

Color Saturation and Advertising

SI 557 Visual Persuasion: Final Report

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Problem Statement

Why is color important in advertising? While this seems like a simple question, looking at data from color studies around the world reveals a complex story. Clarke and Honeycutt, Jr. (2000)¹ have determined that different cultures use different color schema due to the amount of sun received, natural selection, biological factors (number of cones and rods in the eye), etc. Zettl (2005)² indicates that these differences lead to different color conventions among the cultures around the world. When we delve further into the science behind color itself, people are affected by the many varying properties of color, specifically saturation, brightness, and hue. Studies have even been done looking at the effects of different combinations of color and lighting during shopping (Babin, Hardesty, Suter, 2003)!³

A study by Gorn et al. (1997)⁴ looked at saturation in advertising and feelings of excitement, relaxation, and boredom. Their findings indicate a positive correlation between saturation and excitement. One problem in Gorn et

¹ Clarke, I. III & Honeycutt, E. D. Jr. (2000) Color usage in international business to business advertising. *Industrial Marketing Management* 29, 255-261

² Zettl, H. (2005) *Sight, Sound, Motion*. Thomson Wadsworth, Belmont, CA.

³ Babin, B. J., Hardesty, D.M., & Suter, T. A. (2003) Color and shopping intentions: The intervening effects of price fairness and achieved affect. *Journal of Business Research*, 56, 541-551

⁴ Gorn, G.J., Chattopadhyay, A., Yi, T., & Dahl, D.W. (1997). Effects of color as an executional cue in advertising: They're in the shade. *Management of Science*, 43, 1387-1400.

al's study is that they only tested a small subset of emotions, which according to Mehrabian's Pleasure-Arousal-Dominance (PAD) emotional-state model (1980)⁵, previously used to test the effects of color, all fall under arousal. Another study by Gorn et al. (2004)⁶ demonstrated that the color of a webpage background can affect the perceived loading time of the page. The researchers used a sliding scale between 1 and 9 and tested for feelings of relaxation, calm, peacefulness, uneasiness, tension, and anxiousness. Gorn et al. found that as the attributes of the background colors changed, so did the participant's feelings of relaxation and perceived quickness. Once again, these measurements also fall under various aspects of Mehrabian's PAD emotional-state model. A study by Detenber, Simons, and Reiss (2000)⁷ gathered self-report and physiological measurements (such as skin conductance) concerning color and black-and-white television clips. They found that although people report a more positive attitude to a color TV clip than one of black-and-white, there were no noticeable physiological changes. Nevertheless, the effects of colors on emotions are still a prevalent research topic, so much so that the depth of the subject matter cannot be fully covered here.

⁵ Mehrabian, A. (1980). Basic Dimensions for a General Psychological Theory: Implications for Personality, Society, Environmental, and Developmental Studies. *Cambridge, MA: Oelgeschlager, Gunn and Hain Publishers, Inc. et al.*

⁶ Gorn, G.J., Chattopadhyay A., Sengupta, J., & Tripathi, S. (2004) Waiting for the web: How screen color affects time perception. *Journal of Marketing Research*, *XLI*, 215-225.

⁷ Detenber, B.H., Simons, R.F., & Reiss, E.J.(2000). The emotional significance of color in television presentations. *Mediapsychology*, *2*, 331-355.

Due to the findings by Detenber, Simons, and Reiss, we decided that a simpler study may be the key to revealing answers to the relationship between color and emotions. We decided to take on an aspect of color that can easily be manipulated and frequently is used in television and magazine ads: saturation. We also decided not to focus on any specific set of emotions, but to generally look at the level of emotional response that color generates, similar to a previously mentioned study by Gorn et al. (1997), which seemed a perfect application for Mehrabian's PAD emotional-state model.

The PAD emotional state-model was developed with the idea in mind that a person's emotional states change continuously as he progresses throughout his day. Since Mehrabian proposed the framework in 1980, he has continued to test and develop it for many years, with a recent study demonstrating 97% reliability in measuring pleasure, 89% in arousal, and 80% in dominance. (Mehrabian, 1996)⁸. Valdez and Mehrabian (1994)⁹ used the PAD emotional-state model to measure the effects of color, hue, saturation and brightness on emotional responses. They found that saturation and brightness positively correlated with effects on emotions.

⁸ Mehrabian, A. (1996). Pleasure-Arousal-Dominance: A General Framework for Describing and Measuring Individual Differences in Temperament. *Current Psychology: Development, Learning, Personality, Social*, 14(4), 261-292.

⁹ Valdez, P. & Mehrabian, A. (1994). Effects of Color on Emotion. *Journal of Experimental Psychology*. Vol. 123, Issue 4.

Using Mehrabian's Pleasure-Arousal-Dominance emotional state-model, we tested for the effects of two largely varying levels of saturation in magazine print advertisements on the participants' emotions. Our subjects were given three ads, each either in its original saturation or in a desaturated state, and were asked to rate each ad using the provided PAD scales. The subjects indicated their answers on our internally created input software. We predicted that our participants would have higher scores on pleasure and arousal when viewing ads in their original saturation, but have a lower dominance score. The opposite would be true for desaturated ads; participants would have lower scores on pleasure and arousal, but would have a higher dominance score. In short, participants would have a higher emotional response to the saturated ads than the desaturated ads. We hoped to find results similar to those of the previously mentioned experiment by Gorn et al. and the study by Valdez and Mehrabian. In each of these experiments, it was demonstrated that the various features of color, including saturation, have an effect on emotions when altered. If emotions can be affected solely by changing saturation, further research should be done to determine how much of an effect saturation can really have.

Literature Review

In order to verify our initial thoughts about color saturation and its emotional effects on the viewer, we started by gathering a number of research

materials that pertained directly to studies testing color theory. We built our initial thoughts off of two specific texts. The first was Herbert Zettl's *Sight, Sound, Motion: Basic Media Aesthetics*¹⁰. Being one of our class texts, it was an obvious first choice as a resource. Zettl's book contains a number of excellent color slides and tables, and a broad discussion about the importance of color in media aesthetics. On page 73, Zettl argues that "color energy is principally determined by saturation level: highly saturated warm colors carry more aesthetic energy than do desaturated cold colors." He also warrants the importance of desaturation theory, which "asserts that one way of reducing the blunt and brazen impact of high-energy colors in a quiet, introspective scene is to lessen their saturation, give them a monochrome tint, or omit color altogether" (77). Zettl's remarks were also backed up in Anne Barry's book *Intelligence: Perception, Image, and Manipulation in Visual Communication*¹¹. Although her book does not cover media techniques in the depth that Zettl does, Barry presented us with examples from real world situations in marketing that bolstered our confidence in the subject of desaturated color as an advertising technique.

¹⁰ Zettl, H. (2005). *Sight, Sound, Motion: Basic Media Aesthetics*. Belmont, CA: Thomson Wadsworth. 53-70, 73, 77-78.

¹¹ Barry, A. (1997). *Intelligence: Perception, Image, and Manipulation in Visual Communication*. Albany, NY: State University of New York Press. 127-133, 264-266.

Our initial survey of relevant research papers yielded a number of results. One of the early papers we found was Gerald Gorn and others' *Effects of Color as an Executional Cue in Advertising: They're in the Shade*¹². Their research tested consumers' reaction to hue, saturation, and brightness of colors in print advertising using dimensions of arousal and pleasure as response variables. The experiment included eight hypotheses, testing three aspects of color (hue, saturation, and brightness) and their effects on feelings of relaxation, excitement, boredom, and tension using Apter's pleasure-arousal framework. The Apter model they used draws on a two-dimensional view of arousal. "One dimension of arousal goes from boredom to excitement," labeled as excitement, and "the second dimension of arousal goes from tension to relaxation," labeled relaxation (1389). Gorn and associates felt this view was more true to life than the traditional, one-dimensional inverted U-shaped relationship of arousal, because "[the two-dimensional view] proposes that low arousal, and not just high arousal, can be a pleasant state for the organism" (1390). Their results led to the conclusion that saturation of a color in an advertisement is positively correlated with feelings of excitement, whereas no correlation was found between saturation and feelings of relaxation. This conclusion by Gorn and his associates establishing positive correlation between the saturation of ads and levels of

¹² Gorn, G. J., A. Chattopadhyay, T. Yi, and D. Dahl (1997). Effects of Color as an Executional Cue in Advertising: They're in the Shade. INFORMS publishing. In *Management Science*, vol. 43, no. 10. 1387-1400.

consumer excitement provided us with early confirmation that we were on to something.

Another resource we discovered was Joan Meyers-Levy and Laura A. Perracchio's *Understanding the Effects of Color: How the Correspondence Between Available and Required Resources Affects Attitudes*¹³. Their research tested the differences in impact between full-color versus black-and-white advertising photos under difference processing resource conditions. The research was broken into two experiments. The first was intended to test whether black-and-white ads would "enhance high-motivation viewers' product attitudes in comparison with full-color ads" (123). The experiment

"employed a 2 (ad color) X 2 (resource demands of ad) factorial design. Subjects' processing motivation in all treatments was held constant at a high level. Further, all subjects received an ad containing the same ad photo accompanied by a common set of relatively strong, function-oriented ad claims, and the ad photo was presented in either full color or in black-and-white" (123).

The second experiment is an extension of the first, throwing in alternative variables to bolster their claims. Specifically, Meyers-Levy and Perracchio changed the level of resources needed to process the ad by manipulating the

¹³ Meyers-Levy, J. and Perracchio, L. A. (1995). Understanding the Effects of Color: How the Correspondence Between Available and Required Resources Affects Attitudes. *Journal of Consumer Research*. 22, 121-151.

“nature of the verbal ad claims” (126). The data “were analyzed as a 2 (processing motivation: high or low) X 2 (type of ad claim: low [function-oriented] or high [image-oriented] resource demands) X 4 (ad color: full color, color highlighting of product or object highly relevant to function-oriented ad claims, color highlighting of context or object highly relevant to image-oriented ad claims, or black-and-white) between-subjects factorial” (129).

The study found that when processing motivation is low and consumers allocate few of their cognitive resources to processing an ad, using color ads is beneficial because it enhances the perceived attractiveness of the objects in the photos. When processing motivation is high, color can have two effects. If the processing requires few resources, ad claims are “benefited by the use of color that reinforces the ad claim” (122). However, if processing requires more cognitive resources, black-and-white ads or ads using color highlighting on the product are judged more favorably by the viewer.

Although their research presented a potential methodology to test the relationship between color ads versus black-and-white ads versus color highlighted ads and their correlation with viewers’ attitudes, we could not find ample research to suggest using their methods to test ad saturation and its emotional affects on the viewer. Still, Meyers-Levy and Perracchio did provide

us with further background information on relevant research concerning effects of color on cognition and emotions in print advertising.

It was the next two research abstracts that solidified our decision to use the Pleasure-Arousal-Dominance (PAD) emotional-state model in our experiment.

The first was R. F. Simon and J. E. Reiss' *The Emotional Significance of Color in Television Presentations*¹⁴. Their research looked at color versus monochrome and black-and-white in television ads. The authors believed that even though people claim to prefer color TV to black-and-white, actual emotional experiences are not consistent with the self-report of these emotions. In order to test this hypothesis, they used physiological reactions measuring skin conductance response (SCR), and a questionnaire utilizing Lang's Self-Assessment Manikin (SAM) 9-point test of valence, arousal, and dominance, derived partially from research by Albert Mehrabian, the author of the PAD emotional-state model. The study found that actual physiological responses to black-and-white and full-color video clips were not significantly different, yet the researchers noted a positive correlation between self-reported emotional response and color saturation:

"Color clips were also experienced as more arousing than achromatic clips, $F(1,33)=8.32, p<.01$. These differences were small in magnitude, but as the [results

¹⁴ Simon, R. F. and Reiss, J. E. (2000). The Emotional Significance of Color in Television Presentations. *Mediapsychology*, 2, 331-355.

indicate], they were consistent across subjects” (334). This article provided support for the use of a tri-part model in measuring emotional responses through self-report. The research also suggested that we may find conflicting results to some previous studies, which indicates that careful experimental design is necessary in order to prevent any extraneous variables from interfering.

This was soon followed by P. Valdez’s and Albert Mehrabian’s *Effects of Color on Emotion*¹⁵. Building on earlier experiments by Mehrabian, this research studied the effects of color, hue, brightness and saturation using the PAD emotion model and standard color chips. Saturation and brightness correlated strongly with effects on emotions. Brightness effects were nearly the same for chromatic and achromatic colors. Blue, blue-green, green, red-purple, purple, and purple-blue were found to be the most pleasant hues, while yellow and green-yellow were the least pleasant. Green-yellow, blue-green, and green were the most arousing (exciting), and purple-blue and yellow-red were the least arousing. Green-yellow induced greater dominance than red-purple - that is, it made subjects feel a higher degree of control in their environment. Although this research concentrated solely on a single color variable, we were confident we could apply this information in our own study.

¹⁵ Valdez, P. and Mehrabian, A. (1994). Effects of Color on Emotion. *Journal of Experimental Psychology*. Vol. 123, Issue 4.

The three preceding articles both used Mehrabian's PAD model for emotional response to measure the effects of specific media forms on participants. Because we liked the idea of testing for pleasure, arousal, and dominance, we decided to do some background work regarding Albert Mehrabian's research and other uses of the PAD model. We quickly discovered three of Mehrabian's own productions. The first was his *Basic Dimensions for a General Psychological Theory: Implications for Personality, Society, Environmental, and Developmental Studies*¹⁶. In this book, he lays the groundwork of why the PAD emotional-state model is a legitimate research method and how it can be implemented and measured, giving examples for each. It is as much a review and research piece as it is an analysis of the model. The book "provides the empirical and theoretical basis" for studies of human emotion using a PAD emotional-state model and analysis, explores how these measures of emotion can be deduced from interaction with the physical environment, and gives specific examples of research correlating physical reactions to external stimuli using the PAD model. The most important aspect of this book is Mehrabian's definitions of the terms pleasure, arousal, and dominance. He argues that "pleasure-displeasure is a feeling state that can be assessed readily with semantic differential measures or with behavioral indicators such as smiles, laughter, and

¹⁶ Mehrabian, A. (1980). *Basic Dimensions for a General Psychological Theory: Implications for Personality, Society, Environmental, and Developmental Studies*. Cambridge, MA: Oelgeschlager, Gunn and Hain Publishers, Inc. et al.

in general, positive versus negative facial expressions” (15). Arousal is a “combination of activity and alertness” and “dominance-submissiveness is...the inverse of the judged potency of the environment” (16-17). These definitions laid the groundwork of our conceptualization of what the PAD emotional-state model could do. Mehrabian further proposes that “these three emotional responses are conceptualized as the basic dimensions of emotion, meaning that all three dimensions are necessary to adequately describe any emotional state” (19).

Mehrabian based his decision of using word-pair comparisons to measure the three variables of pleasure, arousal, and dominance based on earlier research, and on the bipolarity of his measurements. Specifically he cites V. Nowlis’ *Research with the Mood Adjective Check List* and P. M. Bentler’s *Semantic Space is (Approximately) Bipolar* and *An Analysis of Responses to Adjectives: A Reply to Samelson* as precursors to his research on the optimal word-pairs. He performed three experiments analyzing 28, 23, and 18 adjective word-pairs. His results for each were “factor analyzed and a principal components solution was obtained...[T]here were three factors with eigenvalues exceeding unity” (24). He then performed an oblique rotation of the factors, and because the factorial composition of the second and third experiments coincided, he settled on the

final 18 adjective word-pairs in experiment three, the same comparisons we used in our study.

The other two research articles from Mehrabian were: *Framework for a Comprehensive Description and Measurement of Emotional States*¹⁷ and *Pleasure-Arousal-Dominance: A General Framework for Describing and Measuring Individual Differences in Temperament*¹⁸. The former is a three-part article from Mehrabian. The first part is simply an overview of the findings and rationale of the PAD emotional-state model. The second part is a summation of previous research Mehrabian had been involved with. The third part gave results of another three studies; all used to further refine the PAD emotion scales. The second article featured similar methodological testing of the model. Specifically, this article argued that through extensive research on emotional states, Mehrabian's PAD model was 97% reliable in measuring pleasure, 89% in measuring arousal, and 80% in measuring dominance. Because these two pieces do not significantly change the PAD model and methodology from Mehrabian's 1980 text, we will not go into significant detail here.

¹⁷ Mehrabian, A. (1995). Framework for a Comprehensive Description and Measurement of Emotional States. *Genetic Social And General Psychology Monographs*, Vol. 121, issue 3, 339-361.

¹⁸ Mehrabian, A. (1996). Pleasure-Arousal-Dominance: A General Framework for Describing and Measuring Individual Differences in Temperament. *Current Psychology: Development, Learning, Personality, Social*, Vol. 14, 261-292.

We also discovered Susan Ball's *Online First Impressions: The Role of Verbal, Vocal, and Visual Factors on First Impressions*¹⁹. Her research investigates the role of three sensory channels (audiovisual, audio only, and online text transcripts) in forming first impressions using 15 adjective trait pairs from the Garlick study to measure emotional response to various statements. Although this study did not use the PAD model's methodology, the implementation of the 15 word pairs mirrors Mehrabian's experiments. The study concludes that no single channel dominates in the formation of positive or negative first impressions, and the results directly contradict earlier work suggesting an audiovisual primacy in impression formation. This article may not have provided us with further support for our hypothesis, but it did give us an exemplary indication of how the PAD model can be implemented to test a hypothetical emotional response in comparison to Mehrabian's experiments. For the purposes of our research, this article also provided useful examples of the statistical methods used by another researcher in evaluating emotional states when using adjective trait pairs. Specifically, Ball created a 3X2 MANOVA with the 15 personality pairs as independent variables using an SPSS statistical software program. This was deemed optimal because all of her data was collected on the computer, a technique we later adopted in our experiment.

¹⁹ Ball, S. (1998). *Online First Impressions: The Role of Verbal, Vocal, and Visual Factors on First Impressions*. *Nonverbal Behavior, Nonverbal Communication*, <http://clearinghouse.mwsc.edu/manuscript/upload/60-1.pdf>.

Perhaps we as a group should have been more careful to study further examples of unbiased usage of the PAD model and methodology in the measurement of emotional responses to external stimuli. We felt that having studied Mehrabian's work and research, combined with enough proof to support or hypothesis using other methods of experimentation, we would be successful in our research. Our experiment and results did not yield any recognizable patterns in the data to support our hypothesis. After this became clear to us, we took it upon ourselves to do some extra research for our literature review, specifically searching for potential reasons why our attempts had not succeeded.

We believe we have found two specific articles that could explain our findings (or lack thereof). The first is a web article entitled *Is it Time to Dump the "7%-38%-55% Rule"?*²⁰ This is a response to a question regarding an article written by Herb Oestreich in a 1999 volume of the journal *Transitions*. Apparently Oestreich was calling into question Mehrabian's research methods and findings. The author of this web posting offers numerous comments and quotes from PAD model and methodology texts to illustrate that Mehrabian was aware of the shortcomings of some of his findings, and that further research was needed. One particular quote caught our notice:

²⁰ Bradbury, A. (2005). Is it Time to Dump the "7%-38%-55% Rule"? *Honest Abe's NLP Emporium*, <http://www3.mistral.co.uk/bradburyac/nlpfax17.htm>

"In a comprehensive study of inconsistent messages of pleasure-displeasure and dominance-submissiveness in vocal and visual (face and/or body) cues, it was established that visual cues were more powerful than vocal cues in determining the overall effect inferred from *moderately* inconsistent messages. This effect was greater when the visual cues involved the face. However, in the case of *extreme* inconsistency, visual cues were weighted less than vocal cues. The latter reversal was interpreted by noting that subjects are less likely to believe and rely upon visual cues (which are easier to control) when visual and vocal cues are extremely discrepant, thus implying deception." From Mehrabian's *Silent Message*, page 77. Italics added.

The three ads used in our experiment all included visualizations of human activity. If Mehrabian does believe that facial expressions are such a strong aspect of the emotional response of a viewer, then potentially our desaturated colors may have been struggling for impact with the images and expressions of the characters in the ads. This could then verify that our results were skewed due to the content of the ads.

The final resource we found was another experiment performed around Mehrabian's PAD model. Pieter Desmet and his associates introduce the Product

Emotion Measure, “an instrument to assess emotions elicited by product appearance.” The research, from the article entitled *When a Car Makes You Smile: Development and Application of an Instrument to Measure Product Emotion*²¹, uses the PAD model to help measure the emotional response to a product appearance itself as opposed to the overall response to consumption (111). What this article mentions though is a new method used to implement the PAD model to measure the emotional response to stimuli. Developed by Lang in 1985, the Self Assessment Manikin (SAM) “depicts each PAD dimension with a graphic character arrayed along a continuous nine-point scale” (112). Desmet and associates argue this non-verbal, non-textual system is better for measuring the emotional response to a product advertisement. Considering that while implementing our experiment, we did have to answer a number of questions regarding the meanings of certain adjective terms in our word-pairs, and referencing the last article in which Mehrabian himself argued that facial expressions could be highly influential in the results, perhaps our experiment would have benefited from graphical representations as opposed to textual comparisons.

Delving further into alternate previous research could lead to other theories as to why our experiment did not yield sufficient results. The use of the

²¹ Desmet, P. M. A., Hekkert, P. and Jacobs, J. J. (2000). When a Car Makes You Smile: Development and Application of an Instrument to Measure Product Emotions. *Advances in Consumer Research*, 27, 111-117. Eds. S.J. Hoch and R. J. Meyer.

PAD model and methodology is widespread, covering such topics as television advertising, interior design, parent-child interaction, and food-consumption. Numerous variations have been implemented. These final two articles we have reviewed point to a couple of potential problems with our research, and the divergent paths we could take to reiterate our experiment. In the next section, we will lay out the methodology we decided upon after reviewing the available literature.

Research Methodology

Using Mehrabian's Pleasure-Arousal-Dominance emotional state-model, we tested the effects of saturation in advertising on the participants' emotions. Our subjects were given three ads, each either in its original (high) color saturation or in a desaturated state, and were asked to rate each ad using computer-based PAD scales. Our hypothesis was that our participants would give higher scores on pleasure and arousal when viewing highly saturated ads in their original saturation, but have a lower dominance score.

Subjects

For our test participants, we recruited 22 University of Michigan School of Information graduate students to perform our experiment, both male and female. A mass e-mail was sent to all SI students (using si.students@umich.edu) that contained the following body:

"We are a small group of fellow SI students currently enrolled in SI 557, Professor Karen Markey's Visual Persuasion course. We are trying to gather volunteers to take a short (10 - 15 minute maximum) experiment up in the DIAD. We are testing the effects of various advertising techniques on viewers' responses to advertisements and need participants to help us out in our endeavors. We will be in the DIAD from now until 8pm tonight. For participating in our experiment, you will receive a delicious TWIX BAR!"

We did not disclose the true nature of the experiment to our subjects until after they filled out the questionnaire in order to prevent biased answers. Data received from color-blind subjects would have been eliminated from the study, although none of our participants were color-blind.

The ads for this study were selected from a travel magazine (Condé Nast Traveler, March 2005 issue). We limited the selection to full-page color ads that had a large photograph. Advertisements that did not use highly saturated colors (such as black-and-white ads) were eliminated. Since we had to produce versions of the ads with lower saturation, the saturation values for the colors used in the original ad had to be fairly high.

Methodology

To start, we collected a total of 3 advertisements to use to test our fellow students. We then created a counterpart for each of these advertisements – a duplicate ad with the color desaturated (see Appendix). This desaturation procedure was performed using Adobe Photoshop CS on a PC. The saturation value for the master channel was lowered to -50 using Hue/Saturation function. While the resulting images still had clearly distinguishable hues (they were not black-and-white), the colors were less intense than those of the original photos. Neither hue nor brightness of the images was affected by desaturation procedure.

We labeled the chosen pictures as 1, 2, 3, 6, 7, and 8, where 1, 2, and 3 were the original versions and 6, 7, and 8 were the respective desaturated versions of the former. We showed each subject a collection of three of these ads. The viewer did not see both versions (saturated or desaturated) in the same experiment. In other words, the participant saw either (1 or 6), (2 or 7), and (3 or 8). All possible combinations of images were used. On the computer screen, a thumbnail image of the advertisement was displayed, directing the participant to a full-size copy of the image in a binder they were given at the beginning of the experiment (containing only the three images for that particular participant).

We asked our participants to study each image, and then to select their level of feeling based on a series of comparative emotions using a sliding bar on the computer. Please refer to the Appendix for an example of the bar. These comparison word sets were as follows:

| | | |
|-------------------------|----------------------|--------------------------|
| Happy – Unhappy | Stimulated – Relaxed | Controlling – Controlled |
| Pleased – Annoyed | Excited – Calm | Influential – Influenced |
| Contented – Melancholic | Jittery – Dull | Important – Awed |
| Hopeful – Despairing | Wide Awake – Sleepy | Dominant – Submissive |

The first column represents comparisons that measure Pleasure; the second measure Arousal; and the third measure Dominance. Each of these terms is defined in the Pleasure-Arousal-Dominance model which we used to calculate the results and present our findings. We have taken all of these word pairs from Albert Mehrabian's work in the past.

Each of the above sets of terms is currently displayed in the “positive – negative” arrangement. To avoid unnecessary bias in our findings, we inverted the order of half of these terms. Also, they were not listed in order by category, instead they were again randomly ordered to avoid prejudiced results. The exact layout is represented in the Appendix item.

We had each participant answer all of these questions. Since according to research, the length of time it takes for a subject to finish the PAD model does not directly influence the results, we did not record length of time to completion. We asked the volunteer to input their age and sex as a further variable in our results.

To summarize, our experiment was run as follows:

- The e-mail presented earlier was sent to all School of Information students using the `si.students@umich.edu` e-mail address.
- Participants were welcomed. They were given the Consent Form to follow along as one of the experimenters read it out loud.
- The participant was read the Script and instructed to log-in using the provided unique identifier.
- The participant input data for three images on the computer equipped with the thumbnails of the images and the full-size prints.
- When the participant indicated he/she was finished, any further questions were answered; the participant was thanked for his/her time and given a Twix bar.

Collected Data and Analysis Procedures

This experiment tested the difference in the strength of emotional responses between full-color and desaturated images. Full-color and desaturated copies of three different ads were used, with each respondent rating only the saturated or the desaturated version of each advertisement. The order in which the images were shown was carefully manipulated so that our research subjects saw all possible combinations of images.

The experiment was conducted through a web interface. Each subject received a slip of paper with a unique identifier on it, which was the key to log into the system.

Subjects placed a check mark along a continuous line under each word pair on the computer screen. Using this tool helped to circumvent natural tendencies towards numbers at the center of a linear scale. The mark was subsequently converted to a value between 0 and 100. A pure answer for either comparison resulted in a score of 0 to 100, depending upon which extreme was chosen. For example, if the participant decided an ad made him/her completely “happy” (designated by placing their measurement at the far end of the comparison line next to happy), it resulted in a 100 score in that category for that advertisement. For the same individual, choosing the extreme value of “unhappy” produced a 0.

For each of the three images, viewers saw a series of 12 word pairs, four representing Pleasure, four representing Arousal, and four representing Dominance. We collected a total of three records from the user input on each line: the image name, whether it is in a saturated or desaturation state, and a score for each of Pleasure, Arousal or Dominance depending on the comparison for each of the word pairs. With 22 total subjects, this gave us an $n = 66$.

Scores for pleasure word-pairs were averaged (arithmetic mean), as were the scores for arousal and dominance. So, for ad 1, we had an average score devised from the results of some number of users on each of the 12 comparisons. From these values, we were then able to calculate 3 average scores for the Pleasure, Arousal, and Dominance categories. These final 3 scores for all 6 advertisements formed the basis for our interpretation. Our dataset was analyzed in the JMP software package, using both linear regression and simple t-tests. Three regressions were run, with the independent variables image name, and saturation level (binomial) and dependent variables of Pleasure, Arousal or Dominance.

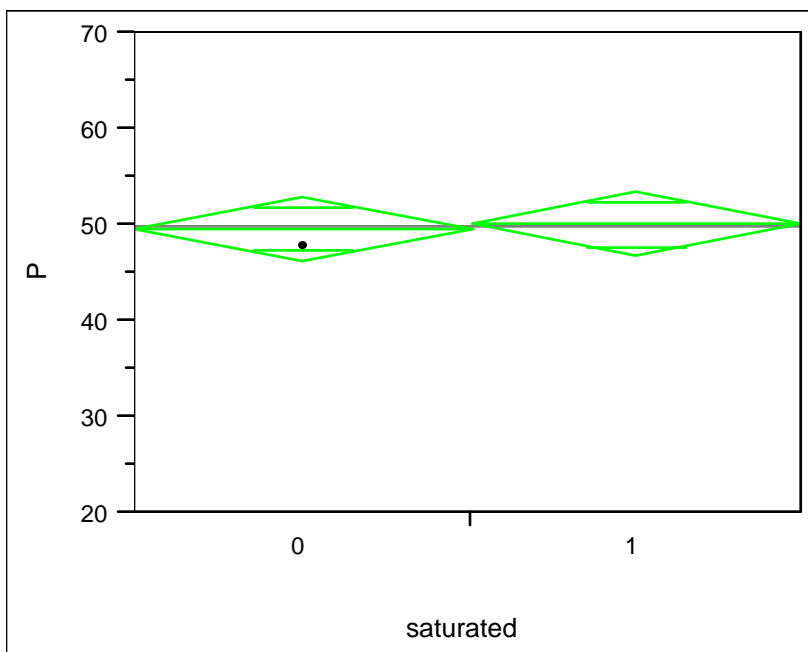
We believed that the untouched ads would have a higher Pleasure and Arousal rating, and a lower Dominance rating than the desaturated counterparts. Based on past research that used the PAD methodology to measure subject

reactions to color values, the difference in the measurements of the original and the desaturated ads should have been significant.

Results

Our data was inconclusive. We were unable to reject the null hypothesis. The degree to which our results were inconclusive was highly impressive. The following three box plots show the results of the initial t-test used to compare the saturated (1) and desaturated (0) advertisements. None of our response variables (pleasure, arousal, dominance) showed any statistical correlation with the saturation level. Pleasure had a Probability $> |t|$ of 80%. Arousal was 22%. Dominance was 96%. To reject the null hypothesis, we required a Prob $> |t|$ of 5% or lower.

One-way Analysis of Pleasure by Saturation

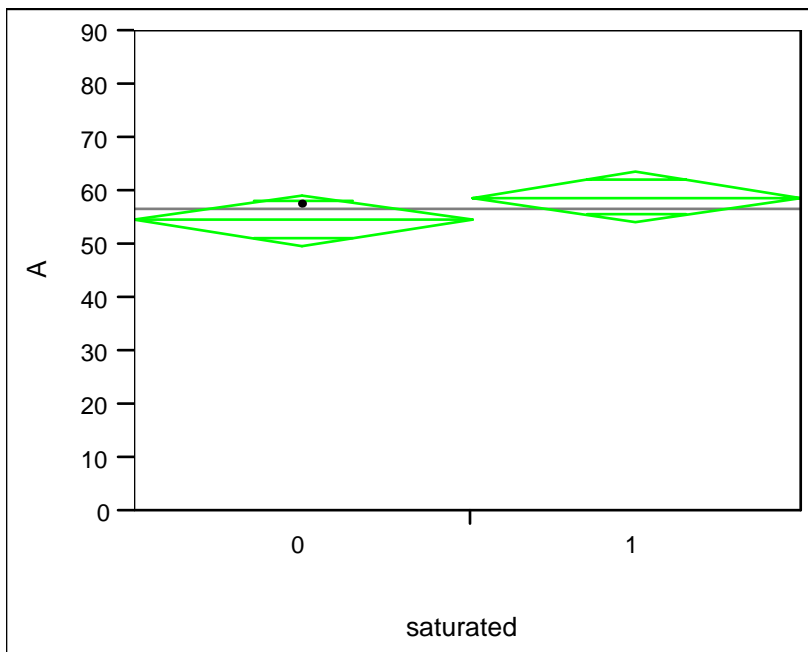


t Test

Assuming unequal variances

| | Difference | t Test | DF | Prob > t |
|-----------|------------|--------|----|-----------|
| Estimate | -0.5701 | -0.243 | 61 | 0.8085 |
| Std Error | 2.3424 | | | |
| Lower 95% | -5.2539 | | | |
| Upper 95% | 4.1138 | | | |

One-way Analysis of Arousal by Saturation

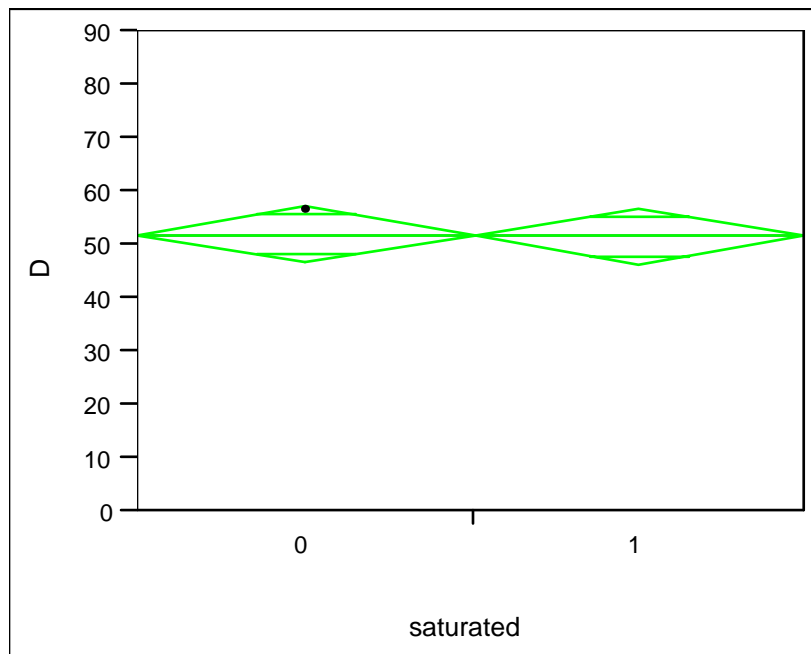


t Test

Assuming Unequal variances

| | Difference | t Test | DF | Prob > t |
|-----------|------------|--------|----|-----------|
| Estimate | -4.2409 | -1.245 | 61 | 0.2180 |
| Std Error | 3.4074 | | | |
| Lower 95% | -11.0545 | | | |
| Upper 95% | 2.5727 | | | |

One-way Analysis of Dominance by Saturation



t Test

Assuming Unequal Variances

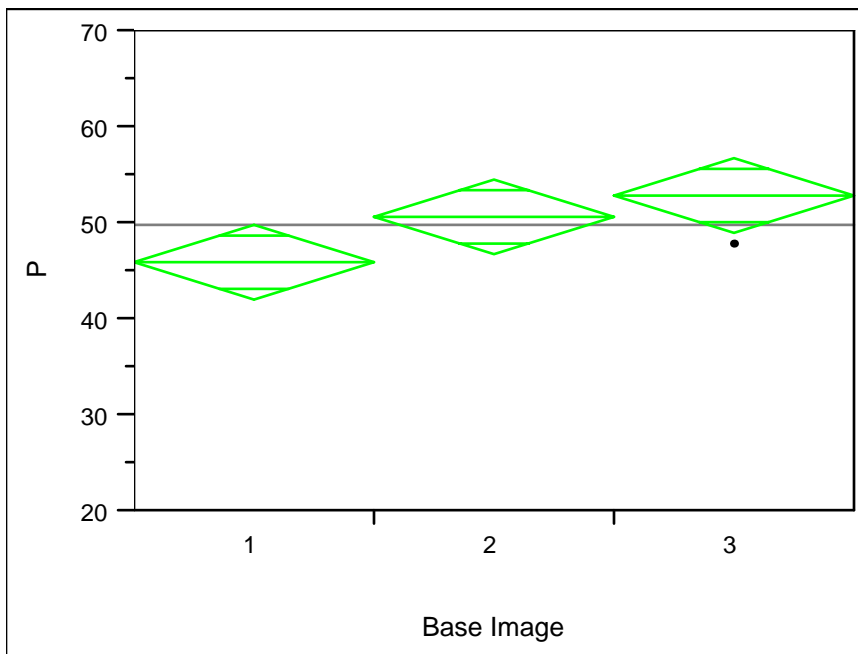
| | Difference | t Test | DF | Prob > t |
|-----------|------------|--------|---------|-----------|
| Estimate | 0.1835 | 0.049 | 52.4435 | 0.9615 |
| Std Error | 3.7818 | | | |
| Lower 95% | -7.3581 | | | |
| Upper 95% | 7.7251 | | | |

Our results were unexpected, to say the least. Further statistical examination of individual factors (that is, individual word-pairs) showed that no single pair, or combination of word pairs, yielded statistically significant results.

If we consider the three images, ignoring for a moment their saturation level, we do see a difference in the emotional response among the ads. We combined images 1 and 6, 2 and 7 and 3 and 8 into group 1, 2 and 3, and performed an Analysis of Variance on each of the three emotions by this set of

three images. Pleasure is lowest in image 1, higher in image 2 and highest in image set 3. This is statistically significant at the 5% level. Our adjusted R-Square value is still only a meager 6.5%. Arousal was *almost* significant, with an F-score of 5.7%. Were our sample larger, this would likely have improved. Dominance scores showed no significant variation among the images. For details, see the following box plots.

One-way Analysis of Pleasure by Base Image



One-way Anova

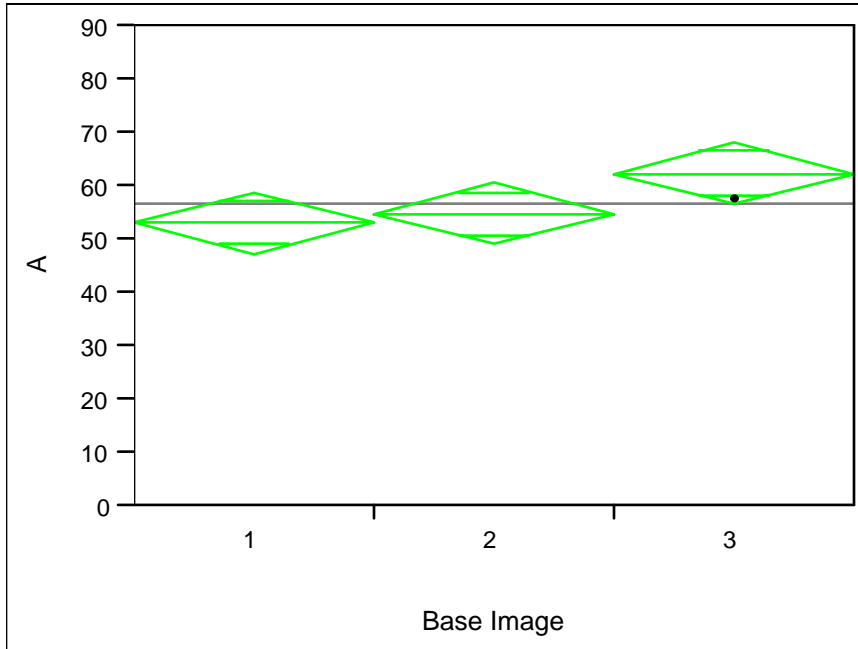
Summary of Fit

| | |
|----------------------------|----------|
| Rsquare | 0.095598 |
| Adj Rsquare | 0.065452 |
| Root Mean Square Error | 8.917039 |
| Mean of Response | 49.70238 |
| Observations (or Sum Wgts) | 63 |

Analysis of Variance

| Source | DF | Sum of Squares | Mean Square | F Ratio | Prob > F |
|------------|----|----------------|-------------|---------|----------|
| Base Image | 2 | 504.2917 | 252.146 | 3.1711 | 0.0491 |
| Error | 60 | 4770.8155 | 79.514 | | |
| C. Total | 62 | 5275.1071 | | | |

One-way Analysis of Arousal by Base Image



One-way Anova

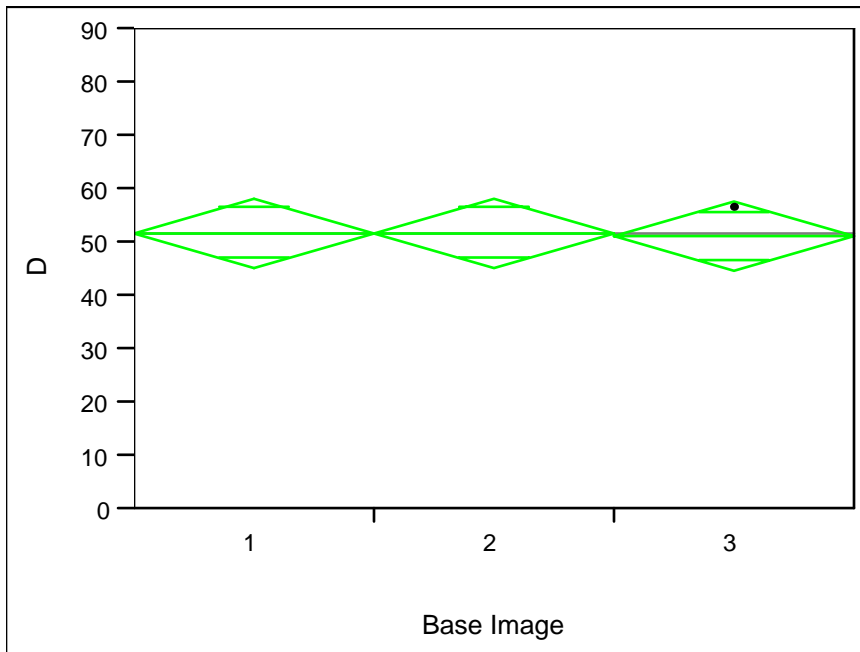
Summary of Fit

| | |
|----------------------------|----------|
| Rsquare | 0.09098 |
| Adj Rsquare | 0.06068 |
| Root Mean Square Error | 13.16239 |
| Mean of Response | 56.55556 |
| Observations (or Sum Wgts) | 63 |

Analysis of Variance

| Source | DF | Sum of Squares | Mean Square | F Ratio | Prob > F |
|------------|----|----------------|-------------|---------|----------|
| Base Image | 2 | 1040.389 | 520.194 | 3.0026 | 0.0572 |
| Error | 60 | 10394.917 | 173.249 | | |
| C. Total | 62 | 11435.306 | | | |

One-way Analysis of Dominance by Base Image



One-way Anova Summary of Fit

| | |
|----------------------------|----------|
| Rsquare | 0.000351 |
| Adj Rsquare | -0.03297 |
| Root Mean Square Error | 15.03787 |
| Mean of Response | 51.47222 |
| Observations (or Sum Wgts) | 63 |

Analysis of Variance

| Source | DF | Sum of Squares | Mean Square | F Ratio | Prob > F |
|------------|----|----------------|-------------|---------|----------|
| Base Image | 2 | 4.770 | 2.385 | 0.0105 | 0.9895 |
| Error | 60 | 13568.244 | 226.137 | | |
| C. Total | 62 | 13573.014 | | | |

In conclusion, our results were entirely inconclusive. Perhaps with a much larger sample size we would have seen more statistically significant results. However, we were unable to reject our null hypothesis in this case.

Our test of the PAD model itself, however, showed that Pleasure—and probably Arousal—did vary with the image, however Dominance did not.

Discussion

The main goal of our study was to prove existence of positive correlation between levels of color saturation in print advertisement and feelings of pleasure, arousal and dominance that the ads elicits in viewers. Our lack of conclusive results for our saturation tests points to several potential causes.

First, it is possible that the content of the advertisements overwhelmed the color. We saw different emotional responses to the ads (arousal and pleasure) but the difference was seen only among the actual content of the ads—it did not depend on the color saturation. Perhaps with simpler ads, or with solid monochromatic samples, responses to saturation would have been more obvious.

Second, the amount of desaturation, or ambient lighting conditions in the lab, may have created color differences that were hard for the participants to discern. Were we to repeat the experiment, a more dramatic desaturation of original images might make the results more significant.

Third, a larger number of participants could yield more pronounced results.

Finally, we have noticed that some of participants (both native and non-native English speakers) had difficulties relating to certain word pairs.

Verbalizing attitudes and feelings towards an image is not an easy task. Lang's Self-Assessment Manikin (SAM) 9-point test of valence, arousal, and dominance, that is based on research by Albert Mehrabian, uses several graphics depicting the manikin with various facial expressions to rate viewers' emotional responses. Employing a non-verbal and non-textual model to measure emotional response could help avoid confusion caused by non-trivial word pairs.

Since previous research that pointed us to our hypothesis indicated that there was positive correlation between saturation of ads and viewers' emotional responses, it would be interesting to discover the exact cause for our inconclusive results. To do that we would first have to repeat the experiment on a larger group of participants, and possibly with a more pronounced difference in saturation levels. If the second experiment still fails to support our hypothesis, the content of images chosen for the third experiment should be much simpler. For instance, Gorn et al (Gorn 1997) used a fake ad with an image of a solid color paint "swoosh" for their study. Such an ad should not elicit any emotional response based on content, so subjects' responses will depend solely on their response to color itself.

If successful in proving our hypothesis, the results of this final study, combined with the results of previous experiments, could lead to fascinating research on correlation between effects of content and visual elements in

advertising. It is possible that while graphic design elements can be used successfully to manipulate viewers' attitudes towards simpler ads, effects of these visual techniques are reduced dramatically for ads that present viewers with more complex content. Such research could be applied not only to advertising, but also to design of interfaces and thus is directly relevant to the field of human-computer interaction.

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Appendix

The appendix follows and includes:

1. Six ads that were used in the experiment (3 in original, or high saturation, the other 3 desaturated versions of the former)
2. Pre-questionnaire
3. Consent form
4. Script with instructions that were read to the participant prior to the experiment
5. Screen shot of the data collection application that the participants used to provide responses