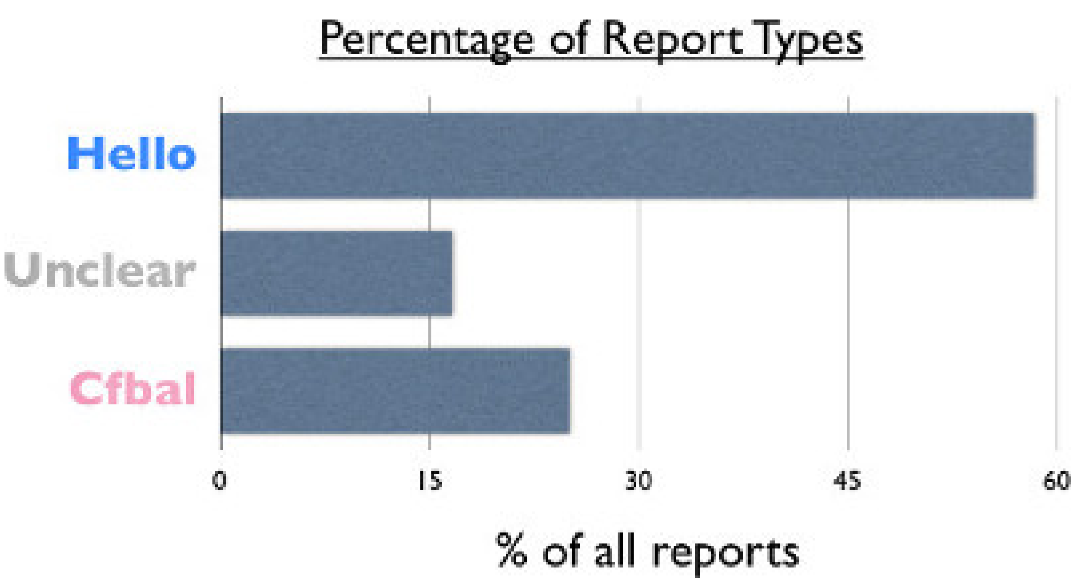

Figure 4. Percentage of reporting each category of visual image. The majority of reports clearly involve the coherent word ‘Hello.’

Looking at the results like this should make it clear that even though the participant’s experience changed rapidly and frequently, the word ‘Hello’ dominated. This and similar results are taken as evidence that the brain evaluates the contents of each image and prefers to bring to awareness things that make sense, are familiar, and have meaning.

Applications and Summary

Binocular rivalry forms the basis for most 3D movies and games—although these days, they usually use other kinds of filters, not red and cyan. The logic is the same though: If two images are different in just the right ways, and presented to each eye separately, then the brain can be tricked into seeing 3D when the surface it is looking at is actually 2D, like a movie screen.

If you look at this picture (**Figure 5)** with the glasses, it should appear to be 3D.

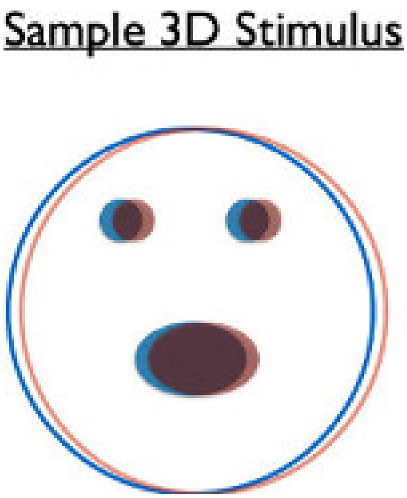

Figure 5. A sample of a 3D stimulus that takes advantage of binocular rivalry. In this case, the two overlaid images are identical, but slightly misaligned. This takes advantage of the fact that the brain always uses slight misalignment in the two images arriving at the eyes to infer 3D relationships between objects in the world.

In recent years, binocular rivalry has also become one of the main paradigms used in studies that try to find the 'Neural Correlates of Consciousness,' NCC for short. The idea is that some events in the human brain must make information—and visual information in particular—conscious. What are they? Binocular rivalry lets researchers with neuroimaging tools know when the nature of a person's conscious experience is changing suddenly—like the participant in this demonstration who went from seeing one word to the other. Researchers can then try to map those changes in conscious experience onto events taking place in the brain at those moments. For example, it has been known for quite sometime that different states of wakefulness —whether a person is asleep, relaxed, or wide awake and even on edge— each correlates with different brain waves, measured using the electroencephalogram (**Figure 6)**. Current research is trying to determine whether changes between states of wakefulness correlate with changes in conscious perception, diagnosed using the binocular rivalry paradigm.

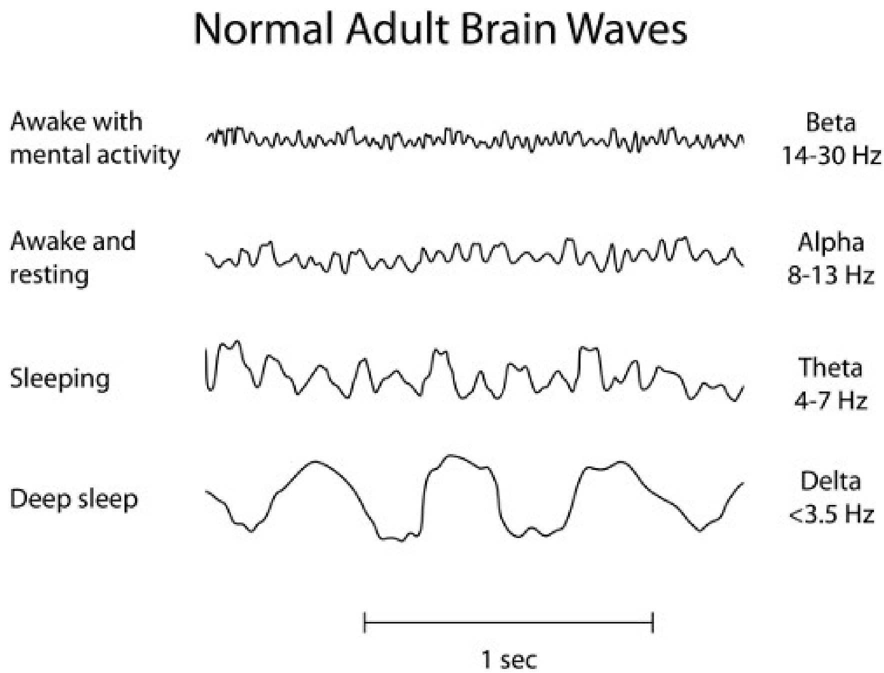

Figure 6. Normal Adult Brain Waves. Normal adult brain waves for adults awake with mental activity, awake and resting, sleeping, and in a deep sleep.