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Preattentive Processing and MarketWatch.com

A Case Study

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The process that the brain uses to translate raw visual information into recognizable features is not instantaneous; it takes milliseconds before a viewer mentally acknowledges an element in his sight (Treisman & Gormician, 1988; Healey et. al, 1996). During this time, the brain uses preattentive processing to detect what features stand out from the surroundings (Treisman & Gormican, 1988). As a species, we have evolved to possess preattentive processing in order to automatically defend against potential threats without the need to classify the possibly dangerous entity (Öhman, 1997). As early as the 1920's, psychologists have been working on identifying the shortcuts the brain uses to group features (Gordon, 2004). The earliest school of thought whose observations hold relevant in the modern era is Gestalt psychology. Although the observations were valid, the neurological components of their specific theories have been proven to be inadequate (Gordon, 2004). For the modern UX designer, knowing how the brain groups objects together preattentively will allow information being relayed through their designs to be quickly and clearly understood. For this case study, we will review how MarketWatch, a website for viewing stock information in real time, attempts to group pieces of information together.

Preattentive Processing

A key feature that distinguishes preattentive processing from more active forms of brain processing is that little to no perceptual resources are required to execute (Ben-av et. al, 1992; Healey et. al, 1996). As such, the response time to process preattentive information is constant and independent of how much irrelevant information is presented (Treisman & Gormician, 1988, Nakayama & Silverman, 1986). The maximum amount of time for a task to be considered preattentive is up for debate among neuroscientists, ranging from 10 milliseconds per item (Treisman & Gormician, 1988) to 200 milliseconds for large multielemental displays (Healey et. al, 1996). For UX designers, all that needs to be known is that preattentive processing in terms of speed is rapid, but not instantaneous. However, the actions that take place biologically during this time should be explained.

The Biology

When the eye shifts from one position to another, the muscles around the eye rotates the whole eye so that the light shining through the eye gets focused most on the fovea (Deubel & Schneider, 1996). These rapid eye movements, known as saccades, are used to locate high-attention areas and direct the eyes' rotation towards those areas (Deubel & Schneider, 1996). Saccades occur even when the person's view is focused on one spot because it would allow the ganglion cells in the eyes receive more light (Hikosaka et. al, 2000).

Ganglion cells within the retina combine the light information from specific rods and cells. These ganglion cells also have their own receptive field, which measures the intensity of light that is being received (Róka et. al, 2007). . There are two classifications of the center-surround receptive fields found in ganglion cells (Róka et. al, 2007). On-center off-surround receptive fields get activated when the center receives light and becomes inhibited when light hits the area surrounding the center. Off-center on-surround receptive fields react in the exact opposite way. By comparing the intensities of light they are receiving to the intensity of light their neighbors receive, ganglion cells can start to piece together how the contours of the view are shaped (Marr & Hildreth, 1978).

The primary purpose of the Lateral Geniculate Nucleus (LGN) is to deliver the sensory information from the retina's ganglion cells to the Primary Visual Cortex (Ling et. al, 2015). However, evidence has shown that the LGN itself has its own set of receptive fields and may play a role in processing orientation information (Ling et. al, 2015).

The Primary Visual Cortex (V1) is the part of the brain that receives the visual information processed from the LGN and starts to group together elements of what was seen (Livingston & Hubel, 1988). Livingstone & Hubel (1988) explain that the cells in V1 are all tuned to react to specific features from the visual data received from the LGN. While many cells that detect orientation and size can also be found in other visual processing areas in the brain, V1 is the only place that contains what is known as blob cells, which react to different colors. When these cells are collectively activated or inhibited, that areas of interest stand out visually as the brain inhibits the visuals surrounding those areas (Series et. al, 2004; Yang et. al, 2015). With this filtered set of information, V1 finds the contrasting elements to determine the contours detected in view (Field et. al, 1992; Yang et. al 2015). From there, V1 begins to construct feature maps, which are used in combination to start to group items together (Treisman & Gormician, 1988).

Methods of Grouping

For items in sight to be grouped quickly, the cells in V1 are tuned to react to the exposure of specific visual features. Several researchers (Julesz & Bergen, 1983; Treisman & Gormician, 1988; Ben-av et. al, 1992; Logan, 1996) have identified several characteristics that make items stand out from their surroundings. Lines that have orientations and curvature that differ from the lines surrounding them will immediately stand out. Unique shapes, sizes, colors and hues will also stand out from crowded surroundings. Distance also plays a part in how items stand out, as an element or a set of elements that are separated from other elements will be immediately noticeable.

When these features are organized on the appropriate feature maps, the brain uses these feature maps to group elements, allowing the brain to process more information per view (Treisman & Gormacian, 1988, Ben-av et. al, 1992). The perceptual effectiveness of grouping is enhanced when multiple grouping methods are utilized cooperatively and reduced when multiple grouping methods are competing against each other (Luna & Montoro, 2011). The following section will serve as a review of the various methods of grouping sections of sight.

Elements can be grouped together by proximity, which is dependent on the distance from one element to its surrounding elements (Logan, 1996; Palmer & Beck, 2007). Elements are most likely to be grouped together by proximity if the distance between the elements is significantly less than surrounding elements (Ben-av et. al, 1992; Logan, 1996; Palmer & Beck, 2007; Gori & Spillmann, 2010; Im et. al, 2016). Gori and Spillmann (2010) suggested that for two sets of elements to be interpreted as belonging to separate groups, the distance between the two closest elements of the two sets should be five times the distance between any two elements within the same set.

Grouping by similarity is based on the idea that elements that share the same visual characteristics should be associated with each other. Elements that are similar in orientation, size, color, or luminosity are likely to be grouped together in this fashion (Ben-av et. al, 1992, Healy et. al, 1996; Palmer & Beck, 2007; Gori & Spillmann, 2010, Luna & Montoro, 2011). Elements that share a similar shape may also be grouped together, but that specific grouping is less likely if the shapes are oriented in a way that is not easily comparable (Ben-av et. al, 1992).

Elements will also be grouped together if there is a continuous and predictable path from one element to another, which is grouping by continuation. If the individual positions of a set of dots from a larger set a dots form to create a line, the subset of elements will be considered a separate group from the surrounding elements (Conci et. al, 2009; Field et al, 1992). Field et. al (1992) demonstrated that a set of Gabor patches is more likely to be grouped together if there is also enough similarity in the orientation of neighboring elements so that a continuous curved line can be perceived. Elements that contain contours that align with one another are more likely to be grouped together, as there is a sense of connection between these objects (Conci et. al, 2009).

Closure is based on the idea that an element stands out more if the contour that surrounds it does not have gaps (Elder & Zucker, 1995). The region within the closed contour is then recognized as a common region, and all items within the contour would be associated with each other (Elder & Zucker, 1995). While the other grouping methods can be classified as intrinsic grouping principles, or grouped solely by each element's relationship to one another, common region can be identified as an extrinsic grouping principle, which means that external elements play a part in the grouping of these elements (Palmer & Beck, 2007; Luna & Montoro, 2011). As such, common regions can play a more influential role in grouping elements than the other grouping principles as long as there is not an overabundance of common regions (Palmer & Beck, 2007).

Case Study: MarketWatch

MarketWatch is a website dedicated to real-time viewing of stock markets. The website has up-to-date information on the performance of all stocks in the markets in New York, London, and Japan, and presents information that may influence the value of the stocks a visitor may possess. Having information presented clearly will help visitors quickly determine whether to buy or sell specific stocks. However, because MarketWatch does not adhere to some of the preattentive grouping principles, this process of information slows down, presenting a disadvantage to users.

The use of green is abundant throughout the website (See Figure 1), making information harder to organize at a glance, as information using the color green would be automatically grouped together by the similarity grouping principle. Green is used for information delivery (such as upcoming information titles, story titles, and positive stock growth arrows), dropdown menu buttons, branding, and even some advertising banners. While all of these features should be considered their own respective entities allocated to their own spaces, they preattentively get grouped from their common use of the color green.

Fully alleviating this issue is tricky, as green has been integrated in the branding of both MarketWatch and many of their advertisers. Marketwatch should at least consider, for their navigational features and titles, the use of a different color. Avoiding the use of the color green is also recommended within the small advertising banners on the site. MarketWatch should have the capability to curate the smaller banners and encourage advertisers who use green in their ads to use a different color scheme.

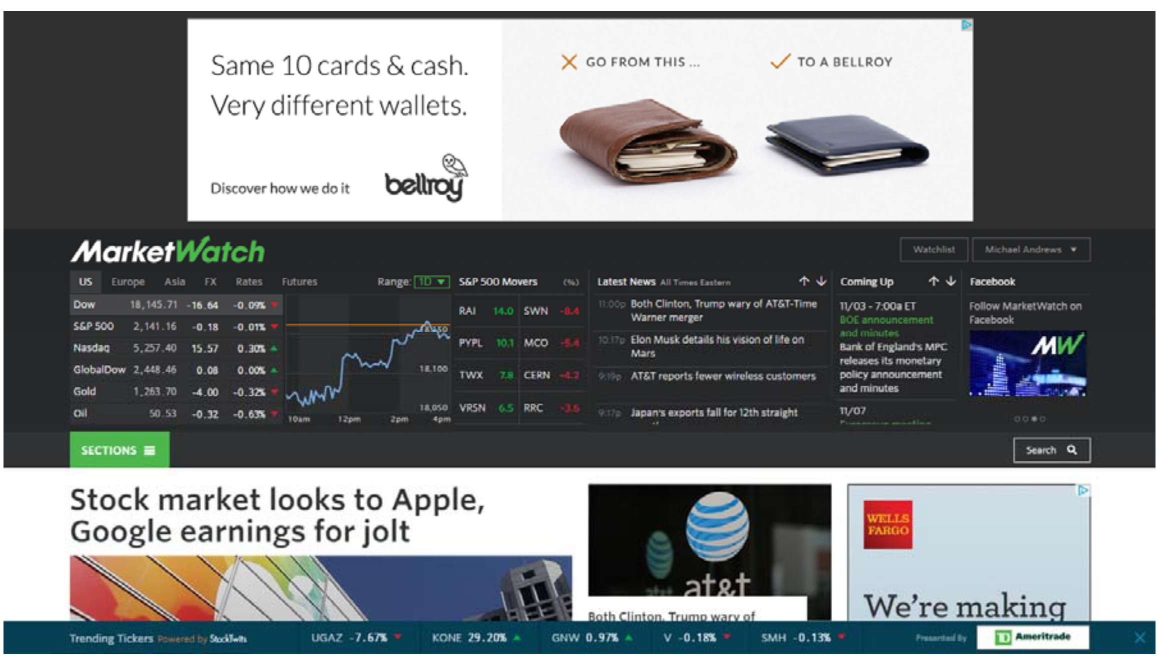

Figure 1: The first view of MarketWatch Website

Another issue the website faces involves the header of the homepage. The header contains a large amount of information in a small amount of space, and the result of this is that the columns of information are crammed together. Due to how close the sections are to one another, all the information becomes associated with each other when they should be considered separate entities, resulting in a violation of the proximity grouping principle. The only two elements that should be associated with each other are the chart and the graph on the far left (See Figure 2), but the unnoticeable difference in spacing between each column of information does not make this connection obvious.

To resolve this issue involving the involuntary grouping of informational columns, it would be recommended to remove the rightmost column and relocate it to another part of the page, perhaps as another row on the header. The rightmost column contains an advertisement and social media links, so placing social media links in their own area of the webpage would be appropriate. By doing this, the site designers can start to add space between the other sections of information by moving them to the right, allowing the chart and graph to be considered its own entity.

Figure 2: A closer look on the chart and graph in the header

When a user select one of the rows in the far left column, it alters the information that is displayed on the graph to its immediate right, showing how the prices have altered over time. There are also tabs at the top of these sections that allows users to see more information than just the five graphs a user can see by default. While the overlap these buttons make over the graph may cause the eventual association between the chart and the graph, several grouping principles cause these buttons to be unnoticeable.

The top buttons align with the static headers from the other columns of information, which means that the continuation principle will fall into effect. The coloration and font size of the top buttons and the headers are also similar enough that these elements tend to be grouped together by the similarity principle rather than segregated as their own entities. The presence of the interactive dropdown menu, which looks radically different from the tabs, increases the similarity with the static headers. In addition, the alignment of the text of the Futures tab with the start of the graph makes it appear as if this is the title of the graph section rather than another tab of the chart.

If the changes involving the increased spacing between information columns were implemented, increasing the chart's horizontal size would be an available option to remove the "Future" tab's alignment grouping with the graph. Changing the text color to another color, perhaps one to match the new color for the dropdown menus, would also make the tabs less likely to be associated with the static titles. An alternate method to ensure these elements stand out is to implement a negative polarity text display for the active tab, so that dark text on a light background is displayed. This change would fall in line with the minimalist style of the header and decreases the grouping with the headers.

Conclusion

While the brain is a very powerful organ that scientists still don't fully understand, it is still prone to vulnerabilities that can result in the thought process being overwhelmed before the thinker can even register the issue. Knowing how the human brain automatically processes information and groups elements together allows the brain to quickly and clearly present key information pertaining to what messages the UX designer wants to deliver to the end user of their products.

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