Outsmarting Contrast, Together.

Waze: A Case Study on Biological Processing Systems

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Introduction

The science of perception contains a vast amount of information on how human beings process, gather, store, group, transform, map, interpret and manipulate data in terms of visualization. Human beings are accustomed to this process and are extremely good at it because evolution has provided primates with a complex patchwork of visual areas occupying the posterior 50% or so of the cerebral cortex[i] and we have been wired to do it for millions of years in order to survive. Human capacity to manage visual data is so complex that, more information is acquired through vision than all other senses - sound, taste, touch and smell- combined.

Humans are organization animals. Our attention gravitates towards grouping by proximity, perimeter and contour changes in the objects we observe. We connect the dots and blend the visual data. We can't help but to group by proximity depending on the attraction constant of similar objects[ii], and categorize what we see. The grouped and connected lines form a shortcut to be memorized and used intuitively. This accumulated visual data is grouped throughout the cognitive process and simplifies our understanding of the perceived image and enable us to process the world we see much more efficiently.

In order to process this visual data, one of the fundamental components is to find similar patterns of data and sort out similarities in many variables including color, texture and movement patterns which helps to enhance the speed of perception. This mechanism is so important that nearly 20 billion neurons are devoted to this single task of analyzing visual information[iii].

The Nature of Biological Receptors

Human visual system can be thought to be composed of two major segments: the superior system subserving visual constructive and spatial relationships and the inferior system subserving object recognition[iv]. In order to visually perceive, human visual system needs to interact with the light, which enters the eye first and passes through cornea and reaches into the light-sensing section of the eye, the retina. Retina is composed of two different types of cell systems, rods and cones. The rod system has very low spatial resolution but is extremely sensitive to light; it is therefore specialized for sensitivity at the expense of resolution. Conversely, the cone system has very high spatial resolution but is relatively insensitive to light; it is therefore specialized for acuity at the expense of sensitivity. The properties of the cone system also allow humans and many other animals to see color[v]. When the light meets these rods and cones in the retina, a chemical reaction starts that results in visual perception, seeing thus

understanding the world. Until late seventies, the visualization theory suggested that a visual image is constructed inside the mind, thus, it is possible to see without visual data.

Today, it is known that visualizing data is not an internal process but a graphical representation of data and concepts, an external artifact supporting decision making, therefore the way the visualized data perceived may also function as cognitive tools, such as thinking and interacting with the world around us.[vi]

Signal Detection and Strength

Interaction with the outside world through visual data is formed upon a framework called signal design. Signal design is about stronger signals accessing the threshold first and receiving the attention of the observer. Once a possible target is located in visual search, it becomes necessary to confirm that it really is the item of interest[vii]. It is related to the signal detection theory, a framework for understanding accuracy that makes the role of decision processes explicit. There are four main possible outcomes when evaluating a signal for decision making, depending on either; the signal is present and perceived (hit), absent and not acted upon (correct rejection), and either the receiver perceives a false presence of the signal (false alarm) or unable to detect its existence (miss).[viii]

The theory states that the relevant information is represented by the observer identifying some aspects of the representation with sensitivity, or inherent accuracy, and others with response factors. Errors arise due to the fact that while the the signal is perceived, noise is also perceived and when these two overlap, it causes inaccurate results and sensitivity issues in the perception of the visualized data[ix] As an efficiency principle, human beings are very adaptable to their surroundings and when overly used signals overwhelm the observer by continuous stimuli, it causes fatigue.

In user experience design, an effective result may be achieved while sending out a signal, by using the adequate strength that suits best to the conditions of the observer. According to De Valois, stimuli can be divided into three broad categories. The explicitly attended stimuli which can be recognized and acted upon, the stimuli that attention never reaches which seem to leave marks of their preattentive features but probably not of their more complex properties and finally the stimuli that receive some processing resources but fail to leave any lasting impression on the observer, which may be seen but instantly forgotten, leaving implicit but not explicit traces for the experimenter to measure.[x]

When the explicitly attended stimuli is overly used in a need to gain attention at all times, it may cause fatigue and loss of attention, therefore being able to manage the attention by optimizing the signal strength in accordance with the user and concurrently taking into account the environment and the tasks involved are the most important factors for the efficiency and continuity throughout the user experience.

The visual representation of the information reduces complex cognitive work needed to perform certain tasks[xi]. To be able to detect the signal which will be interpreted as visual data, to determine its strength, to synthesize information and to derive insight from it, there are many variables that may be used, changed and controlled.

The Importance of Contrast as a Variable

One of these variables is contrast, the measure of perceived difference between the foreground and the background of an object. There are several ways to achieve and control contrast. One way to change contrast is to change the background color of the object, in other words, surrounding the object with a lighter or a darker color. Differentiating the color that surround the object and creating a frame effect is also highly preferred. Another method is changing the size of an image in which the contrast level increases and the perception of the visual data changes as well. The color is basically determined by three variables: hue, saturation and the perceived brightness. Hence, contrast may also be changed using these variables. Sometimes, the contrast formed by the processing of the visual data gets so dense, it contains a blur effect. John Maeda exemplifies it through iPods, where the control button blurs all controls into one image of simplicity[xii].

Contrast sensitivity, the ability to perceive a lightness or brightness in two areas, generally measured as the reciprocal of the contrast threshold[xiii], sheds light on an important efficiency principle of the cognitive system that operates on its ability to detect the changes in the environment such as strikingly different variances. The higher the contrast is, the quicker it reaches the visualization platform of the brain. It is also one of the key elements that form the strength of a signal in a sensory perspective. To sum up, contrast receives utmost attention and is one of the most basic tools used in interaction design.

Waze: A Product Review

Acquired by Google in 2013 for a reported 1.3 billion $, Waze is A GPS-based app for smartphones, which displays screens that provides turn-by-turn information and user-submitted travel times and route details. It is a community-driven application and gathers traffic data from users so it enables real-time traffic updates. And it is free as well, so the app has more than 50 million active users[xiv]. Waze uses "Outsmarting Traffic, Together" as its motto. Waze has some usability issues in terms of biological detection of the signal, especially related to contrast issues.

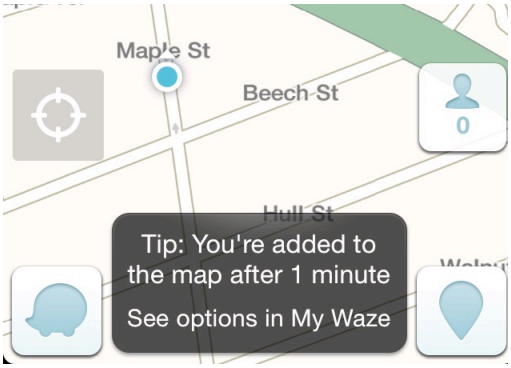

Fig. 1

Weak contrast impacts the ability to see main features. In its navigation screen, it uses light blue symbols on grey and beige background (Fig 1). Other than the main roads that are hard to spot on the overview map, the symbols surrounding the visual are hard to see as well.

Blue color is known to offer poor visual acuity so the colors chosen for this interface of the app are not suitable for elderly people who have trouble seeing blue color, and people who have visibility problems, especially colorblind males who make up of 8% of the population should have been taken into account. Using blue on beige and grey background decreases the ability to observe the symbols clearly and this is a major contrast issue.

In Waze's main menu, Gas Prices and Map Chat symbols in the menu both use green colors (Fig2). They are hard to differentiate.

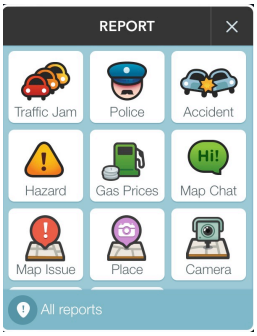

Fig 2.

Also; Map Issue, Place and Camera symbols on the bottom next to each other use the same background shapes and all three have the same background colors. Regular patterns that repeat should have been avoided.

Repeating similar patterns and lack of color differentiation may be observed throughout the symbols in Waze menu (Fig 3, 4, 5):

- Fig. 3 describes Police in Visible and Hidden form, yet use the similar patterns.
- Fig. 4 successfully uses yellow color to warn about the hazard but On Road and Shoulder symbols are so alike, it is hard to differentiate these two symbols and it may cause errors in the placement of the hazard.
- Fig 5 uses yellow colors to imply that a traffic accident has occurred, yet the size of both Minor and Major accident symbols are hard to differentiate from each other.

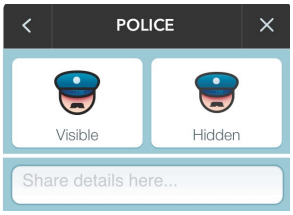

Fig 3.

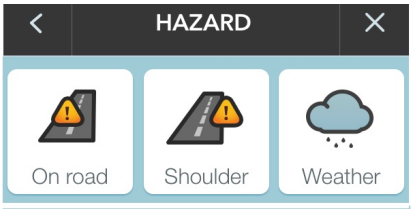

Fig 4.

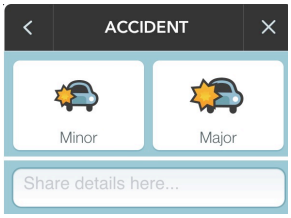

Fig 5.

Conclusion:

Ability to produce meaningful visual outcomes needs hands-on experience in terms of information visualization. To avoid misses and false alarms while receiving signals is of utmost importance. Thus; in order to offer superior value and optimized visual experience to the user, a designer has to take into account the principles of the perception of light, signal detection, contrast calibration, brightness, hue and luminance adjustments, and simplify the experience by thoughtful reduction of the complexities of the visual interaction to maximize the quality of the user experience.

Waze, a globally used smartphone navigation application has usability problems related to contrast issues. The colors used on the app make it harder to spot the symbols. In my opinion, the app may offer a much efficient visual interaction experience once the contrast issues are minimized and repeating patterns eliminated. Due to the visual acuity problems, especially contrast related usability problems, I believe that Waze, while outsmarting traffic, has to outsmart contrast related issues for a better user experience, too.

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