This is to certify that the

thesis entitled

DEVELOPMENT OF A METHODOLOGY TO QUANTIFY PACKAGE AND LABEL LEGIBILITY

presented by

JAMES PIETROWSKI

has been accepted towards fulfillment
of the requirements for

MASTER degree in PACKAGING

Hugh E. Lockhart

HUGH E. LOCKHART, PH.D.
Major professor

Date MAY 10, 1993

DATE DUE	DATE DUE	DATE DUE
1 9 1998	MAR 2 0 2009	2009
0325 09		

Development of a Methodology to Quantify Package and Label Legibility

By

James Pietrowski

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

School of Packaging

1993

ABSTRACT

Development of a Methodology to Quantify
Package and Label Legibility
By
James Pietrowski

This study was conducted to develop and test an apparatus capable of determining the legibility of copy. The apparatus called the Light Gradient Box (LGB) works on the principle of varying the amount of light available to the viewer of label copy by two means, the Filtered Light Method and the Incident Light Method.

Nine different messages using two different type faces printed in three different sizes where evaluated using both methods. Forty-five consumers were used as evaluators and eight print industry professionals were used as a control. The results from the experts correlated with those of the consumers using LGB both methods.

High correlation coefficients of 0.976 and 0.984 between the expert and the consumer results for the incident light method and filtered light method respectively, indicate that the LGB, when used by consumers ranks legibility of copy in the same order as experts rank it. Therefore, the LGB is a valid instrument for determining legibility of copy. Consumer visual acuity and age along with type size and type face all significantly influenced legibility.

This thesis is dedicated to my wife and best friend, Beth. Without her love, encouragement and patience this thesis would not have been possible, to Dr. Lockhart, Dr. Harte and the School of Packaging for providing me with the funding to help financially support my research. Finally, I would like to express my deepest appreciation to my parents for providing the foundation for everything I have accomplished.

Thank You.

ACKNOWLEDGMENTS

The author would like to express his appreciation and gratitude to the following individuals who have had an impact on his graduate studies:

* Dr. Hugh Lockhart, School of Packaging, Michigan State University, for his advice and guidance as my major professor throughout my program.

* Dr. Dennis Gilliland, Statistics Department, Michigan State University, for assistance and guidance with the experimental design and statistical analysis of the data.

* Dr. Bruce Harte, School of Packaging, for his help and direction serving as a member of my graduate committee.

* Mutune Wa Gitau for his prior work in the area of legibility which provided the foundation for this and future studies.

* Mr. Glen Petitt for helping in the initial experimental design and providing his expert support in various areas throughout this study.

* All of the people, both experts and consumers, who took the time to participate in this study.

* Finally, a special thanks to the students, staff members and faculty at the School of Packaging at Michigan State University for making my studies as meaningful as they were.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF ILLUSTRATIONS

Illustration Page

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

"Legibility is a dangerous - and interesting - word. It is dangerous because it is so often used as if it had a definitive or absolute meaning, which it does not. It is a personal word neither scientific nor precise. If you say 'that is legible', you mean only that you can read it: you do not know whether I can. Illegible is worse, because it is nearly always emotive and expresses annoyance, rather than fact". In writing this, Ruari Mclean (1) sums up many of the dilemmas regarding legibility in the world today.

Much has been done in the area of legibility; however a clear concise understanding and definition of legibility has yet to be agreed upon. In typography the word legibility is used to define a desirable quality in typefaces, lettering, pages of books, posters, road signs and words in any form. Reichl (3), implies that legibility results from a learned response, and that, "Identical reproduction of the forms with which he is familiar means therefore the greatest reading ease, or legibility for the reader".

Numerous tests have been developed in an attempt to quantify legibility and determine what is legible. Gitau (6) discusses several different methods including the Distance Method, The Tachiscope (T-Scope) or the Short Exposure Method, The Focal Variaton Method, The Rate of Involuntary Blinking Method, the Polariscope, and the Luckiesh-Moss Visibility Meter and Design & Market Research Laboratory (DMR) Visibility Meter. Unfortunately, many of the experiments using such devices and methods were developed without a clearly stated common goal, and have produced conflicting results. One explanation for such results is often a simple lack of a clear interpretation of the definition of legibility, and the consequent different methods of measurement.

Presently, the primary means of assigning a degree of legibility to copy involves subjecting the copy in question to expert scrutiny and having the expert assign the degree of legibility to the copy. This is fine except for the fact that even individual expert opinion is subjective and may be swayed by personal opinion. Consumers' evaluation of legibility may be even more subjective.

Because of the lack of a common methodology to determine legibility, the author and Dr. Hugh Lockhart of Michigan State University's School of Packaging began assessing alternative means to quantify legibility. The primary objective, and the objective of this study is to be able to quantify legibility without having to directly rely on the observations of print

industry experts. Thus, the ultimate goal is to develop a method to objectivly measure consumer perception of legibility and prove that method through comparisons and correlations with print industry experts.

Another objective of this study was to compare serif and sans-serif type faces to determine if one style of type face appeared to be more legible than the other. Much has been written on this subject, often in contradiction. McLean (1) writes, "Sans-serif type is intrinsically less legible than seriffed type" . The reasoning behind this is that with sans-serif letters, the resemblance between letters is greater, thus making them less decipherable. However, McLean further states that all in all, it can be said that a well used sans-serif is more legible than a poorly used serif (1).

Dr. Lockhart has held an interest in this area of study for many years. Working in 1988 with then graduate student Mutune Wa Gitau, this dilemma was approached from the fact that for a person to read, there must be enough available light to view the copy to be read. Developing this idea further, Dr. Lockhart began theorizing that there may be a correlation between the amount of light necessary to read copy, and the degree of legibility of that copy. With his hypothesis stated, Dr. Lockhart and Gitau succeeded in using the Polariscope and a DMR Visibility Meter, both capable of varying the amount of available light, to assess legibility (6).

In this study, Gitau used child resistant closures with various colored type as the media to be studied and determined that indeed there was a correlation between the amount of light necessary to read different copy and the degree of legibility that an expert in the printing field would give to that copy. Gitau concluded that the Polariscope Procedure and the DMR Visibility Meter Procedure can, by varying the amount of light available to the subject, be used as effective tools to determine legibility of child resistant closure systems.

The polariscope that Gitau used was a self made apparatus constructed from a set of large polarizing filters placed in a corrugated box. An incandescent desk lamp was used as a light source for this analysis and the instrument produced very encouraging results. Because of these results it was determined that a refined version of this crude apparatus should be developed. The new apparatus was called the Light Gradient Box, (LGB) and was a durable, portable apparatus that would allow copy to be read under specific light conditions. It was able to vary the amount of light using two different methods, the first being the Incident Light Method, and the second being the Filtered Light method.

The primary function of the LGB is to allow a person to view copy under controlled amounts of light. Simply, a person can use the apparatus to vary the amount of light available to view copy. The amount of light necessary to read the copy could then be recorded and further analyzed. Any correlations between

the amount of light necessary to read the copy and the nature of the copy itself could be determined.

In order to substantiate the results of the experiment, print industry professionals were asked to view the copy used in the experiment. If the results of the experiment were consistent with the degree of legibility assigned by the experts, a correlation would lead to success, and the LGB could be said to be a satisfactory device for measuring legibility of the copy studied.

CHAPTER 2

MATERIALS AND APPARATUS

2.1. Type Faces

Keeping in mind one of the primary objectives of the study, serif and sans-serif type styles were chosen for comparison. Serif type can be characterized as having short lines stemming from and at the upper and lower ends of the strokes of a letter, thus giving the letter more detail. Sans-serif type face on the other hand is a type style which has no serifs. Helvetica was chosen to represent sans-serif type face, and Times Roman was chosen to represent serif type face (see illustration #1, below). All copy used was printed in upper case lettering in 5 point, 8 point and 12 point type sizes (see illustration #2, page 7). A point is a unit that is used to measure the size of type used in printing and it can be defined as being 0.013837" or approximately 1/72 of an inch in height.

Illustration 1: Examples of Serif and Sans-Serif type

Serif Type Sans-Serif Type

Nine different messages were used as text for the study

(See table 1, page 8). The messages were simple three word phrases containing words that may be used with each other but were not so closely dependant on each other that a consumer participant would be able to guess a portion of the phrase without actually being able to read it. All phrases were purposely designed to be simple, the objective was to test for legibility, not comprehension. All messages were printed in both the serif and sans-serif type faces and the three different point sizes, providing a total of fifty four different size/face combinations.

Illustration 2: Examples of type Size

	Times Roman	Helvetica
Five Point:	BE ON TIME	IT MAY HELP
Eight Point:	PUT IT HERE	HERE ARE SOME
Twelve Point:	WHO WAS THERE	ORDER TO GO

All messages were printed horizontally on cards measuring 5.5 inches by 4.25 inches. The messages, regardless of type size were centered horizontally and vertically on the cards. The original messages were printed on an IBM personal Laserwriter using an IBM PS2 Personal Computer and Word Perfect 5.1 word processing software. The professional printing service of Kinko's Copies, Inc., of East Lansing, Michigan, was used to print the cards that were to be used for the experiment. Four

sets of cards were printed on twenty pound white card stock and sets were rotated throughout the testing.

Table 1: Messages Used in Study for Consumer and Expert Participants.

Card Number	Message
1	PUT IT HERE
2	HERE ARE SOME
3	THERE WILL BE
4	ORDER TO GO
5	WILL BE DONE
6	CAN NOT GROW
7	WHO WAS THERE
8	IT MAY HELP
9	BE ON TIME

Black print on white card stock was chosen for this experiment in order to achieve a high degree of contrast. In general, the greater the contrast, the greater the readability, (2). Tinker (5), goes farther in suggesting that black print on white background is also most legible in speed reading tests.

2.2 The Light Gradient Box

The Light Gradient Box was designed and built by the author at the School of Packaging at Michigan State University. Dr. Lockhart, who can be credited with the original idea for the apparatus was actively involved throughout the development process and provided support and input when necessary.

The Light Gradient Box (LGB) was designed to allow a person to view copy under controlled light conditions. More precisely, the LGB would allow the researcher to vary the amount of light available to the eye of the participant. (see illustration 3, page 9).

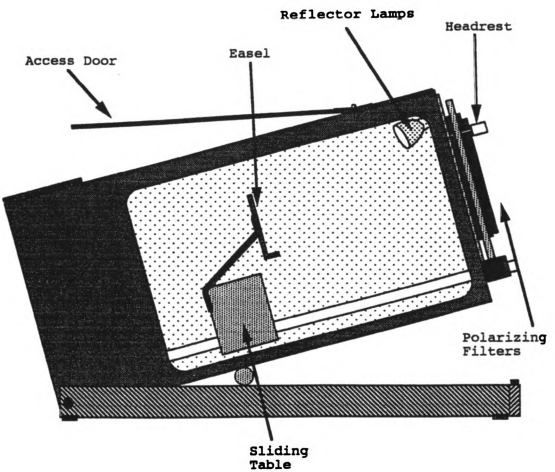
The Light Gradient Box is approximately thirty inches long. At one end is a round hole measuring approximately eight inches in diameter. The hole is placed such that by looking through, the inside of the box could be viewed. The inside of the LGB was lined with a light gray matte finish felt. The felt was used to reduce reflections and reduce shadows thus creating a more uniform light intensity throughout the LGB.

The LGB is designed so that copy could be viewed at different distances from the viewer. Inside is a small platform mounted on two steel rods which span the length of the box. The platform is very simple, and is designed to hold a variety of different fixtures allowing a multitude of different shaped objects to be studied. The LGB is outfitted with a rest for

Illustration 3

The Light Gradient Box

(Internal View)



the forehead of the viewer, this ensures minimal lateral head movement, thus providing consistent distances from the viewer's eye to the message throughout the study.

For this study small easels were fabricated to hold the cards containing the different messages. Two different easels were constructed. One easel positioned the messages in the center of the LGB and was used for those people who did not wear multi focaled glasses. The second easel was designed to accommodate those who required bi- or trifocal glasses to read. This easel positioned the message in the lower portion of the viewing area and allowed the readers to use the multi-focaled portion of their glasses without having to tip their heads back. Only one easel was mounted in the LGB at any given time.

Inside the Light Gradient Box were reflector light bulbs to be used for illuminating the copy being analyzed. Outfitted with two twenty-five watt General Electric reflector lamps placed out of view in the upper corners, the LGB was able to provide its own light for experimentation.

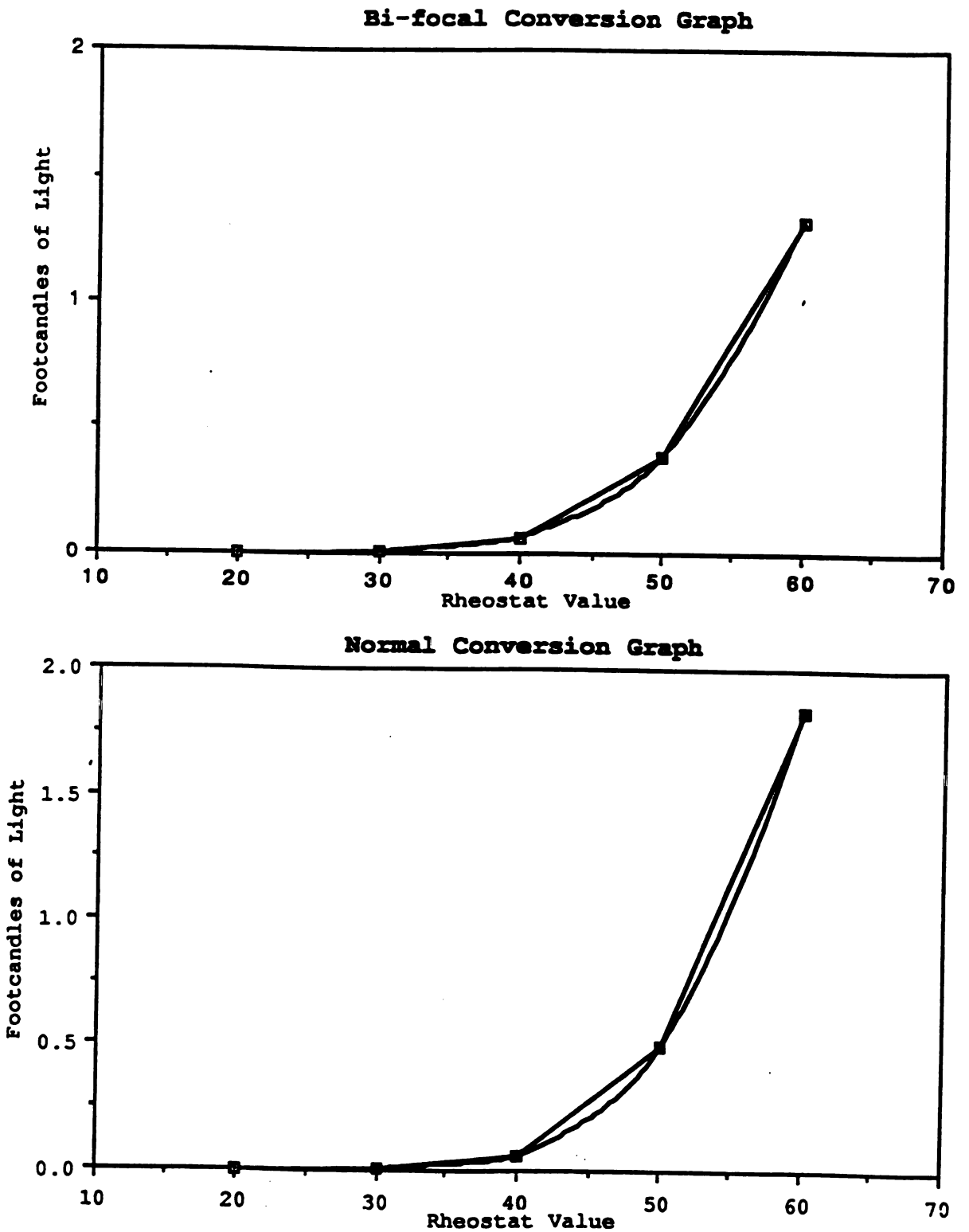
Although all light was provided by the same light source, the LGB was equipped with two different means of varying the light available to the viewer. Using the simplest method, the Incident Light Method, the LGB varied the amount of light available to the viewer by means of a rheostat. Beginning with the ambient room light and the light inside the LGB completely dimmed, the rheostat was used to gradually increase the illumination of the light bulbs inside the box, thus increasing

the amount of light transmitted to the message cards. The rheostat was equipped with a scale which was numbered from zero through one hundred and forty, with zero providing no illumination of the lamps, and one hundred and forty providing maximum illumination. All raw data using the Incident Light Method was recorded directly from this scale on the rheostat switch.

Once recorded this data then had to be converted into footcandles to be more useful. To do so, a photometer was placed on the easel (this method was replicated using both easels) in the LGB and readings were recorded from the photometer at five unit increments on the rheostat. These readings were then graphed and the graphs were used for converting the raw consumer data into footcandles, (see figure 1, page 13). Throughout the duration of the study, the rheostat was checked periodically for repeatability using this method and was found to remain consistent.

The Filtered Light Method was used as the second method for varying light to the viewer using the Light Gradient Box. This method was modeled after a similar method used by Gitau in his 1988 studies. The method used a Type 1534-PI Polariscope lens mounting system manufactured by the General Radio Company, Cambridge, Massachusetts, to hold the Polaroid Linear Polarizing Filters. These lens holders allowed one polarizing filter to be rotated while the other was kept stationary. When the filters were oriented so that their polarizing axes were crossed

Figure 1
Rheostat Value to Footcandle Conversion Scale
for Use in Conversions using the Incident Light Method



(90 degrees) they would allow minimal light transmittance. As the filters were rotated towards their parallel orientation, they would allow more light transmittance. It was this principle that allowed the Light Gradient Box to vary the amount of light available for a participant to view copy.

The Polariscope filter system was mounted on the front of the LGB between the viewer and the copy to be studied. The copy to be viewed was placed on the appropriate easel for the participant in the LGB and illuminated with a constant light level of five footcandles. This light was measured by photometer placed on the easel prior to the experiment. Beginning with the filter axes crossed, the polarizing filters would allow no transmission of light reflected from the card. With one filter fixed while the other was slowly rotated, the filters would allow more reflected light to be transmitted to the viewer through the filters.

Polaroid HN22 Linear Polarizing Filters having a thickness of .030" were chosen for this experiment from among several types of filters available from the Polaroid Corporation. As demonstrated in Figure 2, (page 15), the HN 22 at .030" allowed the least variation in light transmittance over the 90 degree turning rotation. This in turn provided the greatest sensitivity on the rotation scale and thus the most precise data. Figure 3, page 16, demonstrates the light frequency transmittance curves for the HN 22 filter. Brode (10) writes that the sensitivity of the human eye to various colors in the

Figure 2

Light Transmittance Plots for

Various Polarizing Filters

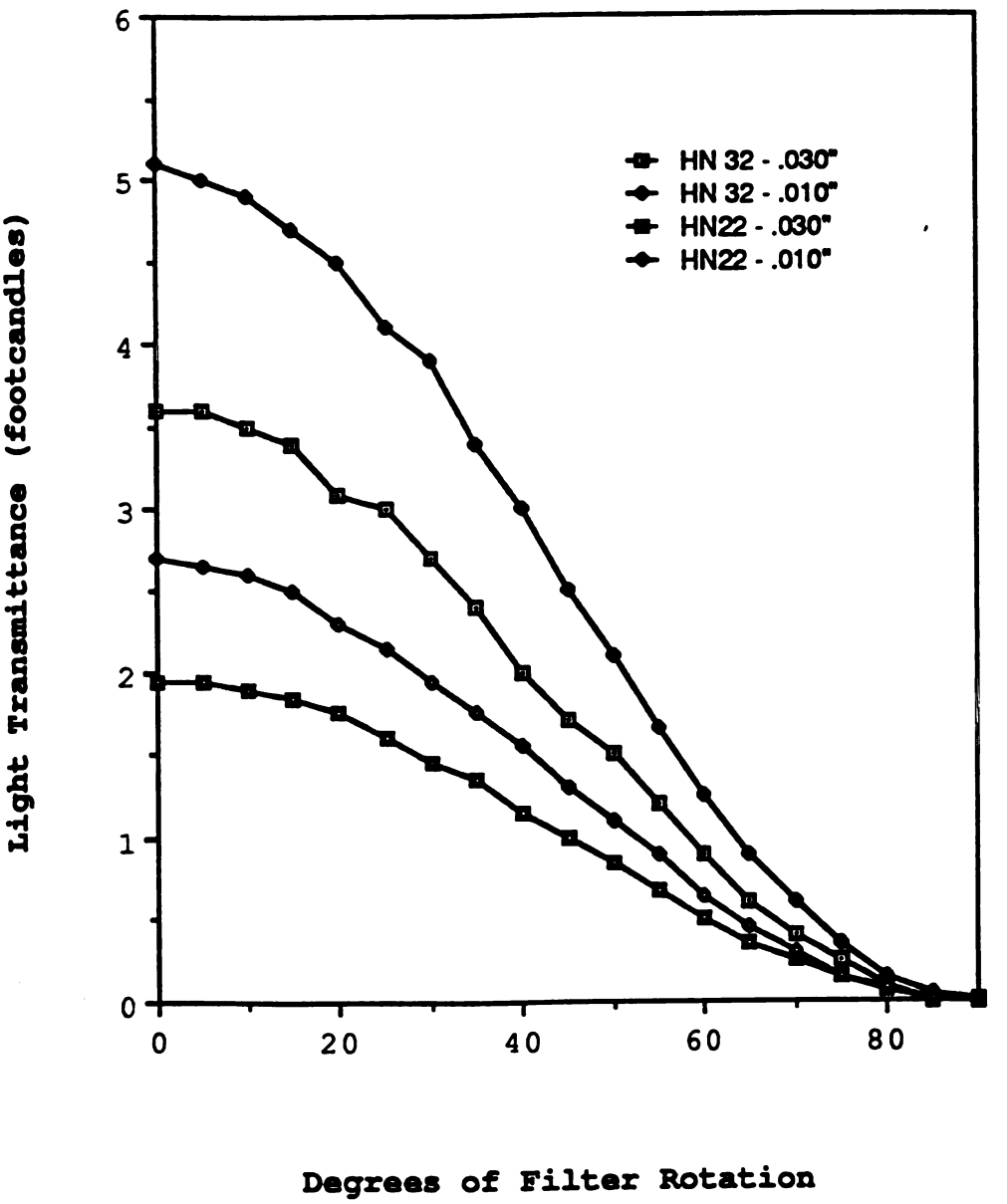
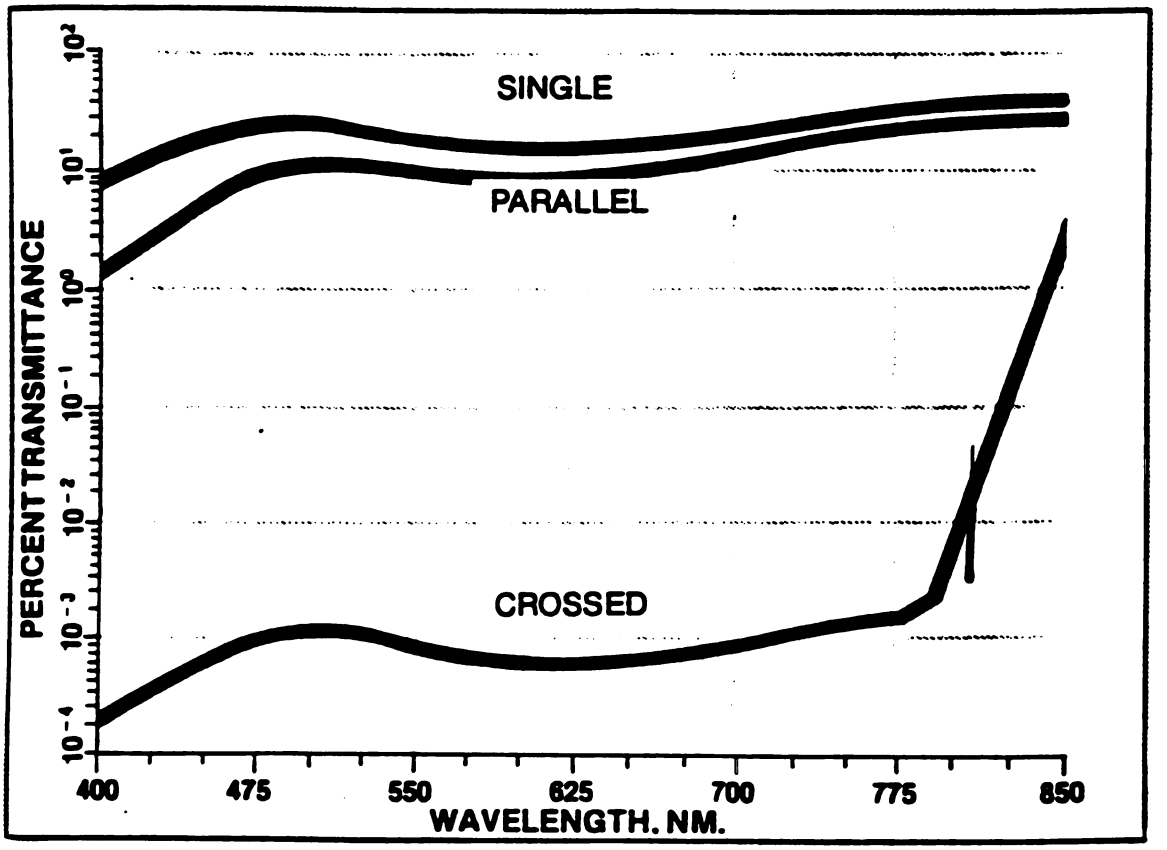


Figure 3

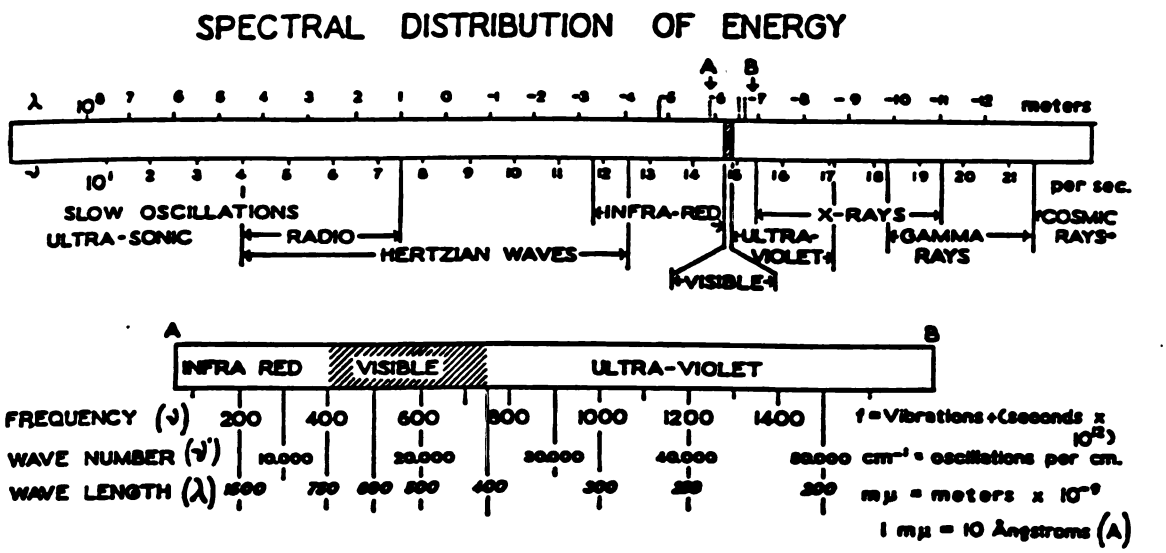
Light Frequency Transmission Curve

for Polaroid HN 22 Linear Polarizing Filters



spectrum varies, with the maxumum sensitivity at about 555mμ and the lower and upper limits at about 400 and 750mμ (see figure 4, page below for an illustration of the light spectrum). As represented in Figure 3, page 27, the HN 22 had a uniform level of light transmittance throughout this portion of the visible light spectrum.

Figure #4: Spectral Distribution of Light Energy*:



---

*Source: Chemical Spectroscopy, Wallace Brode, 1943

CHAPTER 3

TEST PROCEDURES

3.1 Expert Panel Test Procedures

The copy was first submitted to a panel of industry experts for their assessment of it's legibility. The panel of experts used in this study consisted of male and female professionals in the printing and typography industry. The expert participants were questioned about their experience in printing, graphics or typography, and their responses ranged from six to thirty five years with the mean experience being just over sixteen years. Experts were individually asked to spend a few moments evaluating legibility of the cards developed for the experiment. The results of their observations were used as a benchmark for further study using the LGB and consumer participants.

All work was done in room with controlled lighting to ensure that the lighting conditions remained constant throughout testing. Ambient room light was maintained constant at 50 foot candles, for which a mix of incandescent and fluorescent lighting was needed. The room had no exterior windows so the time of day in which the experts viewed the copy had no effect on the available light.

The experts were interviewed over a four week time period. All experts were escorted into the room and seated. They were

then immediately asked to fill out a consent form and a brief questionnaire that provided some basic information pertaining to their professional background (see Appendix C, page 57). Once this was finished, the experts were briefed on why they were asked to participate, what the objective of the research was, and how the experiment would benefit from their participation. It was clearly stated that if they had any questions, they were free to ask them. Once this was made clear, the experts were asked if they had any questions prior to beginning the experiment. When all questions were answered, the expert analysis portion of the study would begin.

Experts were first tested for visual acuity using a standard visual acuity card, and their acuity was recorded for possible future use. Once visual acuity testing was completed, the experts were presented the stack of cards containing the messages of different face/size combinations. The cards were arranged in no special order and were mixed differently for each expert. The experts were told to view each card and assign it a degree of legibility on a scale of one to ten with one being the least legible and ten being the most legible. It was clearly explained that this was not a speed reading test, and that what the author was looking for was the degree to which they (the experts) would feel that the message was legible.

The experts viewed the cards one by one. When they orally expressed their feelings as to legibility of the card, it was recorded on a data sheet by the person administering the

experiment (see Appendix C, page 58). The form on which the responses were recorded was kept out of view of the experts during the experiment. This was done to prevent responses from being affected by previous assessments. Once the experts had finished the evaluation they were asked if they had any comments. Any comments were recorded for future use by the reseachers.

The entire test for each person took between twenty and thirty minutes to administer, and each was thanked for taking time to participate. The experts were also told that upon completion of the study, they would be notified as to the final outcome.

3.2 Consumer Panel Test Procedures

Forty five consumer participants were used for the study involving the Light Gradient Box. The population of participants was divided into three age groups, 18-34, 35-49 and 50 and over. Both males and females were used as participants, and their sex was noted on the data sheets that were used to record their results (see Appendix C, page 59). The subjects were chosen at random, and consisted of students, faculty and volunteers from the community.

All experimentation was done in the same room to ensure a consistent testing environment throughout the duration of the testing. Only one participant was allowed in the room at a

time to minimize any problems associated with the subject overhearing the responses of another.

The light in the room was maintained at 50 footcandles as each participant entered the room. Participants were seated and tested for visual acuity using the same procedures as used with the experts earlier. Each participant was put in to one of three visual acuity categories, 20/20, 20/30, or 20/40 and poorer. When acuity testing was completed, the lights were dimmed to approximately 20 footcandles and the subject was asked to read and sign a consent form. Once all paperwork was read and signed, the room lights were dimmed to approximately five footcandles and the testing procedure was described to the participant.

In the description of the procedure, the participants were given details as to the nature of the study. Participants were told that they would be looking into the LGB throughout the study, and that initially there would be no light visible. They were told that the light would gradually increase as the polarizing filters were rotated or as the rheostat provided more energy to the light bulb.

It was made clear to the consumer participants that what we were looking for was the point at which they would be able to read the message on the card. They were told that this was not a contest or a speed reading test. Participants were told that there were no winners or losers, the only possible winner or loser was the LGB.

After all questions were answered regarding the study, the participant was seated in front of the LGB. The height of the chair was adjusted so that the participant was comfortable. The LGB was then adjusted so that the participant would be able to view the copy comfortably. During this process, the inside of the LGB was dimly illuminated enabling the participant to see the easel where the messages would be placed. The room lights were then turned off except for a small light which was kept out of view of the participant. This light enabled the person administering the test to read the scales on the equipment and to record data.

All cards used in the study were presented to each participant in a predetermined order. This order was designed so that each message and size/font combination would be used an equal amount of times throughout the study. Participants viewed twenty four different cards, twelve using the Filtered Light Method, and twelve using the Incident Light Method. All participants viewed each font/size combination four times, (twice using the Filtered Light Method and twice using the Incident Light Method). Messages were arranged so that no person saw the same message more than three times or less than twice.

The test began with either the Incident Light Method or the Filtered Light Method, (the order was alternated throughout the experiment by participant). The cards were stacked in their predetermined order and placed on the easel inside the LGB. No

light was available to the viewer. The light available to the viewer was gradually increased and at the point at which the person could read the message, he/she would say stop and recite the message. At that point, the degrees rotation of the filter or the index number on the rheostat would be recorded on the participant's data sheet. The light inside the LGB was immediately dimmed and the card was removed exposing the next card behind it. This process was repeated until the stack of cards was depleted. At that time the LGB would be outfitted for the other half of the study and the process would be repeated with a different stack of cards.

When the study was completed the lights were turned back on and participants questions were answered.

CHAPTER 4

DISCUSSION OF RESULTS

4.1 Introduction:

The results of the expert pannel and the consumer participants were analyzed in accordance with the primary objectives of the study. A review of these objectives are as follows:

(i) To determine if the Light Gradient Box, utilizing the two methods with consumer participants, produced results that were consistent with the results of the experts. Favorable results, that is, results that were consistent with the objectives of the study would imply that the LGB did in fact quantify legibility similar to experts and that it could be used as an effective tool to rate the legibility of copy similar to that used in this study.

(ii) Determine what effect, if any, type size, type face, age or visual acuity played in determining the degree of legibility with the Light Gradient Box using consumer participants as subjects.

4.2 Correlation Between the Experts Responses and the Light Gradient Box Results

Reliability of Experts

Prior to determining correlations between the Expert responses and the Light Gradient Box results, the experts data was analyzed for reliability. The reliability or internal consistency of the responses given by each expert to nine different messages in each of six type-font combinations was measured by the intracluster correlation coefficient with clusters sizes of nine. Following Cochran (8), a one-way analysis of variance was performed on the fifty four responses and the intracluster correlation coefficient (rho) calculated by the correlation coefficient formula shown below.

$$rho = 1 - \frac{M \cdot SS_{within}}{(M - 1) \cdot SS_{total}}$$

In the correlation formula, M = 9 which represents the cluster size and the sums of squares are within the cluster and total. The results of this portion of the analysis can be found in table 2, page 26.

The average reliability among the experts derived from the above table is 0.88. The overall reliability coefficients among

the pairs of experts (1 to 2, 1 to 3, ect.. for all pairs) ranged from 0.840 to 0.969 and can be found in Appendix D on page 61.

Table 2: Reliability Coefficients of Experts

Expert	1	2	3	4	5	6	7	8
rho	.94	.96	.92	.92	.82	.87	.76	.88

Regarding the interaction between reliability and its test use, Mahrens and Lehmann (9) claim that if a measure is to be used to help make predictions about individuals, then it should be more reliable (high alpha value) than if it is to be used to make predictions about people. The authors also write that standardized tests used to assist in making decisions about "individuals" would have reliability coefficients of at least 0.85, while for "group decisions", a reliability coefficient of about 0.65 may suffice. Miles Tinker (5) helps substantiate these numbers by saying that for group comparisons, such as these ordinarily employed in legibility studies, a reliability should not be less than 0.50; preferably, it should be 0.60 or above. Tinker also states that if one is dealing with individual diagnosis, the reliability coefficient should be at at least 0.80 and preferable 0.90 or above.

For this study, the ratings obtained from the expert participants as a group will be used to help make decisions

about the legibility or the copy. The high average reliability coefficient (0.88) is consistent with the standards mentioned above by Tinker, Manren and Lemann. This further states that there was a high degree of agreement among experts with regard to the legibility of the copy used in this study. It is this high level of agreement that allows the experts to be used as a reference control or standard for this test.

Ranking Order of Expert and Consumer Participants:

The results obtained from consumer participants and the values provided by the experts were then compared and ranked according to the type face/size combinations used in the experiment. For the Filtered Light Method and the Incident Light Method, the ranking results of the mean values obtained were the same as the expert results, (see tables 3 and 4 on pages 29 and 30).

Ranked from least legible to most legible, the font/size combinations were as follows: 5 pt. Times Roman, 5 pt. Helvetica, 8 pt. Times Roman, 8 pt. Helvetica, 12 pt. Times Roman and 12 pt. Helvetica.

These data clearly demonstrate a pattern that the experts consider Helvetica to be more legible than Times Roman when compared to each other in identical type sizes. The results from the LGB also demonstrated that more light was necessary to read the Times Roman than the Helvetica and thus the assumption

can be made that the more light required to read copy, the less legible that copy is.

4.3 Expert Ratings and Consumer Results Correlation:

With the ranking order of the two panels completed, and a definite pattern demonstrated, the next question was to determine the correlation between the expert and consumer panel results. The mean values data from the ranking order tables (tables 3 and 4, page 29 and 30) was used for this comparison. Minitab Statistical Software (Version 7) was used to determine the correlation Coefficients between the experts and the LGB.

A correlation coefficient value of 1.00 would indicate a perfect relationship between the two sample populations and thus total agreement. For this study, two different combinations were compared as follows:

(i) Experts vs. Consumers using the Filtered Light Method
(ii) Experts vs. Consumers using the Incident Light Method

Table 3:
Ranking Order of Expert Results
and the LGB Using Consumer Participants
with the Incident Light Method

Consumer Panel				Expert Panel			
*Rank Order	Type Face	Type Size	Light Required**	*Rank Order	Type Face	Type Size	Expert Rating***
1	Times Roman	5 pt.	0.21	1	Times Roman	5 pt.	2.9
2	Helvetica	5 pt.	0.16	2	Helvetica	5 pt.	4.3
3	Times Roman	8 pt.	0.074	3	Times Roman	8 pt.	5.9
4	Helvetica	8 pt.	0.062	4	Helvetica	8 pt.	7.3
5	Times Roman	12 pt.	0.048	5	Times Roman	12 pt.	8.0
6	Helvetica	12 pt.	0.018	6	Helvetica	12 pt.	9.1

* Ranking order is from one (1) being least legible to six (6) being most legible.

** Light required in footcandles as converted from Rheostat scale

*** Mean value assigned by experts on a one to ten scale with one being the least legible

Table 4:
Ranking Order of Expert Results
and the LGB Using Consumer Participants
with the Filtered Light Method

Consumer Panel				Expert Panel			
*Rank Order	Type Face	Type Size	Degree of Rotation**	*Rank Order	Type Face	Type Size	Expert Rating***
1	Times Roman	5 pt.	46.6	1	Times Roman	5 pt.	2.9
2	Helvetica	5 pt.	38.1	2	Helvetica	5 pt.	4.3
3	Times Roman	8 pt.	26.0	3	Times Roman	8 pt.	5.9
4	Helvetica	8 pt.	23.5	4	Helvetica	8 pt.	7.3
5	Times Roman	12 pt.	18.3	5	Times Roman	12 pt.	8.0
6	Helvetica	12 pt.	15.8	6	Helvetica	12 pt.	9.1

* Ranking order is from one (1) being least legible to six (6) being most legible.

** Degree of Rotation is the mean angular rotation of the filters at the point of legibility.

*** Mean value assigned by experts on a one to ten scale with one being the least legible and ten being most legible

The correlation coefficients can be found in table 5, (below), and the bivariate plots for each comparison can be found on pages 32 and 33, Figures #5 & #6. The negative values found in the bivariate plots represent not disagreement but rather the slope of the fitted line for the correlations.

The correlation coefficients in table #5 are clearly high and demonstrate very strong correlations between the the experts and the consumer participants for both Incident Light and Filtered Light methods of testing. This result further demonstrates that the Light Gradient Box using both methods produces results similar to the expert responses.

Table 5: Correlation Values of Experts vs. Consumers using both LGB Testing Methods:

Correlation Source	Correlation Coefficient
Experts vs. A*	**0.984**
Experts vs. B**	**0.976**

* Consumers using LGB w/ the Filtered Light Method
** Consumers using the LGB w/ the Incident Light Method

Figure 5:
Bivariate Plot of Experts and Filtered
Light Method Using Consumer Participants

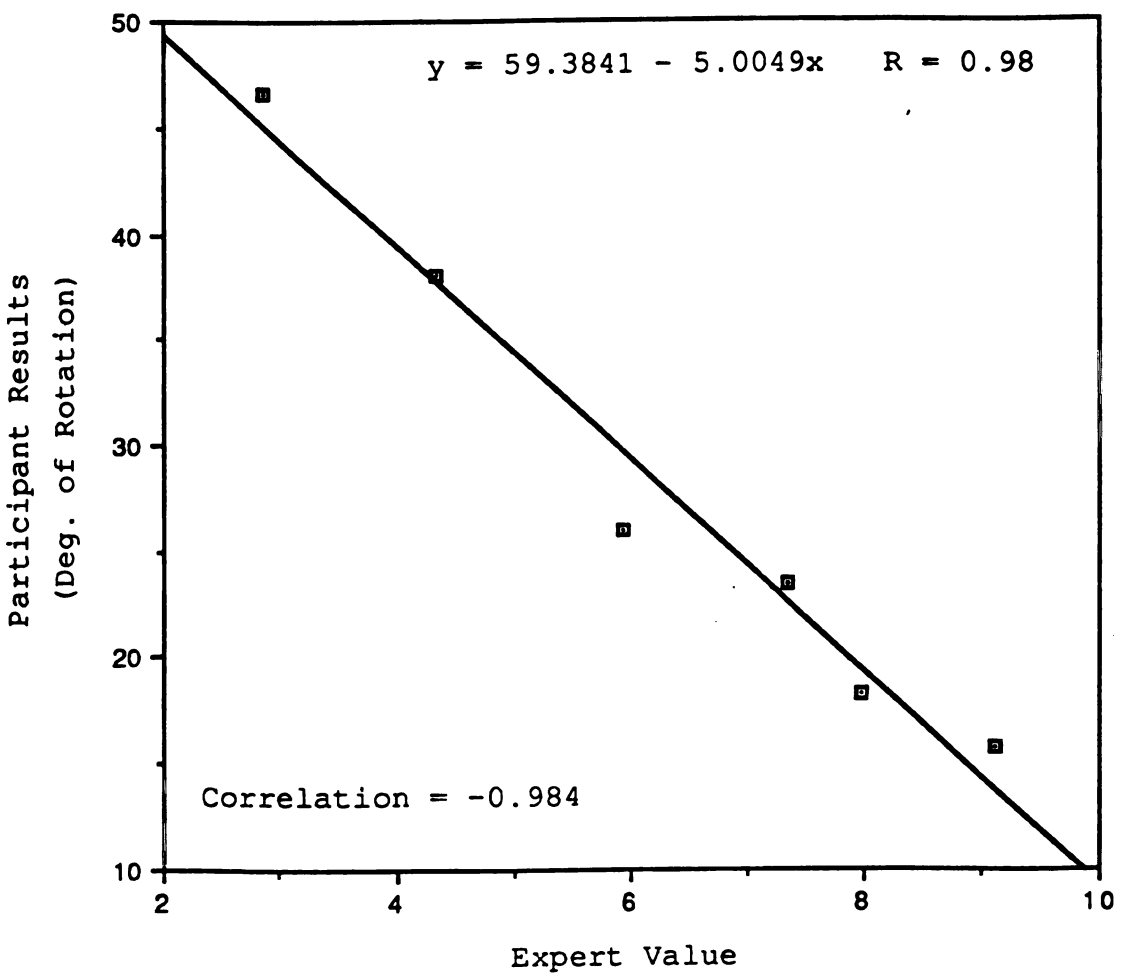
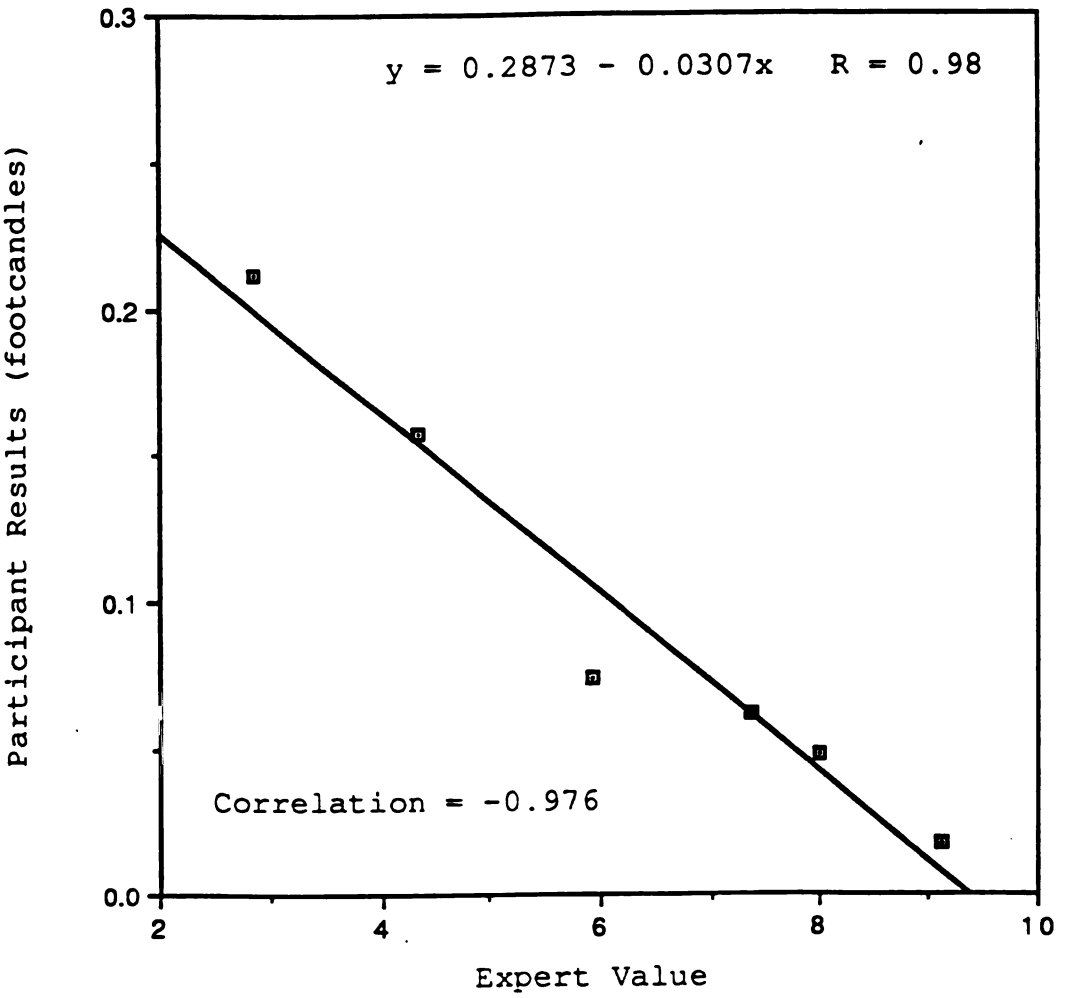


Figure 6:
Bivariate Plot of Experts and Incident Light Method Using Consumer Participants



4.4 Effects of Type Size, Type Face, Age and Visual Acuity on Consumer Results:

The data from the Incident Light Method and Filtered Light Method were analyzed to determine if type size, type face, the participant's age, or participant's visual acuity had any effect on legibility. Analyses of variance, (ANOVA's) were performed on both sets of data for the above mentioned treatments. Sex of the observer was found, by use of the ANOVA, not to be statistically significant. An ANOVA demonstrating this point can be found in Appendix E, page 65.

Message effect was also not tested for in this portion of the study. Preliminary study into the effect of the messages was performed using the expert results at the inception of the study and message effect proved not to be statistically significant. See Appendix H, page 77. Because of these initial results using the expert data, no further analysis of message effect was performed throughout the duration of the study.

In the ANOVA analysis for each method of LGB testing, there were four main treatments, type size, type face, participant age, and participant visual acuity. Of the four main treatments, there were six interactions or combinations that were also tested by means of analysis of variance. Table 6 on page 46 illustrates the main treatments and interactions addressed for each of the two testing methods, Incident Light and Filtered Light.

The usual practice when using statistical analysis is to assign levels of significance to certain values of alpha: traditionally, alpha = 0.005 is very highly significant, alpha = 0.01 is highly significant, and alpha = 0.05 is significant. Indeed alpha is the critical value of p, the probability of random occurance, at which we will decide to take action on the outcome of an experiment. Thus, whenever the analysis produces a p value equal to or less than the alpha, we call it significant and recommend action. By tradition, we choose p=0.05 as the highest value for which to designate alpha, and recommend action.

For this experiment, however, we must recognize that the ultimate issue is whether or not consumers can read labels. In such a case, if we can be as much as 75% sure (alpha = 0.25) that consumers can read one kind of label better than another, we might choose tc call alpha = 0.25 "significant" for the purpose of striving to eliminate labeling of poor legibility. It does not cost much to make the changes needed for consumer comfort, convenience, happiness and safety. Therefore, in this thesis, the p-value is reported for all ANOVA's and is based on the premise that for label legibility issues, the alpha = 0.25 is significant. The reader may choose to do otherwise and that is his/her prerogative.

Table 6: Main Treatments and Interactions from LGB Testing*.

Treatments:	Interactions:		
(A) Type Size	A & B	A & C	A & D
(B) Type Face	B & C	B & D	
(C) Participant Age	C & D		
(D) Visual Acuity	--		

***ANOVA's were run for both the Incident Light Method and the Filtered Light Method using consumer participants.**

4.5 Effects of Type Size Type Face, Age and Visual Acuity on Consumer Results using the Filtered Light Method:

The Filtered Light Method data was first tested by means of an Analysis of Variance, the results of which are in Appendix E, page 64. This analysis clearly demonstrated that type size, type face, visual acuity and age all had a significant effect on the amount of filtered light necessary to read copy using the LGB, (see table 7, page 37). All four main treatments had some effect on the legibility of the copy analyzed in this study by the Filtered Light Method.

Through the use of the ANOVA, type size was found to be highly statistically significant having a confidence interval of 99.99%, (see Appendix E, page 64). Because this only demonstrates a difference among all type sizes, the individual

Table 7: ANOVA Table for Main Treatments using the Filtered Light Method.

Source of Variation:	DF	ANOVA SS	F Ratio	P Value	Stat. Sig.?
Type Size (A)	2	11916.860	91.486	.000	YES
Type Font (B)	1	875.491	7.216	.008	YES
Age (C)	2	12689.892	58.290	.000	YES
Acuity (D)	2	585.091	2.688	.070	YES

***Acuity significant at 92.99 confidence level and font significant at 99.23 confidence level. All others significant at 99.99 confidence level.**

type sizes were broken down by the participant age group and then compared with each other using a two sample t-test. The results of this analysis, (see table 9, Appendix F, page 67) further confirm that for both type faces, type size was highly significant among all consumer age groups. When type sizes were broken down by participant visual acuity groups and compared, all differences were found to be statistically significant among all visual acuity groups for both type faces, (see table 10, Appendix F, page 68).

The two type faces were also found to be statistically highly significant as a result of the ANOVA. The probability for this comparison, while not quite as high as for the type size difference, was 0.0077 suggesting a confidence interval of

99.23%, (see Appendix E, page 64). Because there were only two type faces involved in this comparison, further analysis was not necessary.

Age proved to be highly statistically significant as a result of the ANOVA, having a probability value of .0000 (confidence interval of 99.99%), (see Appendix E). When the ages were broken down and compared by type size, it was interesting to find that age affected the legibility of type much more when the 36 to 50 year age group was compared to the 50 and over age group than when the 20 to 35 year old age group was compared to the 36 to 50 year old age group (see table 11, Appendix F, page 69).

Visual acuity for the participants using the filtered light method proved to be statistically very significant having a probability level of 0.0701 and consequently a confidence interval of 92.99% as reported by the ANOVA in Appendix E. When visual acuity values were broken down by type size and font combinations, the results were varied. Differences between 20/20 consumer participants and 20/30 participants followed no apparent pattern and the same was true for the comparisons between the 20/30 and 20/40 visual acuity groups. When the 20/20 and 20/40 groups were compared, the results were quite different, demonstrating a statistically significant difference among all size/face combinations at alpha = 0.25 (see table 12, Appendix F, page 70).

4.6 Effects of Type Size Type Face, Age and Visual Acuity on Consumer Results using the Incident Light Method:

The ANOVA performed on the consumer data for the Incident Light Method is found in Appendix E, (page 63). Type size, type face, visual acuity and age all proved to be significant suggesting that they had an effect on the amount of incident or reflected light necessary to read copy using the LGB (see table 8, below). As with the Filtered Light Method, all four main treatments had an effect on the legibility of the copy tested using the Incident Light Method.

Table 8: ANOVA Table for Main Treatments using the Incident Light Method.

Source of Variation:	DF	ANOVA SS	F Ratio	P Value	Stat. Sig.?
Type Size (A)	2	1230.7050	182.515	.000	YES
Type Font (B)	1	60.1864	17.851	.000	YES
Age (C)	2	541.7538	80.343	.000	YES
Acuity (D)	2	53.7734	7.975	.000	YES

*Visual Acuity significant at 99.96 confidence level, all others significant at 99.99 confidence level.

Through the use of the ANOVA, type size was found to be highly statistically significant having a probability of .0000. When the various type sizes were broken down by the participants' age groups and compared using a two sample t-test,

the results were statistically highly significantly different among all type sizes among all age groups, (see table 13, Appendix G, page 72). When type sizes were broken down into groups by participants visual acuity, all comparisons were also highly statistically significant except for those in the 20/40 visual acuity group. The comparisons in this visual acuity group were very significant among all type size comparisons for both type faces, (see table 14, Appendix G, page 73).

Type face for copy used in the Incident Light Method also proved to be highly statistically significant having a probability of .0000. Here again, because there were only two variables for the treatment, no further analysis was necessary.

Participant age was also highly statistically significant according to the ANOVA which produced a probability of .0000 (see Appendix E, page 63). When the age groups were then broken down by type size/font combinations, all comparisons of age groups proved to be significant, (see table 15, Appendix G, page 74).

The last primary treatment to be tested was the visual acuity of the participants for the Incident light Method. For this treatment, the ANOVA produced a significance level of .0004 which in turn provides a confidence interval of 99.96%, (see Appendix E, page 63). This clearly demonstrates a highly statistically significant effect of visual acuity on the amount of incident light necessary to read the copy in this study. When visual acuity groups were then broken down and analyzed by

type size/face combinations, it was demonstrated that the difference between the 20/20 participants and the 20/30 participants was very significant for all type combinations and that the difference between the 20/30 participants and the 20/40 participants (except for the 5 pt. Serif), was not statistically significant. When the mean values for the 20/20 and 20/40 participants were compared, all were significantly different except for the comparison analyzing 12 pt. Serif type, (see table 16, Appendix G, page 75)

For both testing methods, Age, Visual Acuity, Type Size and Type Face all had some effect on the legibility. In all cases, the amount of light necessary to read serif type was greater than the amount necessary to read sans-serif type. This will allow us to conclude that for the type sizes used in this study, sans-serif was more legible than serif type.

Both testing methods also demonstrated that age and visual acuity had some effect on legibility. Age was significant for all font size combinations between all age groups using both methods except with the youngest and middle age groups using the Filtered Light Method. When the mean values from these two groups were compared, there were no significant differences among any of the size/font combinations.

The visual acuity of the consumer participants using both testing methods had a significant effect among almost all font/size combinations when the 20/20 and 20/40 acuity groups were compared. The results of the 20/20 and 20/30 participants

using the Incident Light Method also demonstrated significance among all combinations while the results of the 20/30 and 20/40 participants using the same method demonstrated just the opposite.

CHAPTER 5

SUMMARY AND RECOMMENDATIONS

When experts were compared to the Filtered Light Method using a consumer panel, a high correlation of 0.976 was achieved. similarly, when the Incident Light Method was compared to the experts, a correlation of 0.984 was achieved. Because both Light Gradient Box methods gave results similar to those of the experts, either method could be used to evaluate the legibility of packaging.

The reliability of the two LGB testing methods was not determined in this study and this is something that needs to be addressed in future studies. While the final outcome of both methods proved to be similar in the end, each has its own advantages.

The filtered light method uses an extended scale to measure the degree of angular rotation of the polarizing filters. During this study, that scale was almost entirely used and therefor provided much more sensitivity than the limited portion of the rheostat scale that was actually useful in the Incident Light Method. It is for this reason that the Filtered Light Method provides greater sensitivity for data recording. In

future studies, a more sensitive rheostat may be desired when using the LGB for incident light legibility testing.

Because there were no filters involved, the Incident Light Method provided an unobstructed view of the copy being analyzed. The Filtered Light Method on the other hand required the participant to view copy through a pair of tinted polarizing filters. If possible, it should be determined if in fact this may have an effect on the results in future studies.

The type size and type face of copy used affected the legibility of messages. Type size had a significant effect on the results of the study using both LGB methods; the smaller the type, the less legible. Type face also had a significant effect on the legibility of the type using both the Incident Light Method and the Filtered Light Method. In all aspects of this study including the expert analysis, Helvetica type face was more legible than Times Roman type face.

The visual acuity and age of the consumer participants also affected the legibility of the copy used in this experiment. The results from both testing methods using the LGB demonstrated that as a person's age increases, the light necessary to successfully read a message also increases. The opposite was found to be true for visual acuity. As a persons visual acuity increased, less light was necessary for successful reading of messages. In this study, increased visual acuity implies better vision, such as 20/40 increasing to 20/30, 20/30 increasing to 20/20, and so on. The effects of the expert's visual acuity and

age was not addressed in this study and could possibly be incorporated in future studies.

The type used in this study consisted entirely of upper case letters. It is not known if a combination of upper and lower case lettering, or all lower case lettering would provide the same results. Once again, another area for future study.

Color and color contrasts were not addressed in this study and this is an area that needs to be investigated further. While the incident light method will provide direct viewing of color copy, it should be determined if the polarizing filters have an effect on the perception of color in any future studies involving color.

REFERENCES

1. McLean, Ruari, The Thames and Hudson Manual of Typography, Thames and Hudson Ltd., 1980, pp. 42-48.

2. Nonprescription Drug Manufacturers Association, Label Readability Guidelines, NDMA, 1150 Connecticut Avenue, N.W., Washington, D.C., 20036.

3. Reichl, Ernst, Legibility: A Typographical Book of Etiquette, George McKibbin & Sons, Brooklyn, NY, 1949, pp. 7-35.

4. Watts, Lynne and Nisbet, John, Legibility in Childrens Books, A Review of Research, NFER Publishing Company Ltd., 1974, pp. 9-13.

5. Tinker, Miles A., Legibility of Print, Iowa State University Press, Ames, Iowa, 1963.

6. Gitau, Mutune Wa, Legibility of Child Resistant Bottle Caps by Two Methods of Measurement, Graduate Thesis, Michigan State University School of Packaging, 1988.

7. Graham, Clarence H., Vision and Visual Perception, John Wiley and Sons Publishing, 1965.

8. Cochran, William G., Sampling Techniques, Third Edition, John Wiley and Sons Publishing, 1977.

9. William, Mahrens A. and Lehmann, Irvin, J., Reliability and Validity, Measurement and Evaluation in Education and Psychology, Holt Rinehart and Winston, New York, Chicago, 1975.

10. Brode, Wallace R., Chemical Spectroscopy, John Wiley & Sons, Inc.,1943.

11. Webster & Merriam, A., Webster's Third New International Dictionary, Merriam & Webster, Inc., 1986.

Appendix A

Expert Results

Appendix A

Mean Expert Results

Subject #	Averages font A	font B	font C	font D	font E	font F
1	6.67	9.89	10	4.67	9.11	10
2	5	7.56	9.11	4	7.22	9.56
3	1.56	4.44	6.89	1.22	3.89	5.89
4	2.67	7.11	9.89	2	5	8.56
5	2.56	5.33	8.22	1.56	4.33	6.56
6	6.11	8.56	9.67	2.11	5.67	8.11
7	7	8.78	9.78	5.56	7.89	9.44
8	3.11	7.11	9.33	1.78	4.33	5.78
Totals:	34.68	58.78	72.89	22.9	47.44	63.9
Averages:	4.335	7.3475	9.1113	2.8625	5.93	7.9875

Font

A = 12 point Helvetica

B = 8 point Helvetica

C = 5 point Helvetica

D = 12 Point Times Roman

E = 8 Point Times Roman

F = 5 Point Times Roman

Appendix A

Individual Expert Results

EXPERT #1

	A	B	C	D	E	F
1	6	10	10	5	9	10
2	8	9	10	4	8	10
3	7	10	10	4	9	10
4	7	10	10	5	8	10
5	7	10	10	5	10	10
6	7	10	10	5	10	10
7	6	10	10	5	9	10
8	6	10	10	5	10	10
9	6	10	10	4	9	10
Total	60	89	90	42	82	90
Ave.	6.67	9.89	10	4.67	9.11	10

EXPERT #2

	A	B	C	D	E	F
1	5	8	9	4	7	10
2	5	7	9	4	7	9
3	5	8	9	4	8	10
4	5	7	10	4	7	10
5	5	8	9	4	7	9
6	5	7	9	4	8	9
7	5	8	9	4	7	10
8	5	8	10	4	7	9
9	5	7	8	4	7	10
Total	45	68	82	36	65	86
Ave.	5	7.56	9.11	4	7.22	9.56

EXPERT #5

	A	B	C	D	E	F
1	2	5	8	2	4	5
2	2	6	8	2	4	7
3	2	6	8	1	4	8
4	4	8	9	2	4	8
5	3	4	9	2	5	3
6	2	5	8	1	6	8
7	2	4	8	2	4	5
8	3	4	8	1	4	7
9	3	6	8	1	4	8
Total	23	48	74	14	39	59
Ave.	2.56	5.33	8.22	1.56	4.33	6.56

EXPERT #6

	A	B	C	D	E	F
1	7	9	9	2	4	8
2	6	9	9	1	7	8
3	8	9	10	1	8	7
4	5	8	10	4	4	8
5	5	9	9	3	5	9
6	7	8	10	2	7	9
7	5	9	10	3	5	7
8	5	8	10	1	5	8
9	7	8	10	2	6	9
Total	55	77	87	19	51	73
Ave.	6.11	8.56	9.67	2.11	5.67	8.11

Font

A = 12 point Helvetica

B = 8 point Helvetica

C = 5 point Helvetica

D = 12 Point Times Roman

E = 8 Point Times Roman

F = 5 Point Times Roman

Appendix A

Individual Expert Results (cont.)

EXPERT #3

	A	B	C	D	E	F
1	1	5	7	1	4	5
2	2	4	6	1	5	6
3	3	5	7	1	4	7
4	1	4	7	1	4	6
5	2	4	7	1	4	6
6	1	4	7	1	3	6
7	2	4	8	2	3	5
8	1	5	6	2	5	6
9	1	5	7	1	3	6
Total	14	40	62	11	35	53
Ave.	1.56	4.44	6.89	1.22	3.89	5.89

EXPERT #4

	A	B	C	D	E	F
1	3	6	10	1	4	7
2	2	6	10	2	6	9
3	3	6	10	2	4	8
4	3	8	9	1	6	9
5	3	8	10	3	3	9
6	3	8	10	2	5	9
7	3	8	10	2	6	9
8	2	6	10	2	7	9
9	2	8	10	3	4	8
Total	24	64	89	18	45	77
Ave.	2.67	7.11	9.89	2	5	8.56

EXPERT #7

	A	B	C	D	E	F
1	7	10	8	5	8	10
2	6	10	10	4	8	9
3	8	8	10	6	8	10
4	9	7	10	6	8	10
5	7	10	10	5	8	9
6	7	9	10	5	8	9
7	7	8	10	6	8	9
8	6	9	10	7	7	10
9	6	8	10	6	8	9
Total	63	79	88	50	71	85
Ave.	7	8.78	9.78	5.56	7.89	9.44

EXPERT #8

	A	B	C	D	E	F
1	3	8	9	1	5	4
2	3	7	9	1	5	7
3	4	8	9	3	4	5
4	3	7	9	1	4	6
5	4	6	8	1	4	5
6	4	7	10	3	5	8
7	2	8	10	3	4	4
8	2	7	10	1	4	6
9	3	6	10	2	4	7
Total	28	64	84	16	39	52
Ave.	3.11	7.11	9.33	1.78	4.33	5.78

Font

A = 12 point Helvetica

B = 8 point Helvetica

C = 5 point Helvetica

D = 12 Point Times Roman

E = 8 Point Times Roman

F = 5 Point Times Roman

Appendix B

Consumer Data for:

Incident Light Method

Filtered Light Method

Appendix B

CONSUMER DATA

Listed in the following appendix is the raw consumer data obtained through the use of the Light Gradient Box. Included are three different tables. The first table represents the raw data for the Filtered Light Method, the following tables represent the data for the Incident Light Method expressed in rheostat value and rheostat value converted to footcandles.

In all three tables, the age group, sex and visual acuity columns are coded according to the following key:

Age Group:	1 = 20 to 35 years old 2 = 36 to 50 years old 3 = 51 + years old
Sex:	1 = male 2 = female
Visual Acuity	1 = 20/20 2 = 20/30 3 = 20/40 or poorer
Font/Size Combinations:	5H (A) = Five Point Helvetica 8H (B) = Eight Point Helvetica 12H (C) = Twelve Point Helvetica 5T (D) = Five Point Times Roman 8T (E) = Eight Point Times Roman 12T (F) = Twelve Point Times Roman

APPENDIX A
RAW DATA - INCIDENT LIGHT METHOD
(RHEOSTAT VALUE)

Part. #	Age Group	Sex	Visual Acuity	5H(A)	5H(A)	8H(B)	8H(B)	12H(C)	12H(C)	5T(D)	5T(D)	8T(E)	8T(E)	12T(F)	12T(F)
2	1	1	1	42	39	37	36	35	35	40	43	37	37	37	36
5	1	1	1	37	37	36	36	34	34	38	38	36	37	35	35
7	1	2	1	39	41	37	37	38	36	40	43	39	38	37	37
10	1	1	1	42	42	40	41	38	39	44	45	42	38	40	41
29	1	2	1	38	40	36	36	34	34	41	39	36	37	35	36
34	1	1	1	41	42	38	38	36	37	42	43	39	39	38	37
42	1	1	1	37	37	35	35	34	34	38	37	36	37	34	35
3	1	2	2	40	41	37	36	35	34	42	41	38	39	36	35
9	1	1	2	39	39	36	36	35	35	42	40	37	38	37	36
15	1	1	2	40	40	37	37	35	35	41	41	38	39	36	37
25	1	2	2	40	39	37	38	36	36	42	45	38	39	37	37
30	1	1	2	41	41	38	38	36	35	43	43	39	39	37	37
39	1	2	2	40	42	38	38	37	36	42	43	40	40	37	38
14	1	2	3	39	39	36	35	35	34	40	41	37	37	35	36
16	2	2	1	43	43	39	39	37	37	45	44	41	40	38	38
20	2	2	1	39	39	37	37	35	35	40	40	38	37	36	36
8	2	1	1	42	41	38	37	36	36	43	43	40	39	37	39
1	2	1	2	48	49	44	44	40	40	48	47	42	43	41	41
6	2	2	2	40	39	37	37	35	38	44	41	39	39	36	37
11	2	2	2	43	43	41	41	39	37	45	44	43	42	38	38
17	2	2	2	41	40	37	37	36	36	43	43	38	38	37	37
18	2	2	2	41	42	39	38	36	37	43	42	40	38	38	38
19	2	2	2	40	41	37	37	35	36	42	41	38	38	36	37
23	2	2	2	40	40	38	37	35	36	41	42	38	39	37	37
24	2	2	2	42	43	39	38	37	36	47	44	40	40	38	37
26	2	1	2	43	42	39	39	38	38	45	44	39	41	40	39
27	2	1	2	41	42	39	38	36	36	43	42	39	40	37	37
35	2	2	2	41	43	39	39	36	37	42	43	39	40	37	38
32	2	1	3	45	43	41	41	37	36	52	45	42	40	38	38
41	3	1	1	43	43	41	43	38	38	44	46	43	41	39	41
12	3	1	2	44	44	40	39	37	38	46	45	40	39	38	38
13	3	1	2	46	44	40	41	40	37	48	42	41	40	40	41
21	3	1	2	43	41	39	40	38	37	45	41	42	39	38	39
22	3	2	2	40	40	37	38	36	37	41	40	38	38	37	37
31	3	1	2	48	47	41	41	38	38	47	49	41	41	39	39
33	3	1	2	44	43	39	39	38	38	44	43	39	39	38	38
37	3	1	2	48	47	41	41	39	40	48	52	43	41	41	41
38	3	1	2	46	45	40	40	38	38	47	48	42	40	39	39
40	3	1	2	51	51	42	44	39	41	53	52	42	44	41	43
43	3	2	2	48	48	44	45	38	38	50	49	44	44	42	40
44	3	1	2	43	45	40	39	37	38	45	45	40	42	40	39
4	3	2	3	56	54	43	42	45	41	58	52	49	45	40	44
28	3	1	3	49	52	41	45	40	41	54	46	44	46	42	42
36	3	1	3	46	51	44	42	41	39	48	59	40	46	41	39
45	1	2	2	44	43	39	39	38	39	43	47	40	40	39	39

APPENDIX A
RAW DATA - INCIDENT LIGHT METHOD
(RHEOSTAT VALUE CONVERTED TO FOOTCANDLES)

Part. #	Age Group	Sex	Visual Acuity	5H(A)	5H(A)	8H(B)	8H(B)	12H(C)	12H(C)	5T(D)	5T(D)	8T(E)	8T(E)	12T(F)	12T(F)
2	1	1	1	0.11	0.045	0.035	0.03	0.025	0.025	0.06	0.14	0.035	0.035	0.035	0.03
5	1	1	1	0.035	0.035	0.03	0.03	0.02	0.02	0.04	0.04	0.03	0.035	0.025	0.025
7	1	2	1	0.045	0.08	0.035	0.035	0.04	0.03	0.06	0.14	0.045	0.04	0.035	0.035
10	1	1	1	0.11	0.11	0.06	0.08	0.04	0.045	0.18	0.21	0.11	0.04	0.06	0.08
29	1	2	1	0.04	0.06	0.03	0.03	0.02	0.02	0.08	0.045	0.03	0.035	0.025	0.03
34	1	1	1	0.08	0.11	0.04	0.04	0.03	0.035	0.11	0.14	0.045	0.045	0.04	0.035
42	1	1	1	0.035	0.035	0.025	0.025	0.02	0.02	0.04	0.035	0.03	0.035	0.02	0.025
3	1	2	2	0.06	0.08	0.035	0.03	0.025	0.02	0.11	0.08	0.04	0.045	0.03	0.025
9	1	1	2	0.045	0.045	0.03	0.03	0.025	0.025	0.11	0.06	0.035	0.04	0.035	0.03
15	1	1	2	0.06	0.06	0.035	0.035	0.025	0.025	0.08	0.08	0.04	0.045	0.03	0.035
25	1	2	2	0.06	0.045	0.035	0.04	0.03	0.03	0.11	0.21	0.04	0.045	0.035	0.035
30	1	1	2	0.08	0.08	0.04	0.04	0.03	0.025	0.14	0.14	0.045	0.045	0.035	0.035
39	1	2	2	0.06	0.11	0.04	0.04	0.035	0.03	0.11	0.14	0.06	0.06	0.035	0.04
14	1	2	3	0.045	0.045	0.03	0.025	0.025	0.02	0.06	0.08	0.035	0.035	0.025	0.03
16	2	2	1	0.13	0.13	0.05	0.05	0.035	0.035	0.18	0.16	0.08	0.065	0.045	0.045
20	2	2	1	0.045	0.045	0.035	0.035	0.025	0.025	0.06	0.06	0.04	0.035	0.03	0.03
8	2	1	1	0.11	0.08	0.04	0.035	0.03	0.03	0.14	0.14	0.06	0.045	0.035	0.045
1	2	1	2	0.35	0.42	0.18	0.18	0.06	0.06	0.35	0.29	0.11	0.14	0.08	0.08
6	2	2	2	0.06	0.045	0.035	0.035	0.025	0.04	0.18	0.08	0.045	0.045	0.03	0.035
11	2	2	2	0.14	0.14	0.08	0.08	0.045	0.035	0.21	0.18	0.14	0.11	0.04	0.04
17	2	2	2	0.08	0.06	0.035	0.035	0.03	0.03	0.14	0.14	0.04	0.04	0.035	0.035
18	2	2	2	0.08	0.11	0.045	0.04	0.03	0.035	0.14	0.11	0.06	0.04	0.04	0.04
19	2	2	2	0.06	0.08	0.035	0.035	0.025	0.03	0.11	0.08	0.04	0.04	0.03	0.035
23	2	2	2	0.06	0.06	0.04	0.035	0.025	0.03	0.08	0.11	0.04	0.045	0.035	0.035
24	2	2	2	0.11	0.14	0.045	0.04	0.035	0.03	0.29	0.18	0.06	0.06	0.04	0.035
26	2	1	2	0.13	0.11	0.05	0.05	0.045	0.045	0.18	0.16	0.05	0.08	0.065	0.05
27	2	1	2	0.08	0.11	0.045	0.04	0.03	0.03	0.14	0.11	0.045	0.065	0.035	0.035
35	2	2	2	0.08	0.13	0.05	0.05	0.3	0.035	0.11	0.13	0.05	0.065	0.035	0.045
32	2	1	3	0.21	0.14	0.08	0.08	0.035	0.03	0.69	0.21	0.11	0.06	0.04	0.04
41	3	1	1	0.14	0.14	0.08	0.14	0.04	0.04	0.18	0.25	0.14	0.08	0.045	0.08
12	3	1	2	0.16	0.16	0.065	0.05	0.035	0.045	0.22	0.18	0.065	0.05	0.045	0.045
13	3	1	2	0.22	0.16	0.065	0.08	0.065	0.035	0.28	0.11	0.08	0.065	0.065	0.08
21	3	1	2	0.13	0.08	0.05	0.065	0.045	0.035	0.18	0.08	0.11	0.05	0.045	0.05
22	3	2	2	0.065	0.065	0.035	0.045	0.3	0.035	0.08	0.065	0.045	0.045	0.035	0.035
31	3	1	2	0.28	0.24	0.08	0.08	0.045	0.045	0.24	0.33	0.08	0.08	0.05	0.05
33	3	1	2	0.18	0.14	0.045	0.045	0.04	0.04	0.18	0.14	0.045	0.045	0.04	0.04
37	3	1	2	0.28	0.24	0.08	0.08	0.05	0.065	0.28	0.52	0.13	0.08	0.08	0.08
38	3	1	2	0.22	0.18	0.065	0.065	0.045	0.045	0.24	0.28	0.11	0.065	0.05	0.05
40	3	1	2	0.45	0.45	0.11	0.16	0.05	0.08	0.61	0.52	0.11	0.16	0.08	0.13
43	3	2	2	0.35	0.35	0.18	0.21	0.04	0.04	0.495	0.42	0.18	0.18	0.11	0.06
44	3	1	2	0.13	0.18	0.065	0.05	0.035	0.045	0.18	0.18	0.065	0.11	0.065	0.05
4	3	2	3	1.19	0.92	0.14	0.11	0.21	0.08	1.5	0.69	0.42	0.21	0.06	0.18
28	3	1	3	0.33	0.52	0.13	0.18	0.065	0.08	0.69	0.22	0.16	0.22	0.11	0.11
36	3	1	3	0.22	0.45	0.16	0.11	0.08	0.05	0.28	1.09	0.065	0.22	0.08	0.05
45	1	2	2	0.18	0.14	0.045	0.045	0.04	0.045	0.14	0.29	0.06	0.06	0.045	0.045

APPENDIX A
RAW DATA - FILTERED LIGHT ROTATION
(DEGREE OF FILTER ROTATION)

Part. #	Age Group	Sex	Visual Acuity	5T(A)	5T(A)	8T(B)	8T(B)	12T(C)	12T(C)	5T(D)	5T(D)	8T(E)	8T(E)	12T(F)	12T(F)
2	1	1	1	19	19	11	12	8	8	26	28	10	12	10	8
5	1	1	1	12	14	9	9	6	6	13	16	8	10	8	9
7	1	2	1	23	21	16	15	15	12	24	22	18	19	18	18
10	1	1	1	32	32	20	19	15	14	36	37	24	24	18	14
29	1	2	1	39	39	16	13	9	12	25	23	19	18	14	13
34	1	1	1	31	41	24	20	18	14	35	51	28	30	19	22
42	1	1	1	20	21	12	13	9	9	26	20	12	14	10	10
3	1	2	2	25	24	18	22	13	14	36	35	20	21	12	13
9	1	1	2	26	27	20	21	13	13	31	31	19	20	14	15
15	1	1	2	21	23	14	15	10	11	26	25	16	17	12	12
25	1	2	2	59	38	30	28	22	22	75	62	36	26	24	19
30	1	1	2	28	35	21	20	13	12	38	39	21	26	18	16
39	1	2	2	41	46	25	22	18	14	50	61	21	21	13	16
14	1	2	3	26	26	20	16	15	10	34	32	22	22	17	12
16	2	2	1	42	41	20	22	15	17	46	49	24	23	17	18
20	2	2	1	28	29	19	16	11	11	33	42	19	18	14	12
8	2	1	1	27	25	22	17	15	14	39	33	23	20	17	15
1	2	1	2	16	19	10	11	6	7	26	35	12	12	13	8
6	2	2	2	21	23	14	13	11	8	23	37	19	18	10	12
11	2	2	2	48	47	30	31	25	24	50	52	32	34	26	26
17	2	2	2	32	32	17	19	13	14	38	36	21	20	15	15
18	2	2	2	21	20	21	15	12	12	26	25	24	19	14	13
19	2	2	2	34	29	17	20	14	12	35	43	16	19	17	14
23	2	2	2	40	30	18	20	11	12	38	46	16	21	12	14
24	2	2	2	45	37	21	24	14	15	38	41	26	24	18	18
26	2	1	2	45	40	30	33	20	21	52	48	29	28	27	21
27	2	1	2	27	40	17	20	10	12	48	41	21	21	12	15
35	2	2	2	24	30	18	19	15	11	54	42	23	19	13	12
32	2	1	3	28	46	23	19	12	14	32	38	28	28	16	16
41	3	1	1	79	72	54	56	31	28	86	87	61	39	33	29
12	3	1	2	38	45	22	23	18	18	48	46	25	24	21	19
13	3	1	2	38	48	33	27	19	20	64	58	30	32	21	20
21	3	1	2	32	34	25	27	13	14	48	37	31	27	16	17
22	3	2	2	36	29	19	24	18	13	31	36	23	21	19	19
31	3	1	2	52	48	28	21	17	19	39	80	34	24	18	21
33	3	1	2	29	30	22	19	15	13	31	44	23	20	15	18
37	3	1	2	41	40	26	28	20	15	42	50	26	25	17	18
38	3	1	2	50	41	32	22	19	19	90	61	34	31	21	21
40	3	1	2	61	57	36	40	38	32	78	68	45	48	42	39
43	3	2	2	90	89	39	63	29	41	90	90	63	57	34	26
44	3	1	2	46	48	21	26	14	12	90	51	29	23	17	18
4	3	2	3	28	30	21	19	14	12	42	36	19	17	17	15
28	3	1	3	90	90	34	42	24	27	90	90	43	59	32	31
36	3	1	3	90	90	64	53	21	25	90	90	49	83	41	54
45	1	2	2	31	31	28	21	19	24	90	81	33	29	24	24

Appendix C:
Expert & Consumer Data Forms and Questionairs

Michigan State University
School of Packaging
Spring 1991

I would like to thank you for taking the time to participate in this study on Package and Label Legibility. In an effort to obtain some background information on the participants in this experiment, I would appreciate it if you would take the time to fill out the following questionnaire.

1. Name:

2. Work Address & Telephone Number:

3. Sex:

4. Age:

5. Title

6. Education/Academic Level:

7. Years Experience in Printing/Graphics/Typography:

8. Have you ever taken part in a research study involving your expert opinion?

9. Would you be willing to participate in another study of this nature in the future?

Thanks Again,
Jim Pietrowski

Michigan State University
School of Packaging
Spring 1991

Measurement of Legibility of Copy
Data Sheet
Expert Panel

Message #	Font/Size Code A	B	C	D	E	F
1						
2						
3						
4						
5						
6						
7						
8						
9						

Comments:

Michigan State University
School of Packaging
Spring 1991

Measurement of Legibility of Copy
Participants Data Sheet

Participant #_____ Visual Acuity_____

Age Group:_____ 20-35
_____ 36-50
_____ 51-older

Sex _____

	LGB			Rheostat	
	Card #	Degree of Rotation		Card #	Footcandles
1	_____	_____	1	_____	_____
2	_____	_____	2	_____	_____
3	_____	_____	3	_____	_____
4	_____	_____	4	_____	_____
5	_____	_____	5	_____	_____
6	_____	_____	6	_____	_____
7	_____	_____	7	_____	_____
8	_____	_____	8	_____	_____
9	_____	_____	9	_____	_____
10	_____	_____	10	_____	_____
11	_____	_____	11	_____	_____
12	_____	_____	12	_____	_____

Appendix D:

Reliability Coefficients Among Paired Experts

Appendix D

Expert Reliability Coefficient

Reliability Coefficient Matrix

	Expert							
Expert	1	2	3	4	5	6	7	8
1	-							
2	0.942	-						
3	0.903	0.973	-					
4	0.900	0.963	0.911	-				
5	0.895	0.955	0.992	0.911	-			
6	0.901	0.857	0.856	0.892	0.901	-		
7	0.960	0.972	0.961	0.969	0.970	0.954	-	
8	0.854	0.840	0.914	0.939	0.947	0.924	0.917	-

APPENDIX E:

ANOVA'S FOR LGB USING FILTERED LIGHT AND INCIDENT LIGHT TESTING METHODS

ANALYSIS OF VARIANCE FOR LIGHT GRADIENT BOX

USING THE INCIDENT LIGHT METHOD

WITH CONSUMER PARTICIPANTS

ANALYSIS OF VARIANCE FOR LGB - TYPE III SUMS OF SQUARES

Variation	SS	d.f.	Mean Sq.	F-ratio	Sig.
Main Effects					
A:size	1230.7050	2	615.35249	182.515	.0000
B:font	60.1864	1	60.18639	17.851	.0000
C:age	541.7538	2	270.87691	80.343	.0000
D:acuity	53.7734	2	26.88669	7.975	.0004
INTERACTIONS					
AB	3.84630	2	1.923148	.570	.5660
AC	44.13419	4	11.033549	3.273	.0123
AD	46.92794	4	11.731986	3.480	.0087
BC	1.05790	2	.528951	.157	.8549
BD	.75684	2	.378420	.112	.8939
CD	131.52561	4	32.881403	9.753	.0000
RESIDUAL	822.64865	244	3.3715108		
TOTAL (CORRECTED)	3888.7417	269			

0 missing values have been excluded
All F-ratios are based on the residual mean square error.

ANALYSIS OF VARIANCE FOR LIGHT GRADIENT BOX

USING THE FILTERED LIGHT METHOD

WITH CONSUMER PARTICIPANTS

ANALYSIS OF VARIANCE FOR LGB - TYPE III SUMS OF SQUARES

Variation	SS	d.f.	Mean Sq.	F-ratio	Sig.
Main Effects					
A:size	19916.860	2	9958.4301	91.486	.0000
B:font	785.491	1	785.4914	7.216	.0077
C:age	12689.892	2	6344.9461	58.290	.0000
D:acuity	585.091	2	292.5455	2.688	.0701
INTERACTIONS					
AB	548.0352	2	274.0176	2.517	.0828
AC	1783.7396	4	445.9349	4.097	.0031
AD	213.4541	4	53.3635	.490	.7429
BC	23.6236	2	11.8118	.109	.8972
BD	59.2474	2	29.6237	.272	.7620
CD	4285.9373	4	1071.4843	9.844	.0000
RESIDUAL	26559.851	244	108.85185		
TOTAL (CORRECTED)	80300.774	269			

0 missing values have been excluded
All F-ratios are based on the residual mean square error.

ANALYSIS OF VARIANCE FOR LIGHT GRADIENT BOX

USING THE FILTERED LIGHT METHOD

WITH CONSUMER PARTICIPANTS DEMONSTRATING

THE EFFECT OF SEX ON THE RESULTS

Variation	SS	d.f.	Mean Sq.	F-ratio	Sig.
MAIN EFFECTS					
A:size	1208.9784	2	604.48922	191.241	.0000
B:font	59.6013	1	59.60133	18.856	.0000
C:age	505.9745	2	252.98727	80.037	.0000
D:acuity	36.1236	2	18.06182	5.714	.0038
E:sex	3.5687	1	3.56871	1.129	.2891
INTERACTIONS					
AB	3.84630	2	1.923148	.608	.5451
AC	36.76094	4	9.190235	2.907	.0224
AD	47.21774	4	11.804434	3.735	.0057
AE	.32160	2	.160800	.051	.9504
BC	.83188	2	.415942	.132	.8768
BD	.72287	2	.361433	.114	.8920
BE	.02097	1	.020975	.007	.9360
CD	168.00669	4	42.001673	13.288	.0000
CE	36.52291	2	18.261455	5.777	.0036
DE	26.93013	2	13.465066	4.260	.0152
RESIDUAL	745.96680	236	3.1608763		
TOTAL (CORRECTED)	3888.7417	269			

0 missing values have been excluded
All F-ratios are based on the residual mean square error.

APPENDIX F:
COMPARATIVE TABLES FOR TYPE SIZES, PARTICIPANTS ACUITY GROUPS AND PARTICIPANTS AGE GROUPS USING THE FILTERED LIGHT METHOD

Table 9.

Type Size Comparisons by Participant Age Groups - Filtered Light Method

Helvetica

	5 Point Mean	P-Value	8 Point Mean	P-Value	12 Point Mean
Age 20 - 35 Years	29.0	.0000	18.3	.0000	13.3
Significant		YES		YES	
Age 36 - 50 Years	32.2	.0000	19.9	.0000	13.6
Significant		YES		YES	
Age 50 + Years	53.0	.0000	32.2	.0001	20.6
Significant		YES		YES	

Times Roman

	5 Point Mean	P-Value	8 Point Mean	P-Value	12 Point Mean
Age 20 - 35 Years	37.6	.0004	20.5	.0000	15.1
Significant		YES		YES	
Age 36 - 50 Years	39.5	.0000	21.9	.0000	15.7
Significant		YES		YES	
Age 50 + Years	62.8	.0000	35.5	.0001	24.3
Significant		YES		YES	

*t-Tests are said to be significant when p is equal to or less than .25

Table 10.

Type Size Comparisons by Participant Visual Acuity Groups - Filtered Light Method

Helvetica

	5 Point Mean	P-Value	8 Point Mean	P-Value	12 Point Mean
20/20	32.1	.0001	19.8	.0096	13.5
Significant		YES		YES	
20/30	37.3	.0000	23.4	.0000	16.3
Significant		YES		YES	
20/40	60.8	.0690	33.9	.1100	18.5
Significant		YES		YES	

Times Roman

	5 Point Mean	P-Value	8 Point Mean	P-Value	12 Point Mean
20/20	36.2	.0004	21.5	.0040	15.7
Significant		YES		YES	
20/30	48.4	.0000	25.5	.0000	18.1
Significant		YES		YES	
20/40	62.0	.0680	41.8	.0150	27.4
Significant		YES		YES	

*t-Tests are said to be significant when p is equal to or less than .25

Table 11.

Participant Age Group Comparisons by Type Size - Filtered Light Method

	20-35 Mean	P-Value	36-50 Mean	P-Value	50+ Mean
5 Point Helvetica	29.0	.3500	32.2	.0036	53.0
Significant		NO		YES	
8 Point Helvetica	18.3	.4400	19.9	.0032	32.2
Significant		NO		YES	
12 Point Helvetica	13.3	.8400	13.6	.0048	20.6
Significant		NO		YES	
5 Point Times Roman	37.6	.7200	39.5	.0009	62.8
Significant		NO		YES	
8 Point Times Roman	20.5	.5200	21.9	.0043	35.5
Significant		NO		YES	
12 Point Times Roman	15.1	.7200	15.7	.0053	24.3
Significant		NO		YES	

*t-Tests are said to be significant when p is equal to or less than .25

Table 12.

Visual Acuity Comparisons by Type Size/Face Combinations - Filtered Light Method

	20/20 Mean	P-Value	20/30 Mean	P-Value	20/40 Mean
5 Point Helvetica	32.1	.3800	37.3	.2700	60.8
Significant		NO		NO	
8 Point Helvetica	19.8	.3800	23.4	.3500	33.9
Significant		NO		NO	
12 Point Helvetica	13.5	.2200	16.3	.5800	18.5
Significant		YES		NO	
5 Point Times Roman	36.2	.0860	48.4	.4700	62.0
Significant		YES		NO	
8 Point Times Roman	21.5	.3100	25.5	.2100	41.8
Significant		NO		YES	
12 Point Times Roman	15.7	.3000	18.1	.3200	27.4
Significant		NO		NO	

	20/20 Mean	P-Value	20/40 Mean
5 Point Helvetica	32.1	.2100	60.8
Significant		YES	
8 Point Helvetica	19.8	.2300	33.9
Significant		YES	
12 Point Helvetica	13.5	.2500	18.5
Significant		YES	
5 Point Times Roman	36.2	.2300	62.0
Significant		YES	
8 Point Times Roman	21.5	.1600	41.7
Significant		YES	
12 Point Times Roman	15.7	.2400	27.4
Significant		YES	

*t-Tests are said to be significant when p is equal to or less than .25

APPENDIX G:

COMPARATIVE TABLES FOR TYPE SIZES, PARTICIPANTS ACUITY GROUPS AND PARTICIPANTS AGE GROUPS USING THE INCIDENT LIGHT METHOD

Table 13.

Type Size Comparisons by Participant Age Groups - Incident Light Method

Helvetica

	5 Point Mean	P-Value	8 Point Mean	P-Value	12 Point Mean
Age 20 - 35 Years	0.071	.0002	0.037	.0000	0.011
Significant		YES		YES	
Age 36 - 50 Years	0.11	.0005	0.056	.0015	0.017
Significant		YES		YES	
Age 50 + Years	0.29	.0042	0.094	.0001	0.025
Significant		YES		YES	

Times Roman

	5 Point Mean	P-Value	8 Point Mean	P-Value	12 Point Mean
Age 20 - 35 Years	0.11	.0000	0.044	.0000	0.035
Significant		YES		YES	
Age 36 - 50 Years	0.17	.0002	0.064	.0014	0.041
Significant		YES		YES	
Age 50 + Years	0.36	.0005	0.12	.0025	0.068
Significant		YES		YES	

*t-Tests are said to be significant when p is equal to or less than .25

Table 14.

Type Size Comparisons by Participant Visual Acuity Groups - Incident Light Method

Helvetica

	5 Point Mean	P-Value	8 Point Mean	P-Value	12 Point Mean
20/20	0.079	.0006	0.045	.0006	0.012
Significant		YES		YES	
20/30	0.17	.0013	0.063	.0000	0.0201
Significant		YES		YES	
20/40	0.25	.0800	0.099	.0440	0.019
Significant		YES		YES	

Times Roman

	5 Point Mean	P-Value	8 Point Mean	P-Value	12 Point Mean
20/20	0.11	.0005	0.052	.0099	0.039
Significant		YES		YES	
20/30	0.22	.0000	0.078	.0005	0.05
Significant		YES		YES	
20/40	0.42	.0650	0.11	.0540	0.061
Significant		YES		YES	

*t-Tests are said to be significant when p is equal to or less than .25

Table 15.

Participant Age Group Comparisons by Type Size - Incident Light Method

	20-35 Mean	P-Value	36-50 Mean	P-Value	50+ Mean
5 Point Helvetica	0.071	.0840	0.11	.0170	0.29
Significant		YES		YES	
8 Point Helvetica	0.037	.0790	0.056	.0180	0.094
Significant		YES		YES	
12 Point Helvetica	0.011	.1300	0.017	.1500	0.025
Significant		YES		YES	
5 Point Times Roman	0.11	.0430	0.17	.0220	0.36
Significant		YES		YES	
8 Point Times Roman	0.044	.0240	0.064	.0160	0.12
Significant		YES		YES	
12 Point Times Roman	0.035	.1500	0.041	.0021	0.068
Significant		YES		YES	

*t-Tests are said to be significant when p is equal to or less than .25

Table 16.

Visual Acuity Comparisons by Type Size/Face Combinations - Incident Light Method

	20/20 Mean	P-Value	20/30 Mean	P-Value	20/40 Mean
5 Point Helvetica	0.79	.0170	0.17	.4800	0.25
Significant		YES		NO	
8 Point Helvetica	0.045	.0980	0.063	.3100	0.099
Significant		YES		NO	
12 Point Helvetica	0.012	.0095	0.02	.8900	0.019
Significant		YES		NO	
5 Point Times Roman	0.11	.0120	0.22	.2400	0.42
Significant		YES		YES	
8 Point Times Roman	0.052	.0490	0.078	.3900	0.11
Significant		YES		NO	
12 Point Times Roman	0.039	.0860	0.05	.6100	0.061
Significant		YES		NO	

	20/20 Mean	P-Value	20/40 Mean
5 Point Helvetica	0.079	0.15	0.25
Significant		YES	
8 Point Helvetica	0.045	0.16	0.099
Significant		YES	
12 Point Helvetica	0.012	0.23	0.019
Significant		YES	
5 Point Times Roman	0.11	0.1	0.42
Significant		YES	
8 Point Times Roman	0.052	0.17	0.11
Significant		YES	
12 Point Times Roman	0.039	0.33	0.061
Significant		NO	

*t-Tests are said to be significant when p is equal to or less than .25

APPENDIX H:

ANALYSIS OF VARIANCE FOR EXPERT PARTICIPANTS DEMONSTRATING MESSAGE EFFECT

ANALYSIS OF VARIANCE FOR LGB - TYPE III SUMS OF SQUARES

Variation	SS	d.f.	Mean Sq.	F-ratio	Sig.
Main Effects	2286.6790	16	142.91744	193.835	.0000
message	6.8025	8	.85031	1.153	.3277
size	1498.5617	2	749.28086	1000.00	.0000
font	129.7068	1	129.70679	175.918	.0000
rather	651.6080	5	130.32160	176.752	.0000
2- FACTOR INTERACTIONS	103.16358	17	6.0684459	8.230	.0000
size & font	1.48756	2	.7438272	1.009	.3659
size & rather	56.88272	10	5.6882716	7.715	.0000
face & rather	44.79321	5	8.9589420	12.150	.0000
RESIDUAL	213.82099	290	.7373138		
TOTAL (CORR.)	2603.6636	323			