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AN EXPONENTIAL MODEL FOR PREDICTING TRIAL
OF A NEW CONSUMER PRODUCT

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By

Albert Joseph Martin, Jr., B.A., M.B.A.

******

The Ohio State University
1969

Approved by

Faculty of Marketing
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VITA

December 4, 1942
Born - Wilmington, Delaware

1964 .............
B.A., University of Delaware, Newark, Delaware

1964 - 1966 ....
Research Assistant, College of Business and Economics, University of Delaware, Newark, Delaware

1966 .............
M.B.A., University of Delaware, Newark, Delaware

1966 - 1967 ....
Teaching Assistant, Department of Business Organization, The Ohio State University, Columbus, Ohio

1967 - 1968 ....
Teaching Associate, Department of Business Organization, The Ohio State University, Columbus, Ohio

FIELDS OF STUDY

Major Field: Marketing

Studies in Consumer Behavior. Professors James F. Engel and Roger D. Blackwell

Studies in Quantitative Methods. Professor Fred E. Kindig

Studies in Management. Professor Reed M. Powell
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CHAPTER I

INTRODUCTION

This study examines the relationship between advertising media weight, brand awareness, and trial for a new consumer product introduction. It also considers several types of awareness measures used in measuring advertising effectiveness to determine whether they are intercorrelated.

Measuring advertising effectiveness is a complex problem facing the advertising decision maker. The issue is unavoidable in view of demands by management that proof of the value of the advertising investment be provided. However, as Light noted, "Unfortunately, the present state of knowledge does not provide the advertising practitioner with sufficient unambiguous guidelines."\(^1\)


\(^2\)M. Lawrence Light, "An Experimental Study of the Effects of Repeated Persuasive Communications" (Ph.D. Dissertation, The Ohio State University, 1967), p. 3.
The measurement of advertising effectiveness necessarily implies the setting of advertising objectives. There is controversy with respect to whether these objectives should be stated in terms of communications or sales. Those favoring communications objectives believe that advertising objectives should be separated from marketing objectives. They feel that communication aspects of advertising are what can be measured. Sales objective advocates make the point that sales and profits are more relevant measures and that advertising is not the only source of communication.

Progress in the measurement of advertising effectiveness has been slow even though researchers (Scott, Vaile, Hotchkiss and Franken)

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4 Engel, Wales, and Warshaw, pp. 455-456.


Cowen, Brown and Mancina, Berreman, and Cover et al. have been concerned with the problem since early in this century. Palda traces this lack of progress to the difficulty of isolating advertising from the other variables having a bearing on sales.

Newell considered the problem of isolating the effects of advertising and concluded, "... that there is no single answer to be found but only an endless process of acquiring deeper and more useful insight into the advertising function..."
This study is not an attempt to solve the complex problem of advertising effectiveness. Its purpose is to examine some of the variables in the advertising process with the hope that it be just one empirical addition to a body of knowledge which needs much more research effort if the advertising practitioner is to be armed with meaningful and unambiguous guidelines. To this end, a cross-sectional time series study was conducted which investigated some of the variables in the process.

REVIEW OF THE LITERATURE

Advertising Objectives

Advertising is communication, a behavioral process; and buying and purchasing are forms of human behavior. Logically, psychologists have contributed to the study of advertising and were among the first to study the subject.

Scott, Hollingworth and Adams are examples of psychologists who published works on advertising before 1920. Scott asserted in 1903 that nothing except psychology could provide the basis for a theory of advertising. Concepts such as attention, association of ideas, perception, and memory were introduced into the analysis of advertising by both Scott and
The emphasis on understanding the psychology of how advertising functions has lead to the development of the hierarchy-of-effects theory. The theory states that consumers move through a sequence of steps, beginning with exposure to advertising and ending with purchase.15

There exists no general consensus as to the nature or number of steps in the hierarchy. For example, Colley concluded that all commercial communications must carry a potential consumer through the following four levels if they are to achieve the ultimate objective of a sale:

1. Awareness of the brand or company
2. Comprehension of what the product is and what it will do for him
3. Conviction to buy
4. Action16


16 Colley, pp. 37-38.
Lavidge and Steiner offered the following model:

1. Unawareness of product existence
2. Awareness of product existence
3. Knowledge of product attributes
4. Favorable attitudes toward product
5. Preference for the product
6. Conviction to buy
7. Purchase

Wolf, Brown, and Thompson proposed the following five-stage hierarchy:

1. Creation of product awareness
2. Nurturing an acceptance for the product
3. Establishing a preference for the product
4. Arousing an interest to buy the product
5. Provoking the sale

Writers also differ as to the extent to which the first stages are necessary conditions for the later stages.

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19 Dalbey et al., p. 57.
Those favoring the measurement of advertising effectiveness in terms of communications objectives offer the hierarchy-of-effects theory as rationale for their conclusion. The assumption is "that each step in the hierarchy contributes to an increased probability of purchase."  

Lavidge and Steiner concluded that advertising should be viewed as a force moving people through the stages of the hierarchy toward purchase and that effectiveness measures should provide indication of changes at all levels of the hierarchy. Lee and Mason felt that the objective of advertising is effective communication. They stated that the proper index of good advertising is measurement in terms of how it affects and modifies attitudes (awareness, comprehension, interest, conviction, and desire for the product), not sales in dollars.

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20 Ibid.

21 Lavidge and Steiner, p. 62.

On the other side of the controversy over measurement, there are those who believe that sales effects are the only realistic objectives for advertising. The reasoning here says that little is known today about the specific relationships among the stages of the hierarchy-of-effects theory and even if these relationships were known, it may not be more difficult to study the direct link between advertising dollars and sales.  

Dalbey et al. commented that "Although there is no conclusive empirical evidence supporting a causal relationship between awareness of either the product or the advertisement and sales, there is some evidence to indicate a correlation between both these measures and sales." The use of effectiveness measures based on the hierarchy-of-effects concept such as awareness, attitude, and the like depends on the existence of a relationship between stages in the hierarchy and purchase behavior.  


24Dalbey et al., p. 56.

25Ibid., p. 58.
Palda was critical of the communications objective approach because most evidence supporting the hierarchy theory is correlational and only shows that higher awareness coexists with higher purchasing rates. He noted that little evidence exists to prove that changes in knowledge, recall, or recognition precede rather than follow purchase behavior.\(^{26}\)

The final hypothesis in this study deals with the assumption underlying the hierarchy-of-effects approach to measuring advertising effectiveness that each step contributes to an increased probability of purchase. A relationship between measures of awareness and trial of a new consumer product is hypothesized.

**Awareness Measures**

The literature on measuring advertising effectiveness deals with several types of awareness measures. Awareness or knowledge has been used in connection with recognition of advertisements, recall of advertisements, brand recall, and copy point or product attribute recall.\(^{27}\)


\(^{27}\)Engel, Wales, and Warshaw, pp. 440-450.
Light defined saliency, a combination measure of awareness and attitude, as "... those ads considered conspicuous ..." First ad mentioned and first brand mentioned are measures of saliency.

Dalbey et al. discussed measures of awareness or knowledge about advertisements and brands, as indicators of advertising effectiveness. They mentioned that the assumption of a direct relationship between knowledge of an advertisement or brand and the probability of purchase presupposes that all knowledge will have a positive effect on sales. Put another way, the supposition is that advertisers know what to communicate.

The first hypothesis in this study is concerned with the question of correlations among different measures of awareness.

**Learning**

Hotchkiss and Franken opened a section of their 1927 book on advertising effects with the heading, "Knowledge Is the First Step in the Sale." The role

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28Light, p. 29.

29Dalbey et al., p. 61.

30Hotchkiss and Franken, p. 4.
of knowledge is an important factor in gaining an understanding of consumer behavior. Engel et al. discussed many areas of consumer behavior that are inherently involved with knowledge, for example, problem recognition, search processes, evaluation of alternatives, and attitude change.\(^\text{31}\) Clement stressed the role of awareness in understanding the influence of advertising on consumer behavior.\(^\text{32}\) Light noted that "Most human behavior is learned."\(^\text{33}\)

All knowledge or awareness is learned. Any study of man's nature, according to Hilgard, leads sooner or later to questions about how his knowledge is obtained and utilized.\(^\text{34}\) Much research in psychology has concerned itself with the study of learning.

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\(^\text{33}\)Light, p. 4.

\(^\text{34}\)E. R. Hilgard, *Theories of Learning* (New York, 1948).
The following section of the literature review will provide the theoretical background for the two hypotheses concerning the effects of repetitive exposure to advertising on awareness. The survey covers two areas of subject matter, mathematical models of learning and forgetting.

**Mathematical Models of Learning.** Psychologists, including Krueger, Cantril, Allport, and Hellyer, inspired by the early work of Ebbinghaus, have studied the effects of repetition and concluded that "recall improves with an increase in the number of repetitions and with briefer intervals of delay."35 Others, including Hilgard and Bower, supported this theoretical principal and stated it as follows, "The more times a target item is presented . . ., the better is the recall of the target item at every retention test interval."36

As psychologists made progress in the study of learning, attempts were made to express the relationships between the relevant variables in the form of

35 Light, p. 6.

mathematical models. Thurstone, Gulliksen, and Wiley and Wiley all made contributions toward this goal.\textsuperscript{37}

Hull proposed a theory of learning which he expressed in the following equation:

\[ H = M(1-e^{-in}) \]

where: \( H \) = habit strength
\( M \) = maximum strength of habit
\( e \) = the base of the natural logarithm
\( n \) = the number of practice trials
\( i \) = the rate of learning\textsuperscript{38}

Habit strength was defined as a bond connecting stimulus and response and is a direct function of the number of reinforced trials.\textsuperscript{39}

A modification of this Hullian model was tested by Light. Light's model was found to be a "good fit" of awareness data obtained in a laboratory experiment. Subjects were exposed to ads and later asked if they remembered seeing newly presented ads among those

\textsuperscript{37} Light, p. 9.
\textsuperscript{38} Ibid., p. 10.
\textsuperscript{39} C. L. Hull, \textit{Essentials of Behavior} (New Haven, Conn., 1951).
previously presented. This was the measure of awareness. The model, found to predict levels of awareness not significantly different from the actual levels of awareness recorded in the laboratory study, is shown graphically in Figure 1 and is expressed mathematically as follows:

\[ A_n = A_o + (A_m - A_o)(1 - e^{-n}) \]

where:

- \( A_n \) = level of awareness after \( n \) repetitions
- \( A_m \) = maximum expected level of awareness
- \( A_o \) = level of awareness before the first exposure
- \( e \) = base of the natural logarithm
- \( n \) = number of repetitions

In discussing the results of his study, Light stated, "While this model may provide a good description of mean learning curves across many ads, it is inadequate in completely describing curves for particular advertisements." Figure 2 shows two learning curves

\[ ^{40} \text{Light, p. 39.} \]
\[ ^{41} \text{Ibid., p. 30.} \]
\[ ^{42} \text{Ibid., p. 66.} \]
FIGURE 1
EXPONENTIAL LEARNING FUNCTION
FIGURE 2
EXPONENTIAL LEARNING FUNCTIONS
WITH DIFFERENT LEARNING RATES
with the same horizontal asymptote, but curve $L_1$ has a smaller initial slope than curve $L_2$. Light's conclusion was that some ads are better than others in that they may achieve the maximum level of awareness faster than others. Therefore, a complete learning model should include Hull's learning rate parameter. The larger $i$, the faster the rate of learning. The complete model is:

$$A_n = A_o + (A_m - A_o)(1-e^{-in})$$

where: $i = $ the rate of learning.

Light mentioned that $i$ could be used to scale the learnability of ads, but this index is somewhat difficult to interpret. This parameter could also be labeled "the quality of the advertising" in terms of its learnability.

In order to use this learning model in the laboratory, two data points are required: (1) a benchmark point before exposure to advertising will yield $A_o$, and (2) a second data point will permit a solution

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$^{43}$Ibid., pp. 66-69.
for 1 using

$$1 = \frac{1}{n} \ln \left( \frac{(A_m-A_o)/(A_m-A_n)}{100\%} \right)$$

where:  ln = natural logarithm and $A_m = 100\%$.

This complete model suggested by Light in his laboratory study forms the basis for the second hypothesis of this study. The predictive validity of the model will be tested using data collected in a market test.

Validation of this type is needed in marketing. Too often studies are completed, conclusions drawn, and no attempt at validation is made. McNiven criticized this when he stated that "... there has been a lack of concern and certainly a lack of work with the basic psychological problems that are still inherent in the problem of persuading mass audiences through advertising."44 A dialogue on research in consumer behavior in 1968 indicated a similar viewpoint stressing the need for research on research

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findings which is at the heart of any scientific field. 45

Forgetting. According to Britt, "Every time an advertisement or commercial appears, the objective is to have the reader or viewer learn something . . . and remember what he learned." 46

The goal of having the receiver of the advertising communication remember what he learned introduces the problem of forgetting. Forgetting has been studied by psychologists in the laboratory as has learning. Ebbinghaus investigated the effects of time lapse on memory yielding the forgetting curve which showed that most forgetting occurs very soon after the original learning. 47 He proposed that the percentage forgotten increases as the logarithm of the time since the initial learning. 48

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47 Light, p. 5.

48 H. Ebbinghaus, Memory (New York, 1913).
Strong duplicated the forgetting curves of Ebbinghaus in 1912 using advertisements. Adams in 1916 found that the rate of forgetting for advertisements is inversely related to the number of repeat exposures during the original learning.

Zielske, in 1959, also replicated the forgetting curves of Ebbinghaus. He showed that forgetting following the last ad exposure followed the classic Ebbinghaus curve. His research indicated that increasing exposures, not only increases the percentage of audience aware, but also increases the time that the ad is remembered. "The rate of forgetting decreased as the number of exposures increased."

Zielske's investigation pointed out that during time intervals between exposures to the ads, forgetting

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52 Ibid., p. 240.
took place. The curve had a "saw-toothed shape" as shown in Figure 3. Little and Lodish, in their media selection model, raised the question of forgetting. They noted that people are subject to forgetting and so retained exposure level decays with time in the absence of new exposures and should be discounted by a constant fraction each time period.

In Figure 3, the incremental value of an additional exposure is measured by the change in awareness level at each exposure (E). Graphically, this is the length of the vertical line which represents the change in awareness level after previous awareness level is discounted (taking into account the effect of forgetting) and at the point of the additional exposure.

It is important to note that if the length of this vertical line (i.e., incremental value of a new exposure) is less than the amount of decay in previous awareness due to forgetting, the learning curve

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53 Ibid.

where: $E_i$ = exposure for $i = 1$ to $13$

FIGURE 3
SAW-TOOTHED CURVE
will turn down, that is, it will exhibit decreasing returns.

Light's model will not account for forgetting between exposures nor can it account for decreasing returns. The model exhibits diminishing returns throughout. That is, its slope is positive and decreasing until it asymptotes and becomes zero. The second derivative is negative throughout.

The discussion of decreasing returns (i.e., negative sloping curve) raises the question of whether it is possible to have decreasing awareness with continuing advertising expenditure. This is the question of advertising wear-out. Appel commented in a 1966 speech that

The problem of advertising decay or wear-out is one which is the subject of considerable discussion these days, and many advertisers deliberately change their advertising in an effort to forestall this decay. To the best of my knowledge, however, there is little published evidence available having to do with the rates at which advertising messages decay in effectiveness, if indeed, they decay at all.55

Engel, Blackwell, and Kollat wrote, "Granted the obvious values of repetition, the problem of persuasive wear-out or boomerang looms large. At what point do . . . . negative effects set in?" Britt, while listing five unsolved advertising problems, asked, "How long does it take for an advertising theme or slogan to wear out?"

Engel et al. noted that "... wear-out can occur for the reason that repetition often leads to a significant loss of meaning. This phenomenon is referred to as semantic satiation." Only a few researchers have confirmed the satiation effect experimentally. Early work showed that the meaning of a familiar monosyllabic noun repeated aloud was lost. Lambert and Jakobovits employed Osgood's semantic differential scale to detect the


59 Ibid.
satiation effect and concluded that the meaning of a stimulus word disappears with repetition.\(^{60}\)

Light felt that attempts at verifying the generalizability of satiation effects to other than verbal stimuli had not been successful. Findings were not sufficiently clear; and in his study he failed to find a satiation effect with repeated visual advertisements while using the semantic differential scale measurement technique.\(^{61}\) Part of the difficulty here may rest with the technique of employing a measuring instrument to assess the satiation effect for visual stimuli that was designed to measure verbal satiation.

Jakobovits and Lambert argued that "Since all learning depends on repeated presentation of certain stimulus materials, it is of theoretical and practical importance to determine under what conditions such repeated stimulation is constructive, as in learning,


\(^{61}\)Light, p. 60.
or disruptive, as in semantic satiation." 62 Engel et al. suggested more research in semantic satiation for "... it may contain some of the keys to understanding persuasive wear-out." 63

In a recent study, Grass investigated the satiation effects of advertising. 64 He based his efforts on the satiation theory of Jakobovits.

Figure 4 depicts the generalized generation and satiation curve proposed by Jakobovits and used by Grass. The section of the curve reflecting increase in response level is called "generation". The point at which the slope is zero is the "satiation point" or the "onset of satiation". The section showing decrease in response level is referred to as satiation. 65


65 Ibid.
FIGURE 4

GENERALIZED GENERATION-SATIATION CURVE
Grass measured subject "interest" or "attention" by means of an operant behavior technique (CONPAAD) which required the subject to perform physical work in order to maintain audio level and illumination of repeated television commercials. Figure 5 shows the generation-satiation pattern obtained. 66

Learning was measured by Grass using a Learning Score index based on structured depth interviews with viewers. Figure 6 depicts the pattern found. The learning curve exhibited decreasing returns.

Grass hypothesized that learning must be accompanied by attention. He noted that the apparent "unlearning" effect (learning decay or forgetting) may be explained in terms of satiation in attention and subsequent forgetting of previous knowledge. He stated, "Initial attention is important to perform the original communications job; continued attention is necessary to maintain this level of knowledge at its maximum value. Otherwise, the audience will become satiated with the advertisement, turn its attention elsewhere, and begin to forget what it has learned." 67

66 Ibid.
67 Ibid.
FIGURE 5

ATTENTION VERSUS EXPOSURE FREQUENCY
FIGURE 6

LEARNING VERSUS EXPOSURE FREQUENCY
Other research has indicated that repetition to advertising exhibits negative effects. One report noted a decline in preference after four exposures to a commercial, and another study indicated that a weak commercial seems vulnerable to negative effects of repetition.\textsuperscript{68} Satiation may be the phenomenon underlying wear-out.

If satiation affects attention, permitting forgetting to take place with continued exposure, then a complete model of learning must allow for forgetting. The third hypothesis in this study considers such a learning function.

\textsuperscript{68}"Frequency in Broadcast Advertising," \textit{Media Scope}, (March 1962), pp. 57-64.
CHAPTER II

DEFINITIONS AND HYPOTHESES

Independent Variables

The variable most often manipulated by learning researchers has been number of exposures. The major independent variable in this study is advertising media weight.

Media weight is measured in terms of audience size by means of gross rating points (GRP). A rating is defined by BBDO as "... a survey estimate of the size of an audience, expressed as a percentage of the total group sampled. Ratings describe the average minute or broadcast reach level for television, and average issue audiences for print. They can be expressed on a household or 'person' basis."¹

"Gross rating points," according to BBDO, "is a summation of the ratings of the various media vehicles employed by the advertiser. It offers a description

¹One Hundred Media Terms Defined (New York, December 1966), p. 36.
of the total impression weight being delivered by a particular schedule (without regard to audience duplication)."²

There exists a mathematical relationship between advertising expenditures and gross rating points which is quite linear. As expenditures accumulate over time, gross rating points accumulate; and time is an underlying variable.³

Gross rating points divided by 100 equals the average number of times a member of the audience is exposed to the advertising.

Let: \[ \frac{\text{GRP}}{100} = n \]

then \( n \) = the mean of frequency distribution of exposures.

The major independent variable in this study is \( n_j \), where \( n_j \) is the average number of exposures delivered by the media schedule in time period \( j \).

Two additional independent variables are considered in the study. They are promotion and net effective volumetric distribution.

²Ibid., p. 19.

Promotion is defined here as a combination variable including couponing and price competition in the form of cents off deals for the brand being studied. The variable is constrained to three possible values, 0, 1, or 2 as follows: If $P_j$ = promotion in time period $j$, then:

- $P_j = 0$ if in $j$, there is neither couponing nor cents off.
- $P_j = 1$ if in $j$, there is either couponing or cents off.
- $P_j = 2$ if in $j$, there is both couponing and cents off.

Volumetric distribution is defined as the percentage of the total market sales volume that is sold through retailers carrying the brand being studied exclusively or along with competing brands.\(^4\)

Net effective volumetric distribution ($D_j$) represents the volumetric distribution in time period $j$ adjusted for stock outs of the brand being studied occurring in retail stores carrying the brand.

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Intervening Variables\textsuperscript{5}

The intervening variable between media weight and the dependent variable is awareness. The following measures of awareness are used in the study (the questionnaire employed is shown in Appendix A):

Unaided brand awareness (UBA) is the percentage of respondents who have ever used the type of product,\textsuperscript{6} who recalled the brand being studied. Respondents were asked to name the brand of product X that came to mind first and what other brands they could name (Questions 1 and 2 in the questionnaire). The total percentage of respondents mentioning the brand in question was calculated using these two questions to yield UBA.

Total brand awareness (TBA) is the percentage of product X users, who were aware unaided; plus the

\textsuperscript{5}In an attempt to disguise the type of product and brand being investigated in this study, a set of terms analogous to the example below is used throughout:

Terms
General class of product = auto cleaning aids
Type of product (or product X) = car wash
Brand being studied = Du Pont "7"

\textsuperscript{6}The marketing plan aimed to increase market share among users. The objective did not include expanding the total market. All awareness and trial percentages are calculated with the number of respondents who indicated that they had ever used the product as the denominator of the fraction.
percentage of product X users who claimed to have heard of the brand being studied while being read a list of brand names (Question 7).

First brand mentioned is the percentage of product X users who named the brand being studied as having come to mind first (Question 1).

Advertising awareness (AdA) is the percentage of product X users who recalled having seen or heard the brand advertised during the past month (Question 4).

First ad mentioned (FAM) is the percentage of product X users who recalled having seen or heard the brand advertised first (Question 4).

There were three copy points (brand attributes) in the advertising for the brand being investigated. Question 5 was designed to provide the data needed to calculate the percentages of product X users who recalled the copy points. CR1, CR2, and CR3 are these percentages for copy point one, two, and three respectively.

The percentage of product X users who recalled the way in which the advertising went about telling or showing the copy points (Question 6), is defined as advertising format awareness (FR).
Dependent Variable

The dependent variable employed in this study is trial. Trial is defined as the percentage of product X users who can recall having tried the brand being studied while being read a list of brand names of product X.

Trial, so defined, could decrease over time. The definition embodies a point of view which contends that if a consumer cannot recall having tried, even though she may have actually purchased the product, she can be considered a prospect.

Hypotheses

Several measures of awareness are employed in the measurement of advertising effectiveness. A question which arises is whether or not these measures are measuring the same thing. The first hypothesis in this study is:

(1) There is no correlation between the measures of awareness used in the study.

Light recommended that a field validation of the exponential function tested in his study be undertaken. 7

7Light, p. 80.
The model selected to accomplish this aim, in this study, is a modification of Light's model and is as follows:

\[ A_j = A_o + (A_m - A_o)(1-e^{-i\Sigma n_j}) \]

where:

- \( j \) = time period determined by the timing of data collection
- \( A_j \) = level of awareness at the end of time period \( j \)
- \( A_m \) = maximum expected level of awareness
- \( A_o \) = level of awareness before advertising begins (awareness at \( j = 0 \))
- \( e \) = base of the natural logarithm
- \( i \) = rate of learning
- \( \Sigma n_j \) = cumulative average number of exposures delivered by the media schedule from \( j = 0 \) to the end of time period \( j \)

The second hypothesis includes the above model.

(2) The function:

\[ A_j = A_o + (A_m - A_o)(1-e^{-i\Sigma n_j}) \]

is a good description of the learning curve associated with media weight.

The next hypothesis includes an exponential model which is a further modification of Light's function. The difference is that the new model incorporates an additional parameter in order to account for forgetting.
The model is as follows:

\[ A_j = K A_{j-1} + (A_m - A_{j-1})(1 - e^{-i\Sigma j}) \]

where: \( j, A_j, A_m, e, i, \) and \( \Sigma j \) are defined as in the above model

\( A_{j-1} = \) level of awareness at the end of the previous time period \((j-1)\)

\( K = \) the fraction of \( A_{j-1} \) remembered at the end of time period \( j \)

The third hypothesis includes this "K model."

(3) The function:

\[ A_j = K A_{j-1} + (A_m - A_{j-1})(1 - e^{-i\Sigma j}) \]

is a good description of the learning curve associated with media weight.

Next, an hypothesis is stated which relates to the assumption made by those who feel that advertising effectiveness should be measured in terms of communications objectives. The assumption is that accomplishment of communications objectives will increase the probability of consumer-purchase behavior.

If the assumption is valid, some relationship should exist which would account for trial in terms of some awareness measure or combination of awareness measures. Since promotion, in the form of couponing
and cents off deals and net effective volumetric distribution may effect trial, it is possible that the relationship would include these variables ($P_j$ and $D_j$) also.

The final hypothesis in this study concerns the existence of such a relationship between trial and awareness measures. If a relationship does exist, then accomplishment of communications objectives does increase the probability of consumer trial.

(4) There is no relationship between trial and a set of independent variables, a subset of which includes awareness measures.
CHAPTER III

METHODOLOGY

Research Design

The hypotheses previously described will be evaluated on the basis of data collected in a cross-sectional time series study.¹ The design used can be depicted as:

\[ O_0 \times_1 O_1 \times_2 O_2 \times_3 O_3 \times_4 O_4 \times_5 O_5 \]

where:

- \( O_j \) = observation (measurement) at the end of time period \( J \)
- \( X_j \) = introduction of advertising during the time period \( J \)

The independent variable in this design was \( n_j \). Five measurements of the intervening variables (awareness measures) and the dependent variable (trial) were taken after an initial benchmark measurement taken at

¹ The data used here were generated for a BBDO client, who was collecting information about the brand prior to making a decision concerning whether or not to market the brand nationally. Data collection cost exceeded $200,000. The author began the present study at a point after the final wave was collected.
\( j = 0 \), that is, before the introduction of the advertising for the brand being studied.

The timing of the dependent variable measurements determined the length of the five time periods as follows:

- For \( j = 1 \), the period = 1 month
- \( j = 2 \), the period = 2 months
- \( j = 3 \), the period = 2 months
- \( j = 4 \), the period = 3 months
- \( j = 5 \), the period = 3 months

Campbell classified this type design as a quasi-experimental design which suffers threats to validity due to the lack of control. He noted that the failure to control history is the most important weakness of the design. History is a likely alternate explanation for changes in the dependent variable because experimental isolation is difficult to achieve in a social science application of the design.\(^2\)

---

Sample

The above research design was used in two test market cities. Both City One (C₁) and City Two (C₂) were mid-western cities chosen because they were both considered to be representative of the national population.

The observations were made in both cities at the same time. Within C₁ and C₂, the respondents for each time period were selected by a random procedure from the set of households with telephones using the telephone directory. No respondent was interviewed more than once.

The sampling procedure had the advantage of overcoming other possible threats to validity including testing, regression, and mortality. However, in addition to the problem of history, other threats to validity were uncontrolled for including maturation, instrumentation, selection, and the reactive effect of testing.³

Data Collection

The dependent variable $n_j$ was manipulated in both C₁ and C₂. Both cities received the same total GRP delivery of 3,530, but the media schedule varied slightly between the two cities as shown by the

---

³Ibid.
following GRP listing:

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_1$</td>
<td>410</td>
<td>1,180</td>
<td>720</td>
<td>890</td>
<td>330</td>
<td>3,530</td>
</tr>
<tr>
<td>$C_2$</td>
<td>205</td>
<td>1,305</td>
<td>720</td>
<td>905</td>
<td>395</td>
<td>3,530</td>
</tr>
</tbody>
</table>

Throughout the campaign, the same television commercial was used to advertise the brand being studied.

**Questionnaire.** The questionnaire employed to obtain the data is in Appendix A. The actual data collection via telephone interview was conducted by an independent research firm selected by BBDO.

Question 1 supplied data to yield first brand mentioned (FBM). Questions 1, 2, and 7 made it possible to calculate total brand awareness (TBA) which equals the sum of unaided brand awareness (Questions 1 and 2) and aided brand awareness (Question 7).

Question 3 provided the data needed in order to calculate all of the awareness and trial percentages in terms of percentage of product X users.

First brand mentioned seen or heard advertised in the past month (FAM) and advertising awareness (AdA) are based on data from Question 4.
Question 5 yielded the information required to compute first, second, and third copy point awareness (CR1, CR2, and CR3 respectively); and advertising format awareness (FR) information was obtained by means of Question 6. The interviewer instructions between Questions 4 and 5 were meant to minimize the effect on succeeding questions of sensitizing the respondent to the two brands used in Questions 5 and 6.

Question 8 provided the data enabling the calculation of trial (TR). The remaining information was used to insure against repeat sampling of the same respondent.

P_j and D_j. Couponing and cents off promotional data were obtained from the BBDO client conducting the test market study of their brand.

Net effective volumetric distribution was computed on the basis of data supplied by an independent firm that supplies data on product movement by brand through retail stores.
CHAPTER IV

DATA ANALYSIS

Awareness Measures

(1) There is no correlation between the measures of awareness used in this study.

To evaluate this hypothesis, each of the nine measures of awareness obtained in this study was correlated (Pearson r) with every other measure of awareness. The resultant correlation coefficient matrix is shown in Table 1.

Those correlation coefficients that are significant with alpha at 0.05 are enclosed in parentheses. This level of significance is used for all of the statistical tests in this study. Every r was calculated with n=12; since for the two cities, there was a total of 12 observations. With degrees of freedom = n-2 = 10, the critical value of t, where \( t = \frac{r \sqrt{n-2}}{\sqrt{1-r^2}} \) is \( t_c = 2.228 \).
TABLE 1
CORRELATION COEFFICIENTS

<table>
<thead>
<tr>
<th></th>
<th>UBA</th>
<th>TBA</th>
<th>FBM</th>
<th>AdA</th>
<th>FAM</th>
<th>CR1</th>
<th>CR2</th>
<th>CR3</th>
<th>FR</th>
<th>TR</th>
</tr>
</thead>
<tbody>
<tr>
<td>UBA</td>
<td>1</td>
<td>(.932)</td>
<td>(.583)</td>
<td>(.937)</td>
<td>(.877)</td>
<td>(.763)</td>
<td>(.895)</td>
<td>(.927)</td>
<td>(.932)</td>
<td>(.570)</td>
</tr>
<tr>
<td>TBA</td>
<td>(.583)</td>
<td>1</td>
<td>(.784)</td>
<td>(.680)</td>
<td>(.646)</td>
<td>(.728)</td>
<td>(.832)</td>
<td>(.821)</td>
<td>(.763)</td>
<td></td>
</tr>
<tr>
<td>FBM</td>
<td>(.784)</td>
<td>(.680)</td>
<td>1</td>
<td>(.165)</td>
<td>(.272)</td>
<td>(.200)</td>
<td>(.463)</td>
<td>(.393)</td>
<td>(.923)</td>
<td></td>
</tr>
<tr>
<td>AdA</td>
<td>(.937)</td>
<td>(.680)</td>
<td>(.165)</td>
<td>1</td>
<td>(.981)</td>
<td>(.849)</td>
<td>(.971)</td>
<td>(.923)</td>
<td>(.961)</td>
<td>(.270)</td>
</tr>
<tr>
<td>FAM</td>
<td>(.877)</td>
<td>(.646)</td>
<td>(.272)</td>
<td>(.981)</td>
<td>1</td>
<td>(.819)</td>
<td>(.969)</td>
<td>(.875)</td>
<td>(.914)</td>
<td>(.120)</td>
</tr>
<tr>
<td>CR1</td>
<td>(.763)</td>
<td>(.728)</td>
<td>(.200)</td>
<td>(.849)</td>
<td>(.819)</td>
<td>1</td>
<td>(.750)</td>
<td>(.701)</td>
<td>(.820)</td>
<td>(.153)</td>
</tr>
<tr>
<td>CR2</td>
<td>(.895)</td>
<td>(.832)</td>
<td>(.463)</td>
<td>(.971)</td>
<td>(.969)</td>
<td>(.750)</td>
<td>1</td>
<td>(.880)</td>
<td>(.900)</td>
<td>(.193)</td>
</tr>
<tr>
<td>CR3</td>
<td>(.927)</td>
<td>(.821)</td>
<td>(.393)</td>
<td>(.923)</td>
<td>(.875)</td>
<td>(.701)</td>
<td>(.880)</td>
<td>1</td>
<td>(.961)</td>
<td>(.480)</td>
</tr>
<tr>
<td>FR</td>
<td>(.932)</td>
<td>(.763)</td>
<td>(.270)</td>
<td>(.961)</td>
<td>(.914)</td>
<td>(.820)</td>
<td>(.900)</td>
<td>(.961)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>TR</td>
<td>(.570)</td>
<td>(.763)</td>
<td>(.120)</td>
<td>(.153)</td>
<td>(.193)</td>
<td>(.153)</td>
<td>(.193)</td>
<td>(.480)</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

where:  \( (r) \) = significant correlation coefficient at alpha = .05

UBA = Unaided Brand Awareness
TBA = Total Brand Awareness
FBM = First Brand Mentioned
AdA = Advertising Awareness
FAM = First Brand Mentioned Seen or Heard Advertised
CR1 = First Copy Point Awareness
CR2 = Second Copy Point Awareness
CR3 = Third Copy Point Awareness
FR = Advertising Format Awareness
TR = Trial
Trial was correlated with each of the awareness measures, and these correlation coefficients are also included in Table 1.

The correlation coefficient matrix indicates that there are three sets of significantly intercorrelated variables which are not mutually exclusive. The sets are:

Set $A = \{\text{UBA, TBA, AdA, FAM, CR1, CR2, CR3, FR}\}$
Set $B = \{\text{FBM, TBA, TR}\}$
Set $C = \{\text{FBM, UBA}\}$

The intersection of sets $A$ and $B$ includes TBA. The intersection of sets $A$ and $C$ includes UBA. Finally, the intersection of sets $B$ and $C$ includes FBM. Therefore, the above null hypothesis is rejected; and it may be concluded at the 95% confidence level that a significant positive correlation exists between all of the measures of awareness used in this study.

Since it has been shown that the measures of awareness are correlated, it will not be necessary to evaluate the three remaining hypotheses stated in Chapter II for more than one of the awareness measures.

Since the use of communications objectives in measuring advertising effectiveness depends on the assumption that changes in these variables will yield changes
in consumer purchase behavior, the awareness measure most closely related to trial should be used as the measure of awareness.

Applying the above decision rule to the two awareness measures that are significantly related to trial (FBM and TBA with r's of 0.923 and 0.763 respectively to trial) would result in the use of FBM. However, it was the belief of research department members at BBDO that FBM was more closely related to TR than TBA due to the unusually heavy expenditure on advertising for the brand in the two test cities.

In order to determine whether the correlation coefficients between FBM and TR \( (r_1 = 0.923) \) and TBA and TR \( (r_2 = 0.763) \) differ significantly from each other, the following null hypothesis was tested:

\[ H_0: \text{There is no significant difference between } r_1 \text{ and } r_2. \]

A z test was used with \( n_1 = n_2 = 12 \). The critical values of z were +1.96 and -1.96. The computed value of z was -1.68; therefore, the null hypothesis was accepted. It can be concluded with 95% confidence that there is no significant difference between \( r_1 \) and \( r_2 \).

It was decided to use total brand awareness (TBA) as the awareness measure in the evaluation of the three
remaining hypotheses of this study.

**Light's Model**

(2) The function:

\[ A_j = A_o + (A_m - A_o)(1-e^{-i\Sigma n_j}) \]

is a good description of the learning curve associated with media weight.

In order to test the above hypothesis, it was necessary to generate predicted levels of awareness using the model. Before the function can be used, \(A_m\), \(A_o\), and \(i\) must be known.

The maximum expected level of awareness, \(A_m\), was set at 0.950. It is unrealistic to set \(A_m = 1.00\) in a market study. \(A_m\) was determined by setting it equal to the median value of total brand awareness for the established major brands of product X (independent data supplied by BBDO).

\(A_o\) was determined from the measure of TBA at \(j = 0\).

The remaining unknown, \(i\), was solved for using the following equation and \(A_1\). (See Appendix B.)

\[ i = \frac{1}{n_1} \ln \left[ \frac{(A_m - A_o)/(A_m - A_1)} \right] \]

The assumption was made that \(i\) is constant, and the calibrated model, based on observations in time periods
j = 0 and 1, was used to predict levels of total brand awareness, \( \hat{\text{TBA}}_j \) = predicted TBA in time period \( j \), given \( n_j \), for \( j = 2, 3, 4, \) and 5.

To test the above hypothesis, a Chi-Square goodness of fit test was used. Before this could be done, the awareness data had to be converted to frequency data. Tables 2 and 3 include the information needed to arrive at the computed value of Chi-Square for the two test cities, \( C_1 \) and \( C_2 \) respectively, using \( \text{Chi-Square} = \sum_{j=2}^{5} \frac{(N_j - \hat{N}_j)^2}{N_j} \).

In Tables 2 and 3:

\[
\begin{align*}
\text{TBA}_j & = \text{the observed TBA in time period } j \\
N_j & = \text{the observed number of respondents aware (TBA) in time period } j \\
\hat{\text{TBA}}_j & = \text{the predicted TBA in time period } j \\
\hat{N}_j & = \text{the predicted number of respondents aware (TBA) in time period } j, j = 2 \text{ to } 5.
\end{align*}
\]

Also included is the computed Chi-Square value.

The following null hypothesis was used to test whether or not the predicted frequencies fit the observed data:

\[ H_0: \text{ There is no significant difference between } N_j \text{ and } \hat{N}_j \text{ in time periods } j = 2, 3, 4, 5. \]
TABLE 2
OBSERVED AND PREDICTED FREQUENCIES
IN $C_1$ (LIGHT'S MODEL)

<table>
<thead>
<tr>
<th>$J$</th>
<th>$TBA_j$</th>
<th>$N_j$</th>
<th>$\hat{TBA_j}$</th>
<th>$\hat{N}_j$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.029</td>
<td>28</td>
<td>(0.000)</td>
<td>—</td>
</tr>
<tr>
<td>1</td>
<td>0.624</td>
<td>241</td>
<td>(0.614)</td>
<td>—</td>
</tr>
<tr>
<td>2</td>
<td>0.539</td>
<td>187</td>
<td>0.944</td>
<td>328</td>
</tr>
<tr>
<td>3</td>
<td>0.597</td>
<td>219</td>
<td>0.950</td>
<td>349</td>
</tr>
<tr>
<td>4</td>
<td>0.613</td>
<td>246</td>
<td>0.950</td>
<td>381</td>
</tr>
<tr>
<td>5</td>
<td>0.548</td>
<td>211</td>
<td>0.950</td>
<td>366</td>
</tr>
</tbody>
</table>

Chi-Square = 243.904
<table>
<thead>
<tr>
<th>J</th>
<th>( TBA_j )</th>
<th>( N_j )</th>
<th>( \hat{TBA}_j )</th>
<th>( \hat{N}_j )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.041</td>
<td>35</td>
<td>(0.000)</td>
<td>—</td>
</tr>
<tr>
<td>1</td>
<td>0.619</td>
<td>232</td>
<td>(0.604)</td>
<td>—</td>
</tr>
<tr>
<td>2</td>
<td>0.558</td>
<td>207</td>
<td>0.950</td>
<td>352</td>
</tr>
<tr>
<td>3</td>
<td>0.647</td>
<td>249</td>
<td>0.950</td>
<td>366</td>
</tr>
<tr>
<td>4</td>
<td>0.554</td>
<td>227</td>
<td>0.950</td>
<td>390</td>
</tr>
<tr>
<td>5</td>
<td>0.579</td>
<td>206</td>
<td>0.950</td>
<td>338</td>
</tr>
</tbody>
</table>

Chi-Square = 216.806
With degrees of freedom = \((r-1)(c-1)\), where \(r\) = number of rows and \(c\) = number of columns in the matrix, \(df = (4-1)(2-1) = 3\) for both cities. With \(df = 3\), the critical value of Chi-Square is 7.815. Since this critical value was exceeded in both cities, the above null hypothesis was rejected. It can be concluded with 95\% confidence that Light's model is not a good description of the learning curve associated with media weight.

**The Model Including K**

(3) The function:

\[
A_j = KA_{j-1} + (A_m - A_{j-1})(1 - e^{-1\Sigma j})
\]

is a good description of the learning curve associated with media weight.

In order to test the hypothesis, it was necessary to generate predicted levels of awareness using the model. Before the function can be used, \(A_m, A_0, i,\) and \(K\) must be known.

\(A_m\) was set at 0.950, as in Light's model. \(A_0\) was determined from the measure of TBA at \(j = 0\).

For \(j = 1\) and \(K = 1\), it can be shown that \(i\) solved for using Light's model equals the \(i\) obtained by using the \(K\) model. (See Appendix B). This parameter was solved for using the following equation and \(A_1\).
The assumption was made that $i$ is constant, as in Light's model, and $K$ was solved for using the following equation and $A_2$.

$$K = \frac{A_2 - (A_m - A_1)(1 - e^{-i \Sigma n_j})}{A_1}$$

The assumption was made that $K$ is constant, and the calibrated model, based on observations in time periods $j = 0, 1, \text{ and } 2$, was used to predict levels of total brand awareness, given values of $n_j$, for $j = 3, 4, \text{ and } 5$.

To test the above hypothesis, a Chi-Square goodness of fit test was used. The awareness data were converted to frequency data. Tables 4 and 5 include the information needed to determine the computed value of Chi-Square for the two test cities, $C_1$ and $C_2$ respectively,

---

1 The equation is the solution for $K$ using:

$$A_j = KA_{j-1} + (A_m - A_{j-1})(1 - e^{-i \Sigma n_j})$$

$$-KA_{j-1} = -A_j + (A_m - A_{j-1})(1 - e^{-i \Sigma n_j})$$

$$K = \frac{A_j - (A_m - A_{j-1})(1 - e^{-i \Sigma n_j})}{A_{j-1}}$$

The solution for $K$ above is based on the third data wave, that is, where $j = 2$. 
TABLE 4
OBSERVED AND PREDICTED FREQUENCIES IN $C_1$ (K MODEL)

<table>
<thead>
<tr>
<th>$j$</th>
<th>$N_j$</th>
<th>$\hat{N}_j$</th>
<th>$TBA_j$</th>
<th>$\hat{TBA}_j$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>28</td>
<td></td>
<td>0.029</td>
<td>0.000</td>
</tr>
<tr>
<td>1</td>
<td>241</td>
<td></td>
<td>0.624</td>
<td>0.614</td>
</tr>
<tr>
<td>2</td>
<td>187</td>
<td></td>
<td>0.539</td>
<td>0.546</td>
</tr>
<tr>
<td>3</td>
<td>219</td>
<td></td>
<td>0.597</td>
<td>0.595</td>
</tr>
<tr>
<td>4</td>
<td>246</td>
<td></td>
<td>0.613</td>
<td>0.564</td>
</tr>
<tr>
<td>5</td>
<td>211</td>
<td></td>
<td>0.548</td>
<td>0.548</td>
</tr>
</tbody>
</table>

Chi-Square = 1.774
TABLE 5

OBSERVED AND PREDICTED FREQUENCIES
IN C₂ (K MODEL)

<table>
<thead>
<tr>
<th>J</th>
<th>TBAₖ</th>
<th>Nⱼ</th>
<th>TBÂₖ</th>
<th>N̂ⱼ</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.041</td>
<td>35</td>
<td>(0.000)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.619</td>
<td>232</td>
<td>(0.604)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.558</td>
<td>207</td>
<td>(0.567)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.647</td>
<td>249</td>
<td>0.591</td>
<td>228</td>
</tr>
<tr>
<td>4</td>
<td>0.554</td>
<td>227</td>
<td>0.576</td>
<td>236</td>
</tr>
<tr>
<td>5</td>
<td>0.579</td>
<td>206</td>
<td>0.585</td>
<td>208</td>
</tr>
</tbody>
</table>

Chi-Square = 2.296
using Chi-Square = \( \sum_{j=3}^{5} \frac{(N_j - \hat{N}_j)^2}{\hat{N}_j} \). \( TBA_j \), \( N_j \), \( \hat{TBA}_j \), and \( \hat{N}_j \) are the same as defined above for Tables 2 and 3.

The following null hypothesis was used to test whether or not the predicted frequencies fit the observed data:

\[ H_0 : \text{There is no significant difference between } N_j \text{ and } \hat{N}_j \text{ in time periods } j = 3, 4, 5. \]

With degrees of freedom = \((r-1)(c-1) = (3-1)(2-1) = 2\) for both cities, the critical value of Chi-Square is 5.991. Since this critical value was not exceeded in either city, the above null hypothesis was accepted.

It can be concluded with 95% confidence that the model including \( K \) is a good description of the learning curve associated with media weight.

**Trial**

(4) There is no relationship between trial and a set of independent variables, a subset of which includes awareness measures.

To evaluate this hypothesis, the data for both cities (12 observations) were combined and analyzed by means of linear regression analysis. Ten separate analyses were run with trial (\( TR_j \)) as the dependent variable throughout. Each run utilized a different set
of independent variables, a subset of which always included awareness measures.

The set of independent variables made up of all those independent variables used at least once in the regression analysis included the following variables:

\[ TBA_j, TBA_{j-1}, \Delta TBA_j \text{ (where } \Delta TBA_j = TBA_j - TBA_{j-1} \text{), } TR_{j-1} \text{ (trial in the preceding time period), } P_j, \text{ and } D_j \]

For each of the ten regression runs, the following null hypothesis was tested:

\[ H_0: \text{ The percentage of the total variance in trial accounted for by the set of independent variables (in the run) is zero.} \]

This null hypothesis states that the coefficient of determination of the population of observations is not significantly different from zero for the run in question.

Table 6 summarizes the results of the ten regression analyses in the order in which they were run.

The degrees of freedom were determined for the F test as follows:

\[ \text{df for the numerator} = m \]
\[ \text{df for the denominator} = (n-m)-1 \]

where:
\[ m = \text{the number of independent variables and} \]
\[ n = \text{the number of data points (observations).} \]
### TABLE 6

**REgression Results**

<table>
<thead>
<tr>
<th>Run</th>
<th>Independent Variables</th>
<th>$R^2$</th>
<th>$F$ (Computed)</th>
<th>$F$ (Critical)</th>
<th>Reduced $R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$TBA_j$</td>
<td>0.582</td>
<td>13.94</td>
<td>4.96</td>
<td>0.540</td>
</tr>
<tr>
<td>2</td>
<td>$TBA_j$, $\Delta TBA_j$</td>
<td>0.830</td>
<td>22.05</td>
<td>4.26</td>
<td>0.792</td>
</tr>
<tr>
<td>3</td>
<td>$TBA_j$, $TBA_{j-1}$</td>
<td>0.846</td>
<td>24.72</td>
<td>4.26</td>
<td>0.812</td>
</tr>
<tr>
<td>4</td>
<td>$TBA_j$, $\Delta TBA_j$</td>
<td>0.861</td>
<td>27.97</td>
<td>4.26</td>
<td>0.830</td>
</tr>
<tr>
<td>5</td>
<td>$TBA_j$, $TBA_{j-1}$, $\Delta TBA_j$</td>
<td>0.868</td>
<td>17.48</td>
<td>4.07</td>
<td>0.817</td>
</tr>
<tr>
<td>6</td>
<td>$TBA_j$, $TBA_{j-1}$, $D_j$</td>
<td>0.846</td>
<td>14.70</td>
<td>4.07</td>
<td>0.788</td>
</tr>
<tr>
<td>7</td>
<td>$TBA_j$, $TBA_{j-1}$, $P_j$</td>
<td>0.875</td>
<td>18.61</td>
<td>4.07</td>
<td>0.827</td>
</tr>
<tr>
<td>8</td>
<td>$TBA_j$, $\Delta TBA_j$, $P_j$</td>
<td>0.538</td>
<td>3.10</td>
<td>4.07</td>
<td>—</td>
</tr>
<tr>
<td>9</td>
<td>$TBA_j$, $\Delta TBA_j$, $P_j$</td>
<td>0.904</td>
<td>24.99</td>
<td>4.07</td>
<td>0.867</td>
</tr>
<tr>
<td>10</td>
<td>$TBA_j$, $\Delta TBA_j$, $P_j$, $D_j$</td>
<td>0.909</td>
<td>17.47</td>
<td>4.12</td>
<td>0.540</td>
</tr>
</tbody>
</table>
The above null hypothesis was rejected for every run except number eight at the 95% confidence level. Therefore, it can be concluded that the fourth hypothesis in this study was rejected with 95% confidence.

There is a relationship between trial and a set of independent variables, a subset of which includes awareness measures.

The regression model with a significant $R^2$, that accounted for the largest proportion of the variance in trial after the overstatement in $R^2$ due to the relationship between number of variables fit and data points available was reduced, was run number nine.

The regression model calibrated in run number nine is the function:

$$TR_j = b_0 + b_1 TBA_{j-1} + b_2 \Delta TBA_j + b_3 P_j$$

where:

- $b_0 = 0.006$
- $b_1 = 0.260$
- $b_2 = 0.082$
- $b_3 = 0.028$

The following hypothesis was then evaluated:

The function:

$$TR_j = 0.006 + 0.260(TBA_{j-1}) + 0.082(\Delta TBA_j) + 0.028(P_j)$$
is a good description of the relationship between the set of independent variables including $TBA_{j-1}, \Delta TBA_j$, and $P_j$ and $TR_j$.

In order to test this hypothesis, it was necessary to generate predicted levels of $TR_j$. The above calibrated regression model was used to yield $\hat{TR}_j$ (predicted levels of trial) in both cities, $C_1$ and $C_2$. The levels of TBA used for $TBA_{j-1}$ and in the calculation of $\Delta TBA_j$ were the predicted levels of total brand awareness ($\hat{TBA}_j$) generated by the K model and listed in Tables 4 and 5 for both cities, $C_1$ and $C_2$ respectively.

To test the above hypothesis, a Chi-Square goodness of fit test was used. Before this could be done, both the observed $(TR_j)$ and predicted $(\hat{TR}_j)$ trial data had to be converted to frequency data. Tables 7 and 8 contain the information needed to determine the computed value of Chi-Square for the two cities, $C_1$ and $C_2$ respectively.

In Tables 7 and 8:

$$N_j = \text{the observed number of respondents classified as triers in time period } j.$$  

$$\hat{N}_j = \text{the predicted number of respondents classified as triers in time period } j.$$  

Also included is the computed Chi-Square value determined using \[ \text{Chi-Square} = \sum_{j=1}^{5} \frac{(N_j - \hat{N}_j)^2}{\hat{N}_j}. \]
<table>
<thead>
<tr>
<th>J</th>
<th>$\hat{N}_j$</th>
<th>$\hat{N}_j$</th>
<th>$\hat{N}_j$</th>
<th>$\hat{N}_j$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.006</td>
<td>(6)</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.117</td>
<td>45</td>
<td>0.084</td>
<td>32.4</td>
</tr>
<tr>
<td>2</td>
<td>0.190</td>
<td>66</td>
<td>0.160</td>
<td>55.5</td>
</tr>
<tr>
<td>3</td>
<td>0.204</td>
<td>75</td>
<td>0.184</td>
<td>67.5</td>
</tr>
<tr>
<td>4</td>
<td>0.219</td>
<td>88</td>
<td>0.215</td>
<td>86.2</td>
</tr>
<tr>
<td>5</td>
<td>0.192</td>
<td>74</td>
<td>0.185</td>
<td>71.2</td>
</tr>
</tbody>
</table>

Chi-Square = 7.84
<table>
<thead>
<tr>
<th>J</th>
<th>$T_{R_j}$</th>
<th>$N_j$</th>
<th>$\hat{T}_{R_j}$</th>
<th>$\hat{N}_j$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.001</td>
<td>(1)</td>
<td>0.000</td>
<td>(0)</td>
</tr>
<tr>
<td>1</td>
<td>0.067</td>
<td>25</td>
<td>0.084</td>
<td>31.5</td>
</tr>
<tr>
<td>2</td>
<td>0.127</td>
<td>47</td>
<td>0.160</td>
<td>59.3</td>
</tr>
<tr>
<td>3</td>
<td>0.148</td>
<td>57</td>
<td>0.180</td>
<td>69.3</td>
</tr>
<tr>
<td>4</td>
<td>0.212</td>
<td>87</td>
<td>0.215</td>
<td>88.1</td>
</tr>
<tr>
<td>5</td>
<td>0.211</td>
<td>75</td>
<td>0.179</td>
<td>63.7</td>
</tr>
</tbody>
</table>

Chi-Square = 8.10
The following null hypothesis was used to test whether or not the predicted frequencies fit the observed data:

\[ H_0: \text{There is no significant difference between } N_j \text{ and } \bar{N}_j \text{ in time periods } j=1 \text{ to } 5. \]

With degrees of freedom \( (r-1)(c-1) = (5-1)(2-1) = 4 \), the critical value of Chi-Square is 9.488. Since the critical value was not exceeded, the above null hypothesis was accepted. It can be concluded at the 95% confidence level that the regression model above is a good description of the relationship between the set of independent variables including \( TBA_{j-1}, \Delta TBA_j, \text{ and } P_j \) and \( TR_j \).
CHAPTER V

DISCUSSION OF RESULTS

**Awareness Measures**

The test on the first hypothesis indicates that there is a positive relationship between the measures of awareness used in this study.

This indicates, for the awareness measures used here, that they are measuring the same underlying variable. Researchers then would be free to choose, from among the set of measures, which one to use. A practical benefit, for example, is that the measure involving the lowest data collection costs could be used.

It should be noted that the set of measures of awareness studied does not exhaust the set of possible measures. The above conclusion applies only to the set examined here.

**Light's Model**

The data analysis indicates that the second hypothesis is rejected. Light's model:

\[ A_j = A_0 + (A_m-A_0)(1-e^{-\lambda \Sigma n j}) \]
is not an accurate description of the relationship between advertising media weight and awareness.

In Light's laboratory experiment, the independent variable in the model was \( n \), where: \( n \) = number of exposures. In order to test the model in the market study, it was necessary to use media weight measured in terms of average numbers of exposures delivered by the media schedule in a given time period \( (n_j) \).

It was not possible, given the cross-sectional time series design, to use number of exposures as the independent variable since no data were available on exposures to individual respondents. Such data could be obtained, if individual respondents were observed over time in a panel (longitudinal) study.

The Model Including \( K \)

The test on the third hypothesis indicates that the curvilinear function:

\[
A_j = K A_{j-1} + (A_m - A_{j-1})(1 - e^{-i\Sigma n_j})
\]

is an accurate description of the relationship between advertising media weight and awareness.

\( K \) Assumption. The data analysis assumed that \( K \) was a constant. Solving the exponential equation for \( K \) yields (see footnote 1, Chapter IV):
This indicates that \( K \) is a function of \( n_j \) and may vary.

\[ K = A_j - \frac{(A_m - A_{j-1})(1 - e^{-i\Sigma n_j})}{A_{j-1}} \]

\( K \) is the fraction of awareness in \( j-1 \) remembered at the start of period \( j \). Both Ebbinghaus and Zielske noted that the percentage forgotten increases as the logarithm of the time since the initial learning. Assuming \( K \) constant does not violate these findings. A constant \( K \) will yield a logarithmic curve with negative slope increasing to zero.

However, Adams and Zielske, among others, found that the rate of forgetting is inversely related to the number of repeat exposures during initial learning. In other words, the length of time something is remembered is directly related to the number of repetitions during initial learning.

In terms of the slope, these findings state that the slope of the forgetting curve is negative and closer to zero immediately after learning ends as the number of repetitions during initial learning is increased. That is, as the number of repetitions is increased, the slope of the forgetting curve is initially smaller in absolute value. This can be seen in Figure 3.
Assuming \( K \) constant does violate these findings. This results in assuming that the rate of change of the slope of the forgetting curve is independent of the number of repetitions when it should be a function of the number of repetitions during learning.

**Assuming \( i \) constant.** The data analysis also assumed \( i \) to be constant. Solving the \( K \) model for \( i \) yields (see Appendix B):

\[
i = \frac{1}{\sum n_j} \ln \left( \frac{A_m - A_{j-1}}{(A_m - A_{j-1} - A_j + KA_{j-1})} \right)
\]

This indicates that \( i \) is a function of \( n_j \) and may vary.

If an effect of repetition is the onset of satiation, changes in \( i \) could be reflecting this phenomenon. If \( i \) equals zero, the \( K \) model reduces to:

\[
A_j = KA_{j-1}
\]

which is the classic forgetting curve and is what would be expected if the effect of satiation results in a zero level of attention to the stimulus.

Assuming \( i \) constant contradicts the above.

The effects of repetition on \( K \), on \( i \), and the relationship between \( i \) and \( K \) need more investigation if \( i \) and \( K \) are to be completely understood as reflecting
basic psychological factors inherent in the problem of advertising effectiveness. However, the fact that the model predicted the observed levels of awareness so closely seems to indicate that the assumptions of $i$ and $K$ being constants would yield predictions not significantly different from predictions that would be generated if $i$ and $K$ were better understood and allowed to vary. Practically, a difference that has little impact may be considered as no difference at all.\(^1\)

**Calibration.** In order to use the $K$ model tested in this study, three data points were required for calibration. Three waves of data were collected before this could be accomplished.

An alternate means of calibrating the $K$ model using three data points is as follows. Given $A_m$ and assuming $i$ to be constant,

\[ i_j = i_{j+1} \]

where:

\[ i_j = \frac{1}{\Sigma n_j} \ln \left[ \frac{(A_m - A_{j-1})/(A_m - A_{j-1} - A_j + KA_{j-1})}{(A_m - A_{j-1})/(A_m - A_{j-1} - A_j + KA_{j-1})} \right] \]

and

\[ i_{j+1} = \frac{1}{\Sigma n_{j+1}} \ln \left[ \frac{(A_m - A_j)/(A_m - A_j - A_{j+1} + KA_j)}{(A_m - A_j)/(A_m - A_j - A_{j+1} + KA_j)} \right] \]

These two expressions can be equated and the resulting equation solved to yield $K$. The solution requires three data points, $A_{j-1}$, $A_j$, and $A_{j+1}$. Then $i$ can be solved for using the $K$ model as in Appendix B.

The conclusion is that the $K$ model can be calibrated using any three adjacent data points. It is not a necessary condition that $A_{j-1} = A_0$. This finding will aid in the application of the model to established products.

**A Further Modification.** The $K$ model could be modified by adding another $K$ as follows:

$$A_j = KA_{j-1} + (A_{m} - KA_{j-1})(1 - e^{-i\xi n_j})$$

This modification reflects the fact that the "potential" awareness yet to be achieved at the end of a period between exposures is not the same as the "potential" awareness at the previous exposure; that is, before forgetting has had its effect. The "potential" awareness immediately preceding the next exposure is $A_{m} - KA_{j-1}$.

This modified function is a more complete reflection of what the learning curve is like on an individual exposure basis. (See Figure 3.)
The data analysis indicates that the fourth hypothesis in the study is rejected. There is a relationship between trial and a set of independent variables, a subset of which includes awareness measures.

The relationship is correlational. Critics of the communications objective approach to measuring advertising effectiveness, such as Palda, argue that little evidence exists to show that awareness precedes rather than follows purchase behavior. In addition, for a respondent to claim trial of a brand, the respondent must necessarily be aware of the brand.

In view of the above criticism of correlation analysis, the regression model was used to predict trial using data for the awareness variables generated by means of the K model. These data were not verbal responses from consumers, and the model was found to be an accurate description of the relationship between trial and measures of awareness ($TBA_{j-1}$ and $\Delta TBA_j$) and promotion ($P_j$).

In addition, the regression analysis provides further information with respect to the question of causality. The regression coefficients determined in run nine

---

(see page 61) indicate that of the variance in trial explained by the awareness measures ($TBA_{j-1}$ and $\Delta TBA_j$), a greater amount is accounted for by $TBA_{j-1}$. That is, a larger proportion of the variance in trial in $j$ is explained by awareness in $j-1$. This awareness precedes trial. A smaller proportion of the variance in trial in $j$ is explained by new awareness in $j$. The analysis does not determine whether this new awareness ($\Delta TBA_j$) is due to advertising or to trial.

Those favoring communications objectives in advertising do not limit the set of intervening variables to awareness measures. They include creation of favorable attitudes as a step in the hierarchy-of-effects. Attitude data were not collected in the study. The $R^2$ results indicate that such data may not have had a significant impact on the amount of variance in trial accounted for by the regression model.

History was uncontrolled for in the research design. One of the leading brands of product X offered cents off deals in $C_2$ while the study was in progress. This may have contributed to the larger Chi-Square value (see Table 8) in that test city.
Concluding Comments

This study developed two relationships which relate advertising media weight to trial for a new consumer packaged goods product. The first relationship is described by an exponential function relating advertising media weight to brand awareness. The second relationship is a linear regression model with a set of independent variables including two measures of awareness and a variable for promotion.

In the two test market cities, it was found that the learning curve associated with media weight is a function which includes two parameters, \( i \) and \( K \), where \( i \) is a learning rate parameter and \( K \) is a parameter which reflects the effect of forgetting by discounting awareness.

The data indicates it is possible for the learning curve to exhibit decreasing returns with continuing advertising. This may possibly be due to the negative effect of satiation on attention. The two parameter
exponential model provides a good description of this curve.

In addition, an analysis of the measures of awareness used in the study indicates that there is a significant positive correlation among them.

Limitations

The research design used in this study did not allow for complete control and, at best, could be called quasi-experimental.

Other research has indicated that intervening variables, such as awareness, are important in explaining aggregate purchase behavior; but the importance varies by brand and type of product. This study involves one brand of one type of new product.

In order to calibrate and use the K model, three waves of data are required for new product introductions.

The study did not completely establish that brand awareness necessarily precedes trial.

---

Future Research

Because of the importance of the topic of advertising effectiveness, further research in this area is needed. The following are recommended as being worthy of further research.

(1) Field validation of the exponential function described and tested in this study across brands and products.

(2) Behavioral studies of the nature and relationship of the two parameters in the exponential function, \( i \) and \( K \).

(3) An investigation of the effects on \( i \) and \( K \) of different media schedules varying the amount of pressure and timing.

(4) Investigation of the applicability of the model to established products.

(5) Continued investigation of the cause of forgetting with continued exposure including validation of a measure of visual satiation.

The findings obtained from the above research would be enlightening both to psychologists with interest in mass communications and to marketing decision makers.
APPENDIXES
APPENDIX A

QUESTIONNAIRE

Hello, I am (interviewer) of (research firm). We are conducting a survey about (class) products, particularly about (specific product type). (Continue interview with household member who performs the activity in which the class of products is used.)

1. Now thinking about (X = product), what brand of X first comes to mind?
2. What other brands of X can you name?
3. Do you ever use X?
4. What brands of X have you seen or heard advertised in the past month? (Record in order respondent mentions brands.)

(If X is mentioned, ask about X and one other brand mentioned earliest; if X is not mentioned, ask about first and second brand mentioned in questions 5 and 6.)

5. What did the advertising tell you about (Brand)? Anything else? (Probe.)
6. How did the advertising go about telling or showing you this about (Brand)? (Probe.)
7. I am going to read you a list of (brand names). Even though you may have mentioned it before, have you ever heard of (Brand)?

8. For each brand name I read, please tell me if you have ever tried it. Even though you may have already mentioned it, have you ever tried (Brand)?

Name ____________________. Telephone # ____________.
Address ____________________. City ____________.
Interviewer ____________________. Date ________.
Directory Name ____________________. 
APPENDIX B

SOLUTIONS FOR \( i \) IN BOTH MODELS

Light's model:

\[
A_j = A_0 + (A_m - A_0)(1 - e^{-i\Sigma n_j})
\]

can be solved for \( i \) as follows:

\[
e^{-i\Sigma n_j} = 1 - \left[ \frac{(A_j - A_0)}{(A_m - A_0)} \right] = \frac{(A_m - A_j)}{(A_m - A_0)}
\]

\[
-i\Sigma n_j = \ln \left[ \frac{(A_m - A_j)}{(A_m - A_0)} \right] = \ln (A_m - A_j) - \ln (A_m - A_0)
\]

\[
-i\Sigma n_j = \ln (A_m - A_0) - \ln (A_m - A_j)
\]

\[
i = \frac{1}{\Sigma n_j} \ln \left[ \frac{(A_m - A_0)}{(A_m - A_j)} \right]
\]

For \( j = 1 \) the last equation reduces to:

\[
i = \frac{1}{n_1} \ln \left[ \frac{(A_m - A_0)}{(A_m - A_1)} \right]
\]

Now the model including \( K \):

\[
A_j = K A_{j-1} + (A_m - A_{j-1})(1 - e^{-i\Sigma n_j})
\]

can be solved for \( i \) as follows:

\[
e^{-i\Sigma n_j} = 1 - \left[ \frac{(A_j - K A_{j-1})}{(A_m - A_{j-1})} \right]
\]
\[
\begin{align*}
-i \Sigma n_j &= \ln \left[ \frac{(A_m - A_{j-1} - A_j + KA_{j-1})}{(A_m - A_{j-1})} \right] \\
&= \ln \left[ \frac{(A_m - A_{j-1} - A_j + KA_{j-1})}{(A_m - A_{j-1})} \right] - \ln (A_m - A_{j-1}) \\
i \Sigma n_j &= \ln (A_m - A_{j-1}) - \ln (A_m - A_{j-1} - A_j + KA_{j-1}) \\
&= \ln \left[ \frac{(A_m - A_{j-1})}{(A_m - A_{j-1} - A_j + KA_{j-1})} \right] \\
i &= \frac{1}{\sum_i \Sigma n_j} \ln \left[ \frac{(A_m - A_{j-1})}{(A_m - A_{j-1} - A_j + KA_{j-1})} \right]
\end{align*}
\]

For \( j = 1 \) and \( K = 1 \), this last equation reduces to:

\[
i = \frac{1}{n_1} \ln \left[ \frac{(A_m - A_0)}{(A_m - A_1)} \right]
\]

Therefore, it has been proven that for \( j = 1 \) and \( K = 1 \), \( i \) is the same in both models.

Light's model is a special case of the model including \( K \) in the first time period \( (j = 1) \).
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