Measuring Physiological Arousal Towards Packaging: Tracking Electrodermal Activity within the Consumer Shopping Environment

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ABSTRACT

Contrasted against the popular belief that consumers make purely rational decisions, purchasing decisions are rapid, subconscious, and emotional decisions. In order to understand a consumer's purchasing decisions, we suggest finding methods beyond focus groups, which typify this type of research, to measure and interpret consumer reactions to various packaging designs. In this paper, we examine electrodermal activity, a measure of emotional arousal, and eye tracking in the context of a realistic shopping environment as possible measures to support insight into customer preference of packaging. We hypothesized that presenting consumers with an experience more closely related to actual shopping would encourage more natural selections. Further, that the combination of eye tracking and physiological measures with self-report would support a more holistic understanding of decision-making. Although our eye-tracking hypothesis was supported in the studies conducted, a revision of our approach to physiological measurement is necessary to fully understand the validity of electrodermal activity for in-context experiments. We end by presenting suggestions for future research in the field of consumer emotions, highlighting the struggles and successes of measuring one's subconscious motives.

Key Words:

emotion, arousal, packaging design, electrodermal activity, eye tracking, CUshop™

INTRODUCTION

A history of marketing reflects the directive that “emotion leads to action” [1]. Indeed, studies have shown that 95% of thinking is unconsciously realized where consumers make purchasing decisions based on emotion rather than rational thought [2-6]. In addition to being emotionally driven, research has found that decision making occurs in brief phasic events, approximately 2.5 seconds in length [7]. A combination of rapid, subconscious decision making and the competitive marketplace, consisting of product duplicates, has led the designers of most packaging to utilize a person’s emotional trigger [8-11].

In attempt to identify these emotional triggers, designers have largely relied on focus group sessions as a means of self-report measures to gain valuable insight into consumer perception of packaging [12-13]. However, the focus group removes the consumer from the context where decisions are made and asks for a conscious reflection on subconscious motives [14-15]. Amongst other things, this reflection can introduce response bias where the consumer creates false memories and perceptions of the experience [16]. We suggest that traditional methods of research in packaging must be updated to accurately measure a consumer’s emotion in reaction to packaging designs in the physical shopping context. These enhanced methods introduce tools that do not rely on self-report, to allow researchers to assess how a consumer feels in several ways [17].

In this research, the combination of self-report, eye tracking (eye movements and areas of interest) and measures of electrodermal activity (correlated with emotional and cognitive arousal) are explored. Wireless and unobtrusive eye tracking glasses are used to immerse consumers in realistic shopping environments, where real-life tasks enable consumers to react naturally to packaging design [18]. This toolset is created with the vision that future costly production runs in packaging can be prevented by a highly triangulated and descriptive means of consumer testing [19-20]. In other words, these tools can capture the exchanges quiet conversations between consumers and packaging.

BACKGROUND

Eye tracking is a useful technique in recording where consumers focus when shopping. Focusing on the consumer’s field of view allows researchers to see where attention is diverted, forming descriptive regions of interest. Eye trackers can record the geographic location of fixations on a retail shelf in consumer studies. Head mounted, mobile eye tracking glasses provide a lightweight and unobtrusive means of monitoring eye movements [21-22]. Previous packaging studies reveal how longer fixation times correlate to increased sales or higher purchasing decisions [23]. Eye tracking is useful in documenting the geographic locations of eye movements, however, eye tracking does not reveal the emotional valence of the fixation [21].

Balanced activity within the sympathetic and parasympathetic divisions of the autonomic nervous system supports the regulation of physiological states of arousal. When the sympathetic nervous system activity increases, sympathetic fibers that surround eccrine sweat glands modulate the production of sweat. The skin, in turn, momentarily becomes a better conductor of electricity (i.e., electrodermal activity or EDA), and this can be measured. Although, numerous events such as pain, significant thoughts (not related to the current context), lying, exercise, individual changes in biochemistry, and motion artifacts can lead to changes in skin activity; it has also been used in research measuring stress and anxiety. In this research, we utilize an unobtrusive, wearable sensor that enables comfortable long-term assessment of electrodermal activity or, EDA.

To acknowledge the subconscious emotional directives of the consumer, the efforts of eye tracking and electrodermal activity are combined as physiological measures of consumer behavior. The validity of electrodermal activity, as a measure of arousal, is investigated with a thorough methodological approach applied inside the physical shopping context. The shopping context has been the missing link in traditional consumer studies using EDA and other physiologic tools. A study is conducted to discuss the validity of EDA as a tool to (1) measure arousal towards packaging designs (2) applied within a realistic shopping context of both time and appearance.

A study was completed using skin conductance and facial electromyography (EMG) to understand if consumers have unconscious emotional reactions to packaging designs [24]. Reaction times in relation to package aesthetics, which included images, colors, and typefaces of chocolate bars, were investigated. It was concluded that physiological data could reveal emotional responses to packaging designs. Thoughts of consumers traversing supermarket aisles in decision-making processes are briefly mentioned; however, a computer monitor, rather than the testing of physiological measures inside a realistic shopping context itself is not utilized [24].

Groeppel-Klein concluded with several in-store experiments that EDA is a valid way to measure arousal at the point-of-sale [25]. Studies focused on asking the participant to perform a task (shop for an item) and then answer verbal questions to confirm their personal valence towards the reactions defined in the EDA data. This research is beneficial for starting a more detailed discussion on using EDA in shopping environments; however, the research is not detailed enough to provide insight into the smaller scale of packaging. Many advocates agree that consumer testing must be completed in realistic and persuasive environments [25-26]. We intend to dig deeper from the environmental and surroundings level, to the personal and intimate level of the package design. Previous literature supports EDA as a valid tool in evaluating consumer environments; however, we would like to extend its causes to see if this applies to packaging.

MATERIALS AND METHODS

Materials

Cereal boxes were chosen as the type of packaging stimuli due to the large surface area available for advertising graphics. Two packaging stimuli were fabricated for the EDA experiment: Negative (Figure 1) and Positive (Figure 2) The following keywords were used to design the positive package: sustainable, all-natural, sunshine, happy, healthy, recycled, smiling, green, yellow, and blue. The positive package used graphic design elements that appeared to be happy and healthy while the negative package implemented contrasting graphics. Keywords including: hazardous, warning, tetrachloroethane, harmful, dangerous, and black, were used to influence the negative package's design. A 5-point Likert scale (extremely negative, negative, neutral, positive, extremely positive) was used in a survey to rate the design keywords. This self-report measure was taken to validate and describe the valence of any emotional responses recorded through EDA.

Figure 1: Negative Stimuli

Figure 2: Positive Stimuli

Objectives

The effect of emotionally designed packaging stimuli was measured using electrodermal activity, eye tracking, and self-report measures. Participants completed a brief shopping task inside a realistic shopping environment where they selected products they would like to purchase.

Participants

All participants of the study were undergraduate students from Clemson Universities' Packaging Science department. There were a total of 42 participants (26 male, 16 female), ages 18-29 years. A total of six participant's data were removed from the data set due to improper calibration, which is common for eye tracking experiments. None of the participants suffered from eye impairments such as glaucoma or cataracts. Participant's names and personal identifying information were removed from any record and an identification number was assigned for analysis purposes. Participants were informed that their participation was voluntary and that they could leave the study at any time.

Survey

An online survey, utilizing Survey Monkey, collected 126 responses from people on their emotional reactions to the packaging stimuli. Each participant that completed the survey was rewarded with $3.00 USD as an incentive. The emotions were recorded with the S.A.M.: Self Assessment Manikin Scale to determine the emotional feelings associated with the two packaging stimuli [27]. The survey included one random package design at the beginning that was used to accustom the respondent to the S.A.M. scale. There are three scales in the S.A.M. including happiness, arousal, and dominance. To complete the survey, the online participants selected the manikin that best represented their feeling towards the packaging design pictured above the scale. All eye tracking and EDA study participants at the conclusion of the shopping task completed the same S.A.M. survey questions.

Eye Tracking Apparatus

The physiological responses of consumers were measured through the use of eye tracking. Tobii mobile eye tracking glasses were used to measure participant eye movements. These glasses resemble ordinary glasses, however they are monocular, only sampling from the right eye, and parallax is compensated in the analysis software, Tobii Studio. Two other pieces of hardware are used to record the eye movements: a handheld recording assistant and infrared markers The recording assistant stores the data while the participant shops and also assists in the calibration process. The infrared markers are placed in a grid along the grocery-shelving units to delineate an Area of Analysis (AOA). Areas of Interest (AOIs) are drawn in Tobii Studio software, post experiment, to extract fixations for a specific area in the plane of the AOA. The sampling rate for the Tobii glasses is set at 30 Hz. In order to allow for freedom of movement throughout the shopping context, a shoulder strap and case was provided to alleviate the need for the participant to hold the recording assistant, connected to the glasses with a small wire. The eye tracking glasses are used in this study to locate the time of the first and last fixations of each participant on the packaging stimuli. Through documenting this interval, we are able to define and align a stimulus viewing time with a participant's EDA recording.

Electrodermal Activity Apparatus

An Affectiva Q-Sensor™ Curve was the unit used to measure electrodermal activity. This is a mobile, lightweight, and wireless device that uses Bluetooth to stream real-time participant data. The sensor consists of a light box attached to the wrist of the user by an elastic wristband. Two electrodes

are located on the inner face of the device, which come in contact with the skin. The Q-Sensor™ was set to sample at 32 Hz. The Q-Sensor™ was desirable to use in the packaging evaluation workflow due to the reasoning that it is wireless, unobtrusive, and fairly cost-effective at $2,000.00 USD. The Q-Sensor™ was viewed as a simple addition for consumers to wear as they walk normally in the shopping context. In addition to measuring EDA, the Q-Sensor™
measures acceleration and skin temperature. A white button on the exterior of the device allows event marking in the data when processed post-study [28]. By using the white, event-marking button, we were able to synchronize the EDA data with the video of the eye tracking recording. This synchronization helped to understand the EDA arousal levels in comparison to packaging stimuli throughout the shopping context.

Experimental Design

This experiment was conducted in the realistic shopping environment of CUshopTM at Clemson University's Sonoco Institute of Packaging Design and Graphics (Figure 3). Packaging was displayed on a 12ft wide shelf for cereal packages in an industry standard fashion: primary display panels facing outward and positioned parallel to the face frame of the shelving. Figure 4 is a diagram that represents the layout of the emotionally designed stimuli within the cereal aisle; stimulus placement is represented with X's.

The participants were divided into two separate groups of 21 participants each. Each of the groups was exposed to one of the packaging stimuli (Negative or Positive). These groups experienced the packaging stimuli in a cereal aisle where all of the surrounding boxes were current and familiar cereal packages. The packaging stimuli were then placed in the direct center of the aisle at eye-level (Figure 3). Each cereal type was grouped in duplicates of five each. A previous study was completed in the CUshop™ environment using blank, white boxes surrounding the packaging stimuli instead of the realistic packaging described here [29]. The white box study provided results indicating that people were aroused inside the cereal aisle. However, it was not possible to determine the specifics of the arousal, whether it was connected to the stimuli, or the strange environment in which they were placed. The study outlined here only employs realistic cereal boxes to make the shopping context extremely life-like and current.

By keeping the appearance of the shopping context realistic and current, we were able to focus more closely on the validity of using EDA as a measure of arousal within the shopping environment.

Figure 3: CUshop™ at Clemson University's Sonoco Institute of Packaging Design and Graphics

Figure 4: Layout of the emotionally designed stimuli within the cereal aisle

Procedure

The procedure consisted of five steps; the participants were told that their participation was voluntary and they may end the study at any time without penalty. First, the participants were calibrated to the EDA device. To calibrate to the Q-Sensor™ an appropriate moisture barrier needed to be established between the skin and the electrodes. Participants first placed the EDA device on the wrist opposite to their writing hand so as to reduce the chance of bumping or moving the sensor during the shopping task [30]. After securing the device, the participant was left alone inside a blank and sterile room to listen to five minutes of calming, classical music. After the five minutes, the study proctor returned to the room and asked the participant to sing their favorite song as loudly as possible. The purpose of the singing exercise was to find a maximum arousal level, easily caused by high stress and anxiety [31]. Next, after the singing exercise, the participant was left alone again to listen to three minutes of the same calming, classical music.

Next, the participant was qucikly calibrated to the eye tracking glasses. The study proctor followed automatic prompts on the Tobii recording assistant to lead the participant through the calibration process. To complete the process, the participant is asked to remain still while only moving their eyes. Before sending the participant into the shopping environment the participant is asked to raise their EDA device in front of their eye tracking glasses. Once the wrist device is in front of the eye tracking camera lens, the participant is asked to lightly press the button on the Q-Sensor™. Once the button is pressed, a light shines and can easily be found on the eye tracking video. This critical step is the method of synchronizing the two streams of data.

Following proper calibration, the participant was asked to enter the realistic and immersive CUshop™ shopping environment. Verbal instructions were provided, where each person was asked to shop as they normally would shop. Participants were asked to shop for six items. The list read as follows: laundry detergent, cookies, healthy cereal with whole grains, sugary cereal, pasta, and toilet paper. After the shopping task, the participant was able to remove the eye tracking glasses and EDA sensor. A post-experiment survey followed the shopping task.

This survey was completed on a computer using the online tool Survey Monkey. The survey consisted of 30 questions listed in four sections:

1. Self-Assessment Manikin scales of emotional stimuli
2. A 5-point Likert scales used to measure the consumer's feelings towards keywords used to design the stimuli
3. Introvert and extrovert character questions
4. Basic demographic and vision questions.

Immediately following the shopping task and survey, a post-experiment interview was conducted to gather additional self-report data [32]. This self-report data was geared towards determining the valence of the arousal experienced inside the shopping context. The participant was shown a playback video recording of their eye movements during moments of high arousal. The participant was asked to share how he/she felt and any thoughts which he/she remembered at the moment in the video [33]. This interview was the last step in the study.

Dependent Measures

Electrodermal activity was normalized across participants using the following formula derived from Lykken and Rose's Range Correction process [34]. This formula uses the personal maximum and minimum EDA recordings of the participant to normalize the amplitude peak heights experienced during the stimulus-viewing interval. The stimulus-viewing interval can be defined at the time to first fixation on the stimulus through five seconds after the time to last fixation on the stimuli. Through reporting of EDA arousal ratios per stimulus we can illustrate the arousal experienced per emotional stimuli.

Eye tracking metrics were studied to see if there was a difference in visual attention when comparing the negative and positive stimuli. Metrics collected were time to first fixation (TTFF), total fixation duration (TFD), and fixation count (FC). TTFF is the time, in seconds, for which it takes a participant to first fixate on the Area of Interest (AOI). TFD is the time, in seconds, during which a participant spends time viewing an AOI. FC is the total number of fixations measured on a particular AOI. Pearson correlation coefficients were planned to compare both EDA ratios and eye tracking metrics and also between EDA ratios and S.A.M. scale measures. The differences between the EDA levels of introverts and extroverts were also planned.

$$EDA\ arousal\ ratio = \frac{(EDA_{peak} - EDA_{min})}{(EDA_{max} - EDA_{min})}$$

$$EDA_{peak} = EDA\ recording\ at\ the\ peak's\ maximum$$

$$EDA_{min} = overall\ personal\ minimum\ EDA\ recording$$

$$EDA_{max} = overall\ personal\ maximum\ EDA\ recording$$

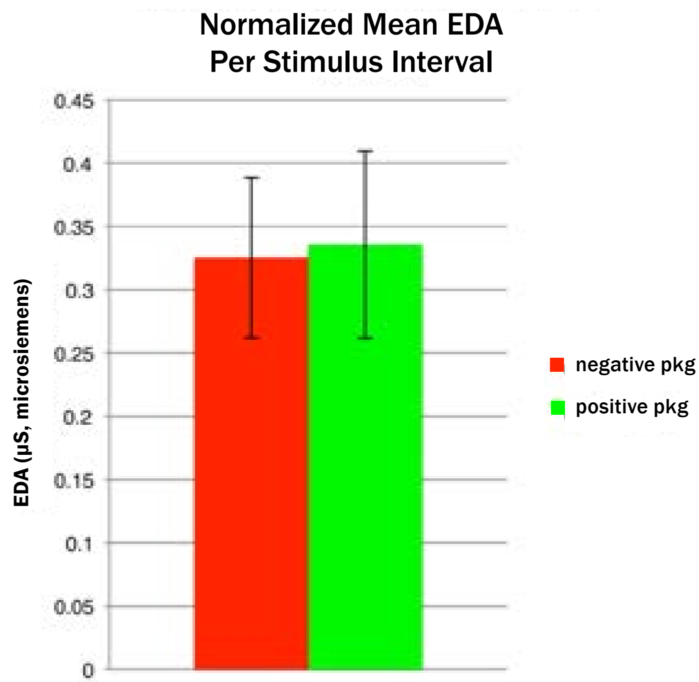
RESULTS AND DISCUSSION

Peak detection was used from Affectiva's Q-Analytics program where the data stream was smoothed from artifacts and the location of each peak was determined. Eye tracking metrics were obtained from Tobii Studio and statistically analyzed to find significance. Self-report survey data was exported from the online tool Survey Monkey to report findings from the Self-Assessment Manikin Scale and the design keyword Likert scales.

Once stimulus time viewing intervals were established for each participant, the peak detection files were read to understand if any peaks were experienced during the viewing of the stimulus. An obvious trend was found, reporting that almost all of the participants experienced a total of zero peaks per stimulus interval. Only three out of 36 participants (8.33%) that viewed the emotional stimuli experienced peaks in electrodermal activity. It was determined that these three participants be understood as outliers in the data because they each experienced a very high level of peaks (91, 48, and 17), while the larger trend reported zero peaks per participant. When compared to the peaks experienced in the pilot study and showing an increase in sample size, this supports the reasoning that EDA is very difficult to apply to packaging studies within the shopping context.

The intent of the methodology states that an EDA ratio would be established for each of the emotional stimuli based off of EDA recorded at the peaks of each participant. This could not be generated due to the fact that the majority of participants did not experience any peaks within the interval. An alternative graph was generated to investigate if there was any trend in EDA per stimulus interval (Figure 5).

Figure 5: Normalized mean (reported with std. error, α=0.05)



The low contrast between the two EDA recordings highlights how it is difficult to naturally engage the consumer in experiencing emotional stimuli within a shopping context. While a shopping context will produce natural, subconscious reactions to packaging, the quick and unpredictable movements of consumers make recording and understanding these reactions very difficult.

The heat maps are used to highlight the "hot-spots" across the Area of Analysis (AOA) in areas of red (Figure 6-7). No major visual trends are shown across the packaging stimuli. However, the top right of the image is somewhat weighted. It can be hypothesized that these large areas of visual attention could be linked to the solid and brightly colored packages. This visual reaction should be noted when designing future experimental packaging layouts.

The eye tracking metrics of TTFF, TFD, and FC all produced no significance ($p>0.05$), calculated through the application of a one-way ANOVA test. Through lack of significance in eye tracking metrics, it can be understood that the packaging stimuli were equally camouflaged amongst the real cereal brands.

Significance was revealed through the findings of the Self-Assessment Manikin (S.A.M.). If peaks in EDA had been experienced across the participants during the stimulus viewing interval, the S.A.M. data would have been compared to the EDA data to determine the valence of the arousal (positive or negative emotion). We could, however, confirm the intended valence of the stimuli with the S.A.M. scale. The significance found in the S.A.M. ratings is important to the validity of the study because we were able to confidently report the valence of the designed stimuli. The ranges of happiness/pleasantness and arousal/stimulation both produced significance ($p<0.01$). The range of dominance did not produce significance; however, reasoning for this outcome could be attributed to low levels of experienced dominance or participant misunderstanding.

Figure 6: Positive Stimulus Eye Tracking Heat Map

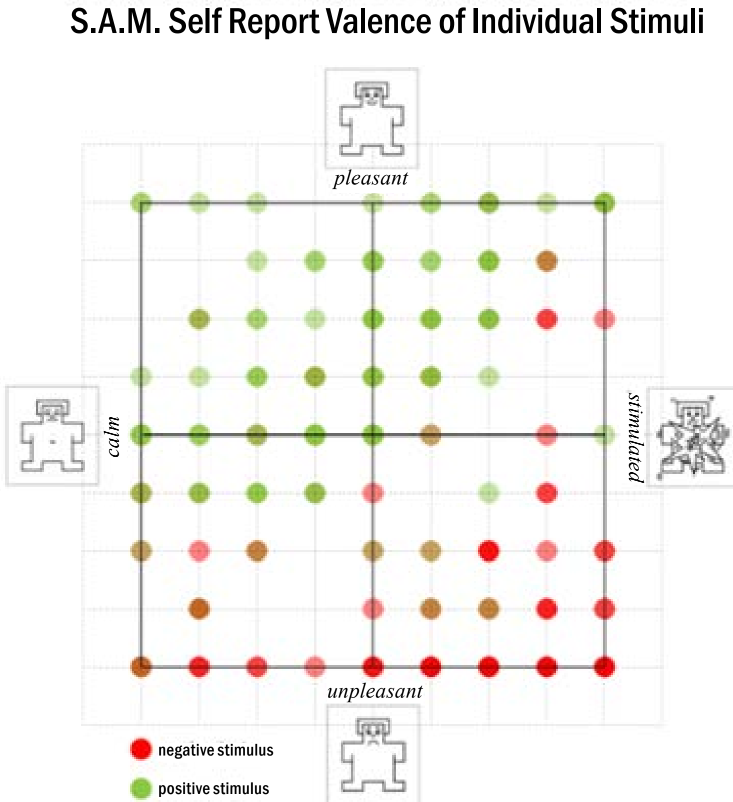
Figure 7: Negative Stimulus Eye Tracking Heat Map

Several participants noted that it was difficult to express dominance through the viewing of a package design. Dominance experienced through viewing a package design could be low, while dominance experienced through more interactive media, such as video and audio, could be much more notable [27]. Some can find it strange where consumers were asked to relate dominance to packaging designs. Happiness and arousal are more useful terms when discussing packaging. The two main emotional factors of the S.A.M. test in an x,y coordinate system are illustrated in Figure 8. The x-axis denotes boring or low-stimulated responses in the negative range and happy or pleasurable emotions in the positive range. The red dots illustrate that the participants found the negative package design to be highly arousing and highly depressing or sad. The green dots show an opposite trend of highly pleasing or happy feelings with a more neutral arousal representation. Likert scales, measuring the valence of the design keywords, also produced significance ($p<0.01$) when the negative and positive groups were compared. A one-way ANOVA test was used to test for significance. (see next page)

A fundamental issue is highlighted in the experimental set-up of stimuli in shopping contexts. It is very difficult to naturally engage the consumer in experiencing the emotional stimuli within a fast paced context. While a shopping context will produce natural, subconscious reactions to packaging, the quick and unpredictable movements of consumers make recording and understanding these reactions very difficult. Most likely, the consumer experienced an emotional reaction during the decision made on the cereal aisle. This arousal however was considerably small, rapid and hard to detect through the current measure of EDA. As future physiological research methods develop, it would be worthwhile to apply new techniques in an effort more boldly outline these small and rapid emotional responses.

The realistic branding of the cereal aisle could also have created issues with the consumer. Due to previous knowledge and brand loyalty towards certain products, participants could have quickly missed the emotional stimuli. A future study of this type could see more contrasting results through the design of completely new brands with unnoticeable traits. It would be suggested to run a new simple study using new brands so that the EDA device can detect small changes observed in packaging evaluation. This would allow us to decipher if the stimuli

Figure 8: S.A.M. Self-Reported Valence of Packaging Designs



were appropriate and if the device is in fact measuring what has been intended in this study. Doing this would create an even playing field for the stimulus against its real-life competitors.

While significance was not found, we cannot conclude that EDA is not a valid tool for measuring arousal towards packaging designs inside the shopping environment. However, this is not to be stated in complete abandonment. While a shopping context will produce natural, subconscious reactions to packaging, the quick and unpredictable movements of consumers make recording and understanding these reactions very difficult. EDA is listed as a measure of arousal towards many unique stimuli and is supported with requests for future experimentation and development. EDA has seen much success through the efforts of studies involving longer periods of measurement. The conclusion of this study is not meant to disregard all future intersections with EDA and packaging evaluation. Instead, more tactics in experimental design must be used to understand the connections between the brain, the body's nervous system, a consumer's visual attention, and their self-report measures.

A 3-dimensional model representing renderings of future possibilities with EDA, eye tracking, and S.A.M. visualizations in tandem is shown in Figures 9-10. The results taken from this study did not produce significant results and are not appropriate for an accurate dimensional mapping concept such as the one presented. However, with future advancements in these technologies, a physical and tangible experience can be generated to express the physiological responses of the consumer. To combine the data from the three tools used in this study, a multidimensional scaling approach is conceptualized [35-36]. The S.A.M. scales are plotted as x,y coordinates on the x-y plane. The Total Fixation Duration of the participant determines the height of each plotted point. The EDA arousal ratio adds the final layer of information as a radius to a circle. Cylinders are lofted between the extruded circles and a surface is generated between the three dimensions of the model. Products can quickly be evaluated and visually compared against one another to understand the degree and valence of a consumer's arousal (Figure 9). The spirit and value of the research of emotions towards packaging design can be experienced through this model form. Through experiencing a dimensional graph, such as the one proposed, future studies can demonstrate how emotional reactions occur during the critical instance of the purchasing decision (Figure 10). During this quick moment, it is shown that emotion is key to action, not conscious and rational thought.

With a better understanding of measuring consumer emotion, designers are provided with a process by which to design more positive interactions for people.

Figure 9: Experimental Visualization—Plan View

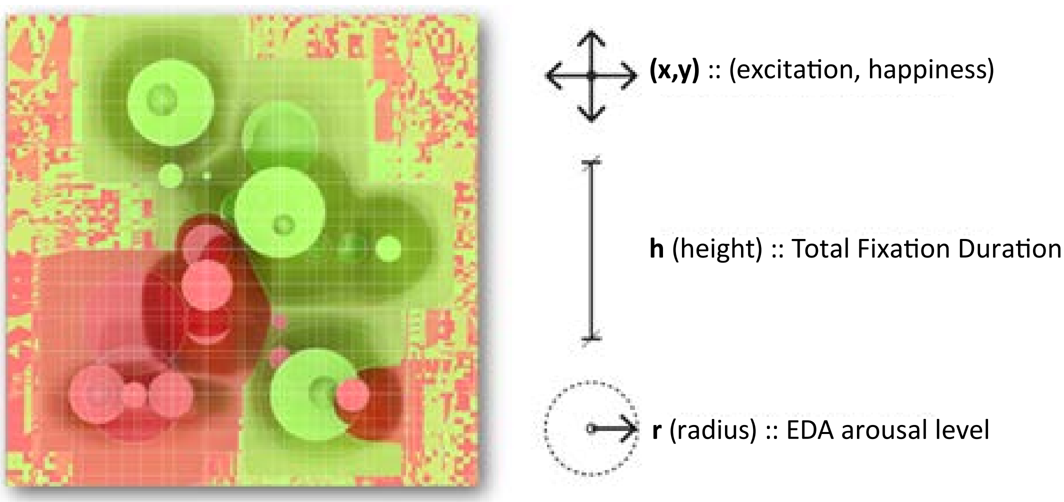
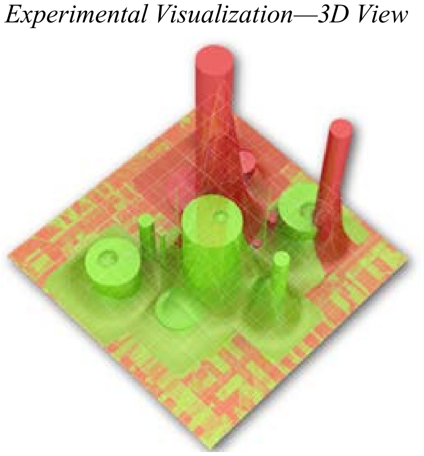


Figure 10: Experimental Visualization—3D View



CONCLUSIONS

Electrodermal Activity has been introduced to the toolset of packaging designers in an effort to better understand the emotions that connect consumers to the products that they buy. This experiment is unparalleled in that it increases the reality of the study participant. Study participants navigated the experiments as if they were realistically shopping in the retail environment. This insertion of reality reveals the complexities of consumer behavior where many fast processes occur in short flashes of time. In the design of this experiment, the Q-SensorTM, a wireless tool of measuring electrodermal activity, was not valid for measuring arousal to packaging stimuli in the shopping context. Eye tracking metrics provided an unobtrusive means of pairing the EDA data with the packaging stimuli. Through eye tracking it is possible to visually document the consumer's journey.

While a shopping context will produce natural, subconscious reactions to packaging, the quick and unpredictable movements of consumers make recording and understanding these reactions very difficult. The study was designed to occur under the most realistic conditions; however, this could also be understood as a limitation. EDA recordings require more time and stimulus isolation than what is natural to consumers in a shopping context. The conclusion of this study is not meant to disregard all future intersections with EDA and packaging evaluation. Instead, more tactics must be used to understand the connection between the brain, the body's nervous system, a consumer's visual attention, and their self-report measures.

With a better understanding of measuring consumer emotion, designers are provided with a process by which to design better interactions for people. With a powerful understanding of emotion, designers can help target the claims that draw consumer engagement. Packaging designers should aim to parallel the fields of neuroscience, psychology, and physiology in order to attempt any applications in measuring consumer emotions. By combining the successes of these fields, an exciting and rewarding future of emotion in consumer behavior can result.

REFERENCES

[1] Blakeslee S. Is There A ‘Buy Button’ In the Brain? The International Herald Tribune 2004.

[2] Bradley, M.M.,& Lang, J.P. Measuring Emotion: The Self-Assessment Manikin and the Semantic Differential. Journal of Behavior Therapy and Experimental Psychiatry 1994, 25, 49-59.

[3] Chandon P. Do We Know What We Look at? An Eye-Tracking Study of Visual Attention and Memory for Brands at the Point of Purchase. Journal of Consumer Research 2002, 60 ,1–41.

[4] Dawson, M., Schell A., Fillion, L.D. The Electrodermal System. In The Handbook of Psychophysiology, (ed.). Dawson, Schell, Filion, and Berntson, Cambridge University Press: Cambridge, 2007; 159-181.

[5] Duchowski A. Eye Tracking Methodology: Theory and Practice, 2nd ed. Springer: New York, 2007.

[6] Folch-Lyon, E., & Trost J. Conducting Focus Group Sessions. Studies In Family Planning 1981, 12, 443–449.

[7] Grifantini, Kristina. Wearable Sensor Reveals What Overwhelms You. MIT Technology Review 2011.

[8] Groeppel-Klein, A. Arousal and Consumer In-Store Behavior. Brain Research Bulletin 2005, 67(5), 428–37, DOI:10.1016/j.brainresbull.2005.06.012 2005.

[9] Guan, Z., Cuddihy, L.S., Ramey J. “ The Validity of the Stimulated Retrospective Think-Aloud Method as Measured by Eye Tracking,” in Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 2006. DOI:10.1145/1124772.1124961.

[10] Hurley R.A, Galvarino J., Thackston, E, Ouzts, A., Pham, A. The Effect of Modifying Structure to Display Product Versus Graphical Representation on Packaging. Packaging Technology and Science 2012, 10, 1–8, DOI:10.1002/pts.

[11] Hurley, R.A. “Persuasive Packaging: An Eye-Tracking Approach to Design,” Ph.D. dissertation, Clemson University, Clemson, SC, USA, 2011.

[12] Hutcherson, D., Hurley, R.A., Daily, S., Ouzts, A. Talk to Me: Biometrically Adaptive Consumer Packaging. The International Journal of Science in Society. [online] 2013. http://www.science-society.com/ (Accessed; October 1, 2013).

[13] Kohan X. A Physiological Measure of Commercial Effectiveness. Journal of Advertising Research 1968, 8(4), 46–49.

[14] LaBarbera, P., & Tucciarone, J. GSR Reconsidered: A Behavior-Based Approach to Evaluating and Improving the Sales Potency of Advertising. Journal of Advertising Research 1995, 35, 33.

[15] Liao, Lewis, Corsi, A., Lockshin, L., Chrysochou, P. “Can Packaging Elements Elicit Consumers’ Emotional Responses?”, in the 41st European Marketing Academy Conference, 2012.

[16] Lindstrom, Martin. Buyology: Truth and Lies About Why We Buy. Randon House: New York, 2010.

[17] Lykken, D.T., Rose, R., Luther, B., Maley, M. Correcting Psychophysiological Measures for Individual Differences in Range. Psychological Bulletin 1996, 66(6), 481-484.

[18] McClure, S.M., Li, J., Tomlin D., Cypert K.S., Montague LM, Montague PR. Neural Correlates of Behavioral Preference for Culturally Familiar Drinks. Neuron 44 , 379-387.

[19] Ohme, R, Reykowska, D, Wiener, D, Choromanska, A. Analysis of Neurophysiological Reactions to Advertising Stimuli by Means of EEG and Galvanic Skin Response Measures. Journal of Neuroscience, Psychology, and Economics 2009, 2 , 21–31. DOI:10.1037/a0015462.

[20] Pawle, J., Cooper, P. Measuring Emotion-Lovemarks, the Future Beyond Brands. Journal of Advertising Research 2006,46, 38–48. DOI:10.2501/S0021849906060053.

[21] Picard, R.W., & Daily, S.B. “Evaluating Affective Interactions: Alternatives to Asking What Users Feel,” in the CHI Workshop on Evaluating Affective Interfaces: Innovative Approaches, 2005.

[22] Poh, M.Z., Swenson, N.C., Picard, R.W. A Wearable Sensor for Unobtrusive, Long-Term Assessment of Electrodermal Activity. IEEE transactions on bio-medical engineering 2010; 57(5) , 1243–52. DOI:10.1109/TBME.2009.2038487.

[23] Pop, C.M., Lacramioara, R, Maniu, I.A., Zaharie, M.M. Neuromarketing-Getting Inside the Customer’s Mind. Annals of Faculty of Economics 2009, 4, 804–807.

[24] Raghubir, P & Greenleaf, E. Ratios in Proportion: What Should the Shape of the Package Be? Journal of Marketing 2006, 70(2), 95–107.

[25] Rebollar, R., Lidón, I., Serrano, A., Martín, J., Fernández, J.M. Influence of Chewing Gum Packaging Design on Consumer Expectation and Willingness to Buy: An Analysis of Functional, Sensory and Experience Attributes. Food Quality and Preference 2012, 24, 162–170, DOI:10.1016/j.foodqual.2011.10.011. 2012.

[26] Rettie, R., & Brewer, C. The Verbal and Visual Components of Package Design. Journal of Product & Brand Management 2000, 9, 56–70, DOI:10.1108/10610420010316339.

[27] Rundh, B. Packaging Design: Creating Competitive Advantage with Product Packaging. British Food Journal 2009,111(9), 988–1002, DOI:10.1108/00070700910992880.

[28] Shiv B, Fedorikhin. A Heart and Mind in Conflict: The Interplay of Affect and Cognition in Consumer Decision Making. Journal of Consumer Research 1999, 26(3), 278–292.

[29] Thaler, H.R., Sustein, R.C. Nudge: Improving Decisions About Health, Wealth, and Happiness. Penguin Group, New York, 2009.

[30] Tonkin, C. “CUshop: A Simulated Shopping Environment Fostering Consumer-Centric Packaging Design & Testing,” Ph.D. dissertation, Clemson University, Clemson, SC, USA, 2011.

[31] Tonkin C, Ouzts A, Duchowski A. “Eye Tracking Within the Packaging Design Workflow: Interaction with Physical and Virtual Shelves,” in the NGCA Conference on Novel Gase-Controlled Applications, 2011.

[32] Valentino-DeVires, J. MIT Researchers Read Consumers’ Faces to Make a Better Taste Test. The Wall Street Journal 2010, p. 1.

[33] Wansink, B. Can Package Size Accelerate Usage Volume? The Journal of Marketing 1996, 60(3),1–14.

[34] Wickelmaier, Florian. An Introduction to MDS, 2003.

[35] Witchalls, C. Pushing the Buy Button; Companies Are Starting to Turn to Powerful Brain-Scan Technology in Order to Figure Out How We Choose Which Products to Purchase. Newsweek International 2004.

[36] Zaccai, G. Why Focus Groups Kill Innovation, from the Designer Behind Swiffer. Fast Co. Design, 2012.