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LAW AND LEARNING THEORY: A STUDY IN LEGAL CONTROL*

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THIS study lies within the province of jurisprudence. It also lies within the field of behavioristic psychology. It places the province within the field and, in doing so, fragments the province into disconnected pieces. The problems of jurisprudence become psychological problems to be attacked by the use of the propositions of a psychological theory of behavior and by quantitative and experimental methods.

Although analytical, natural-law, historical, sociological, and "realistic" jurists, legislators, administrators, cultural anthropologists, sociologists,

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The methods of field work, down to the smallest detail of observation and instruction and supervision of observers, were planned by Miss Emma Corstvet, who supervised the studies made prior to the fall of 1936, and the tabulation of the data obtained from them. She was ably assisted by Mr. William L. Dennis, who also was invaluable as a supervisor for the later studies.

The present category system was devised and the earlier mathematical analysis made by Mr. Warren A. Tyrrell and Miss Jane Moore. The present formulae were derived by Mr. Bengt G. Carlson, Instructor, Department of Mathematics, Yale University.

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and others have dealt with positive law and with whatever each classifies as law, they have not undertaken investigations, empirical, experimental, and quantitative of the quantity and degree of conformity to a rule of positive law to the end that the propositions describing that quantity and degree of conformity may be subsumed under a general theory of human behavior.

It is likely that the failure of jurists and others to undertake such investigations of the quantity and degree of conformity to rules of law is in great part the result of their harboring, more or less unconsciously, one or more of the following presuppositions. The first of these is that the effect of a rule of law or of its administration is so different from the effect of all other devices affecting behavior that it is to be accounted for by a particular theory, applicable to law alone, and that the effect of law cannot be accounted for by a general theory of behavior which accounts for the effect of devices other than law. The second presupposition is that a proposition of law, or its administration, is the single and only cause of "its" effect; that is to say, that the behavior which follows the enactment of a law or its enforcement is a dependent variable, the value of which depends alone upon the law or its enforcement and upon no other variable. The presence of either one or both of the first two of these presuppositions so successfully insulates the investigator from contact with the theories and methods of disciplines investigating human behavior that the investigator either withdraws, *in limine*, from the prospect of unrewarded effort, or undertakes statistical surveys of this and that somehow connected with law and its administration. The third presupposition is either that complete conformity on the part of substantially all the persons whose behavior is prescribed or proscribed by the proposition follows the issuing of the rule, or that, if all do not completely conform, the number or percentage of persons conforming and the degree of conformity are known. Entertaining it leads natural-law and analytical jurists to restrict the study of law to dialectic; historical jurists to the art of writing either the history of a literature of legal propositions or the history of a larger fragment of culture; sociological jurists to speculation upon the more remote consequences of propositions of law, speculation upon the effect of the supposedly known but in fact unknown quantity and degree of conformity to the proposition upon behavior which is not prescribed or proscribed in the proposition; and "realists" to random behavior.

In this state of affairs it has seemed worthwhile to challenge each and all of the presuppositions, first, by hypothesizing that a proposition of law is an artifact and its administration behavior, the effect of which may be described by the same laws as describe the effect of any artifact or behavior, for example, the effect of the ringing of a telephone bell

on the behavior of the listener, and secondly, by a combination of logical and empirical processes attempting to verify hypotheses deduced from propositions of a general theory accounting for human behavior. This investigation is such a challenge.

The data of the investigation were obtained by observing the effect of certain ordinances regulating the parking and driving of automobiles upon certain aspects of the behavior of parkers and drivers. The investigators, however, had no particular interest in parking and driving or in generalizations applicable to traffic alone. It happened that at the time and place of work experiments with traffic ordinances could be made. It was possible to make relatively accurate observations of behavior yielding quantitative data.

The quantity and degree of conformity to the ordinances which the investigation discloses are in accord with the theorems of a psychological behavioristic theory of learning, in particular, the propositions of that theory referring (1) to stimulus situations in which mutually conflicting responses have been learned to the cues which are present and (2) to the gradient of reward. The investigation suggests that the quantity and degree of conformity to any proposition of law will be in accord with the propositions of such a learning theory. And, since by the propositions of such a theory a proposition of law is nothing more than a sensible object which may arouse a drive and cue a response, the investigation further suggests that there is reason not to isolate the study of law from the study of other behavior phenomena.¹

During the years 1933 through 1937 certain aspects of the behavior of persons who drove or parked automobiles in fifteen different areas located on six streets in the City of New Haven, Connecticut, were observed. In each area observations were made immediately before, and again, immediately after the regulation by ordinance of driving or parking in the area and the introduction into the area of police notices stating such regulation. In one of the areas observations were repeated during a third and fourth period while controlled and directed police administration of the posted ordinance was in progress. During all of the several periods of observation, at all of the areas, the number of happenings of a series of acts meeting the same operational definition was noted and each of the happenings was measured. In each of the areas, during each of the several periods of observation, the social and other environmental conditions were tentatively judged to have remained substantially unchanged. But in many of the areas the social and other environmental conditions were tentatively judged to be different from those present in

1. See article by Moore and Callahan in *MY PHILOSOPHY OF LAW* (1941) 201, 204-07.

the other areas. And the periods of observation in some of the areas occurred at different times of the year from those in the other areas and were separated from the others by long intervals of time.

The objectives of the study were to secure a basis for judging:

1. Whether such observations, made as these were made, justify the formulation of *any* propositions or hypotheses as to cause, in view of: the interval of time between the observations made before and those made after the posting of the notice; the absence of operational standards for determining that the places in which the observations were made were neighborhoods of significantly the same, or significantly different, character; and the fact that no differentiation was made between the persons who severally performed the acts observed.

2. Whether there are periods of time during which the absolute and relative frequencies of the happenings of the defined series of acts do not change; whether, in each area, each of the periods of observation was a period in which these absolute and relative frequencies did not change; whether, in each area, the frequencies of the period before would have been the same as the frequencies of the period after, if the posted ordinance had not been introduced; and whether the changes following the introduction of the posted ordinance may justifiably be related to the introduction of that ordinance.

3. Whether the assertion may be made that the change was caused by any particular item or items, less than all, in the situation before and after the introduction of the posted ordinance.

4. Whether the assertion may be made that the measurements, which were made in time or space units, are quantitative aspects of behavior which either are, or have a one-to-one correspondence to, the entities of a general theory of behavior.

5. Whether the posted ordinances, or particular administrative behavior, are, or have a one-to-one correspondence to, the entities of such a theory.

6. Whether the changes disclosed in each of the areas, though different from the changes disclosed in each of the other areas, are changes which are described by the same propositions, general and specific, of a general theory of social behavior.

7. Whether all of the changes disclosed can be expressed in the same formulae, the variables and constants of which can be associated with the entities of the theory and are related in a way consistent with the verbal propositions of the theory.

8. Whether—in view of the behavior observed, the measurements made, and the fact that in each study one of the variables introduced into the situation was an ordinance regulating traffic—the conclusion may be drawn that the same methods would be proper methods to verify the

hypothesis that the same propositions of the general theory should describe the changes which occur in other behavior, when measured in units of time or space, following the introduction into the situation of a law of another type or indeed of any new act or artifact.

OBSERVATIONS AND QUANTITATIVE ANALYSES

The Parking Studies

The Measurements Made Before and After the Introduction of the Posted Ordinances.

In each of the parking studies a specified area of pavement on a street was measured and observed for a specified period. The parkings of automobiles in that area were counted and the duration of each parking was measured and recorded by observers posted in an inconspicuous place, usually a second or third story window overlooking the observed area. At the close of the period of observation, parking on the observed area for longer than a specified time was forbidden by ordinance, and notices briefly paraphrasing the ordinance were posted on or near the observed area. Immediately or very shortly after parking in the observed area was forbidden, the area was again observed for a specified period; the number of parkings were counted; and the duration of each was measured. The parking studies are described in detail in Appendix A. The data obtained in each study are set out in column A of the tables in Appendix B.

In Each Study There Were No Significant Differences Between First and Second Periods Except in Parking and Ordinance.

It is judged that the only significant differences between the first and second periods of observation in each study were in the measurements of parking and in the fact that during the second period an ordinance and posted notices forbade parking for longer than a specified time. During the second period there was no warning, tagging, summoning, or arresting for violation of the ordinance on the block or blocks including the observed area except for three tags in two experiments. During both periods the observers and their supervisors used the same observation posts. During both periods the condition of the pavement, the buildings abutting, the use to which these buildings were put, and also, it is judged, the volume of street traffic were the same. Both periods were in the same season of the solar and social year. There was no significant difference between the two periods in respect to such factors as war, boom, or depression. If a complex of factors which might be significantly associated with the number and duration of parkings in the vicinity of the area, such as a Sunday, a holiday, a parade, or a fire, occurred in one of the periods of

observation, measurements of the day on which the complex occurred were discarded and the duration of the other period correspondingly lessened. Further, it is judged that in each period a sufficient sample was taken to make it probable that unknown factors, such as psychological and experiential differences between the parking persons, and such observed factors as temperature and rainfall, occurred in each sample as they occurred in the universe from which both samples were taken. Dates of each period of observation and details of specific factors relating to the comparability between the first and second periods of observation in each study are set out in Appendix A.

Conditions of Each Study Which Were Different from Every Other.

Each of the parking experiments was performed under conditions judged to be different from the others. The studies were made on areas in five types of neighborhood. One area was in a hotel, theatre, better retail shop district; one in a wholesale and industrial office building district; two in the post office, bank, general office building district; four in a run-down residence district close to the central business district; two in one of the best residential districts, which also included college buildings; and one in a poorer class retail food store district. Some of the studies were made in one, and some in another season of the year. In some of the studies the hours of observation were between 4:30 P.M. and 8:00 P.M.; in the others, between 8:00 A.M. and 5:00 P.M. The studies were scattered through the years 1933, 1934, 1935, 1936, and 1937. In some of the observed areas parking had not been limited before the studies were made; in others a parking limitation ceased to be in force shortly before the study. A description of the general vicinity of each study and of the hours of observation is set out in Appendix A.

Conditions of Each Study Which Were the Same in Every Other.

All of the studies were made in the same city and on areas no two of which were more than one and one-half miles apart. All were made within a period of four years. It is thought that most, but not all, of the persons parking in all the studies resided in the city, its environs, and near-by towns and cities. There is no reason to suppose that the regions represented by the parkers in the several studies were different or that they were differently represented.

Range of Variation in Parking and Ordinances.

The number and duration of parkings observed on each area, during both the first and second periods, varied substantially from those observed

in every other area. In each area and during each period, however, the frequency of parkings of shorter durations was greater than the frequency of those of longer durations.²

In four of the studies the ordinance forbade parking for more than a reasonable time to receive and discharge passengers and goods; in two, parking for more than fifteen minutes; in two, parking for more than thirty minutes; and in two, parking for more than sixty minutes. The ordinance times for specific studies are set out in Appendix A.

The Administrative Studies

There were two administrative studies. In the first of these an area which already had been observed in one of the parking studies was re-observed during another period beginning three months after the conclusion of the parking study. At the conclusion of this period another period of observation was begun during all of which every car parking within the area for eighty minutes or more was tagged in the regular manner by a policeman placed by the Chief of Police under orders of the experimenters. Each of the persons so tagged was subjected to the regular police procedure: most were fined one dollar; a few were relieved of the fine. Immediately upon the conclusion of the tagging period, the area was observed for a period during which there was no tagging. A month later the area was again observed for a period during which there was again no tagging.

The second administrative study was begun about a month after the conclusion of the first. It was made on the same area which was again observed for a period during which there was no tagging. At the conclusion of that period, a period of observation was begun during which every car parking within the area for forty-five minutes or longer was tagged in the same manner as previously. Immediately upon the conclusion of this tagging period, the area was observed for another period during which there was no tagging.

During each period of each of the administrative studies an ordinance limiting parking on the area to thirty minutes was in force, and notices of this ordinance were posted on or near the area.

Observable differences relating to the administrative studies were: that the six periods extended from March 16 through August 20, while the second period of the original parking study was concluded in the preceding December; that a store which was vacant during both periods of the original parking study was occupied by a wholesale grocer during all six periods of the administrative studies; and that during the second

2. See App. B.

administrative study a first floor room occupied as an office during all preceding periods was vacant.

The dates of each period of the administrative studies, a detailed description of them, and the data obtained are set out in Appendix C.

The Rotary Traffic Studies

There were four rotary traffic studies, each of which was made on the same area located in New Haven. The area was a large circular tract of pavement from which five streets radiate. In the first study, traffic moving across the area from south to north was observed; in the second, traffic moving from north to south; in the third, traffic moving from south to west; and in the fourth, traffic moving from west to south. There were five periods of observation in each of which the four streams of traffic were observed simultaneously. In each period of observation an attempt was made to determine the path taken by each car crossing the area with reference to inconspicuous marks upon the pavement.

The first period of observation was before the ordinance established rotary traffic on the area and before any symbols signifying such an ordinance had been placed on the pavement. The second period of observation, like the first, was before the ordinance was enacted; but during this period the symbols regularly used for symbolizing a rotary traffic ordinance—a large white oval painted in the center of the area and the words "Keep Right" painted where the radiating streets enter the area—were present. The third period immediately followed the enactment of the ordinance; during it the ordinance was symbolized in the regular manner as during the second period. In the fourth period, the ordinance was in force and was symbolized in the same manner as in the third, except that, in accordance with a police practice sometimes followed in the city, traffic stanchions were placed around the periphery of the painted oval in such a manner as to constitute an effective obstruction to cars passing through the oval. The fifth period was the same as the first, except that the ordinance was in force; the ordinance, however, was not symbolized in any manner.

In each period in which symbols were used, the symbols were placed on the pavement immediately before the period began and were removed immediately after it ended. It is believed that a sufficient time elapsed between each period and the succeeding one to extinguish the effect, if any, of the manipulations of the earlier period. Three months elapsed between the beginning of the first period and the end of the last.

A plan of the area is set out in Figures 53-54, and the data recorded in each stage of each of the studies are set out in Appendix D.

Analysis of the Data of the Parking Studies

It will be recalled that one of the objectives of the investigation was to obtain a basis for judging whether in each of the studies each of the periods of observation (the unregulated and the regulated periods) was a period within which the absolute and relative frequencies of the happenings of the events studied (the parking and removal of vehicles) did not change. From the data of the ten studies it is judged that there was no significant change in the absolute or relative frequencies of the observed parkings within either the unregulated or regulated periods in any study. Two exemplary distributions obtained by separating the data of the periods of observation into sub-periods are set out in Appendix B.

But when in each study the observations made during the unregulated period are compared with those made during the regulated period, differences which are believed to be significant do appear, both in the total number of parkings observed over equal periods of time and in the distribution of the durations of these parkings in time categories.

The analysis of these differences has been divided into two parts: the first deals exclusively with distributive differences, those differences which appear in the distribution of the observed parkings among duration categories without regard to any differences in the total number of parkings observed. The second part of the analysis deals with differences in the total number of parkings observed over equal periods of time.

The Distribution Analysis.

The graphs which follow (Figures 1-10 inclusive) show a comparison for each study of the percentage distribution among duration categories of the parkings observed during the regulated period with those observed during the unregulated period. The graphs are based on the figures shown in column B of the tables in Appendix B. For graphical presentation, however, a ten-minute category system has been used rather than the variable category system used in Appendix B. From these graphs it is apparent that, speaking very generally, the distributive change which occurred in each study following the introduction of the ordinance and the posting of the notices was the same. In each case the relative frequencies in the categories of very short duration increased while those in the categories of very long duration decreased. This shift in the distribution is much more violent in some of the studies, notably the Crown Street ("No Parking") studies, than in others.

The second series of graphs (Figures 11-20 inclusive) present essentially the same aspect of the data but with greater detail in that the category system is that of the tables in Appendix B—one-minute categories from zero to thirty minutes, five-minute categories from thirty to one hundred minutes, and ten-minute categories for all parkings over one hundred minutes. These graphs also are more suggestive of regularities. The figures from which they are plotted are those in column C of the tables in Appendix B. One study is plotted on each graph, and each plotted point represents a single time category in that study. Each point is plotted opposite the figure on the horizontal axis which is the cumulated percentage of the total parkings in the unregulated period represented by the parkings which fall in that particular category and all other categories having durations less than that of the particular category. The point is plotted opposite the figure on the vertical axis which represents the cumulated percentage of the category, arrived at by the same method, in the regulated distribution. The method of cumulating is further explained in Appendix B. It will be noted that, although there is but one curve on each graph, the curve states a relation between the *two* distributions—the unregulated and the regulated—which make up each study.

From these graphs the following general observations as to each study may be made: the left part of the curve (formed by the categories of shorter duration) may be regarded as approximately a straight line; the right part of the curve (formed by the categories of longer duration) may be regarded as a negatively accelerating curve; and the point separating these two portions of the curve may be fixed with some degree of accuracy by inspection. Beginning with these observations the problem of stating regularities which appear in the changes in distribution observed in all the studies is a problem of describing, in a generalized way applicable to all the studies: (1) the location of the point which divides the straight-line portion of the curve from the remainder; (2) the change, if any, which occurred in the distribution to the left of that point in each study; and (3) the change, if any, which occurred in the distribution to the right of that point in each study.

Location of the Point. As will be seen from Figures 11-20, there is some range in each study, although in most instances the range is not wide, within which the point referred to above may be placed by inspection. Before attempting a generalized statement of the location of the point in all of the studies, it was thought desirable to determine, by some method more rigorous than visual inspection, its location in each of the separate studies. Accordingly, a method was devised by which a number of points were chosen for each study covering a range within which the

"best" point must surely lie. Beginning with each of these assumed points straight lines were fitted to the portions of the curve to the left and right of that point. For each study the Point finally chosen for use in the analysis was the one at which the two fitted straight lines bore the sharpest angle to each other.³ The results of this process were as follows:

<i>Study</i>	<i>Cumulated Percentage of Unregulated Dis- tribution to Left of Point (computed for each study)</i>	<i>Approximate Location of Point in Minutes</i>
I. Crown A North	19.8	4.5
II. Crown A South	25.5	9
III. Crown A North and South (1936) ..	27.2	8
IV. Crown A North and South (1935) ..	19.0	4
V. Church A	53.8	50
VI. Church B	69.7	24
VII. Water	80.2	160
VIII. College	43.3	22
IX. Prospect East	51.2	110
X. Prospect West	66.8	110

The Points so located are indicated on the graphs (Figures 11-20) by the vertical line drawn through each curve.

After many trials, during which every relationship which suggested itself was tried, it was judged that the closest relationship between a measurement of the location of each of the Points and some other significant measurement in each of the studies was the relationship between the location of the Points, as measured by the cumulated percentage of the respective unregulated distributions to the left of such Points, and the ordinance times, that is, the parking limitations stated in each ordinance, as similarly measured by the cumulated percentage of the respective unregulated distributions to the left of each ordinance time. It was further judged that the best statement of this relationship was the simple straight-line formula $p = 14.5 + r$, in which p is the cumulated percentage of the unregulated distribution to the left of the Point and r is the cumulated percentage of the unregulated distribution to the left of the ordinance time. This relation is set out in tabular form below:

3. The details of this method of determining the Point in each study are set out in App. E.

Study	Cumulated Percentage to Left of		14.5 + r	Cumulated Percentage to Left of Computed Point (p)
	Ordinance Time Minutes ⁴	Ordinance Time (r)		
I. Crown A North	2	8.23	22.73	19.8
II. Crown A South	2	7.85	22.35	25.5
III. Crown A North and South (1936)	2	8.04	22.54	27.2
IV. Crown A North and South (1935)	2	9.55	24.05	19.0
V. Church A	15	35.88	50.38	53.8
VI. Church B	15	62.37	76.87	69.7
VII. Water	30	59.99	74.49	80.2
VIII. College	30	45.20	59.70	43.3
IX. Prospect East	60	32.73	47.23	51.2
X. Prospect West	60	44.16	58.66	55.8

In Figure 21, the relation between these measurements has been graphed. The line drawn on the graph is that of the formula $p = 14.5 + r$, and

4. For a discussion of the ordinance times used here for the Crown Street studies, see App. A.

the plotted points are those chosen separately for each study by the method outlined above.

No Change in Distribution Among the Categories to the Left of the Point. It will be noted that the method of plotting the cumulated percentage graphs (Figures 11-20) is such that the resulting curve will be a straight line and at a forty-five degree angle if the percentage distributions which have been cumulated are identical throughout. Further, if any series of consecutive categories, taken as a single unit, are distributively identical among themselves, the portion of the total curve on the cumulated graph which represents this series of categories will be a straight line, although it may depart from the forty-five degree angle. Accordingly, the observation made above that in each study the portion of the cumulated curve which lies to the left of the Point may be taken to be a straight line means that in each study the distribution of parkings among categories to the left of the Point may be taken to be the same in both the regulated and unregulated series. In other words, there was no change following the introduction of the ordinance in the distribution among time categories of parkings having a duration less than that marked by the Point. The apparent distributive difference in these categories displayed by the graphs (Figures 1-10) is caused by the inclusion of the observations falling in categories to the right of the Point in the percentage base. The likelihood of this conclusion is more forcefully suggested by the graphs (Figures 22-31), in which, for each study and each period—regulated and unregulated—the total number of parkings having a duration less than that marked by the Point is taken as one hundred per cent and distributed among the categories to the left of the Point.⁵

The Change in Distribution Among the Categories to the Right of the Point. The procedure followed in approaching the problem of generalizing the changes in distribution of the parkings which had durations greater than that marked by the Point was, first, to fit a formula to that portion of the curves on the cumulated graphs which lies to the right of the Point in each study, which formula is the same for each study but with values varying with each study; and, second, to attempt to relate the different values of each of the variables in the formula to some other significant measurement in the respective studies. After several trials the following formula was adopted for the portion of the curve which lies to the right of the Point in each study:

$$y = 102 (1 - 10^{-(kx)^n})$$

5. Because of the wide variation in the location of the points in terms of minutes, the category systems used for the graphs have been varied from study to study for better presentation. The graphs of the Crown Street studies are in one-minute categories, those of the Church and College Street studies in five-minute categories, and those of the Water and Prospect Street studies in ten-minute categories.

In the above formula y represents the cumulated percentage of the total regulated distribution at any given time category (the vertical axis on the cumulated percentage graph), x represents the cumulated percentage of the total unregulated distribution at the same category (the horizontal axis on the cumulated percentage graph), and k and n are values which are constant for all categories of a single study but which vary from study to study. The values of k and n , determined separately for each of the studies, were as follows:

Study	Value of k (times 100)	Value of n
I. Crown A North	2.24	1.35
II. Crown A South	2.22	1.23
III. Crown A North and South (1936)	2.25	1.33
IV. Crown A North and South (1935)	1.83	1.40
V. Church A	1.39	1.50
VI. Church B	1.23	2.09
VII. Water	1.36	2.65
VIII. College	1.41	2.03
IX. Prospect East	1.38	1.75
X. Prospect West	1.29	2.07

The remaining problem was the determination of a relationship between these values, taken separately, on the one hand, and some other significant measurement in each of the respective studies. It is judged that there is a significant relationship between each of the values (k and n) in each study and the cumulated percentage of the unregulated distribution to the left of the ordinance time—the same factor which was related to the location of the Points (Figure 21). The relations determined are stated by the following formulae:

$$100k = 2.1 \cdot 10^{-.05 \times r} + 1.35$$

$$n = 1.1 + .02 \times r$$

In each of the formulae r is the cumulated percentage of the unregulated distribution to the left of the ordinance time. These relations are

presented graphically in Figures 32 and 33. In Figure 32, the values of k , as determined separately for each of the studies, have been plotted against the cumulated percentage of the unregulated distribution to the left of the ordinance time in each study. In Figure 33, the values of n have been similarly plotted. On each of the graphs the curve drawn is approximately that of the formula.

Summary of Distribution Analysis. The analysis of the changes in distribution which occurred following the introduction of the ordinance

and the posted notice may be summarized by the following generalizations applicable to each and all of the studies. It is assumed that the percentage data of each study has been cumulated and graphed as in Figures 11-20:

(1) In each study there is a Point to the left of which there was no change in distribution and to the right of which there was a change in distribution following the introduction of the ordinance and posted notices.

(2) In each study the Point referred to in (1) above is so located that the cumulated total of the unregulated percentages to its left is equal to the cumulated total of the unregulated percentages to the left of the ordinance time plus 14.5 ($p = 14.5 + r$).

(3) In each of the studies the change in distribution to the right of the Point referred to in (1) above is such that that portion of the cumulated is described by the formula $y = 102 (1 - 10 - (kx)^n)$.

(4) In each of the studies the value of k in the formula in (3) above is related to the cumulated total of the unregulated percentages to the left of the ordinance time, r , according to the formula $100k = 2.1 \cdot 10 - .05 \times r + 1.35$.

(5) In each of the studies the value of n in the formula in (3) above is related to the cumulated total of the unregulated percentages to the left of the ordinance time according to the formula $n = 1.1 + .02 \times r$.

In the following graphs (Figures 34-43), that portion of the cumulated curve to the right of the Point in each study has been plotted on an enlarged scale. The Point and curve for each study, computed by the formulae set out above, have been placed on the graphs for comparison with the original data.⁶ On each graph the vertical line marks the "best" Point computed for each study individually by the method set out in Appendix E and referred to above. The circle on each graph marks the Point the location of which, on the horizontal axis, is computed by the formulae in (3), (4), and (5) above.

The Numbers Analysis.

The second part of the analysis of the parking studies was directed at the differences in the total number of cars observed in each study during the regulated period as compared to the total number observed in the unregulated period. It will be recalled that in each study the length of the periods of observation, regulated and unregulated, were made the same. This was done in order to obtain comparability between the two periods in each study in respect of total numbers observed. The total numbers observed in each study during each period were as follows:

	<i>Unregulated</i>	<i>Regulated</i>	<i>Increase or Decrease</i>
I. Crown A North	668	764	+ 96
II. Crown A South	650	477	— 173
III. Crown A North and South (1936)	1368	1263	— 105
IV. Crown A North and South (1935)	314	245	— 69
V. Church A	477	574	+ 97
VI. Church B	170	172	+ 2
VII. Water	720	1160	+ 440
VIII. College	93	120	+ 27
IX. Prospect East	926	747	— 179
X. Prospect West	1250	1081	— 169

From the above table no obvious regularity appears. In five of the studies the total numbers increased following the introduction of the ordinance, while in the other five the total numbers decreased. It will be noted, however, from the tables in Appendix B, in which the total numbers are distributed in time categories, that in all studies increases occurred in the categories of shorter duration and decreases in the categories of longer duration.

The actual operations performed in the numbers analysis of the parking studies were suggested by a consideration of the possible common sense

6. The mathematical curves have been plotted on the basis of from five to seven calculated points, the number varying with the length of the curves. The curve between these points is approximate but believed to be sufficiently accurate for the purpose.

explanations for the occurrence of increases in the number of short-time parkings. Although the development of common sense explanations is not one of the objects of an investigation such as the one here reported, it inevitably accompanies the making of such an investigation. The numerical increases which occurred in the short-term categories might be explained by a concept of shortening of parking time; that is, it might be asserted that the effect of the ordinance was in each case to cause a number of people to park for a shorter time than before or for a shorter time than they would have done were it not for the ordinance. For several reasons this concept of shortening did not seem likely to be fruitful. First, it seemed unlikely that the errands for which people park would be, or could be, substantially shortened; second, it seemed unlikely that, if parking times were shortened, the shortened parking times would distribute themselves among the shorter categories, beginning at one minute, in the same distribution as prevailed among those categories before any shortening took place;⁷ third, the concept of shortening alone does not account for the fact that in five of the studies the total number of parkings observed increased.

A second possible explanation of the increases, and one judged more likely to be fruitful, is that the increases represent parkings which would have appeared in the unregulated distribution had sufficient parking space been available, and which did appear in the regulated distribution because additional parking space was made available by the removal of the long-time parkings. This explanation contemplates that the primary effect of the ordinance is the displacement of certain relatively long-time parkings, that is, these parkings are shifted from the restricted area to other areas in the neighborhood which are unrestricted. This explanation is not, it is believed, subject to the objections stated above with regard to the first explanation; and it was accepted as a guide to this stage of the analysis.

The above explanation suggests that the change in total numbers which followed the introduction of the ordinance was in each study a result of: first, the primary effect of the ordinance in displacing parkings; and second, the effect of the unsatisfied demand for parking space in causing the filling up of all or part of the additional parking space made available by the displacement. The numbers analysis thus requires a measurement of the effect of the ordinance, uncomplicated by the factor of unsatisfied demand, and a measurement of the unsatisfied demand for parking space.

The Measurement of the Effect of the Ordinance Alone. An unregulated situation may be conceived of in which the ratio of the parking space available to the demand for that space is so high that no potential parking is excluded by reason of lack of space. If a parking restriction is intro-

7. The sameness of distribution between zero and the Point is discussed under *The Distribution Analysis*, page 23 *supra*.

duced into such a situation, there will be, by the explanation above, no increase in the number of parkings in any duration category; rather, there will be a decrease by virtue of the displacement. The change in total numbers in such an hypothetical situation would be solely the primary effect of the ordinance, since it is assumed that there is no unsatisfied demand for parking space prior to the introduction of the ordinance. Accordingly, an attempt was made to separate, in the actual parking studies, the primary effect of the ordinance from the effect of the unsatisfied demand by constructing, hypothetically, a regulated numbers distribution designed to represent what those numbers would be were the actual situation in each study one in which there was no unsatisfied demand for parking space.

The method of constructing this hypothetical regulated numbers distribution was dictated by the judgment that the factor of unsatisfied demand for parking space affects only the total numbers observed, *not* their distribution among the categories. It is believed that, when a sufficient number of parkings are observed, the distribution among categories which is obtained is a sample, distributively, of the whole universe from which it is taken, that is, the potential parkings for that site and period of time. In other words, the *percentage distribution* which is obtained in any period of any study will be the same whether the particular situation be one in which there is no unsatisfied demand or one in which there is a great deal of unsatisfied demand. Therefore, in respect to the hypothetical construction under consideration, the unregulated and regulated *percentage distributions* actually obtained in each study may be taken as the distributions which would have been obtained had the situation been one in which there was no unsatisfied demand for parking space.

One further analytical step is necessary. It has been stated above that in such an hypothetical situation (no unsatisfied demand) there will be no increases. It is further believed that, at least in most instances, not every category will show a numerical decrease. It does not seem likely that parkings of one-minute duration will be reduced in number by the introduction of a sixty, or a thirty, or a fifteen minute parking restriction; nor, in view of the location of the Points to the left of which the distributions are the same and the formula derived for determining such location,⁸ does it seem likely that the number of such one minute parkings would be reduced even by the introduction of a strict "No-Parking" restriction.

The two assertions above make possible the construction of the complete hypothetical numbers distribution. If in each of the studies the situation were one in which, during the unregulated period, there were no unsatisfied demand, the regulated numbers distribution would have been one in which the numbers in the categories of very short duration would

8. See Fig. 21.

have remained unchanged and the numbers in each and all of the categories would be such that the entire numbers distribution would be *in percentage distribution* identical with the *percentage distribution* of the parkings actually observed during the regulated period. Thus the entire hypothetical numbers distribution may be constructed, since the entire hypothetical percentage distribution is known (assumed) and the absolute number of parkings in at least one category is known. Since both the unregulated

and the regulated parkings are taken as distributively the same to the left of the Point, the actual unregulated and the hypothetically constructed regulated parkings are *numerically* the same to the left of the Point. The Point marks the category at which the primary effect of the ordinance begins.

The graph in Figure 44 is designed to illustrate the process of constructing the hypothetical numbers distribution. It does not represent actual data from any study.

The numerical difference in each study between the actual number of parkings observed in the unregulated period and the total number obtained by adding the numbers in each of the categories of the hypothetical regulated distribution constructed as above is a measurement of the effect of the ordinance alone on numbers in that study. The primary effect of the ordinance, however, under the accepted common sense explanation of the actual studies, affects total numbers in conjunction with the effect of the unsatisfied demand for parking space. The explanation, it will be recalled, is that one significant aspect of the primary effect of the ordinance is the creation of additional available parking space. A measurement of the primary effect of the ordinance in terms of simple numerical differences between actual unregulated and hypothetical regulated distributions does not take this space-creating aspect of the effect of the ordinance into account. The removal of one parking from the 100-110 minute category is quite different from the removal of one car from the 600-610 minute category with respect to the number of parkings of ten minute duration which may occupy the time-space units thus made additionally available for parking. To meet this difficulty, all of the data, for purposes of the numbers analysis, were converted from simple numbers to "parking minutes used." The process of conversion is simply to multiply the number of cars parking in each duration category by the time duration⁹ of that category. The results of the conversion are set out in column D of the tables in Appendix B. Thus the differences between the unregulated and regulated numbers distributions in each study were, for purposes of this analysis, stated as differences in the total number of parking minutes used, a form of measurement which takes account not only of the total number of parkings observed during each period but also of the distribution of those parkings among duration categories. Similarly, in measuring the effect of the ordinance alone by means of the hypothetical distributions described above, all of the distributions and all of the differences between them were stated in terms of parking minutes used rather than in simple numbers. Further, in order to obtain comparability among the several studies, it was necessary to state the several differences not in terms of absolute parking minutes but in terms of percentages. This was necessitated by the fact that, although the unregulated and regulated periods of observation in any one study were of the same length, the length of the periods of observation—and hence the number of parkings and parking minutes used observed—varied from study to study.¹⁰ The differences

9. For purposes of the conversion of the data into parking minutes used, all parkings tabulated in a particular category were assumed to be of the duration marked by the mid-point of the category. Thus all parkings in the 4 to 5 minute category were assumed to have been of 4.5 minutes duration, etc.

10. For lengths of the periods of observation in the several studies, see App. A.

between the unregulated and regulated data of each study in terms of percentage differences in the number of parking minutes used and the measurement of the effect of the ordinances alone in the same terms are set out in the table following.¹¹

The Measurement of the Unsatisfied Demand for Parking Space. It will be recalled that the second factor which was judged to have affected the differences between the total number of parkings observed during the unregulated and regulated periods of the several studies was the quantity of unsatisfied demand for parking space which prevailed during the unregulated period of each of the studies as compared to that which prevailed during the unregulated periods of each of the other studies. It is obvious that "unsatisfied demand for parking space" is nothing but a concept, nothing that is observable. The number of parkings of various durations which would have occurred had there been unlimited space available, but which *did not* occur, could not be counted and timed. The best that could be done was to attempt to find some measurement of the observed data which reasonably might be taken as an index of the non-observable. A measurement which is the ratio, stated as a percentage, between the total number of parking minutes used by parkings observed during the unregulated period and the total number of "parking minutes available" for parking on the observed site during that period has been adopted, for purposes of this analysis, as an index of the quantity of unsatisfied demand for parking space at the site of, and at the time of, the unregulated series of observations in each study. The basis for the adoption of this index is simply the judgment that the greater the demand for parking space on a particular site over a particular period the greater will be the percentage of the available parking space which is used by actual parkings.

The ratios of used to available parking minutes computed for the several studies appear in the table below. The details of the computation are set out in Appendix F. In computing these ratios it was found that the observed data does not permit the making of some of the corrections thought desirable. For example, the data, as recorded by the observers, do not distinguish between double parkings which were cars parked a distance from the curb equal to the width of a car or more and those double parkings which were recorded as such by reason of their being within the statutory definition although they may not have been parked as far from the curb as the width of a car.¹² Hence, no correction for this factor could be made in computing the ratios. For this and other reasons suggested

11. See page 40 *infra*.

12. See the discussion in App. A of the observed parkings which were excluded from the tabulations.

in Appendix F the ratios as computed are not regarded as more than passably accurate statements of the measurements sought.¹³

The Relation Among the Significant Factors. The measurements in each of the several studies of the difference between the unregulated and regulated numbers distributions, the difference attributed to the primary displacement effect of the ordinance, and the difference attributed to the filling in, by parkers who previously were unable to find space, of the additional space made available by the operation of the ordinance, have been related by the equation

$$u = 12 + 1.4x - 1.01v.$$

In the equation u is the difference between the total parking minutes used in the unregulated and the total used in the regulated distributions, the difference (which is in every instance a minus difference) being expressed as a percentage of the total used in the unregulated distribution. x is the difference between the total parking minutes used in the unregulated distribution and total "used" by the hypothetical distribution constructed on the condition of the particular study being one in which there was no unsatisfied demand for parking space, the difference being expressed as a percentage of the total used by the unregulated distribution. v is the percentage ratio between the total parking minutes used during the unregulated period of observation and the total available during that period. The values of x and of v in each study and the value of u as computed by the formula are given in the table below. The actual percentage of decrease in parking minutes ("Observed u ") is given for comparison:

13. The fact that in no study is the percentage of available parking minutes used higher than 82.65, and that in most it is under 60, should not be taken as an indication that there was no unsatisfied demand for parking space on the observed sites at any time. First, the figure takes no account of different hours of the day, during some of which there was much more crowding than during others. Second, the ratio was computed on the basis of the cars being parked bumper-to-bumper, *i.e.*, all space not actually covered by a car was regarded as available for parking; of course, this was not always the case. Third, it is believed that the presence of even a few cars in the area may make parking inconvenient to the extent that some potential parkers may be "crowded out" even though measurement would show that there was plenty of space for the car.

Study	Parking Min- utes Used Unregulated	Parking Min- utes Used Regulated	Decrease as Percentage of Unregulated ("Observed u ")	Calculated $u + 1.4x$ $- 1.01v$	Percentage of Decrease if no Unsatis- fied Demand	Percentage of Avail- able Used
I. Crown A North	72,906.5	6,782.0	90.70	88.67	97.10	58.68
II. Crown A South	72,776.0	4,800.5	93.40	89.39	96.88	57.66
III. Crown A North and South (1936)	149,493.0	11,723.5	92.16	88.82	96.85	58.19
IV. Crown A North and South (1935)	23,458.0	2,243.5	90.44	96.35	95.15	48.38
V. Church A	39,170.5	22,280.5	43.12	53.16	68.97	54.85
VI. Church B	6,544.5	3,556.5	45.66	35.43	55.20	51.35
VII. Water	58,974.5	35,486.0	39.83	38.66	65.95	65.02
VIII. College	6,632.0	4,458.0	32.78	17.35	63.45	82.65
IX. Prospect East	119,140.0	56,647.5	52.45	48.38	59.35	46.25
X. Prospect West	119,428.0	65,867.0	45.69	43.57	48.75	36.32

In determining the relationship expressed by the formula, more weight was given to those studies in which there are greater numbers in the distributions and in which there are records which make it possible to determine the "Percentage of Available Used" with a fair degree of accuracy. In the College Street study, where the fit is least good, the "Percentage of Available Used" is regarded as a rough estimate at best. The figure 82.65 is that determined by the procedure outlined in Appendix F and is used in the above table only for uniformity of presentation. Since the measurement of this variable is somewhat questionable in all of the studies, it is believed that no great significance attaches to the precise details of the formula.

The value of u given by the formula may be translated into numbers by: (1) subtracting from the total parking minutes of the unregulated distribution that percentage of itself indicated by the calculated value of u ; (2) distributing the figure thus obtained by step (1) among the time categories according to the distribution of the regulated observations dictated by the distribution analysis above, after such distribution has been converted from a percentage distribution of numbers to a percentage distribution of parking minutes; and (3) converting the result of step (2) from parking minutes to numbers, category by category. No such re-conversion to numbers has been made for these studies. It is judged that, for most purposes at least, the statement of results in terms of parking minutes is likely to be more significant than the statement in terms of numbers.

Analysis of the Data of the Administrative Studies

The two administrative studies were made on Water Street, the observed area being exactly the same as that on which the Water Street parking study was made. During the first of the studies all cars which parked in the area for eighty minutes or longer were tagged by a regular police officer. During the second study all cars parking forty-five minutes or longer were tagged in the same manner. During both studies the thirty minute parking restriction which became effective at the beginning of the regulated period of the original parking study continued in force and the posted notices stating the restriction continued in place. In addition to the two tagging periods, observations were made for periods immediately preceding and immediately succeeding each of the periods of tagging. These periods have been denominated the "Pre-Eighty", "Post-Eighty", "Pre-Forty-Five", and "Post-Forty-Five" periods. There are thus six separate series of observations. The data of each of these series is set out in Appendix C.

The immediate purpose of the administrative studies was to make the beginning of an attack on the problem of the effect of controlled police

administration of ordinances, as distinguished from the simple enactment and posting of the ordinances, a statement of the effect of which was the immediate goal in the parking studies. To this end it was proposed to compare the data obtained from each of the series of tagging observations with the data of the regulated series of observations made in the original Water Street parking study and to compare the differences thus revealed, if any, with the differences obtained in each of the parking studies.

In Figures 45 and 46, cumulated percentage distributions of the eighty minute and forty-five minute tagging data have been plotted, each against the regulated distribution of the original parking study. It will be noted that, in general, the curves have the same appearance as those on the cumulated percentage graphs of the parking studies. The left portion of each approximates a straight line and is thus indicative of sameness of distribution within these portions. It was not believed, however, that the entire curve on either graph could be taken to be a straight line; the analysis, therefore, proceeded on the assumption that the introduction of the tagging was followed by a distributive change.

Following the method of analysis of the parking studies the first step was the determination of a Point on each curve beyond (to the right of) which it might be said that the distributions began to differ. For each curve a Point was determined by the same mathematical method used in the parking studies. The Points so determined are marked by vertical lines on each of the graphs. When converted from cumulated percentages into minutes the Points fall at seventy-six minutes in the eighty minute study and at forty-nine minutes in the forty-five minute study. The Points are thus so close to the tagging time—the duration at and beyond which all cars were tagged—as to suggest the hypothesis that the two may be considered identical. For the remainder of the analysis this hypothesis was adopted.

The location of the Point so as to coincide with the tagging time immediately suggested the further hypothesis that the differences observed between the tagged and untagged series of observations were the result, not of any general effect of the tagging, but rather of the effect of the tagging on those persons who were tagged and on no one else. Under this hypothesis the differences between the two percentage distributions in each pair would be explained by a decrease in the number, or complete obliteration, of those repeat parkings by persons who were once tagged, which have durations equal to the tagging time or longer. The difference in total numbers, or total parking minutes used, would be explained by this factor plus, as in the parking studies, the effect of the unsatisfied demand for parking space.

A general method of testing this hypothesis by reference to the data readily suggested itself. If the number of repeat parkings, having dura-

tions equal to or longer than the tagging times, which occurred during the untagged (original regulated) period could be ascertained, these parkings could then be subtracted from the untagged observations, or added to the tagged observations. Having thus corrected one series of observations, the two series should be alike in percentage distribution. The differences in total numbers should be reconciled by the numbers (parking minutes) formula derived in the parking studies.

Difficulties were encountered, however, in making such tests with the data at hand:

(1) There were doubts as to the general comparability of the original regulated parking series of observations on Water Street and the other series of tagging and pre- and post-tagging observations. The original regulated distribution was completed on December 18, 1936. The post-forty-five minute tagging period was completed August 20, 1937. The other studies were made between these dates. There was thus a considerable likelihood of seasonal variation.

(2) As has been pointed out above, there were two instances of known changes in the use of the buildings fronting the observed area. A store room, which had been vacant during the original parking study, was occupied by a wholesale grocery during all of the administrative periods, beginning with the pre-eighty. An office, occupied during the original regulated, pre-eighty, eighty minute tagging, and post-eighty periods, was vacated before the beginning of the pre-forty-five period.

(3) The periods of observation were of varying lengths, some of them so short as to make it undesirable to use them for more than checking purposes. The original regulated period covered fifteen days of observation. Others were: pre-eighty, four days; eighty minute tagging, twenty-five days; post-eighty, fourteen days; pre-forty-five, ten days; forty-five minute tagging, ten days; post-forty-five, five days.

(4) In some of the periods, the records kept by the observers with respect to the identification of particular cars were not sufficiently complete to enable the number of repeat parkings by a single car to be determined accurately. The observers were asked to identify cars only to the extent necessary to assure that a time of entering and a time of leaving recorded on a single line of the record ¹⁴ actually referred to the same car. In many instances this identification was made by license number, the records of which are reasonably complete in the original regulated, eighty minute tagging, and forty-five minute tagging periods. In the other periods, however, the records are such that the determination of repeat parkings is not feasible.

In the analysis which follows an attempt has been made to overcome these difficulties by making corrections and reasonable assumptions insofar

14. See App. A.

as the data permit. During the course of the analysis of the eighty minute study it was discovered that, with the corrections that were being made, slightly better regularities were obtained by eliminating not only the *repeat* parkings by an identified car but also the *first* parking by that car. For example, if a car were observed to park six times in the original regulated period for durations longer than eighty minutes, a slightly better fit was obtained by assuming that the effect of the eighty minute tagging was to eliminate not only the five repetitions but all six parkings by that car. This method was carried through to the analysis of the forty-five minute tagging study. Thus, in the presentation below, the eliminations (or additions) are not only the repeat parkings but *all* parkings by cars which are repeaters. If the slight improvement thus effected is accepted as significant it, of course, requires a modification of the original hypothesis. The effect of the tagging would be the elimination of all parkings by persons who were habitual parkers on the area rather than the elimination of repeat parkings by persons who were once tagged.¹⁵ However the improvement in regularity thus obtained was so slight that, in view of the doubt as to general comparability and the numerous corrections that were made in the data, it is not believed that a change in the common sense explanation is clearly dictated by the result.

The Distribution Analysis.

The Distribution to the Left of the Point. The tagging times (eighty and forty-five minutes) having been selected as the location of the Points, two pairs of percentage distributions were made with only the data to the left of the Point being considered as part of the percentage base. In each of these pairs one distribution represents data taken during a tagging period, the other data taken during a period judged comparable, or nearly so, to the tagging period except for the fact that there was no tagging. Graphs of these two pairs of distributions appear in Figures 47 and 48. In Figure 47 the data of the original regulated parking study period are compared to that of the first fifteen days of the eighty minute tagging observations. The cars, the occupants of which went to the new grocery store mentioned above, were excluded before the tabulation of the tagging study data was made.¹⁶ The first fifteen days only of the eighty minute tagging observations were used because it was necessary, for the purposes of the numbers analysis, to have an equal number of days in the tagging period and in the no-tagging period with which it was compared, and it was thought desirable to use the same data for both the distribution anal-

15. See the discussion under *The Theory Applied to the Administrative Studies*, page 83 *infra*.

16. A sufficient record of errand destinations was kept by the observers to justify the conclusion that the exclusions were substantially accurate.

ysis and for the numbers analysis of the eighty minute tagging study.¹⁷ In Figure 48 the data of the pre-forty-five study is compared to that of the forty-five minute tagging study. Since each of these studies was made in the same season of the year, since there were no known differences between the two in the use of buildings in the neighborhood, and since the periods were of equal length, no eliminations were made from the data

for the purpose of this comparison. By the hypothesis the two distributions on each graph should be alike.

The Changes in the Entire Distribution. Under the hypothesis that the effect of the tagging was to eliminate repeat parkings (or all parkings by

17. Distributively the data of the entire twenty-five days of the eighty minute tagging observations and of the first fifteen days thereof are substantially identical. As a further check fifteen days were selected at random and again almost no distributive difference was noted. The first fifteen days were selected because they were the nearest, in point of time, to the original regulated period. The pre-eighty period was so short (four days) that it was not judged profitable to attempt to tailor the eighty minute tagging observations to fit it.

repeaters) of durations longer than the tagging times, no particular regularity would be expected with regard to the change in distribution, if any, which occurred among the categories to the right of the tagging times. Whether these distributions changed or not would depend upon the distribution of the repeat parkings which were eliminated by the tagging. However, since by the hypothesis only those parkings which have durations longer than the tagging time are eliminated, their elimination would result in a change in distribution if each of the distributions, from zero to the end, is considered as a whole. If the repeat parkings, judged to have been eliminated, are replaced in the tagging distribution, the two distributions, tagging and no-tagging, should then be alike. This has been done for each of the tagging studies. The reasons for the corrections made and the method used in making them, as well as the results, are given below:

The Eighty-Minute Tagging Study. The two distributions selected for comparison in the eighty minute tagging study were, again, the regulated period of the original parking studies (fifteen days, no tagging) and the first fifteen days of the eighty minute tagging period, from the latter of which all parkings by persons going to the new grocery store were removed. It was possible to determine with a fair degree of accuracy the parkings of durations over eighty minutes in the original regulated series which were parkings by repeaters. Of the ninety parkings over eighty minutes, eighty could be identified; and of the eighty, forty-four were identified as parkings by repeaters. It was assumed that 44/80 of the unidentified parkings were parkings by repeaters and the number thus assumed was distributed among the categories over eighty minutes in accordance with the distribution of the identified parkings by repeaters.¹⁸ The entire number of repeater parkings thus determined and distributed should account for the difference between the two distributions and it was proposed to add them to the eighty minute tagging observations. However, since the adding was to be done in terms of numbers of parkings, it was necessary to eliminate the effect of unsatisfied demand for parking space, the same factor that was encountered in the numbers analysis of the parking studies. This was done by constructing for the eighty minute tagging period (first fifteen days less grocery parkings) an hypothetical numbers distribution which would be actualized, according to the numbers hypotheses, were the situation one in which there were no unsatisfied demand for parking space before the tagging began.¹⁹ The

18. The details of the process by which the number and distribution of parkings by repeaters was determined are set out in App. C.

19. There was another reason for using the hypothetical eighty minute tagging distribution. By the method of construction this distribution is identical with the untagged distribution to the left of the Point. Hypothetically this portion of the curve is also

method of constructing this hypothetical distribution was the same as that employed in the parking studies. It will be recalled that a distribution so constructed is, by the hypotheses, distributively identical with the regulated, or, in the case of the administrative studies, the tagging distribution; and it is numerically and distributively identical with what would have been observed had there been no unsatisfied demand for parking space. The difference between the original regulated distribution and this hypothetical—no unsatisfied demand—eighty minute tagging distribution should, according to the hypothesis, be accounted for wholly by the elimination of the parkings by repeaters. The addition of the repeater park-

ings to the eighty minute tagging hypothetical distribution and a comparison of the result, in terms of percentage distribution, with the original regulated series of observations appears in Figure 49. By the hypothesis the points on this cumulated percentage graph should fall on a straight forty-five degree line (distributions identical). In Figure 50 the same data has been graphed with the exception that no parkings by repeaters

identical in distribution with the observed tagging observations. However, there would be some differences and, since the operation was designed to test the hypothesis as to the addition of repeaters to the right of the Point, and since the test involved the entire distributions from zero to the end, it was desirable that the primary test should not be affected, as it was thought it might be, by an accumulation of slight differences to the left of the Point.

have been added to the tagging distribution. By the hypothesis the points on this graph should not fall on a straight forty-five degree line.

The Forty-Five Minute Study. For the purpose of the next step in the analysis, the forty-five minute tagging period could not, it was believed, safely be compared with the original regulated period because of the lapse of time between them, nearly eight months, and because no way appeared by which a correction for seasonal differences caused by this lapse of time might be made. It could not be compared with either the pre-forty-five nor the pre-eighty period because the records for those periods were such that parkings by repeaters could not be identified. The best that could be

done, therefore, was to work out a method by which the hypothesis might be tested by means of a comparison between the eighty minute tagging observations and those of the forty-five minute tagging period. The steps, both deductive and operational, by which this was accomplished were as follows:

(1) The difference between the percentage distributions of the data of the eighty minute and the forty-five minute tagging periods is attributable only to: (a) the presence in the eighty minute observations of parkings by persons who went to the particular office which was vacated before the forty-five minute tagging period began, (b) seasonal change, and (c) the difference between the effect of tagging all parkings over eighty minutes and the effect of tagging all parkings over forty-five

minutes. Therefore, if differences (a) and (b) can be eliminated, the remaining difference is the effect of the tagging time differential only.

(2) The difference caused by the presence in the eighty minute, and absence in the forty-five minute, tagging distribution of parkings by persons who went to the particular office was eliminated by removing from the eighty minute tagging distribution all parkings by such persons. These parkings were clearly identified on the observers records with, it is believed, a considerable degree of accuracy.

(3) The difference attributable to seasonal change occurring between the eighty minute and forty-five minute tagging periods was eliminated as follows:

(a) A comparison of the pre-eighty and pre-forty-five periods reflects the same seasonal change as a comparison of the eighty minute tagging and forty-five minute tagging periods. This is an assumption which is justified, it is believed, by the dates of the several periods involved.

(b) The difference between the data of the pre-eighty and pre-forty-five periods is attributable only to: (1) the presence of the office parkings, as above, in the pre-eighty but not in the pre-forty-five and (2) seasonal change. Therefore, if the parkings by persons who went to the subsequently vacated office are removed from the pre-eighty observations, the difference between the distribution of what remains and the distribution of the pre-forty-five observations is a difference attributable to seasonal change only.

(c) The pre-eighty distribution, less the parkings by persons who went to the subsequently vacated office, was compared category-by-category with the pre-forty-five distribution and the difference in each category was stated as a percentage of the pre-forty-five in that category. This percentage by the above analysis represents the seasonal difference (plus or minus) present in that category of the pre-forty-five as compared to the pre-eighty.

(d) The forty-five minute tagging distribution was then adjusted, category by category, to eliminate the seasonal differences determined in (c).

(4) With the differences attributable to the presence in the eighty minute tagging distribution, and absence in the forty-five minute tagging distribution, of parkings by persons who went to the particular office and seasonal change eliminated, the result was two distributions the difference between which is, by the hypothesis, attributable only to the differential effect of tagging all parkings over forty-five minutes as opposed to tagging all parkings over eighty minutes.

(5) From the hypothesis that the effect of tagging is to eliminate all parkings of durations longer than the tagging time by repeaters it follows that the difference between the effect of tagging all parkings over eighty

minutes and the effect of tagging all parkings over forty-five minutes is that, in the former case, all parkings by repeaters will be eliminated from all categories over eighty minutes while, in the latter case, all parkings by repeaters will be eliminated from all categories over forty-five minutes.

(6) It follows, therefore, that the difference between the two distributions in (4) above (the eighty minute distribution corrected for the difference caused by the presence of visitors to the particular office and the forty-five minute distribution corrected for the difference caused by seasonal change) is attributable only to the presence, in the categories between forty-five and eighty minutes of the eighty minute tagging dis-

tribution, of parkings by repeaters and the absence, from the same categories, of such parkings in the forty-five minute tagging distribution. Accordingly, if the parkings by repeaters are eliminated from the forty-five to eighty minute categories of the eighty minute tagging distribution, as corrected for the office parkers, and the result is compared with the forty-five minute tagging distribution, as corrected for seasonal change, the two distributions should be found to be alike.

(7) This operation was performed and the result is shown by the cumulated percentage graph in Figure 51. By the hypotheses the points on this graph should fall on a straight forty-five degree line. The graph in Figure 52 was drawn from the same data except the parkings between forty-five and eighty minutes by repeaters were not eliminated. By the

hypothesizes the points on this graph should not fall on a straight forty-five degree line.

The Numbers Analysis.

The numbers analysis of the two administrative studies is fundamentally the same as that of the parking studies. Two factors are regarded as accounting for the change in numbers: first, the "primary" effect of the tagging, which is hypothesized to be the elimination of all parkings by repeaters which parkings have durations of longer than the tagging time; second, the filling-in of the space made available through the elimination

of repeater parkings by parkings of shorter duration, which filling-in reflects the existence of an unsatisfied demand for parking space.

For purposes of the numbers analysis the eighty minute tagging observations (first fifteen days, less grocery parkers) were compared with the regulated observations of the original Water Street parking study and the forty-five minute tagging observations were compared with the pre-forty-five observations.

As in the parking studies, an hypothetical numbers distribution was constructed for each pair which distribution is numerically and distributively identical with the no-tagging distribution to the left of the Point and distributively identical with the tagging distribution to the right of the Point. This is the distribution which hypothetically would have been

obtained had there been no unsatisfied demand for parking space. The difference between the total parking minutes used by this hypothetical distribution and the total used by the observed no-tagging distribution is taken as an index of the primary effect of the tagging (x in the formula).

A determination was made of the ratio between the total parking minutes used by the no-tagging distribution and the total parking minutes available during the period over which that distribution was taken. This percentage of available used is taken as an index of the amount of unsatisfied demand for parking space at that site during that period (v in the formula). The same formula ($u = 12 + 1.4x - 1.01v$) was used as in the parking studies. In the formula u is the difference between the two observed numbers distributions, after the distributions have been converted to parking minutes used and the difference stated as a percentage of the total parking minutes used during the no-tagging period. The formula predicts rather closely the differences between the observed distributions:

	<i>Parking Minutes Used No-tagging</i>	<i>Parking Minutes Used Tagging</i>	<i>Decrease as Percentage of No Tagging ("Observed u")</i>
Eighty Minute Tagging vs. Original Regulated	35,486.0	23,225.0	34.55
Forty-Five Minute Tagging vs. Pre- Forty-Five	24,080.0	15,098.0	37.30
	<i>Value of x</i>	<i>Value of v</i>	<i>Calculated u $12 + 1.4x - 1.01v$</i>
Eighty Minute Tagging vs. Original Regulated	42.35	37.89	33.02
Forty-Five Minute Tagging vs. Pre- Forty-Five	45.07	35.40	39.35

The Rotary Traffic Studies

It will be recalled that the four rotary traffic studies were made on a single site, an intersection from which five streets radiate. A scale drawing of the site appears in Figure 53. Four classes or streams of traffic were observed. Traffic passing from Davenport Avenue to Broad Street was recorded by an observer at "A" on the drawing. Traffic passing from Broad Street to Davenport Avenue was recorded by an observer stationed at "B." An observer stationed at "C" recorded traffic making a left turn from Davenport Avenue into Oak Street or Dow Street and also traffic making a right turn from Oak Street or Dow Street into Davenport Avenue. Each of these streams of traffic was categorized by the observers into seven lanes descriptive of the path taken across the

intersection. The lanes were defined with reference to the oval sketched in broken lines on the drawing and with reference to the location of the observer. The seven lanes or categories were: (1) Passing Beyond Oval—Far Side, (2) Intersecting Oval—Far Side, (3) Passing Through Oval, (4) Intersecting Oval—Near Side, (5) Passing 0-20 Feet from Oval, (6) Intersecting Two Lanes, and (7) Passing 0-20 Feet from Curb.²⁰ The listing of the lanes is in order of their distance from the location of the observer. The position of each car with reference to these

lanes was determined as of the time it crossed an imaginary line drawn toward the oval from the observer's position (the lines on the drawing connecting "A," "B," and "C" with the oval). The observer was aided by inconspicuous marks on the pavement marking the division into lanes.

Each of the four streams of traffic was observed in five separate stages. For this analysis the data of Stage I will be compared to that of Stage III.

20. The lanes designated "0-20 Feet From Oval" and "0-20 Feet From Curb" actually measured less than twenty feet and varied somewhat in width from one study to another.

During Stage I there was no ordinance specifically regulating the flow of traffic across the intersection, other than the general regulation requiring vehicles to keep to the right; there were no marks of any kind on the pavement other than the inconspicuous ones necessary to enable the observers to separate lanes. During Stage III a traffic ordinance, regularly enacted by the traffic authority, established rotary traffic at the intersection; an oval, of the size and position illustrated in Figure 53, was painted in white on the pavement, and the words "Keep Right" were painted in white at the entrance to the intersection of each of the radiating streets.²¹

The total numbers of cars crossing the intersection in each of the four streams of traffic during Stage I as compared to Stage III were as follows:

<i>Studies</i>	<i>Stage</i>	
	I	III
Davenport to Broad	3167	3553
Broad to Davenport	2168	2507
Davenport to Oak-Dow	145	129
Oak-Dow to Davenport	205	198

There was thus a considerable increase in the total number of cars observed in Stage III as compared to Stage I in the two studies in which the data are numerous. This increase may perhaps be attributed to the change in season. The Stage I observations were made January 16, 17, and 18, 1934; those of Stage III were made March 21, 22, and 23 of the same year. Whatever the causal factor or factors related to this increase, it was believed that it was entirely outside the control supplied by the data and in the analysis of the data the change in total numbers was disregarded, that is, the total numbers of each stage were equated at 100; and the analysis proceeded on the assumption that the percentage distributions were both percentage and numbers distributions.

The distributions which were obtained in the four studies were such as to make any detailed analysis impossible or very difficult. The categories were so set up that in several instances substantially all of the

21. Stages I and III were selected for comparison because they represent the two situations the comparison of which was the principal object of this study as well as the parking studies: (1) a situation in which the behavior observed was not specifically regulated, and (2) a situation identical with the first except that the behavior is specifically regulated by law and posted notices of the regulation appear in the situation. The symbols painted on the street in Stage III were also present in Stage II, but no ordinance had been officially enacted. Stage IV was like Stage III with the addition of stanchions around the painted oval which made driving through the oval virtually impossible. In Stage V the ordinance was in force as in Stages III and IV, but no symbols of any kind appeared on the site to indicate the regulation. The data of all stages are set out in App. D. As may be seen, and perhaps as would be expected, the distribution of drivings among the seven lanes in Stage II was very like that of Stage III; and the distribution of Stage V was very like that of Stage I.

drivings observed fell into one or two categories. The percentage distribution in Stage III of each of the studies as compared to that in Stage I may be seen from the tables below:

<i>Studies</i>	<i>Davenport to Broad</i>		<i>Broad to Davenport</i>	
	I	III	I	III
Passing Beyond Oval—Far Side	.22	0	.04	0
Intersecting Oval—Far Side	.63	0	.04	0
Passing Through Oval	98.20	11.22	2.95	.03
Intersecting Oval—Near Side	.72	16.18	27.49	1.99
Passing 0-20 Feet From Oval	.22	72.50	63.14	64.65
Intersecting Two Lanes	0	.08	5.25	31.91
Passing 0-20 Feet From Curb	0	0	1.06	1.39
TOTAL	99.99	99.98	99.97	99.97

	<i>Davenport to Oak-Dow²²</i>		<i>Oak-Dow to Davenport</i>	
	I	III	I	III
Passing Beyond Oval—Far Side	0	39.53	0	0
Intersecting Oval—Far Side	0	27.90	0	0
Passing Through Oval	7.58	.77	.48	0
Intersecting Oval—Near Side	4.82	3.10	0	.50
Passing 0-20 Feet From Oval	30.34	12.40	1.95	.50
Intersecting Two Lanes	28.96	10.07	4.39	6.06
Passing 0-20 Feet From Curb	28.27	6.20	93.17	92.92
TOTAL	99.97	99.98	99.99	99.98

In the Oak-Dow to Davenport study substantially all of the drivers in Stage I kept well to their right in going through the intersection. The relative location of the two streets was such that it would have been quite inconvenient to do otherwise.²³ As would be expected, there was no substantial difference in the distribution of the Oak-Dow to Davenport traffic in Stage III as compared to Stage I.

A further difficulty arose from the belief that the observations were made in such a way as possibly to make the allocation of drivings among categories misleading. It has been pointed out above that a particular car was recorded as being in one category or another depending on its location when it passed a point in line with the observer. It is now believed that, in some instances, a car recorded by the observer in one category might

22. As was stated above, the categories were designated with reference to the position of the observer. In the case of the Davenport to Oak-Dow study, the observer was so located that traffic keeping to *its* right at the intersection was recorded in the category or categories at the top of the table above. In the other studies the observers were so located that traffic keeping to *its* right was recorded in the categories at or near the bottom of the table. See App. D.

23. See Fig. 53.

have been recorded in another had the entire path of the car across the intersection been observed. This difficulty may be illustrated by reference to Figure 54. A driver proceeding from Broad Street to Davenport Avenue, entering the intersection at point "X" and proceeding on a straight line to point "V," would have crossed the line of observation of the observer at "B" at point "N." He would have recorded this driver in the category "Passing 0-20 Feet from Oval"; yet the car may very well have intersected the oval at or near point "P." Similarly, a car recorded by

the observer at "B" as "Intersecting Oval—Near Side" may have been wholly within the oval at some point further along his path. A like question arises with regard to the Davenport to Broad observations.

The Decrease in Frequency in the Prohibited Categories.

In view of the doubts as to the accuracy of the categorization, as well as of the small number of studies represented, any apparent regularity in these studies must be regarded as highly tentative. Taking the data as it

stands one relationship has been tentatively hypothesized, and it is believed that it is consistent with the theory presented below. The hypothesis is that there is a relation between the percentage of decrease in the frequency of drivings in each category which is prohibited by the ordinance and the distance, laterally, which separates the lane represented by that category and the nearest lane not prohibited by the ordinance. In order to test this hypothesis with the data at hand the prohibited categories were added together and regarded as one for the purpose of determining the percentage decrease which occurred between Stage I and Stage III.²⁴ The decrease thus determined in each of the three studies was related to a distance figure for each study which figure is a weighted average of the lateral distances in that study between each of the prohibited lanes and the nearest unprohibited lane, the average being weighted according to the observed frequency of each lane-category.²⁵ The decrease and distance figures for each study were as follows:

	<i>Percentage of Decrease in Prohibited Categories</i>	<i>Average Distance to Nearest Unpro- hibited Lane</i>
Davenport to Broad	88.7	31.37
Broad to Davenport	99.0	12.22
Davenport to Oak-Dow	67.5	87.24

The relationship between these measurements is graphed in Figure 55. With only three points no attempt has been made to establish a precise relationship. The straight line is drawn on the graph merely to emphasize the relative position of the points.²⁶

24. The frequencies of most of the separate categories were so small that a percentage of decrease figure for such categories would be unreliable. The category, "Intersecting Oval—Near Side," in Davenport to Broad and Broad to Davenport and its equivalent, "Intersecting Oval—Far Side," in Davenport to Oak-Dow were not included as prohibited categories for this purpose. See the discussion at page 60 *infra*.

25. The lateral distances for each separate category of each study, all of which entered into the average for that study, were determined by assuming that all cars in a particular category passed through the mid-point of that category at the observed point. On the basis of this assumption assumed paths across the entire intersection were drawn for each category. The distance measurement for each category was made perpendicularly to the path and at the point at which it was farthest separated from the nearest unprohibited lane.

26. The doubts as to the accuracy of the categorization stated in the text above might affect this relationship. A difference, for example, in the relative numbers recorded in the category "Intersecting Oval—Near Side" and the category "Passing Through Oval" would, or might, affect both the percentage of decrease in the total of the unprohibited and the average distance from the nearest unprohibited lane. It is not believed, however, that such a difference would affect the essential "fit"—if it be such—of the points on the graph. As a partial test of this several different corrections were made in the data on the basis of estimates as to what proportion of the observations recorded in one category would have been recorded in another had the entire path of each car

The Unprohibited Categories and the Adjacent Intersecting Category.

The categories, "Passing 0-20 Feet from Oval" and "Intersecting Oval—Near Side", in the Davenport to Broad and Broad to Davenport studies are the ones most affected by the doubts stated above as to the essential accuracy of the recorded observations. For this reason it is not believed that the data supply any reliable check of any hypothesis as to the effect

of the ordinance on the frequency of these categories. It is possible only to suggest some tentative hypotheses which are not inconsistent with the data and which may be tested by a study or studies devised for the purpose.

across the intersection been observed. These estimates were made on the basis of the relative sizes of the categories on either side of the one in question. In all cases the data, as corrected by the several assumptions, yielded a relationship very like that in the graph above. Although the slope and location of the straight line was in every instance somewhat different from every other, the "fit" of the points to the straight line was, in all instances, about the same.

It will be noted that here, as in the parking studies, the primary effect of the ordinance is taken to be the displacement of behavior from one location to another. In the case of the rotary traffic studies, however, both the place from which and the place to which drivings were displaced were observed. Thus the increase which occurred in some categories was the direct result of displacement rather than the result, as in the parking studies, of the filling in of vacated space. It is tentatively hypothesized that this increase occurs in the categories which are unprohibited and which are nearest to those prohibited categories from which drivings were displaced. There is nothing inconsistent with this hypothesis in the data of the rotary traffic studies. In neither the Davenport to Broad nor the Broad to Davenport study did the categories farthest to the right of the oval increase. In the Davenport to Oak-Dow study there is only one unprohibited category and so, although this category increased markedly, there is no test of the hypothesis.

In the above discussion those cars which passed generally to the right of the oval but intersected it at the point of observation (recorded as "Intersecting Oval—Near Side" in Davenport to Broad and Broad to Davenport, and as "Intersecting Oval—Far Side" in Davenport to Oak-Dow) have been disregarded—that is, they have been treated neither as prohibited nor unprohibited. A strict grammatical construction of the regulation and symbols on the street probably would place this category among those prohibited by the regulation. However, if this category is included as prohibited for purposes of the relation graphed in Figure 55, the regularity—assuming that Figure 55 displays a regularity—disappears. It is believed that the explanation of this is that the frequencies of the intersecting categories react partly as those of prohibited and partly as those of unprohibited categories. There is some support for this in the data. It will be observed that in the Davenport to Broad study the category, "Intersecting Oval—Near Side", increased from .72 per cent in Stage I to 16.18 per cent in Stage III. In Davenport to Oak-Dow the comparable category, "Intersecting Oval—Far Side," increased from 0 per cent in Stage I to 27.90 per cent in Stage III. This is an indication that the intersecting categories are receiving a part of the increase which, it is hypothesized, goes to the nearest unprohibited lane. In Broad to Davenport the comparable category, "Intersecting Oval—Near Side," *decreased* from 63.14 per cent in Stage I to 1.99 per cent in Stage III. This is some indication that the category is decreasing as a prohibited category. An inquiry into the precise effect of a regulation on such "in between" categories must await the making of studies which are set up in such a way as to yield a categorization of the data that is believed to be thoroughly reliable and to enable the separation of the "increase" and "decrease" effects. It is believed that such studies are practicable.

LEARNING THEORY AND ITS APPLICATION

It will be recalled that one of the objectives of this investigation of the effect of one class or type of law was to judge whether the measurements which were made were measurements of aspects of behavior which either are the entities, or have a one-to-one correspondence to the entities, of a general theory of behavior. Unfortunately, a general theory of behavior all of the entities of which are classes of observables has not been constructed. It was necessary, therefore, to adopt the learning theory²⁷ which derives from the work of Pavlov, Thorndike, Watson, Hull, and others. Learning theory has been most completely and precisely formulated by Hull.²⁸ An illuminating presentation of the theory is that of Miller and Dollard.²⁹

What Learning Theory Is

Learning Theory conceives of the overt behavior of an individual, acting either alone or in a group of other individuals, as behavior which he has learned or is learning to perform. His behavior is determined by the relation between four factors—drive, cue, response, and reward—which relation he has learned, or is learning. In order to learn one must be driven to make a response in the presence of a cue, and that response must be rewarded. In order to learn one must “want something, notice something, do something and get something.”³⁰ Having learned, one makes the response when the cue appears and gets the reward; one wants something, does something, and gets what he wants. Having learned, one will continue to make the response whenever the cue appears so long as the making of the response is followed by the reward.

How Learning Theory Explains Behavior in Very Simple Life Situations.

A person who is thirsty sees a drinking fountain, approaches it, operates it, and drinks. His behavior has been learned from his experience in a series of prior attempts to relieve thirst in significantly similar situations. During this learning process the relation between the particular drive, cue, response, and reward was established. These four factors are fundamental in the learning of a particular response and fundamental to the continued appearance of that response in similar situations after it has been learned.

A drive is an internal stimulus which motivates action.³¹ In the example just presented the person would not have learned to approach the fountain

27. For the suggested application of a learning theory to a social situation, see Moore and Callahan in *MY PHILOSOPHY OF LAW* (1941) 201.

28. HULL, *PRINCIPLES OF BEHAVIOR* (1943).

29. MILLER AND DOLLARD, *SOCIAL LEARNING AND IMITATION* (1941) (hereinafter cited as MILLER AND DOLLARD).

30. *Id.* at 2.

31. *Id.* at 18.

and operate it had he never been thirsty; and having learned that response, he will not give it in any future situation unless he is thirsty. Certain drives such as hunger, thirst, pain, sex, and fatigue are generally recognized as innate and universal—as part of the physio-psychological equipment with which all normal human beings begin life. These are the primary factors which induce the action that begins the learning processes and which continue to induce action after particular responses have been learned.

The drive is not the sole significant constituent of a situation in which a response will be learned or, being learned, will be given. Even though thirsty, the person in the example above would not approach and operate the fountain unless he saw it. The cue is the factor which identifies a situation as one in which a particular response will be rewarded.³² Thus the cue includes the drive, but in nearly all cases it includes some external stimulus as well. We learn to lie down, not simply when we are tired, but when we are tired *and* see a bed, or a sofa, or a shaded lawn.

Responses are learned in the presence of climatic factors, a multitude of natural objects and artifacts, and a multitude of events of behavior of other people. One of the learning processes which occur during the learning period is that of cue selection. One learns to select from all the objects and events distinguishable in a particular situation those which are in significant relation with the drive, the response, and the reward. This power of selection is acquired through variation, during the learning period, in the non-significant items in the situation.³³ Referring again to the example above, one learns that the response of approaching and operating a fountain is rewarding whether it is winter or summer, whether the fountain is black or white, and whether the fountain is located in an office building or in a public park. The season of the year and the color and location of the fountain, along with many other aspects of the situation which are observed not to enter into significant relation with the drive, the response, and the reward, are thus eliminated, at least, within the range of their experienced variation, from the cue.

Another learning process which occurs during the learning period is that of cue generalization. This process is similar to that of cue selection. Just as variation in the situation teaches selection of the objects or events which make up the cue, so variation in some of the aspects of the cue itself establishes the cue as a *class* of objects or events. This class may be quite wide, and through subjective generalization it may include objects and events never actually experienced.³⁴ A person who has learned the water fountain response in a wide variety of situations will give that response

32. "The drive impels a person to respond. Cues determine when he will respond, where he will respond, and which response he will make." MILLER AND DOLLARD, at 21.

33. See article by Moore and Callahan, *supra* note 27, at 208-09.

34. *Id.* at 211-12.

upon sight of a fountain which differs considerably from any fountain he has ever seen. Through the process of generalization the cue has become not a fountain of one of the types which he has seen but any fountain; and in approaching and operating a fountain which he has never seen he is giving a response which he has already learned to make to that cue. Similarly, a policeman is giving a learned response when he arrests a man who throws a stone through a window, though he may never before have seen that man, that stone, or that window and may never before have seen anyone throw a stone through a window.

A response is that behavior performed in the presence of a cue the connection of which with the cue is strengthened by reward. Learning takes place in situations which are not self-rewarding, situations in which action of some sort on the part of the learner is necessary to reduce a drive. During the learning period one learns to distinguish the particular action which is followed by a reduction of a drive from the large number of other actions which, though possible in the situation, are not rewarded. Having learned, one attempts to reduce fatigue by lying on a bed, or a sofa, or a shaded lawn—not by lying on a hot stove or a picket fence.

A reward is simply the reduction of a drive which motivated action.³⁵ A particular event of behavior may reduce a drive only partially, or it may reduce it completely. In the case of a partial reduction further action will occur unless the reduction, though partial, has been such that the strength of the drive no longer is sufficient to motivate action. In the case of a complete reduction of a drive no further action will occur until another drive arises or until the same drive reappears. Whether the reduction is partial or complete, the response which produced it has been rewarded.

How Learning Theory Explains Behavior in More Complex Life Situations.

The bare fundamentals of learning theory as outlined above suffice to explain only the most simple instances of human behavior. When a hungry child, seeing a piece of candy, reaches for it and puts it in his mouth the operation of the factors of learning is clear. Other instances of behavior, equally common and still relatively simple, require more extended analysis. A man who is not thirsty drinks a glass of beer. A person who is hungry enters an automobile, drives two miles, parks his car, enters a restaurant, orders a meal, and finally eats. A thirsty child sees a drinking fountain; but instead of approaching it and drinking, he sits down on a near-by bench. In terms of learning theory each of these events of behavior is a response which has been learned because it was followed by a

35. MILLER AND DOLLARD, at 28. A more technical name for reward is reinforcement. *Ibid.*

reward; and each event is a response which will be given in future significantly similar situations so long as it continues to be followed by a reward. In instances such as those above what is the mechanism by which the cue-response relation is established and maintained by reward?

An attempt to relate this somewhat more complex human behavior to learning theory requires: first, a consideration of the concept of acquired drives, that is, drives which are developed during the learning period and which are motivating factors in addition to the innate drives with which an individual is born; and, second, a recognition of the complexity of the conditions under which human behavior is learned and, being learned, occurs. These conditions limit the drives which may be acquired and determine, in large part, the cue-response relations which are learned.

Innate or primary drives supply the motivation which begins the learning processes and they continue to be motivating forces throughout life. But the learner quickly develops acquired, or secondary, drives which operate as motivating forces either in addition to or quite apart from the innate drives.³⁶ Acquired drives are based upon innate drives in the sense that they are acquired in the process of learning to reduce one or more innate drives. For example, the reduction of the hunger drive by eating Danish pastry may create an appetite for Danish pastry which has drive value in itself.

The motivating force of an acquired drive may be sufficiently great to produce action in a situation in which the innate drive upon which the acquired drive was based either is not present or, if present, is too weak operating alone to elicit a response. Thus the beer drinker, in the example above, drinks the beer although he is not thirsty. In the process of learning to reduce the thirst drive he has developed an acquired drive for beer which is strong enough to elicit a response even in the absence of innate thirst. Similarly, in a case in which the innate drive is present in sufficient strength to produce action, the added presence of an acquired drive will explain the consistent choice by an individual of one of two or more responses, any of which will satisfy the innate drive and for all of which cues are present. A person who *is* thirsty may consistently drink beer where both beer and water are available.

Some drives which commonly are acquired are based upon more than one innate drive. In the process of learning to reduce many different innate drives by means of responses which involve the use of money, one may acquire a drive to obtain money. By a somewhat similar mechanism a learner may acquire very early in his learning experience a desire for the approval of others. The conditions under which human learning proceeds are such that the approval of others very frequently accompanies the satisfaction of the different drives by means of responses which are

36. For a discussion of acquired drives, see MILLER AND DOLLARD, c. IV.

"socially acceptable." Satisfaction by other means, or failure to satisfy the drives, is accompanied by disapproval. To many approval is pleasant, disapproval unpleasant. Under such conditions the desire to obtain the reward of approval, or to avoid unpleasant disapproval, may become so strong as to have drive value. The wearing of neckties, the purchase of a more expensive article rather than a less expensive but equally serviceable one, and many other similar instances of behavior may be explained as motivated by this drive.

Another acquired drive, and one of the strongest, is anxiety or fear. During a learning process one gives responses which, in the particular situation in which they are given, result in failure to reduce the drive which motivated them, or perhaps even result in pain. The cues which were associated with the failure or pain become capable of arousing, in advance of the failure or pain, an anxiety or fear stimulus of sufficient intensity to have drive value. The learner is thus driven to action in an attempt to reduce the anxiety. If some of his responses are rewarded by a reduction in anxiety a learning process is begun by which those responses will become learned responses based on the anxiety drive. Thus a pedestrian, seeing a car rapidly approaching, jumps out of the way; his response was motivated by the anxiety which arose upon sight of the approaching car and was rewarded by the reduction in anxiety which occurred when the car passed without striking him.

Even in the simple learning situations of early childhood the responses are likely to include more than one continuous and indivisible physical movement. The child who sees a piece of candy must, perhaps, take a few steps to reach it; he must then extend his hand, grasp the candy, place it in his mouth, chew it, and swallow it. This behavior may be analyzed as a series of instrumental responses leading to the goal response; but the entire chain of responses occurs within such narrow limits of time and space that it is likely to be thought of as an undivided unit unless closer analysis is necessary for some particular purpose. However, the conditions under which an individual must satisfy his various drives are so complex as often to require responses which, in their entirety, extend over considerable time and space.³⁷ Even if a person could see a sandwich at the top of the Empire State Building, he could not fly up to get it. Yet he could enter the door, take an elevator, leave it at the proper floor, pay for the sandwich, and thus obtain it. In such a case a goal response clearly is preceded by several instrumental responses, each of which have separate cues. Similarly in the example given above of the person who drove his car two miles in order to get a meal in a restaurant, the person's behavior may be analyzed as a series of cued responses, each of which is instru-

37. For a discussion of the conditions under which human learning occurs and the influence of these conditions on the learning process, see Ford, *Culture and Human Behavior* (1942) 55 *SCIENTIFIC MONTHLY* 546.

mental to a goal response. It is apparent that the person has learned not only each of the instrumental responses but also the manner in which these instrumental responses may be linked together in a chain which leads to the goal response.

In the case of such chain responses the reward attained at the end of the chain is the reward which strengthens not only the final or goal cue-response relation but also the relation between each of the instrumental responses and its cue. The reward for each of the instrumental responses is thus somewhat delayed, and the more remote the instrumental response from the goal the more the delay in attaining the reward.

Learning theory supplies an hypothesis with regard to chain responses which is important in the theoretic basis which the authors have attempted to construct for the data here reported. The hypothesis, stated in general terms, is that delayed rewards are less effective than immediate ones; and consequently, in a series of responses, given either to a single cue or to a series of cues, those responses nearer the goal response are strengthened progressively more than those more remote from the goal.³⁸ By this hypothesis, the response of getting into the car, in the case of the person in the example above, is strengthened less than the response of starting the car; and each succeeding response in the chain is strengthened more than the preceding one.

It has been pointed out above that the conditions under which human learning occurs are such that in many instances drives may be reduced only by giving a long series of instrumental responses leading to the goal response. The human learning process is also complicated by the large number of conflict situations in which an individual is placed. At any particular time he is likely to be motivated by more than one drive and be confronted by more than one cue. A child who is thirsty may also be tired, and he may see a bench as well as a drinking fountain. He cannot give both responses simultaneously; and the giving of one response, with the consequent reduction of one of the drives, means, at least temporarily, failure to reduce the other drive.

Such a conflict situation may be encountered early in an individual's learning experience, perhaps before he has learned separately any of the conflicting cue-response relations. On the other hand, a particular conflict situation may not be encountered until after the individual has learned each of the conflicting cue-response relations in situations in which the cues are presented separately. In either event the explanation of the individual's behavior in the conflict situation, in terms of learning theory, is not essentially different from the explanation of behavior in simpler situations in which there is no conflict. The individual's behavior in a conflict situation is a response, or series of responses, which is learned because it is rewarded and continues to be given because it is rewarded.

38. See HULL, *op. cit. supra* note 28, c. X; MILLER AND DOLLARD, at 46.

In a conflict situation, however, the determination of which of the two or more conflicting responses will be learned, or, if the conflicting responses have been learned separately, the determination of which will be given when they conflict, requires a consideration of the relative strengths of the rewards which support each of the separate cue-response relations. If only one of two or more responses can be given, the one which will be learned, or, being learned, will be given, will be the one which has been followed consistently by the greatest reward. The strength of the reward supporting each response depends on the strength of the drive which is to be reduced by the response and the proportional amount of reduction which is accomplished by the response.³⁹ In case the reward is to be delayed, as in the case of instrumental responses, the strength of the reward supporting the response also depends on the extent of delay. Thus, in the example of the conflict between the thirst drive and the fatigue drive, the response of approaching the fountain would not be given, the other factors being equal, if the child's fatigue drive were stronger at the time than his thirst drive. And even if the thirst drive were the stronger of the two, the response of approaching the fountain might not be given (a) if the child had learned that only a small quantity of water could be obtained from the fountain or (b) if the fountain were a considerable distance away. In the former case, the partial reduction of the thirst drive might be insufficient to over-balance the greater reduction of the fatigue drive. In the latter case, the delay in obtaining the water might be such that the instrumental response of beginning to walk towards the fountain would be strengthened less than the response of approaching the near-by bench.

A large proportion of the very large number of cues to which human beings learn responses are cues which consist, in part, of a written or spoken word or words. The responses which are learned to be given to such cues may be either the writing or the speaking of another word or words or the executing of non-verbal behavior or both. Two peculiarities attach to these word cues, neither of which should confuse. First, the situations in which word cues appear are so numerous and the limits of

39. In learning theory the strength of the reinforcement for a particular response also varies with the number of times the response has been given and rewarded. This factor is omitted here because it is believed that when, as in the case of the studies reported, the behavior of a very large number of people, each of whom has learned the response, is being studied, the factor may safely be disregarded. The phenomenon of "behavioral oscillation" also has been omitted in this presentation of learning theory. A given individual, subjected to repeated instances of the same drive-cue situation, will not react identically in all instances. See HULL, *op. cit. supra* note 28, c. XVII. It is believed that one of the ultimate causes of this variability lies in the molecular constituents of the nervous system, the neurons. *Id.* at 309. For the same reason as above—the fact that the behavior of large numbers of people is being studied—it is believed that this phenomenon may be disregarded.

variation in the situations are so wide that words have acquired a "dictionary" meaning, and "rules" of syntax dealing with the arrangement of words have appeared. These dictionary meanings and syntactical rules are simply verbal responses, and the process by which they are learned is the same as that by which non-verbal behavior responses are learned. Second, a non-verbal response which is learned to be given upon the appearance of a cue which includes words often is a response the verbal description of which corresponds in dictionary meaning to the words in a cue. This fact should not lead to the expectation that responses corresponding to the words in the cue will occur in all or even in a majority of the cases in which cues including words are observed. This is because (1) the responses which are learned to cues including words are not always those a verbal description of which corresponds to the words in the cue and because (2) the cue including words will appear very frequently in a situation in which it conflicts with other cues; in such a situation, the response which is given will depend, as was stated above, upon the relative strengths of the rewards supporting each.

As in the case of other objects or events external to the individual, words, in themselves, are not cues; they do not produce action unless they are part of a cue to which a response has been learned. Words are often thought of as cues in situations in which, from the viewpoint of this analysis, they obviously are not. In a given situation, "Drink Iceco" may be part of a cue for the response of drinking it, if the drinking of Iceco in the past has been rewarding. Otherwise, no learning relation will have been established.

How Learning Theory Explains Stability and Change in Human Behavior Patterns.

Learning theory, the general outline of which as applied to the behavior of an individual has been presented, supplies a theoretical basis from which to approach problems of stability and change in any of the multitude of behavior patterns which is human culture. Any statement of stability or change in the behavior of a group of individuals, whether the group be large or small, is a compendium of statements of stability or change in the behavior of the individuals who make up the group. The statement of an observer that most of the residents of New Orleans abandoned the use of cisterns after a public water purification system was installed may have significance because it attempts to state the behavior of a large number of individuals. It is, nevertheless, an attempt to state in a gross way the observed behavior of each individual in the group. As pointed out above, the behavior of any individual may be different because he is behaving in and with a group of other individuals. The behavior of others is one of the conditions which attend the learning process, and

frequently it is a factor in determining the drives which an individual acquires, the cues and responses which he learns, and the rewards which he receives. But the learning principles which account for his behavior and, by a process of generalization on the part of an observer, for the behavior of a group of which he is a part, are not different because of the effect of the behavior of others on the drives, cues, responses, and rewards of the individual.

Assuming that an individual has certain innate and certain acquired drives and has learned certain cue-response relationships, he will continue to give each response upon the appearance of its cue, so long as the giving of that response is rewarded.⁴⁰ Much of the behavior of human beings consists of the giving of responses which were learned early in life and which continue to be rewarded throughout life. One learns to wear clothes when he appears in public, to use a conveyance when he wishes to get somewhere quickly, and to stand when the National Anthem is played. These and many other of the behavior patterns which make up our culture continue to be rewarded throughout life and therefore continue to be given. And this culture is perpetuated from one generation to another. A child soon learns that behavior which corresponds to that of his parents is rewarded not only by a reduction of his innate drives but also by the approval of his parents.

But changes in human behavior patterns do occur. These changes may be represented by the differences between the data of two or more observations of a broad pattern of behavior which observations are made at widely separated periods of time, as when present methods of cultivating land in the United States are compared to those of the early nineteenth century. On the other hand, changes may be represented by the differences between the data of two or more observations of a relatively narrow pattern of behavior which differences may appear within relatively short periods of time, as when the number of persons who attend a particular church on a particular Sunday is compared to the number attending on the previous Sunday.

The fundamental relationships of learning theory suggest several mechanisms by which changes in human behavior patterns, whatever the scope of the changes, may be effected. One such mechanism is that of extinction brought about by cessation of reward. A cue-response relation, once learned, will not persist unless it continues to be supported, or reinforced, with some degree of regularity by reward. A child who has learned to open a drawer to obtain candy, and who does so regularly, will not continue indefinitely to give the response if candy is no longer kept in the drawer. After the removal of the candy, the frequency of the response

40. More precisely, until extinction following the cessation of reward.

in the presence of the cue will begin to decrease, and finally it will be extinguished altogether. Similarly, extinction may explain a much more elaborate change, such as the abandonment of the fishing industry in a particular locality after the streams have been polluted by manufacturing processes.

A change in a behavior pattern may also occur as the result of the learning of a new cue-response relationship. Although the learning of new responses is most apparent in the case of young children, a considerable proportion of the changes which occur in the behavior of adults, both as individuals and as groups, may be so explained. The many instances of technological and sociological invention or innovation produce changes which may be analyzed as fundamentally the learning of new cue-response relations. For example, the invention of the telephone was followed by the learning, on the part of a large group of people, of a new cue-response relation between the ringing of the bell and the picking up of the receiver.

Even though there has been no extinction of a cue-response relation and no learning of a new cue-response relation, a behavior pattern in a particular situation may change simply because the pattern of cues in the situation changes. This mechanism accounts for a large proportion of the detailed changes in human behavior. We raise umbrellas when it rains and lower them when the raining stops. We begin to eat when food is set before us, and we put down our forks when the food has been consumed. When in church we rise and begin to sing at a sign from the minister. When a new bus service is inaugurated we stop walking to work and begin to ride. A change in the pattern of cues may take any of several forms. First, there may be removed from the situation one or more of the constituent parts of a cue for a particular response. Consequently, the cue for that response no longer exists and the response will not be given. Second, there may be added to a situation a cue not previously there. The response called for by this new cue may be one which does not conflict with any response being given in the situation; in that case, the response to the new cue will be given and the pattern of behavior in the situation will be changed to that extent. If, however, the response called for by the new cue does conflict with one or more responses being given in the situation, there will be a change only if the strength of the rewards supporting the new cue-response relations is greater than the rewards supporting the former cue-response relations.

The Theory Applied to the Parking Studies

It will be recalled that in the parking studies observations were made of the duration of each parking of an automobile on several different sites in New Haven at a time during which there was no legal regulation of parking durations on those sites. In each study the data thus obtained

were tabulated in time categories and the resulting distribution was compared with another distribution of data taken at a later time on the same site under conditions as nearly as possible identical except that a legal regulation of parking for that site had been enacted and signs or notices to that effect were posted in the observed area. A comparison of these two distributions in each study, and a comparison of each pair of distributions with each other pair in each other study, revealed (1) that in each study the data of each distribution might be considered as distributively the same up to a certain duration category, or Point, and that for all greater durations the data was distributively different; (2) that in all studies there was an apparent relation between (a) the percentage of the total number of parkings in the unregulated distribution which had durations less than the "ordinance time" and (b) the percentage of the total number of parkings in the same distribution which had durations less than the duration marked by the Point; and (3) that in all studies there was an apparent relation between (a) the percentage of decrease in the frequency of each category of durations greater than that indicated by the Point, (b) the percentage of the total number of parkings in the unregulated distribution which had durations less than the ordinance time, and (c) the percentage of the total number of parkings in the unregulated distribution which had durations less than that of the particular category in question.

The parking studies are studies of group behavior in the sense that each distribution is a description of one aspect of the behavior of a particular group of persons—those parking automobiles in a particular area during a particular period. But the distributions are composed of data representing a series of observations of the behavior of individuals and are thus a composite description of the behavior of individuals. The application of learning theory to the studies may thus be discussed with reference to the behavior of individuals.

In broad outline, each of the parking studies is viewed as (1) the measurement of the frequency with which a response, or group of responses, occurs in a particular situation, (2) the introduction into that situation of a cue for a conflicting response, and (3) the measurement of the change in frequency of the first response which follows the introduction of the conflicting cue. A more detailed analysis of the studies requires consideration of the drives, cues, responses, and rewards operating both before and after the introduction of the cue for the conflicting response.

The Unregulated Period.

Each of the individuals whose behavior was observed and recorded parked a car in the observed area. In so doing, each of them was giving a response to a cue, which cue included a drive, and the response was

rewarded. The unregulated period is thus thought of, not as a period during which a new response was being learned, but as a period during which each of the individuals, in parking a car, was giving a response which he had already learned to give to that particular cue. This, of course, is an assumption; but the fact that no significant change was observed during the unregulated period, in any study, supports the belief that the assumption is justified.

Drives. In parking his car each of the individuals was motivated by a drive; and, of course, the data reveals nothing about the drive of one individual as distinguished from that of another. One may speculate that there were wide variations in the drives represented both as to the names which might be attached to them and as to their strength. All were doing what popularly would be called an errand; but one may have been on his way to the movies, another to buy a quart of milk, still another to see his dying mother. The drives, however, did have one thing in common; they all were drives with respect to which the parking of a car was at least one step toward their reduction.

It is not necessary to be able to call the drives by name. All of the innate and acquired drives imaginable may have motivated the parking; but, for purposes of an analysis such as this, they are all alike—they were drives which motivated parking. Differences in the *strength* of drives, however, are theoretically significant. The strength of a drive is a factor in the amount of the reward which an individual receives upon the partial or total reduction of the drive and thus is a factor in determining which of two or more conflicting responses will be given. Since nothing is known of the strength of the drive which motivated any parking observed in the studies, the regularities obtained can be explained only on the assumption that drives of varying strength were distributed proportionately not only among the different studies but among the different time categories of any one study. It is believed that this assumption is not unreasonable; it is not unlikely that the proportion of important errands on one site was the same as that on another, or that, on any site, the proportion of important ten minute errands was the same as that of important sixty minute errands.

Cues. The cue to which each individual responded when he parked his car included the drive, whatever it was, that was motivating him. It also included some external stimuli; and these external stimuli must of necessity have included the automobile, as viewed from the driver's position, and a space on the street in which a car might be parked. There must also have been included in the cue some factor which identified the particular neighborhood as one in which the individual might continue the chain of responses which he was pursuing at the time. For all parkers the cue included the car and the street. Assuming that the parkers were

on different errands, had different drives, and were pursuing different response chains, the other constituents of the cue differed from one parker to another.

Responses. The response which was given to that cue was the parking of the car, the act of stopping the car for an appreciable length of time with its wheels near the curb and approximately parallel to the curb.⁴¹ Concededly, this is a portion of a chain of behavior which could either be further subdivided or added to another portion to make a single unit. This particular portion of the chain is regarded as the response: first, because it is sufficiently gross to be observed and identified by an observer and, consequently, there is very little question as to whether or not it occurred in any particular instance; and, second, because, as will be pointed out below, it marks the first point in the chain of responses at which the conflict, with which this discussion is concerned developed. The response as thus defined does not differentiate the parkings with respect to what the individual did after the car stopped; it makes no difference whether he went to a barber shop or a grocery store, or, indeed, whether he got out of the car or not.

Each of the responses observed, and thus defined, are thought of as instrumental responses. The stopping of the car next to the curb was not immediately followed by the reduction of a drive; rather, it was but one of a chain of responses leading sooner or later to a goal response which did reduce a drive.

It will be noted that the measurements of parking durations recorded by the observer are not measurements of the duration of these responses. Rather, they are measurements of the time which elapsed between the response of parking, stopping the car, and another response, starting it away from the curb.

Reward. The significance of this measurement of the time which elapsed between the responses of stopping and starting the car lies in its use as an index of the time which elapses between the instrumental response of stopping the car and the obtaining of the reward which reinforces that response. It is assumed that each person who parked a car attained some reward before he started it again. Everyone had an errand and the accomplishing of that errand, even though it be only a step in a longer chain, is assumed to be rewarding. It is believed that this is not an unreasonable assumption. In some cases which may be imagined, the attaining of the reward is clear as, for example, in the case of a person who parks to eat a meal, to attend a movie, or to pay a social call. In other types of cases, such as those in which persons park to purchase articles or make business calls, it is believed that the errand which is ac-

41. See App. A for the definition of parking given in the instructions to the observers.

complished while the car stands on the street is, in the great majority of cases, a sufficiently significant link in a chain of responses to constitute, at least, a sub-goal; that is, the particular errand is of sufficient significance that its accomplishment is followed by a reward, a reward which perhaps may best be analyzed as a relief of anxiety.

It is further assumed, and it is believed that the assumption is not unreasonable, that, upon the completion of the errand for which the individual parked, the next steps taken will be the return to the car and the starting of the car and that the time elapsing between the completion of the errand—the completion of the goal or sub-goal response with the consequent attaining of a reward—and the starting of the car will be substantially the same regardless of the length of time between the parking of the car and the attaining of the reward. That is to say, after a person has completed his errand, he will return to the car and start it; and this latter chain of behavior will take approximately the same length of time no matter what the length of time required to complete the errand. On the basis of these assumptions, the observed elapsed time between each parking of a car and the starting of the same car is taken as an index of the elapsed time between the parking of the car, regarded as an instrumental response, and the attainment of the reward which reinforces that response.

Relative Time. It will be apparent from the above that in the unregulated situation, each individual who parks a car is regarded as being motivated by a drive which may be reduced by a series of instrumental responses, one of which is parking the car; the cue includes this drive, the automobile, the parking space, and some other factor which identifies the situation for him; the response is the stopping of the car with its wheels near and approximately parallel to the curb; the reward is the reduction of the drive, which reduction is assumed to occur, in the case of all parkers, a short time before the car is removed from the parking space. The analysis is concerned with the change in the frequency of occurrence of this instrumental response of parking the automobile when there is introduced into the situation a cue for a response which conflicts with parking. By learning theory, then, the significant aspect of the unregulated behavior is the strength of the reward which, in each case, supports or reinforces the instrumental response of parking, since this factor is the significant one in determining the resistance of a response to a conflicting situation. In theory, the strength of the reward reinforcing the instrumental response of parking the car, in each instance, varies with several factors—the strength of the motivating drive, the proportion of this drive which will be reduced when the goal response is given, and the time delay which occurs between the giving of the instrumental response and the attainment of the reward which supports it. Two of these factors have been eliminated from the analysis by assumptions. The assumptions

are that the strength of the drives motivating the parkers and the quantity of the rewards which they receive upon attaining their goal are distributed equally among all studies and among all duration categories of a single study. Thus the sole remaining factor bearing on the strength of the reinforcement for the instrumental response of parking the car is the delay in obtaining the reward. The data do differentiate the parkers on the basis of this factor.

While the elapsed time between the parking of the car and its removal from the parking space has been assumed to be an index of the delay in obtaining the reward for the instrumental response of parking, this time measurement does not index the strength of the reinforcement of the response of parking. This is apparent from the fact that the absolute duration of parking (time elapsed between parking and leaving) as such does not enter into the regularities obtained. It will be remembered that the significant measurement in the analysis of the studies was the relative rather than the absolute duration of the parkings. With regard to any particular category the significant measurement was the per cent of the total number of parkings which had a duration of less than that of the particular category rather than the absolute duration depicted by the category.⁴² This relative duration must, then, index the strength of reinforcement of the instrumental response.

The following, it is believed, is an acceptable explanation, on the psychological level, of the significance of relative rather than absolute durations. Although an instrumental response may be learned and continue to be reinforced through the agency of a reward which is delayed, that is, one which is received after the lapse of a considerable period of time following the giving of the response, the determinative factor in the resistance which that response has in the presence of a conflicting cue is the state of the person's mind at the time he must make a choice between conflicting responses. The operative strength of the reinforcement of an instrumental response, assuming other factors to be equal, is not determined by the length of time between the response and reward as measured by an observer; it is determined by the *conception which exists in the mind of the person giving the response* as to the length of time between those events. It is submitted that in most instances in everyday affairs a person's subjective conception of duration is relative rather than absolute. A person who takes thirty minutes to eat his lunch thinks of that length of time as short if he regularly eats in a club where most of the members spend an hour or longer at lunch. If the same person regularly eats at a lunch counter where most of the customers are finished within fifteen minutes

42. In the formula by which the percentage of the regulated distribution which will fall in any category to the right of the Point, is determined, one factor, x , is the cumulated percentage of the entire unregulated distribution which lies to the left of that category. See the discussion under *Analysis of the Data of the Parking Studies*, page 23 *supra*.

he will think of the thirty minutes as long. His conception of the duration of his own behavior depends on his conception of his relative position in a distribution which includes not only his behavior but also the behavior of other persons who, in the judgment of the person affected, are doing the "same thing." It is submitted that this conception of relative duration, and, hence, of *relative* elapsed time between the giving of an instrumental response and the obtaining of the reward, controls the strength with which the reward reinforces the instrumental response.

The above explanation assumes that the person whose behavior is under observation has, at the time he gives the response, a subjective impression not only of the probable duration of his own behavior but also of the probable duration of the behavior of all others whom he thinks of as doing the "same thing." Thus, in the parking studies, a person who is about to park is assumed to "know" not only how long he is going to remain but also the distribution of the durations of parkings by others in the neighborhood. This assumption is not difficult to support. The person in the club or in the lunch room does not have to stand, watch in hand, and carefully time the eating behavior of others in order to have a reasonably accurate impression of the length of time that others spend lunching in the respective places. He is apt to obtain such an impression simply from the surroundings without ever having seen anyone lunch in either place. Similarly, when a prospective parker observes a particular neighborhood, his experience enables him to judge the types of errand which are performed there and their probable relative frequencies; and thus he has an impression of the likely distribution of parking times at that site.⁴³

By way of summary, in the application of the theory to the parking studies, an individual who parks on the observed site during the unregulated period is thought of as being motivated by a drive of unknown quality and strength; the cue is the combination of the drive, the car, the street, and something which identifies the situation as one in which parking will lead to reward; the response is the moving of the car to a position in which the right wheels are near the curb and parallel to it; the goal reward is of unknown quality and strength and is obtained at the end of the period during which the car remains standing at the curb; the instrumental response of parking is reinforced by a reward the strength of which is a function of (1) the strength of the goal reward—which factor is eliminated by the assumption that rewards of varying strengths are distributed proportionately among all studies and all duration categories of all studies—and (2) the person's impression as to the delay which will ensue between the giving of the instrumental response and the obtaining

43. The authors have not yet stated their notions as to relative time in terms of a behavioristic theory.

of the reward. This impression is determined by the person's impression as to his relative position in a distribution of parking durations on that site and this latter impression is, in turn, indexed by an actual measurement of the relative position of the duration of each parking with respect to the others. By this process, the strength of the reinforcement for any response of parking, which parking will be categorized according to the elapsed time between parking and leaving, is related to the percentage of the total parkings which are in categories denoting durations less or greater than the particular parking. In other words, the per cent of the total unregulated distribution to the left of a particular category, on a time axis, is a measurement of the strength of the reinforcement for parkings which fall in that category.

The Regulated Period.

The second series of observations in each parking study was made under conditions as nearly like those of the first series as the means of control would permit, with the exception that there was introduced into the situation, before the beginning of the second series, a notice of the regular police pattern stating that parking on the site was prohibited or limited to some specified duration.

From the viewpoint of a learning theory analysis, two aspects of the situation in each parking study during the regulated period are of primary significance. First, the cue for the response of parking a car still remained. Presumably there was no change in the drives of the various individuals in the neighborhood; there was no change in the characteristics of the neighborhood which would affect the number or type of errands which might be performed there; the cars and the space along the curb still remained. Second, the posting of the police notices changed the pattern of cues in each situation by introducing into that situation a cue for a response which conflicted with the response of parking.

The Drive. The drive which motivates action in this new cue-response relationship is an acquired drive of anxiety. The anxiety is an anxiety which arises upon the sight of the posted notice in conjunction with the other parts of the cue.⁴⁴

The Cue. Like other cues, the cue in the new cue-response relation includes the drive. It also includes the car, the street, and the posted notice stating the regulation. These items alone are sufficient to identify the

44. The cue, which includes the posted notice of the regulation, produces the anxiety, or fear response which is, in itself, a stimulus of such strength as to have drive value. This is a recognized function of cues in learning theory. Such cues are said to have drive value. They play a double role—they arouse the drive and cue the response which reduces the drive. See MILLER AND DOLLARD, c. IV.

situation as one in which the giving of the response will be followed by reward.

The Response. The response is the driving of the car past the area, as opposed to parking it in the area, the latter being the response conflicting with the new cue-response relation.

The Reward. The reward which supports the response in this new cue-response relation is, of course, the relief of the anxiety, the reduction of the drive which motivated the response.

The Degree of Reinforcement of the Response. The degree of support (reinforcement) of the response in this new cue-response relation, which is the significant factor in the determination of whether the response will be given in a conflict situation, varies with the strength of the anxiety which is to be relieved, the extent to which the anxiety (of whatever strength) will be relieved by the giving of the response, and the lapse of time between the giving of the response and the obtaining of the reward.

It is submitted that, in the situation under discussion, the giving of the response of driving past the area is followed immediately by the reward in the case of every individual in the cue-response relation. When the cue which arouses the drive disappears, the drive, at least in a situation such as this, also disappears. There is thus no appreciable lapse of time before the reward is obtained. Further, the giving of the response *completely* reduces the anxiety. It is not partially alleviated by leaving the situation; it is completely eliminated.

As to the one remaining factor, the degree of anxiety which is aroused by the cue and which is present to be relieved, it is believed that this varies from one parker to another. In the first place, it is quite likely that all persons do not develop the same degree of anxiety when confronted by the same cue. Differences in experience, as well as physical and psychological differences, would lead to the expectation of differing degrees of anxiety in different individuals faced with a notice stating a parking restriction in a situation in which each of the individuals also saw a cue to which he had learned to respond by parking. It is believed that in studies such as those reported here such individual differences may be disregarded. When the behavior observed is that of a large number of individuals, it is likely that these individual differences will appear equally in all studies and in all categories of the same study. In the second place, it is believed that the degree of anxiety which is aroused in all individuals by the cue which includes the posted notice of the parking restriction, if any anxiety is aroused at all, will vary with the restriction which the notice states. Since the anxiety is based on a fear of the consequences of "violating" the ordinance, the degree of anxiety which is felt, if any is felt, will vary

with the time which will elapse between the response of parking (if it be given) and the beginning of the "violation." If the person thinks of himself as being about to leave his car in the area for a period that is less than that stated on the notice, the cue will arouse in him no anxiety at all. If he thinks of himself as about to leave his car in the area for a period longer than that stated on the notice he will feel a greater anxiety if he conceives of the "violation" as beginning a short time after the parking of the car than he will feel if he conceives of the "violation" as beginning only after the lapse of a considerable period from the time the car is parked.

Here, as in the situation above, it is believed that the individual's conception of the time which will elapse between the parking and the beginning of the violation is a relative rather than an absolute one. His conception as to whether "60 Minutes" on a police notice states a short or a long period depends on whether he judges it to be long or short relative to the duration of the existing behavior to which he refers the symbols. If no one in the situation parks for more than sixty minutes he will think of it as a long time; if everyone parks for more than sixty minutes he will think of it as a short time.

It follows from the above that in any one parking study the degree of reinforcement for the response of driving past the area is the same, or may be taken as the same, for all individuals who have the drive, that this degree of reinforcement varies from one study to another, and that the differences in the degree of reinforcement of the response from one study to another are related to the differences in the proportion of the entire unregulated distribution represented by parkings having durations less than (or greater than) the ordinance time.

The Differences Between the Behavior Observed in the Unregulated Period and That Observed in the Regulated Period.

In each study a cue-response relationship existed in which the response was parking a car. This cue-response relationship was present both in the unregulated and regulated periods. The number of such responses was counted by the observers during both periods, and these responses were categorized with regard to the time elapsing between the giving of the response and the giving of another response—taking the car away. During the regulated period, in each study, there existed a second cue-response relationship in which the response was driving past the area. This response conflicted with the parking response. The observers did not count the number of "driving past" responses.

The Differences in Relative Frequencies Among Categories. The difference, if any, between the number of observed parkings in each category during the unregulated and the number in the same category during

the regulated period is the direct effect, eliminating for the moment the effect of unsatisfied demand,⁴⁵ of the introduction of the cue for the conflicting response. In a conflict situation the determination of whether one response or the other will be given depends upon the relative degrees of reinforcement of each of the conflicting responses. In the parking studies the degree of reinforcement for the response of parking, in any particular category, is correlated with the cumulated percentage of the entire unregulated distribution to the left of (durations less than) the particular category; the degree of reinforcement for the response of driving past the area is correlated with the cumulated percentage of the entire distribution to the left of (durations less than) the ordinance time.

From all of the above, it is believed that the following propositions as to the samenesses and differences between each pair of parking study distributions, disregarding differences attributed to unsatisfied demand for parking space, may be deduced:

(1) In each study there will be a point on the horizontal (duration of parking) axis to the left of which the frequency of parkings observed during the regulated will be the same as the frequency of parkings observed during the unregulated period.

This follows from the assertion of the theory that no anxiety will be aroused by the posted notice in those persons who think of themselves as being about to park for a period less than that stated in the posted notice. Since these persons have no anxiety there is no drive, and hence no cue for the response of driving past the area. For these persons there is no conflict. Since the other cue-response relationship, in which the response is parking, is present in both periods, they will, therefore, give the parking response with the same frequency as before. Within the limits of verification set by the number of studies and the regularities set out in the *Analyses* above, this deduction is verified by the results (sameness of distribution to the left of a specific point in each study).

(2) The point referred to in (1) above will be at a point on the horizontal (duration of parking) axis such that the percentage of the entire unregulated distribution which lies between that point and the ordinance time will be the same in each study.

The point in (1) marks the first category, from left to right, in which the parkers felt anxiety upon seeing the posted notice, and hence were in a conflict situation. Whether any parker feels this anxiety at the time of parking depends on his conception as to (a) the length of time he is going to park and (b) the length of time stated on the posted notice. The parker's conception of each of these time lengths is relative.⁴⁶ Since individual differences are assumed to appear equally in all studies, it follows

45. See the discussion of this factor under *The Number Analysis*, pages 29, 52 *supra*.

46. See discussion at page 74 *supra*.

that the parkers' conception of the relation between their parking times and the ordinance time should be the same in all studies. This deduction is verified by the relation between the percentage of the entire unregulated to the left of the ordinance time and the percentage of the entire unregulated to the left of the Point. $p = 14.5 + r$.⁴⁷

(3) In each study the frequency of parkings in the categories to the right of the Point referred to in (1) above will decrease and the amount of such decrease will vary with (a) the percentage of the entire unregulated distribution which lies to the left of that category and (b) the percentage of the entire unregulated distribution which lies to the left of the ordinance time.

The parkers in the categories to the right of the Point are each in a conflict situation. Which of the conflicting responses is given depends upon the relative degrees of reinforcement of each response. The degree of reinforcement of the response of driving past the area is the same for all parkers in a single study but varies from study to study and the variation is correlated with the percentage of the unregulated to the left of the ordinance time. The degree of reinforcement of the response of parking varies from individual to individual within a single category of a single study, but the variation *within* each category is assumed to be the same as that within every category of every study. However, the average degree of reinforcement of the response of parking varies from category to category and is correlated with the percentage of the total unregulated distribution which lies to the left of that category on the time axis. In each category to the right of the Point there likely will be some potential parkers for whom the degree of reinforcement of the response of parking is so slight that it is overcome by the reinforcement of the response of driving past the area. Thus the decrease will begin at the Point. The amount of the decrease in each category reflects the average degree of reinforcement of the parking response in that category and the degree of reinforcement of the response of driving past the area. Thus within a single study the decrease in the categories to the right of the Point will vary only with the cumulated percentage of the unregulated distribution to the left of the category and will vary in such a way that the greater the percentage to the left of the category the greater the decrease. This is verified by that portion of the curve on each separate cumulated percentage graph (Figures 11-20) which lies to the right of the Point. However, when the decreases in the categories to the right of the Point in one study are compared with the decreases in the comparable categories of the other study, the differential in the degree of reinforcement of the response of driving past the area must be taken into account; and, when this differential is taken into account, a regularity should appear. This

47. See Fig. 21 *supra*.

is verified by the fit of the formula $y = 102 (1 - 10 - (kx)^n)$ in which x represents the cumulated percentage of the unregulated distribution to the left of each separate category and by the fit of the data to the relations expressed by the graphs in Figures 32 and 33 by which the values of k and n in the above formula are related to the cumulated percentage of the unregulated distribution to the left of the ordinance time in each study.

The Differences in Absolute Frequencies. The basic learning theory relationship is a relationship between drive, cue, response, and reward. Each is necessary to the relationship. There can be no cue without a drive and no response without both a drive and a cue. A response to a cue which includes a drive will not be learned, or continue to be given once it is learned, if there is no reward. Even though a drive is present there will be no response until the other elements necessary to make up the cue appear.

In the parking studies each individual who parked did so in response to a cue which included a drive of an unknown quality and strength.⁴⁸ Since drives as such are unobservable, the number of persons in the neighborhood of each study having such drives is unknown.

From the above, the following propositions with respect to the differences in absolute frequencies between the unregulated and regulated periods in the parking studies may be deduced:

(1) If, in a given parking study situation, there are more potential parkings (parkings which would occur were sufficient parking space available) than there are parking spaces available, the number of observed parkings will increase when the number of available parking spaces is increased.

The number of occurrences of a response is limited by the number of concurrences of a drive and a cue. If there are more drives than cues, the number of responses will increase upon the creation of more cues. The creation of additional parking space is the creation of more cues.

(2) The amount of the increase in the number of observed parkings referred to in (1) above will vary with the number of potential parkings previously unrealized and the number of additional parking spaces made available.

If the situations in the parking studies reported here be taken, as they are, as situations in which, prior to the introduction of the ordinances and the posted notices, there was an unsatisfied demand for parking space,⁴⁹ then each of the two deductions above is verified by the fit of the formula $u = 12 + 1.4x - 1.01v$, in which formula u may be said to represent the increase attributed to this unsatisfied demand, x is a measurement of the number of additional parking spaces created, and v

48. See page 72 *supra*.

49. See the discussions under *The Numbers Analysis*, pages 29, 52 *supra*.

is a measurement (index) of the number of potential parkings unrealized prior to the introduction of the ordinances and posted notices.⁵⁰

The Theory Applied to the Administrative Studies

It will be recalled that the hypothesis on the basis of which the analysis of the administrative studies proceeded was that the effect of the tagging which was done in those studies was to prevent all further parking for durations longer than the tagging time, by the persons whose cars were tagged or alternatively, if a slight improvement in results be accepted as significant, by persons who, prior to the tagging period, had been parking repeatedly in the area for durations greater than the tagging time.

During both the no-tagging and the tagging periods of each study the persons who parked were giving a response in a learning situation the drives, cues, responses, and rewards in which were identical with those described above under the discussion of the parking studies. During the tagging period of each study some of the individuals in the situation faced a conflict. A new cue-response relationship appeared in the situation. This new cue-response relation was similar to that introduced into the parking study situations in that the response was driving past the area (as distinguished from parking in the area), the drive was an anxiety drive aroused by the cue, and the reward was relief of the anxiety. With respect to the cue, however, the cue-response relation differed from the new relation which appeared in the parking studies. In the administrative studies no notice was posted stating that all cars staying over eighty or forty-five minutes were being tagged. The tags, relatively inconspicuous to persons approaching in cars, were placed on the cars which remained longer than the designated period and, of course, remained there for varying periods of time until the car was removed. But during most of the time during the tagging period the physical appearance of the area was no different than during the no-tagging period. It is, therefore, not unreasonable to correlate the tag itself with the concept of cue in the new cue-response relation, and to assert that the only persons who got the cue, which cue aroused anxiety, and which anxiety in conjunction with the tag formed a cue for the delayed response of driving past the area on future occasions, were the persons whose cars were actually tagged.

On the basis of this correlation the following deductions from learning theory may be made with respect to the differences between the no-tagging and tagging distributions:

(1) There will be no change in the frequency of parkings by persons who did not receive tags.

50. See pages 38 *et seq. supra*.

Since there is no new cue for these persons there will be no response. As to such persons there is no new cue-response relation, no conflict, and hence no change.

(2) There will be a decrease in the frequency of parkings of durations longer than the tagging time by persons who do receive tags and this decrease will account for the entire difference between the no-tagging and tagging distributions of each study (temporarily eliminating, again, the difference attributed to unsatisfied demand).

As stated above these persons are faced with a conflict and it is likely that for some, at least, the reinforcement of the parking response will be so slight that it will be overcome by the reinforcement of the response of driving past the area on occasions in the near future.⁵¹

Except for the elimination of *all* parkings by repeaters, rather than of repetitions only, these two deductions are verified by the regularities obtained in the distribution analysis of the administrative studies. The amount of the decrease depends, of course, on the relative strengths of the reinforcement and the absolute strengths of reinforcement cannot be deduced from learning theory. The results of the administrative studies indicate that in both studies the decrease was virtually 100 per cent. Clearly, this is consistent with the theory. It posits a situation in which one of the conflicting responses is reinforced so strongly as to overcome all of the varying degrees of reinforcement supporting the other response.

If the shift from the elimination of repeat parkings to the elimination of all parkings by repeaters, which was made in the analysis,⁵² is regarded as significant, a different correlation to the cue concept of the theory is required. In that event, a cue for a conflicting response must have been seen by persons other than those who received tags since the repeaters, or habitual parkers did not park even once after the tagging began. With such an interpretation the cue would be correlated either to the tags on the cars, as visible to persons in the neighborhood, or the behavior of the policeman in placing the tags on the cars, or the general talk in the neighborhood caused by the tagging, or to any combination of two or all of these factors. Otherwise, the correlations and deductions would be the same as above. It is believed that it would not be impossible to design studies which would resolve this difficulty as to the item to be correlated with the cue.

51. There is nothing in the data of the administrative studies to determine how long the effect of a tag lasts. During the twenty-five days of the eighty minute tagging study (the longest tagging period) there was no indication of a "wearing-off" of the effect. One car was tagged twice during the eighty minute study. Two cars were tagged twice each during the forty-five minute study.

52. See page 45 *supra*.

The numbers analysis of the administrative studies is, it will be recalled, identical with that of the parking studies. The application of the theory to this portion of the analysis also is identical.⁵³

The Theory Applied to the Rotary Traffic Studies

As in the parking and administrative studies, the individuals whose behavior was observed in the unregulated period of the rotary traffic studies were motivated by drives of unknown quality and strength. All the drives, however, were drives one step in the reduction of which was the response of the driving of a car across the intersection at which the observations were made. The cue, for all of these individuals, included the drive and also the car, and the street intersection. The response was the driving of the car across the intersection. The observed occurrences of this response were categorized with respect to the path taken. The reward, as in all other cases, was the reduction of the drive.

As in the other studies, there was present during the regulated period of the rotary traffic studies a second cue-response relation. In this second relation, the drive, as in the other studies, was an anxiety drive; the cue was the cue of the first cue-response relation *plus* the painted notices of the regulation, and the reward was the relief of the anxiety. Unlike the other studies, the response in this second cue-response relation was observed during the regulated period of the rotary traffic studies. The response was driving across the intersection by a path which carried the car to the right of the oval painted on the pavement. The response in this second cue-response relation thus conflicted with some of the responses in the first relation; it did not conflict with others of them.

The rewards of the first cue-response relation—the reduction of the drive which motivated the response of crossing the intersection, during the unregulated period—were received at some point in time after the crossing of the intersection was completed. The time which elapsed between the completion of the crossing of the intersection and the obtaining of the reward doubtless varied with the different individuals; but it is believed likely that, with the large number of drivings observed, these differences will be equally represented in all of the lane-categories. The rewards in the first cue-response relation may thus be regarded as received by all drivers either at the point of completion of the crossing of the intersection or at a point equally removed in all cases, in terms of time, from the point of the completion of crossing. If the situation of each driver is viewed at the point at which he must choose one or the other of the paths across the intersection, the response of entering on the shortest path will have the greatest degree of reinforcement, other factors

53. See the discussion at page 82 *supra* for the application of the theory to the parking studies.

being equal, since the reward, which is assumed to be of equal quantity in all cases, will be obtained in the shortest time by taking the shortest path across the intersection.⁵⁴

The rewards of the first cue-response relation are received by all drivers in both the unregulated and regulated periods and regardless of what path they take across the intersection. There is, however, a differential in the degree of reinforcement of the sub-responses which are the taking of the first steps on one or another of the paths across the intersection. This differential is caused by the differential in time, which, in the conception of the persons about to enter on one path or the other, will elapse between the giving of the response and the obtaining of the reward which reinforces it.

From the above, the following propositions concerning the changes effected by the introduction of the ordinance and the painted notices may be deduced:

(1) There will be no change in the frequency of drivings in the lanes to the right of the oval except such change as represents increase caused by the addition of drivings displaced from the lanes through and to the left of the oval.

The response in the second cue-response relation is driving to the right of the oval. Thus it is identical with driving to the right of the oval when given as a response in the first cue-response relation. There is no conflict. This deduction is verified by the comparison of Stage I (unregulated) and Stage III (regulated) of the Oak-Dow to Davenport study. In that study 99½ per cent of all observed drivings were in lanes passing to the right of the oval both in Stage I and in Stage III.⁵⁵

(2) There will be a decrease in the frequency of drivings through and to the left of the oval, and the amount of this decrease in each lane-category will vary with the distance in space between that lane and the nearest lane which passes to the right of the oval and will vary in such a way that the greater the distance the less the decrease.

It is likely that for many drivers the distance differential between the lane which they would conceive of, at the time of making a choice, as the most rewarding and the lane the driving in which is the response in the second cue-response relation is so slight that it will be overcome by the prospective anxiety relief which reinforces the response in the second cue-response relation. There will be, therefore, a decrease in those categories which mark responses inconsistent with the response in the second

54. Other factors, such as the apprehension of danger, may overcome this differential of lapse of time between the giving of the response and the obtaining of the reward. Hence, it would not be expected that all of the drivers would take the shortest path across the intersection.

55. See page 56 *supra*.

cue-response relation. As the difference in distance increases, the differential with respect to the relative reward values of the two lanes, as conceived by the person about to make a choice, increases. Therefore, the greater the distance between a particular category and the nearest unprohibited category, the less will be the decrease. This deduction, to the extent that the small number of studies and the doubts as to their categorization permit verification, is verified by the relation between the percentage of decrease in the total number of drivings in prohibited paths and the average lateral distance between the prohibited paths and the nearest unprohibited path.⁵⁶

The lateral distance between a prohibited path and the nearest unprohibited path is not, of course, equivalent to a measurement of the relative lengths of the two paths. It may be, however, a better measurement of the conception of the relative lengths of time required by the two paths which exists in the mind of an individual about to choose one path than the actual measurements of the relative lengths would be.⁵⁷

(3) There will be an increase in the lane to the right of the oval which is nearest to the prohibited lanes.

Since all drivings, both those which conflict and those which do not conflict with the response in the second cue-response relation, were observed, and since it is posited above that there will be a decrease in the frequency of drivings through and to the left of the oval, it follows that an increase will appear in the categories to the right of the oval. From the discussion of distance differentials above, it follows that the drivings displaced from the categories to the left of and through the oval will go to the nearest unprohibited category rather than to one for which the distance differential, and hence the reward differential would be greater.

It is not believed that there is anything in the data of the rotary traffic studies inconsistent with this deduction. The data is such, however, that it offers no very significant test as to the location of the increase.⁵⁸

56. See Fig. 55 *supra*.

57. For an interesting presentation of the phase of the application of the goal-gradient hypothesis used here in connection with the rotary traffic studies, see Hull, *The Goal-Gradient Hypothesis Applied to Some 'Field-Force' Problems in the Behavior of Young Children* (1938) 45 *PSYCH. REV.* 271.

58. See pages 55 *et seq. supra*.

APPENDICES

APPENDIX A. DETAILED DESCRIPTION OF PARKING STUDIES

Dates and Hours of Observation

The ten parking studies here reported, with the dates and hours of observation, are as follows:

I. *Crown Street, North Side (Area A)*. Dates of observation: *unregulated*, October 26, 27, 28, 29, 30, 31; December 1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 14, 1936; *regulated* ("No Parking"), November 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 23, 24, 25, 27, 28, 30, 1936. All observations from 8:00 A. M. to 5:00 P. M. each day.

II. *Crown Street, South Side (Area A)*. Dates of observation: *unregulated*, November 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 23, 24, 25, 27, 28, 30, 1936; *regulated* ("No Parking"), October 26, 27, 28, 29, 30, 31; December 1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 14, 1936. All observations from 8:00 A. M. to 5:00 P. M. each day.

III. *Crown Street, North Side and South Side Combined (Area A)*. Dates and hours the same as numbers I and II above with the addition of October 23, 1936, to both unregulated and regulated. Regulation: "No Parking." (See explanation below.)

IV. *Crown Street, North Side and South Side Combined (Area A)*. Dates of observation: *unregulated* and *regulated*, October 28, 29; November 4, 5, 25, 26; December 2, 3, 1935. All observations from 8:00 A. M. to 5:00 P. M. each day. Regulation: "No Parking."

V. *Church Street (Area A)*. Dates of observation: *unregulated*, from 7:00 P. M. to 8:00 P. M.; October 30; November 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 16, 17, 18, 19, 20, 23, 24, 25, 27, 30; December 1, 2, 3, 4, 7, 8, 9, 10, 11, 14, 15, 16, 17, 18, 1936; *regulated* (fifteen minute parking), from 5:30 P. M. to 6:30 P. M. on the same thirty-five days. (See explanation below).

VI. *Church Street (Area B)*. Dates of observation: *unregulated*, from 7:00 P. M. to 8:00 P. M.; May 4, 5, and 6, 1936; *regulated* (15 minute parking), from 5:30 P. M. to 6:30 P. M. on the same three days. (See explanation below).

VII. *Water Street*. Dates of observation: *unregulated*, November 6, 9, 10, 11, 12, 13, 16, 17, 18, 19, 20, 23, 24, 25, 27, 1936; *regulated* (thirty minute parking), November 30; December 1, 2, 3, 4, 7, 8, 9, 10, 11, 14, 15, 16, 17, 18, 1936. All observations from 8:00 A. M. to 5:00 P. M. each day.

VIII. *College Street*. Dates of observation: *unregulated*, from 7:00 P. M. to 7:30 P. M.; December 12, 13, 14, 15, 16, 18, 1933; *regulated* (thirty minute parking), from 4:30 P. M. to 5:00 P. M. on same six days. (See explanation below).

IX. *Prospect Street, East Side*. Dates of observation: *unregulated*, November 16, 17, 18, 19, 20, 23, 24, 27, 30; December 1, 3, 4, 7, 9, 10, 1936; January 5, 6, 7, 11, 12, 1937; *regulated* (sixty minute parking), January 13, 14, 18, 19, 20, 21, 25, 26, 27, 28, 29; February 1, 2, 3, 4, 5, 8, 9, 10, 11, 1937. All observations from 8:00 A. M. to 5:00 P. M. each day.

X. *Prospect Street, West Side*. Dates and hours of observation the same as number IX above. Regulation: sixty minute parking.

The Unregulated and Regulated Periods

In the Water Street study and in the two studies made on Prospect Street, it was known in advance that parking in the areas would be limited by ordinance to be passed and to become effective on a certain date. Consequently, it was possible to make each of these series of observations at a time when the observed area was unregulated and to repeat them after the ordinance was enacted and the police notices posted. However, such experimental situations could not be manufactured at will. In the other studies the ordinance had been enacted by the proper authorities before any observations were made; the unregulated and regulated periods were obtained by taking advantage of the terms

of the ordinance itself and the posted notices. All of the Crown Street studies were made under an ordinance which prescribed "No Parking" for one side of the street during one month and for the opposite side of the street during the succeeding month. At all times, therefore, one side of the street was subject to a "No Parking" restriction and the other was unrestricted, but these sides changed at the end of each calendar month. Thus the unregulated distribution for the north side of Crown Street was obtained from the observations made in October and December, while the regulated distribution, for the same side, was obtained from the observations made in November. The distributions for the south side were obtained similarly. At the end of each calendar month the posted notices, which were on portable stanchions, were moved from one side of the street to the other

Plan of
Central New Haven

Showing Locations of Studies

1. CROWN ST. - NORTH SIDE AREA A	8. COLLEGE ST.
2. CROWN ST. - SOUTH SIDE AREA A	9. PROSPECT ST. - EAST SIDE
3, 4. CROWN ST. - AREA B	10. PROSPECT ST. - WEST SIDE
5. CHURCH ST. - AREA A	11. ROTARY TRAFFIC STUDY SITE
6. CHURCH ST. - AREA B	12. OAK ST.
7. WATER ST.	13. LEGION AVE.

by members of the police department. In the College Street study and in the two studies made on Church Street, advantage was taken of the fact that the ordinances covering these streets became inoperative, by their terms, after 7:00 P. M. each evening. Accordingly, in these studies, a series of observations was made before and another series after 7:00 P. M. on each day. The observations made after 7:00 P. M. were tabulated together to form the unregulated distribution and those made before 7:00 formed the regulated distribution. The problem of comparability of hours raised by this procedure is discussed below.

Description of Areas and Neighborhoods

The areas which were observed were in central New Haven, all within approximately one mile of the center of the business section. The areas are spotted on the map.

All of the Crown Street studies here reported were made on the same area—between York and Howe Streets on Crown. Both the north and south sides of the street were observed for a distance of 175 feet, designated to the observers, and lying approximately in the middle of the block. On the block were four single houses, one of which was vacant at the time of the studies, one double house, one medium sized apartment house, one medium sized rooming house, one small laundry, one small food shop, one shoe shop, one filling station and one motor sales room with an adjacent used car lot, which appeared during the period between the 1935 and 1936 studies. The area is approximately five blocks from the center of the city. The observer was stationed in a second story window projecting onto the sidewalk on the south side.

The two Church Street studies were made in two separate areas. The study designated as *Church Street (Area A)* (No. V.) was made on an area 280 feet long running along the west side of Church Street between Elm and Court Streets, abutting the New Haven Green and directly opposite the City Hall. The observer was stationed in a second story window of the City Hall. *Church Street (Area B)* (No. VI.) was made on an area approximately a block west and on both sides of the street, the west side abutting on the Green and the east side fronting the New Haven Post Office and a bank and office building. The observers were on the street. These two Church Street areas are in the center of the business district.

The Water Street study was made on an area 250 feet long in what may be generally described as a wholesale district. Four wholesale houses—electric and plumbing—fronted on the observed area; also a filling station, a repair shop, and a vacant store room. The entire opposite side of the street is occupied by the general offices of the New York, New Haven, and Hartford Railroad; and the area is approximately two blocks from the New Haven Railroad Station. The observers were in a second story window of a plumbing warehouse.

The College Street study was made on an area covering most of the two blocks on College Street between Chapel and George Streets. Fronting on the area were three theatres, a large hotel, a doctor's office building, two parking lots, and several small stores. The observers were on the street.

The two Prospect Street studies were made in a neighborhood several blocks removed from the center of the city. *Prospect Street, West Side* was made on an area 579 feet long fronting eight large residences. *Prospect Street, East Side*, 476 feet long, was directly across the street and fronted two Yale University buildings, the Sloane Physics Laboratory and the Sterling Chemistry Laboratory. The observers were located in the tower of the Chemistry Laboratory.

The Process of Observation

A large number of observers were required, since several of the studies were conducted simultaneously and it was not thought desirable for an observer to work longer than three or four hours at a time. The observers were, for the most part, students. All were paid and all were subject to close supervision. Every effort was made to place the observers so as to make them inconspicuous and it is believed that this was accomplished with great success.

Each observer was carefully instructed in the method of recording his observations. The records were made on printed forms, a sample of which appears below:

Time of Parking	Identification	No. License	Time Left	Time Parked	Remarks

The observers were instructed to record in the first column the "Time of Parking" of each automobile to the nearest half minute. The "Time of Parking" was defined as the time the wheels of the automobile stopped moving. Similarly the "Time Left" recorded in the fourth column was defined as the time the wheels began to move. The identification and license number columns were used only to enable the observer to identify a car leaving the area as one entered on the card as having parked at a particular time. The "Remarks" column was used to indicate automobiles which double parked, those which parked on the wrong side of the street, those which parked in front of fire hydrants or driveways, and any situation with which the observer was not certain how to deal.

The areas were marked by trees, telephone poles, breaks in the curb, or other marks present on the street before the studies began. The observers were instructed to record any vehicle which they believed to be at least one-half within the area designated.

The hours of observation for each study set out above are the hours during which cars entering the area were counted. Thus on Crown Street, where the hours of observation were from 8:00 A. M. to 5:00 P. M., the observers were instructed to record all cars parking in the area during those hours and to stay until the last car parking between 8:00 and 5:00 was gone. This sometimes required an observer to stay at his post until a late hour. In addition, a record was made of all cars in the area when the period of observation began and the time such cars left. These cars were not, however, included in the primary tabulation. (See below under "Certain Observed Parkings Excluded From the Tabulations.")

It is believed that the observations were made with a great degree of accuracy. Of the thousands of entries on the cards only a few had to be discarded because of obvious errors, and it is believed that other errors were kept to a very low minimum by supervision. Checks were obtained by placing other observers at different posts, unknown to the regular observers, and having them record, for short periods of time, the same situation. No significant differences appeared as a result of this process.

Comparability of the Unregulated and Regulated Situations

In the Water Street study and the two Prospect Street studies no special problems of comparability between the unregulated and regulated periods were raised. Both series of observations were made during the same hours of the day; and there was no change, so far as could be determined, in the use of the buildings in the neighborhood during the two periods. The only known general difference between the two periods (other than the introduction of the ordinance and the posted notice) was the lapse of time which occurred with the attendant change in general weather conditions. It is believed that this did not significantly affect the results in any instance. In these studies, as in the others, isolated and known occurrences which might affect comparability were taken care of by eliminating the entire day's observations from the tabulation. This was done in several instances of irregular weather conditions such as snow and fog, in several instances of special meetings held on or near the observed area, in one instance of a fire and another of a parade, all of which, it was judged, probably disrupted the normal flow of traffic. Weather conditions were checked by means of official Weather Bureau reports.

The Crown Street studies were peculiar in that each of the areas observed during the unregulated period previously had been regulated. It is believed that this did not affect the results. It was observed that at the beginning of each month, when the parking restriction shifted from one side of the street to the other, the effect was immediate. The distribution of parking durations on the regulated side of the street changed at once and continued stable throughout the month. There was no gradual change.

In the College and Church Street studies a special problem of comparability was raised by the fact that the unregulated and regulated series of observations were made at different hours of the day. To obtain a basis for a judgment on this problem two types

of tests were employed: first, the flow of traffic, that is, the number of cars passing the area, in both directions during the hours in question was recorded and compared; second, for long periods of time persons parking cars in the area during the hours in question were shadowed by a second set of observers, or tracers, and their destinations were recorded. These errand destinations were compared hour by hour. As a result of these procedures there was no clear indication that the hours selected were not comparable and it was judged worthwhile to include the studies in the analysis.

Studies Not Reported

Because of doubt as to comparability some of the studies made were not included in the analysis and do not appear in this report. Simultaneously with the making of the studies on the A area of Crown Street, studies were made on another area—one block east on the same street—designated the B Area [Nos. (3) and (4) on the map]. No part of the B Area was at any time unregulated. At all times parking was prohibited ("No Parking") on one side of the street and was limited to thirty minutes on the other side. It was hoped that the A and B Areas would be found to be generally comparable and that additional "before and after" studies could be obtained by pairing each of the regulated distributions obtained on the B Area with the unregulated distributions obtained on the A Area. However, the process of tracing the persons parking on the two areas to their destinations revealed considerable differences. While a large proportion of the parkers in the B Area were traced to destinations in the center of the business district several blocks away, the parkers in the A Area, with only a very few exceptions, were traced to destinations in, or very near, the area. For this reason the observations made on the B Area were excluded from the analysis.

Another study, made April 10, 11, and 12, 1935, is not included in this analysis. Denominated the Oak-Legion study [Nos. (12) and (13) on the map] the study contemplated the comparison of observations made on Legion Avenue, where parking was and continued to be unregulated by ordinance, with observations made on Oak Street, where parking was and for some time had been limited to sixty minutes. The neighborhoods were studied, and the flow of traffic checked. It was decided that the areas were generally comparable and that the observations made on Oak Street might be regarded as a demonstration of what would occur on Legion Avenue, were parking on the latter street limited by ordinance to sixty minutes. The observations revealed, however, that on neither Oak Street nor Legion Avenue was there any significant number of parkings having a duration longer than sixty minutes and the distributions obtained on the two sites are very much the same. If the study be taken as intended, the result is what would be expected—there will be no change when something which is not occurring is forbidden—and this result would, it is believed, fit into the analysis and theory presented in this report. But it was decided not to include the Oak-Legion study in the analysis because the study, as set up, furnishes no real check on the no-change result.

A third set of observations, made on the south side of Water Street, is not included in the analysis. The south side of Water Street was at all times unregulated, that is, it continued to be unregulated after parking on the north side was limited to thirty minutes. The observations were made simultaneously with the north side observations and by the same observers. So far as could be determined the introduction of the ordinance limiting parking on the north side of the street did not affect the distribution of parking durations on the south side.

The Ordinances and Posted Notices

Under authority of the Statutes of Connecticut, CONN. GEN. STAT. (1930) §§ 393-403, the ordinances with which these studies were concerned were adopted by the Board of

Police Commissioners of the City of New Haven, acting as the Traffic Authority for the City. Section 20, Chapter II of the Traffic Regulations adopted by this Board reads as follows:

"No operator and no person having the care, custody or control of any vehicle shall leave or permit the same to remain standing for a period of consecutive minutes longer than is indicated herein on the following streets, between the hours of 8:00 A. M. and 7:00 P. M. of any day, Sundays excepted:"*

[Here follows a long list of streets with specific time limitations. Under this section parking on Church Street was limited to fifteen minutes, on College and Water Streets to thirty minutes, and on Prospect and Oak Streets to sixty minutes.]

The ordinance applying to Crown Street, sec. 30, c. III, was as follows:

"No operator and no person having the care, custody or control of any vehicle shall leave or permit the same to remain standing upon any of the following streets, provided however, that commercial vehicles may stand for the purpose of loading or unloading with reasonable dispatch:"**

[The list which follows includes one side of Crown Street with the provision for monthly alternation of sides noted above.]

It will be noted that this latter section is not an absolute "No Parking" ordinance since it contains the proviso allowing "loading or unloading with reasonable dispatch." This proviso, together with another apparently excepting parking for the purpose of picking up or discharging passengers, caused some concern. The observers were instructed to note instances of loading and unloading and to indicate their judgment as to whether it was accomplished "with reasonable dispatch" and to do the same in cases of cars stopping to pick up or discharge passengers. The intention was to exclude from the distributions those instances in which the time taken was deemed "reasonable." It quickly appeared, however, that there was no uniformity among the observers in their interpretations of the term "reasonable," so this plan was abandoned and entries were included whether the observer had denominated them "reasonable" or "unreasonable." It was decided finally that the situation could best be met by regarding the Crown Street ordinances as allowing parking for a very short period of time rather than as prohibiting parking altogether. Accordingly, the Crown Street ordinances have been treated in the analysis as two-minute rather than as no-parking ordinances.

Thus the restrictions imposed by ordinance in the various studies here reported were as follows:

- All Crown Street studies: two minutes ("No Parking")
- Both Church Street studies: fifteen minutes
- Water and College Street studies: thirty minutes
- Both Prospect Street studies: sixty minutes

In all studies the restrictions were stated in the police notices which were posted on the street in such a way as to be readily visible to a person parking, or about to park, in the area. In the Church, College, Water, and Prospect Street studies the notices were in the form of wooden signs thirty inches long by four inches wide, topped by a seven inch disk, and lettered in white on a red background as follows: "15 [or 30 or 60] MIN. PARKING 8 A. M. to 7 P. M. Police Dept." These notices were attached to trees, or poles, or permanent stanchions. In the case of the Water and Prospect Street studies, where the ordinance became effective during the course of the study, the notices were erected at night while no observations were being made. In the Church and College

* This form of enactment is always used for restrictions on parking in chapter II of the Regulations for any year, although the designated streets may vary.

** This form is always used for prohibitions in Chapter III of the Regulations for any year, although the designated streets may vary.

Street studies the notices were present at all times. In the Crown Street studies the notices were in the form of metal disks approximately fourteen inches in diameter with the inscription "No Parking—P. D." in black on a yellow background. These notices were mounted on portable stanchions.

Certain Observed Parkings Excluded from Final Tabulation

At all times during the making of the observations, the traffic regulations of New Haven prohibited parking on the wrong side of the street, parking within ten feet of a fire hydrant, parking so as to obstruct a driveway, and double parking. A large number of violations of these prohibitions occurred during the making of the observations, and they were noted by the observers. Since the effect of regulations other than the one under study may be involved in these parkings it was decided that all parkings so marked should be excluded from the final tabulations. The approximate numbers of observations so excluded from some of the studies reported were as follows:

<i>Study</i>	<i>Unregulated</i>	<i>Regulated</i>
I. Crown A North	164	100
II. Crown A South	228	172
III. Crown A North and South (1936)	400	280
V. Church A	66	60
VII. Water	423	358
IX. Prospect East	167	134
X. Prospect West	336	189

No separate tabulation has been made of the number of exclusions from the older studies, Crown A North and South (1935), Church B, and College.

As has been noted above, the observers recorded the instances of cars which were in the area when the period of observation began and of cars which parked during the period of observation but which did not leave until after the period of observation closed. No cars which were in the area when the period of observation began were included in the tabulations since the duration of their parkings could not be determined. Further, in the Water and Prospect Street studies, all cars which remained in the areas after 7:00 P. M. were excluded from the tabulations. These exclusions were made because the ordinance, by its terms, was not effective after 7:00 P. M. Such exclusions were not necessary in the Crown Street studies since the ordinance, by its terms, was effective at all times. In the Church and College Street studies no such exclusions could be made. The set-up of the studies was such that all cars in the area at 7:00 P. M. and staying thereafter were cars which parked during the regulated period. If these cars were excluded, there would be no comparable exclusions which could be made from the unregulated distributions.

APPENDIX B. PARKING STUDIES—MEASUREMENTS

Primary Tables

On the pages immediately following appear tables containing the primary data of each of the parking studies. The data of each study appear in a separate table.

In each table column A sets out the number of observed parkings, in both the unregulated and regulated periods, having the time durations indicated in the time category column at the extreme left of the table.

In column B the observed frequencies given in column A have been transformed into percentages of their respective totals. That is, the number of observed parkings falling in each time category has been stated as a percentage of the total number of parkings

in all time categories. That these percentage columns do not, in some instances, total exactly one hundred is explained by the fact that it was not judged worthwhile to carry the percentage figures beyond two decimal places.

In column C the percentage figures of column B have been cumulated category by category beginning at zero. That is, the figure set opposite each category in column C is the sum of the percentages appearing in column B from zero up to, and including, the particular category.

The figures in column D, "Parking Minutes Used," were obtained by multiplying the number of parkings in each time category by the length of time each car parked. For the purpose of this column all parkings in a particular category were assumed to have parked for the length of time which marks the mid-point of the category.

The category system used for these tables and the analysis based on these tables is a shifting one. In each of the studies the cars parking for durations of less than thirty minutes were distributed in one minute categories; those parking for durations of from thirty to ninety-nine and one-half minutes were distributed in five minute categories; those parking one hundred minutes or longer were distributed in ten minute categories. This categorization was designed to obtain an accurate representation of the data without sacrificing, to too great an extent, numerosity in particular categories. During the process of observation the exact duration of each parking, to the nearest half minute, was recorded by the observers. These records were categorized in the process of tabulation.

PARKING STUDY I

Crown Street, North Side (Area A)

Time Categories	A Number of Parkings		B Percentage of Total		C Cumulative Percentage		D Parking Minutes Used	
	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.
0-1	27	102	4.04	13.35	4.04	13.35	13.5	51.
1-2	28	80	4.19	10.47	8.23	23.82	42.	120.
2-3	29	92	4.34	12.04	12.57	35.86	72.5	230.
3-4	27	95	4.04	12.43	16.61	48.29	94.5	332.5
4-5	25	70	3.74	9.16	20.35	57.45	112.5	315.
5-6	22	47	3.29	6.15	23.64	63.60	121.	258.5
6-7	12	26	1.80	3.40	25.44	67.00	78.	169.
7-8	10	26	1.50	3.40	26.94	70.40	75.	195.
8-9	9	16	1.35	2.09	28.29	72.49	76.5	136.
9-10	14	23	2.10	3.01	30.39	75.50	133.	218.5
10-11	5	13	.75	1.70	31.14	77.20	52.5	136.5
11-12	8	19	1.20	2.49	32.34	79.69	92.	218.5
12-13	6	12	.90	1.57	33.24	81.26	75.	150.
13-14	13	11	1.95	1.44	35.19	82.70	175.5	148.5
14-15	8	13	1.20	1.70	36.39	84.40	116.	188.5
15-16	7	7	1.05	.92	37.44	85.32	108.5	108.5
16-17	7	10	1.05	1.31	38.49	86.63	115.5	165.
17-18	6	8	.90	1.05	39.39	87.68	105.	140.
18-19	4	3	.60	.39	39.99	88.07	74.	55.5
19-20	4	5	.60	.65	40.59	88.72	78.	97.5
20-21	6	7	.90	.92	41.49	89.64	123.	143.5
21-22	4	5	.60	.65	42.09	90.29	86.	107.5
22-23	3	4	.45	.52	42.54	90.81	67.5	90.
23-24	7	8	1.05	1.05	43.59	91.86	164.5	188.

Time Categories	A Number of Parkings		B Percentage of Total		C Cumulative Percentage		D Parking Minutes Used	
	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.
24-25	4	4	.60	.52	44.19	92.38	98.	98.
25-26	2	2	.30	.26	44.49	92.64	51.	51.
26-27	3	2	.45	.26	44.94	92.90	79.5	53.
27-28	3	1	.45	.13	45.39	93.03	82.5	27.5
28-29	2	1	.30	.13	45.69	93.16	57.	28.5
29-30	1	3	.15	.39	45.84	93.55	29.5	88.5
30-35	14	12	2.10	1.57	47.94	95.12	455.	390.
35-40	21	8	3.14	1.05	51.08	96.17	787.5	300.
40-45	12	8	1.80	1.05	52.88	97.22	510.	340.
45-50	11	4	1.65	.52	54.53	97.74	522.5	190.
50-55	15	6	2.25	.79	56.78	98.53	787.5	315.
55-60	9		1.35		58.13		517.5	
60-65	11		1.65		59.78		687.5	
65-70	11	2	1.65	.26	61.43	98.79	742.5	135.
70-75	7	2	1.05	.26	62.48	99.05	507.5	145.
75-80	5		.75		63.23		387.5	
80-85	5	2	.75	.26	63.98	99.31	412.5	165.
85-90	6	1	.90	.13	64.88	99.44	525.	87.5
90-95	10	2	1.50	.26	66.38	99.70	925.	185.
95-100	10		1.50		67.88		975.	
100-110	12	1	1.80	.13	69.68	99.83	1260.	105.
110-120	10	1	1.50	.13	71.18	99.96	1150.	115.
120-130	6		.90		72.08		750.	
130-140	7		1.05		73.13		945.	
140-150	6		.90		74.03		870.	
150-160	4		.60		74.63		620.	
160-170	2		.30		74.93		330.	
170-180	5		.75		75.68		875.	
180-190	8		1.20		76.88		1480.	
190-200	14		2.10		78.98		2730.	
200-210	4		.60		79.58		820.	
210-220	4		.60		80.18		860.	
220-230	2		.30		80.48		450.	
230-240	3		.45		80.93		705.	
240-250	8		1.20		82.13		1960.	
250-260	3		.45		82.58		765.	
260-270	2		.30		82.88		530.	
270-280	7		1.05		83.93		1925.	
280-290	3		.45		84.38		855.	
290-300	6		.90		85.28		1770.	
300-310	18		2.69		87.97		5490.	
310-320	13		1.95		89.92		4095.	
320-330	11		1.65		91.57		3575.	
330-340	7		1.05		92.62		2345.	
340-350	5		.75		93.37		1725.	
350-360	4		.60		93.97		1420.	
360-370	2		.30		94.27		730.	
370-380	1		.15		94.42		375.	

Time Categories	A Number of Parkings		B Percentage of Total		C Cumulative Percentage		D Parking Minutes Used	
	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.
380-390	3		.45		94.87		1155.	
390-400	2		.30		95.17		790.	
400-410	1		.15		95.32		405.	
410-420	1		.15		95.47		415.	
420-430								
430-440								
440-450								
450-460	2		.30		95.77		910.	
460-470	2		.30		96.07		930.	
470-480								
480-490	1		.15		96.22		485.	
490-500	1		.15		96.37		495.	
500-510								
510-520	2		.30		96.67		1030.	
520-530	1		.15		96.82		525.	
530-540	5		.75		97.57		2675.	
540-550	2		.30		97.87		1090.	
550-560	1		.15		98.02		555.	
560-570	1		.15		98.17		565.	
570-580	2		.30		98.47		1150.	
580-590	2		.30		98.77		1170.	
590-600	2		.30		99.07		1190.	
600-610	3		.45		99.52		1815.	
610-620								
620-630	1		.15		99.67		625.	
630-640								
640-650								
650-660	1		.15		99.82		655.	
660-670	1		.15		99.97		665.	
.								
.								
.								
810-820	1		.15		100.12		815.	
TOTAL	668	764	100.12	99.96			72,906.5	6782.

PARKING STUDY II
Crown Street, South Side (Area A)

Time Categories	A Number of Parkings		B Percentage of Total		C Cumulative Percentage		D Parking Minutes Used	
	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.
0-1	20	73	3.08	15.30	3.08	15.30	10.	36.5
1-2	31	47	4.77	9.85	7.85	25.15	46.5	70.5
2-3	29	55	4.46	11.53	12.31	36.68	72.5	137.5
3-4	27	32	4.15	6.71	16.46	43.39	94.5	112.
4-5	15	41	2.31	8.60	18.77	51.99	67.5	184.5
5-6	14	28	2.15	5.87	20.92	57.86	77.	154.

<i>Time Categories</i>	A <i>Number of Parkings</i>		B <i>Percentage of Total</i>		C <i>Cumulative Percentage</i>		D <i>Parking Minutes Used</i>	
	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>
6-7	11	21	1.69	4.40	22.61	62.26	71.5	136.5
7-8	8	25	1.23	5.24	23.84	67.50	60.	187.5
8-9	10	26	1.54	5.45	25.38	72.95	85.	221.
9-10	12	4	1.85	.84	27.23	73.79	114.	38.
10-11	12	6	1.85	1.26	29.08	75.05	126.	63.
11-12	13	11	2.00	2.31	31.08	77.36	149.5	126.5
12-13	9	9	1.38	1.89	32.46	79.25	112.5	112.5
13-14	12	6	1.85	1.26	34.31	80.51	162.	81.
14-15	5	5	.77	1.05	35.08	81.56	72.5	72.5
15-16	8	7	1.23	1.47	36.31	83.03	124.	108.5
16-17	10	4	1.54	.84	37.85	83.87	165.	66.
17-18	4	7	.62	1.47	38.47	85.34	70.	122.5
18-19	8	2	1.23	.42	39.70	85.76	148.	37.
19-20	2	2	.31	.42	40.01	86.18	39.	39.
20-21	4	3	.62	.63	40.63	86.81	82.	61.5
21-22	4	1	.62	.21	41.25	87.02	86.	21.5
22-23	1	6	.15	1.26	41.40	88.28	22.5	135.
23-24	8	1	1.23	.21	42.63	88.49	188.	23.5
24-25	4	3	.62	.63	43.25	89.12	98.	73.5
25-26	3	2	.46	.42	43.71	89.54	76.5	51.
26-27	3	6	.46	1.26	44.17	90.80	79.5	159.
27-28	2	1	.31	.21	44.48	91.01	55.	27.5
28-29	2		.31		44.79		57.	
29-30	6	2	.92	.42	45.71	91.43	177.	59.
30-35	13	10	2.00	2.10	47.71	93.53	422.5	325.
35-40	12	7	1.85	1.47	49.56	95.00	450.	262.5
40-45	15	6	2.31	1.26	51.87	96.26	637.5	255.
45-50	11	1	1.69	.21	53.56	96.47	522.5	47.5
50-55	11	3	1.69	.63	55.25	97.10	577.5	157.5
55-60	12	2	1.85	.42	57.10	97.52	690.	115.
60-65	11	5	1.69	1.05	58.79	98.57	687.5	312.5
65-70	13	1	2.00	.21	60.79	98.78	877.5	67.5
70-75	7	1	1.08	.21	61.87	98.99	507.5	72.5
75-80	7	1	1.08	.21	62.95	99.20	542.5	77.5
80-85	7	1	1.08	.21	64.03	99.41	577.5	82.5
85-90	8	1	1.23	.21	65.26	99.62	700.	87.5
90-95	5		.77		66.03		462.5	
95-100	7		1.08		67.11		682.5	
100-110	12	1	1.85	.21	68.96	99.83	1260.	105.
110-120	7	1	1.08	.21	70.04	100.04	805.	115.
120-130	8		1.23		71.27		1000.	
130-140	6		.92		72.19		810.	
140-150	5		.77		72.96		725.	
150-160	7		1.08		74.04		1085.	
160-170	11		1.69		75.73		1815.	
170-180	7		1.08		76.81		1225.	
180-190	4		.62		77.43		740.	
190-200	10		1.54		78.97		1950.	
200-210	2		.31		79.28		410.	

Time Categories	A Number of Parkings		B Percentage of Total		C Cumulative Percentage		D Parking Minutes Used	
	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.
210-220	2		.31		79.59		430.	
220-230	5		.77		80.36		1125.	
230-240	6		.92		81.28		1410.	
240-250	4		.62		81.90		980.	
250-260	10		1.54		83.44		2550.	
260-270	5		.77		84.21		1325.	
270-280	4		.62		84.83		1100.	
280-290	5		.77		85.60		1425.	
290-300	9		1.38		86.98		2655.	
300-310	9		1.38		88.36		2745.	
310-320	6		.92		89.28		1890.	
320-330	6		.92		90.20		1950.	
330-340	4		.62		90.82		1340.	
340-350	5		.77		91.59		1725.	
350-360	4		.62		92.21		1420.	
360-370	3		.46		92.67		1095.	
370-380	4		.62		93.29		1500.	
380-390	1		.15		93.44		385.	
390-400								
400-410	2		.31		93.75		810.	
410-420								
420-430	3		.46		94.21		1275.	
430-440	1		.15		94.36		435.	
440-450	3		.46		94.82		1335.	
450-460	1		.15		94.97		455.	
460-470	1		.15		95.12		465.	
470-480								
480-490	1		.15		95.27		485.	
490-500								
500-510	2		.31		95.58		1010.	
510-520	4		.62		96.20		2060.	
520-530	1		.15		96.35		525.	
530-540	1		.15		96.50		535.	
540-550	4		.62		97.12		2180.	
550-560	3		.46		97.58		1665.	
560-570	3		.46		98.04		1695.	
570-580	5		.77		98.81		2875.	
580-590	2		.31		99.12		1170.	
590-600	2		.31		99.43		1190.	
600-610								
610-620	1		.15		99.58		615.	
620-630	2		.31		99.89		1250.	
.								
.								
.								
.								
740-750	1		.15		100.04		745.	
TOTAL	650	477	100.04	100.04			72,776.	4,800.5

PARKING STUDY III

Crown Street, North Side and South Side Combined (Area A) 1936

<i>Time Categories</i>	<i>A Number of Parkings</i>		<i>B Percentage of Total</i>		<i>C Cumulative Percentage</i>		<i>D Parking Minutes Used</i>	
	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>
0-1	50	176	3.65	13.94	3.65	13.94	25.	88.
1-2	60	129	4.39	10.21	8.04	24.15	90.	193.5
2-3	59	153	4.31	12.11	12.35	36.26	147.5	382.5
3-4	58	131	4.24	10.37	16.59	46.63	203.	458.5
4-5	41	112	3.00	8.87	19.59	55.50	184.5	504.
5-6	36	75	2.63	5.94	22.22	61.44	198.	412.5
6-7	23	48	1.68	3.80	23.90	65.24	149.5	312.
7-8	19	51	1.39	4.04	25.29	69.28	142.5	382.5
8-9	20	45	1.46	3.56	26.75	72.84	170.	382.5
9-10	26	28	1.90	2.22	28.65	75.06	247.	266.
10-11	17	19	1.24	1.50	29.89	76.56	178.5	199.5
11-12	22	31	1.61	2.45	31.50	79.01	253.	356.5
12-13	16	21	1.17	1.66	32.67	80.67	200.	262.5
13-14	27	17	1.97	1.35	34.64	82.02	364.5	229.5
14-15	14	18	1.02	1.43	35.66	83.45	203.	261.
15-16	17	14	1.24	1.11	36.90	84.56	263.5	217.
16-17	18	14	1.32	1.11	38.22	85.67	297.	231.
17-18	10	15	.73	1.19	38.95	86.86	175.	262.5
18-19	13	5	.95	.40	39.90	87.26	240.5	92.5
19-20	7	7	.51	.55	40.41	87.81	136.5	136.5
20-21	10	10	.73	.79	41.14	88.60	205.	205.
21-22	9	6	.66	.48	41.80	89.08	193.5	129.
22-23	4	11	.29	.87	42.09	89.95	90.	247.5
23-24	15	9	1.10	.71	43.19	90.66	352.5	211.5
24-25	9	7	.66	.55	43.85	91.21	220.5	171.5
25-26	5	4	.37	.32	44.22	91.53	127.5	102.
26-27	7	8	.51	.63	44.73	92.16	185.5	212.
27-28	5	2	.37	.16	45.10	92.32	137.5	55.
28-29	4	2	.29	.16	45.39	92.48	114.	57.
29-30	8	5	.58	.40	45.97	92.88	236.	147.5
30-35	27	22	1.97	1.74	47.94	94.62	877.5	715.
35-40	36	15	2.63	1.19	50.57	95.81	1350.	562.5
40-45	28	14	2.05	1.11	52.62	96.92	1190.	595.
45-50	23	5	1.68	.40	54.30	97.32	1092.5	237.5
50-55	26	9	1.90	.71	56.20	98.03	1365.	472.5
55-60	22	2	1.61	.16	57.81	98.19	1265.	115.
60-65	24	5	1.75	.40	59.56	98.59	1500.	312.5
65-70	24	3	1.75	.24	61.31	98.83	1620.	202.5
70-75	15	3	1.10	.24	62.41	99.07	1087.5	217.5
75-80	13	1	.95	.08	63.36	99.15	1007.5	77.5
80-85	12	3	.88	.24	64.24	99.39	990.	247.5
85-90	14	2	1.02	.16	65.26	99.55	1225.	175.
90-95	15	2	1.10	.16	66.36	99.71	1387.5	185.
95-100	18		1.32		67.68		1755.	
100-110	24	2	1.75	.16	69.43	99.87	2520.	210.

Time Categories	A Number of Parkings		B Percentage of Total		C Cumulative Percentage		D Parking Minutes Used	
	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.
110-120	19	2	1.39	.16	70.82	100.03	2185.	230.
120-130	15		1.10		71.92		1875.	
130-140	13		.95		72.87		1755.	
140-150	11		.80		73.67		1595.	
150-160	13		.95		74.62		2015.	
160-170	13		.95		75.57		2145.	
170-180	12		.88		76.45		2100.	
180-190	12		.88		77.33		2220.	
190-200	24		1.75		79.08		4680.	
200-210	8		.58		79.66		1640.	
210-220	6		.44		80.10		1290.	
220-230	8		.58		80.68		1800.	
230-240	9		.66		81.34		2115.	
240-250	13		.95		82.29		3185.	
250-260	13		.95		83.24		3315.	
260-270	7		.51		83.75		1855.	
270-280	11		.80		84.55		3025.	
280-290	8		.58		85.13		2280.	
290-300	15		1.10		86.23		4425.	
300-310	27		1.97		88.20		8235.	
310-320	22		1.61		89.81		6930.	
320-330	17		1.24		91.05		5525.	
330-340	11		.80		91.85		3685.	
340-350	10		.73		92.58		3450.	
350-360	8		.58		93.16		2840.	
360-370	5		.37		93.53		1825.	
370-380	5		.37		93.90		1875.	
380-390	4		.29		94.19		1540.	
390-400	3		.22		94.41		1185.	
400-410	3		.22		94.63		1215.	
410-420	1		.07		94.70		415.	
420-430	3		.22		94.92		1275.	
430-440	1		.07		94.99		435.	
440-450	3		.22		95.21		1335.	
450-460	3		.22		95.43		1365.	
460-470	3		.22		95.65		1395.	
470-480								
480-490	2		.15		95.80		970.	
490-500	1		.07		95.87		495.	
500-510	2		.15		96.02		1010.	
510-520	6		.44		96.46		3090.	
520-530	2		.15		96.61		1050.	
530-540	6		.44		97.05		3210.	
540-550	6		.44		97.49		3270.	
550-560	4		.29		97.78		2220.	
560-570	4		.29		98.07		2260.	
570-580	7		.51		98.58		4025.	
580-590	4		.29		98.87		2340.	

Time Categories	A Number of Parkings		B Percentage of Total		C Cumulative Percentage		D Parking Minutes Used	
	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.
590-600	4		.29		99.16		2380.	
600-610	3		.22		99.38		1815.	
610-620	1		.07		99.45		615.	
620-630	3		.22		99.67		1875.	
630-640								
640-650								
650-660	1		.07		99.74		655.	
660-670	1		.07		99.81		665.	
.								
740-750	1		.07		99.88		745.	
.								
810-820	1		.07		99.95		815.	
TOTAL	1368	1263	99.95	100.03			149,493.	11,723.5

PARKING STUDY IV

Crown Street, North Side and South Side Combined (Area A) 1935

Time Categories	A Number of Parkings		B Percentage of Total		C Cumulative Percentage		D Parking Minutes Used	
	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.
0-1	17	30	5.41	12.24	5.41	12.24	8.5	15.
1-2	13	29	4.14	11.83	9.55	24.07	19.5	43.5
2-3	17	37	5.41	15.10	14.96	39.17	42.5	92.5
3-4	15	27	4.78	11.02	19.74	50.19	52.5	94.5
4-5	21	21	6.69	8.57	26.43	58.76	94.5	94.5
5-6	14	12	4.46	4.90	30.89	63.66	77.	66.
6-7	10	8	3.18	3.27	34.07	66.93	65.	52.
7-8	10	13	3.18	5.31	37.25	72.24	75.	97.5
8-9	7	6	2.23	2.45	39.48	74.69	59.5	51.
9-10	6	12	1.91	4.90	41.39	79.59	57.	114.
10-11	3	4	.96	1.63	42.35	81.22	31.5	42.
11-12	1	4	.32	1.63	42.67	82.85	11.5	46.
12-13	2	3	.64	1.22	43.31	84.07	25.	37.5
13-14	2	8	.64	3.27	43.95	87.34	27.	108.
14-15	1	1	.32	.41	44.27	87.75	14.5	14.5
15-16	2	1	.64	.41	44.91	88.16	31.	15.5
16-17	6	1	1.91	.41	46.82	88.57	99.	16.5
17-18	3	1	.96	.41	47.78	88.98	52.5	17.5
18-19	2	1	.64	.41	48.42	89.39	37.	18.5
19-20	2	2	.64	.82	49.06	90.21	39.	39.
20-21	3	1	.96	.41	50.02	90.62	61.5	20.5
21-22	1	2	.32	.82	50.34	91.44	21.5	43.
22-23	1	2	.32	.82	50.66	92.26	22.5	45.
23-24	2	1	.64	.41	51.30	92.67	47.	23.5

Time Categories	A Number of Parkings		B Percentage of Total		C Cumulative Percentage		D Parking Minutes Used	
	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.
24-25	2		.64		51.94		49.	
25-26	4	2	1.27	.82	53.21	93.49	102.	51.
26-27		3		1.22		94.71		79.5
27-28	3		.96		54.17		82.5	
28-29	3	1	.96	.41	55.13	95.12	85.5	28.5
29-30	5	1	1.59	.41	56.72	95.53	147.5	29.5
30-35	10	2	3.18	.82	59.90	96.35	325.	65.
35-40	4	2	1.27	.82	61.17	97.17	150.	75.
40-45	5	2	1.59	.82	62.76	97.99	212.5	85.
45-50	3		.96		63.72		142.5	
50-55	2	1	.64	.41	64.36	98.40	105.	52.5
55-60	2		.64		65.00		115.	
60-65	6		1.91		66.91		375.	
65-70	6	1	1.91	.41	68.82	98.81	405.	67.5
70-75	4	1	1.27	.41	70.09	99.22	290.	72.5
75-80	2		.64		70.73		155.	
80-85	2		.64		71.37		165.	
85-90	3		.96		72.33		262.5	
90-95	1		.32		72.65		92.5	
95-100	2		.64		73.29		195.0	
100-110	3		.96		74.25		315.	
110-120	9	1	2.87	.41	77.12	99.63	1035.	115.
120-130	5		1.59		78.71		625.	
130-140	4		1.27		79.98		540.	
140-150	5		1.59		81.57		725.	
150-160	6		1.91		83.48		930.	
160-170	6		1.91		85.39		990.	
170-180	3		.96		86.35		525.	
180-190	5		1.59		87.94		925.	
190-200	2		.64		88.58		390.	
200-210	2		.64		89.22		410.	
210-220	2		.64		89.86		430.	
220-230								
230-240	1		.32		90.18		235.	
240-250	2		.64		90.82		490.	
250-260								
260-270	1		.32		91.14		265.	
270-280	2		.64		91.78		550.	
280-290	1		.32		92.10		285.	
290-300	3		.96		93.06		885.	
300-310	6		1.91		94.97		1830.	
310-320	3	1	.96	.41	95.93	100.04	945.	315.
320-330	1		.32		96.25		325.	
330-340	1		.32		96.57		335.	
340-350	1		.32		96.89		345.	
350-360								
360-370	1		.32		97.21		365.	

<i>Time Categories</i>	<i>A Number of Parkings</i>		<i>B Percentage of Total</i>		<i>C Cumulative Percentage</i>		<i>D Parking Minutes Used</i>	
	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>
370-380								
380-390								
390-400	1		.32		97.53		395.	
400-410								
410-420	1		.32		97.85		415.	
420-430								
430-440	1		.32		98.17		435.	
440-450								
450-460								
460-470	1		.32		98.49		465.	
470-480	1		.32		98.81		475.	
480-490								
490-500	1		.32		99.13		495.	
500-510	1		.32		99.45		505.	
510-520								
520-530	2		.64		100.09		1050.	
<hr/>								
TOTAL	314	245	100.09	100.04			23,458.	2,243.5

PARKING STUDY V
Church Street (Area A)

<i>Time Categories</i>	<i>A Number of Parkings</i>		<i>B Percentage of Total</i>		<i>C Cumulative Percentage</i>		<i>D Parking Minutes Used</i>	
	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>
0-1	6	16	1.26	2.79	1.26	2.79	3	8.
1-2	13	24	2.73	4.18	3.99	6.97	19.5	36.
2-3	13	28	2.73	4.89	6.72	11.86	32.5	70.
3-4	14	43	2.94	7.49	9.66	19.35	49.	150.5
4-5	18	32	3.77	5.57	13.43	24.92	81.	144.
5-6	20	30	4.19	5.23	17.62	30.15	110.	165.
6-7	12	30	2.52	5.23	20.14	35.38	78.	195.
7-8	15	25	3.14	4.36	23.28	39.74	112.5	187.5
8-9	11	18	2.31	3.14	25.59	42.88	93.5	153.
9-10	10	14	2.10	2.44	27.69	45.32	95.	133.
10-11	8	13	1.68	2.26	29.37	47.58	84.	136.5
11-12	9	14	1.89	2.44	31.26	50.02	103.5	161.
12-13	8	16	1.68	2.79	32.94	52.81	100.	200.
13-14	8	14	1.68	2.44	34.62	55.25	108.	189.
14-15	6	12	1.26	2.09	35.88	57.34	87.	174.
15-16	6	9	1.26	1.57	37.14	58.91	93.	139.5
16-17	4	9	.84	1.57	37.98	60.48	66.	148.5
17-18	4	7	.84	1.22	38.82	61.70	70.	122.5
18-19	3	2	.63	.35	39.45	62.05	55.5	37.
19-20	3	7	.63	1.22	40.08	63.27	58.5	136.5

Time Categories	A Number of Parkings		B Percentage of Total		C Cumulative Percentage		D Parking Minutes Used	
	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.
20-21	4	3	.84	.52	40.92	63.79	82.	61.5
21-22	1	5	.21	.87	41.13	64.66	21.5	107.5
22-23	5	11	1.05	1.92	42.18	66.58	112.5	247.5
23-24	2	8	.42	1.39	42.60	67.97	47.	188.
24-25	4	7	.84	1.22	43.44	69.19	98.	171.5
25-26	3	5	.63	.87	44.07	70.06	76.5	127.5
26-27	6	1	1.26	.17	45.33	70.23	159.	26.5
27-28	3	1	.63	.17	45.96	70.40	82.5	27.5
28-29	4	3	.84	.52	46.80	70.92	114.	85.5
29-30	4	3	.84	.52	47.64	71.44	118.	88.5
30-35	9	27	1.89	4.70	49.53	76.14	292.5	877.5
35-40	2	18	.42	3.14	49.95	79.28	75.	675.
40-45	9	5	1.89	.87	51.84	80.15	382.5	212.5
45-50	9	12	1.89	2.09	53.73	82.24	427.5	570.
50-55	5	9	1.05	1.57	54.78	83.81	262.5	472.5
55-60	10	5	2.10	.87	56.88	84.68	575.	287.5
60-65	4	4	.84	.70	57.72	85.38	250.	250.
65-70	5	6	1.05	1.05	58.77	86.43	337.5	405.
70-75	6		1.26		60.03		435.	
75-80	7	3	1.47	.52	61.50	86.95	542.5	232.5
80-85	4	2	.84	.35	62.34	87.30	330.	165.
85-90	1	1	.21	.17	62.55	87.47	87.5	87.5
90-95	6	2	1.26	.35	63.81	87.82	555.	185.
95-100	5	1	1.05	.17	64.86	87.99	487.5	97.5
100-110	6	5	1.26	.87	66.12	88.86	630.	525.
110-120	6	2	1.26	.35	67.38	89.21	690.	230.
120-130	5	1	1.05	.17	68.43	89.38	625.	125.
130-140	6	3	1.26	.52	69.69	89.90	810.	405.
140-150	7	1	1.47	.17	71.16	90.07	1015.	145.
150-160	12	1	2.52	.17	73.68	90.24	1860.	155.
160-170	15	3	3.14	.52	76.82	90.76	2475.	495.
170-180	5	6	1.05	1.05	77.87	91.81	875.	1050.
180-190	16	7	3.35	1.22	81.22	93.03	2960.	1295.
190-200	25	7	5.24	1.22	86.46	94.25	4875.	1365.
200-210	21	11	4.40	1.92	90.86	96.17	4305.	2255.
210-220	13	5	2.73	.87	93.59	97.04	2795.	1075.
220-230	9	2	1.89	.35	95.48	97.39	2025.	450.
230-240	6	1	1.26	.17	96.74	97.56	1410.	235.
240-250	2	2	.42	.35	97.16	97.91	490.	490.
250-260	4	1	.84	.17	98.00	98.08	1020.	255.
260-270	5	2	1.05	.35	99.05	98.43	1325.	530.
270-280		2		.35		98.78		550.
280-290	1	1	.21	.17	99.26	98.95	285.	285.
290-300	2	1	.42	.17	99.68	99.12	590.	295.
300-310		1		.17		99.29		305.
310-320								
320-330	1	2	.21	.35	99.89	99.64	325.	650.

<i>Time Categories</i>	A <i>Number of Parkings</i>		B <i>Percentage of Total</i>		C <i>Cumulative Percentage</i>		D <i>Parking Minutes Used</i>	
	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>
330-340	1	1	.21	.17	100.10	99.81	335.	335.
340-350								
350-360								
360-370								
370-380								
380-390								
390-400								
.								
.								
.								
440-450		1		.17		99.98		445.
TOTAL	477	574	100.10	99.98			39,170.5	22,280.5

PARKING STUDY VI
Church Street (Area B)

<i>Time Categories</i>	A <i>Number of Parkings</i>		B <i>Percentage of Total</i>		C <i>Cumulative Percentage</i>		D <i>Parking Minutes Used</i>	
	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>
0-1	2	7	1.18	4.07	1.18	4.07	1.	3.5
1-2	14	21	8.24	12.21	9.42	16.28	21.	31.5
2-3	22	16	12.94	9.30	22.36	25.58	55.	40.
3-4	18	16	10.59	9.30	32.95	34.88	63.	56.
4-5	7	15	4.12	8.72	37.07	43.60	31.5	67.5
5-6	8	11	4.71	6.40	41.78	50.	44.	60.5
6-7	6	7	3.53	4.07	45.31	54.07	39.	45.5
7-8	5	3	2.94	1.74	48.25	55.81	37.5	22.5
8-9	2	7	1.18	4.07	49.43	59.88	17.	59.5
9-10	3	3	1.76	1.74	51.19	61.62	28.5	28.5
10-11	6	2	3.53	1.16	54.72	62.78	63.	21.
11-12	5	11	2.94	6.40	57.66	69.18	57.5	126.5
12-13	2	1	1.18	.58	58.84	69.76	25.	12.5
13-14	2	3	1.18	1.74	60.02	71.50	27.	40.5
14-15	4	2	2.35	1.16	62.37	72.66	58.	29.
15-16	2	2	1.18	1.16	63.55	73.82	31.	31.
16-17	1	2	.59	1.16	64.14	74.98	16.5	33.
17-18		2		1.16		76.14		35.
18-19		2		1.16		77.30		37.
19-20	3	4	1.76	2.33	65.90	79.63	58.5	78.
20-21		1		.58		80.21		20.5
21-22	2	1	1.18	.58	67.08	80.79	43.	21.5
22-23	2	3	1.18	1.74	68.26	82.53	45.	67.5
23-24	2	1	1.18	.58	69.44	83.11	47.	23.5
24-25								
25-26	2	1	1.18	.58	70.62	83.69	51.	25.5
26-27		1		.58		84.27		26.5

Time Categories	A Number of Parkings		B Percentage of Total		C Cumulative Percentage		D Parking Minutes Used	
	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.
27-28	1	1	.59	.58	71.21	84.85	27.5	27.5
28-29		2		1.16		86.01		57.
29-30	1	3	.59	1.74	71.80	87.75	29.5	88.5
30-35	8	4	4.71	2.33	76.51	90.08	260.	130.
35-40	3	1	1.76	.58	78.27	90.66	112.5	37.5
40-45	2	1	1.18	.58	79.45	91.24	85.	42.5
45-50	1	2	.59	1.16	80.04	92.40	47.5	95.
50-55	2	2	1.18	1.16	81.22	93.56	105.	105.
55-60	1	2	.59	1.16	81.81	94.72	57.5	115.
60-65								
65-70								
70-75								
75-80	1		.59		82.40		77.5	
80-85	1		.59		82.99		82.5	
85-90								
90-95								
95-100	2		1.18		84.17		195.	
100-110	1	1	.59	.58	84.76	95.30	105.	105.
110-120	1		.59		85.35		115.	
120-130	2		1.18		86.53		250.	
130-140	1		.59		87.12		135.	
140-150	1		.59		87.71		145.	
150-160	6	2	3.53	1.16	91.24	96.46	930.	310.
160-170	5		2.94		94.18		825.	
170-180	2		1.18		95.36		350.	
180-190	1		.59		95.95		185.	
190-200	1		.59		96.54		195.	
200-210		2		1.16		97.62		410.
210-220	2		1.18		97.72		430.	
220-230	3	1	1.76	.58	99.48	98.20	675.	225.
230-240								
240-250		2		1.16		99.36		490.
250-260								
260-270	1		.59		100.07		265.	
270-280		1		.58		99.94		275.
280-290								
TOTAL	170	172	100.07	99.94			6,544.5	3,556.5

PARKING STUDY VII

Water Street

Time Categories	A Number of Parkings		B Percentage of Total		C Cumulative Percentage		D Parking Minutes Used	
	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.
0-1	24	62	3.30	5.34	3.30	5.34	12.	31.
1-2	25	79	3.44	6.81	6.74	12.15	37.5	118.5

<i>Time Categories</i>	A Number of Parkings		B Percentage of Total		C Cumulative Percentage		D Parking Minutes Used	
	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>
2-3	40	80	5.50	6.90	12.24	19.05	100.	200.
3-4	44	68	6.05	5.86	18.29	24.91	154.	238.
4-5	23	53	3.16	4.57	21.45	29.48	103.5	238.5
5-6	29	50	3.99	4.31	25.44	33.79	159.5	275.
6-7	34	45	4.68	3.88	30.12	37.67	221.0	292.5
7-8	19	41	2.61	3.53	32.73	41.20	142.5	307.5
8-9	21	33	2.89	2.84	35.62	44.04	178.5	280.5
9-10	22	31	3.03	2.67	38.65	46.71	209.	294.5
10-11	14	25	1.93	2.16	40.58	48.87	147.	262.5
11-12	14	32	1.93	2.76	42.51	51.63	161.	368.
12-13	9	32	1.24	2.76	43.75	54.39	112.5	400.
13-14	11	29	1.51	2.50	45.26	56.89	148.5	391.5
14-15	15	24	2.06	2.07	47.32	58.96	217.5	348.
15-16	8	22	1.10	1.90	48.42	60.86	124.	341.
16-17	4	13	.55	1.12	48.97	61.98	66.	214.5
17-18	6	25	.83	2.16	49.80	64.14	105.	437.5
18-19	7	6	.96	.52	50.76	64.66	129.5	111.
19-20	10	19	1.38	1.64	52.14	66.30	195.	370.5
20-21	13	12	1.79	1.03	53.93	67.33	266.5	246.
21-22	8	10	1.10	.86	55.03	68.19	172.	215.
22-23	2	12	.28	1.03	55.31	69.22	45.	270.
23-24	3	5	.41	.43	55.72	69.65	70.5	117.5
24-25	3	11	.41	.95	56.13	70.60	73.5	269.5
25-26	5	8	.69	.69	56.82	71.29	127.5	204.
26-27	10	14	1.38	1.21	58.20	72.50	265.	371.
27-28	6	11	.83	.95	59.03	73.45	165.	302.5
28-29	3	11	.41	.95	59.44	74.40	85.5	313.5
29-30	4	12	.55	1.03	59.99	75.43	118.	354.
30-35	25	47	3.44	4.05	63.43	79.48	812.5	1527.5
35-40	15	26	2.06	2.24	65.49	81.72	562.5	975.
40-45	12	26	1.65	2.24	67.14	83.96	510.	1105.
45-50	18	17	2.48	1.47	69.62	85.43	855.	807.5
50-55	8	24	1.10	2.07	70.72	87.50	420.	1260.
55-60	10	11	1.38	.95	72.10	88.45	575.	632.5
60-65	4	12	.55	1.03	72.65	89.48	250.	750.
65-70	9	15	1.24	1.29	73.89	90.77	607.5	1012.5
70-75	3	11	.41	.95	74.30	91.72	217.5	797.5
75-80	5	6	.69	.52	74.99	92.24	387.5	465.
80-85	6	11	.83	.95	75.82	93.19	495.	907.5
85-90	3	7	.41	.60	76.23	93.79	262.5	612.5
90-95	2	5	.28	.43	76.51	94.22	185.	462.5
95-100	3	5	.41	.43	76.92	94.65	292.5	487.5
100-110	3	4	.41	.34	77.33	94.99	315.	420.
110-120	3	8	.41	.69	77.74	95.68	345.	920.
120-130	6	2	.83	.17	78.57	95.85	750.	250.
130-140	4	4	.55	.34	79.12	96.19	540.	540.
140-150	4	3	.55	.26	79.67	96.45	580.	435.
150-160	3	3	.41	.26	80.08	96.71	465.	465.

Time Categories	A Number of Parkings		B Percentage of Total		C Cumulative Percentage		D Parking Minutes Used	
	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.
160-170	5	5	.69	.43	80.77	97.14	825.	825.
170-180		4		.34	80.77	97.48		700.
180-190	7	3	.96	.26	81.73	97.74	1295.	555.
190-200	4	3	.55	.26	82.28	98.00	780.	585.
200-210	14		1.93		84.21	98.00	2870.	
210-220	11	1	1.51	.09	85.72	98.09	2365.	215.
220-230	9		1.24		86.96	98.09	2025.	
230-240	7	1	.96	.09	87.92	98.18	1645.	235.
240-250	11		1.51		89.43	98.18	2695.	
250-260	6	2	.83	.17	90.26	98.35	1530.	510.
260-270	6		.83		91.09		1590.	
270-280	8	2	1.10	.17	92.19	98.52	2200.	550.
280-290	4	3	.55	.26	92.74	98.78	1140.	855.
290-300	3		.41		93.15		885.	
300-310	3		.41		93.56		915.	
310-320	3		.41		93.97		945.	
320-330	3		.41		94.38		975.	
330-340	1		.14		94.52		335.	
340-350	2		.28		94.80		690.	
350-360	1		.14		94.94		355.	
360-370	1		.14		95.08		365.	
370-380	1		.14		95.22		375.	
380-390								
390-400								
400-410								
410-420								
420-430	3		.41		95.63		1275.	
430-440					95.63			
440-450					95.63			
450-460	2		.28		95.91		910.	
460-470								
470-480		1		.09		98.87		475.
480-490		1		.09		98.96		485.
490-500	1		.14		96.05	98.96	495.	
500-510	2	1	.28	.09	96.33	99.05	1010.	505.
510-520	2	2	.28	.17	96.61	99.22	1030.	1030.
520-530	4	4	.55	.34	97.16	99.56	2100.	2100.
530-540	3	1	.41	.09	97.57	99.65	1605.	535.
540-550	5	1	.69	.09	98.26	99.74	2725.	545.
550-560	3	1	.41	.09	98.67	99.83	1665.	555.
560-570	4		.55		99.22		2260.	
570-580	2		.28		99.50		1150.	
580-590	1	1	.14	.09	99.64	99.92	585.	585.
590-600	1		.14		99.78		595.	
600-610								
610-620	1		.14		99.92		615.	
620-630		1		.09		100.01		625.
630-640	1		.14		100.06		635.	

Time Categories	A Number of Parkings		B Percentage of Total		C Cumulative Percentage		D Parking Minutes Used	
	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.
640-650								
650-660								
660-670								
TOTAL.	727	1160	100.06	100.01			58,974.5	35,486.

PARKING STUDY VIII

College Street

Time Categories	A Number of Parkings		B Percentage of Total		C Cumulative Percentage		D Parking Minutes Used	
	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.
0-1								
1-2	4	2	4.30	1.67	4.30	1.67	6.	3.
2-3	3	4	3.23	3.33	7.53	5.00	7.5	10.
3-4	3	7	3.23	5.83	10.76	10.83	10.5	24.5
4-5	6	4	6.45	3.33	17.21	14.16	27.	18.
5-6	3	7	3.23	5.83	20.44	19.99	16.	38.5
6-7	2	4	2.15	3.33	22.59	23.32	13.	26.
7-8	2	3	2.15	2.50	24.74	25.82	15.	22.5
8-9	1	4	1.08	3.33	25.82	29.15	8.5	34.
9-10	1	5	1.08	4.17	26.90	33.32	9.5	47.5
10-11	4	2	4.30	1.67	31.20	34.99	42.	21.
11-12	2	1	2.15	.83	33.35	35.82	23.	11.5
12-13								
13-14	2	3	2.15	2.50	35.50	38.32	27.	40.5
14-15		1		.83		39.15		14.5
15-16	1	3	1.08	2.50	36.58	41.65	15.5	46.5
16-17	2	2	2.15	1.67	38.73	43.32	33.	33.
17-18		2		1.67		44.99		35.
18-19	1	4	1.08	3.33	39.81	48.32	18.5	74.
19-20		5		4.17		52.49		97.5
20-21	1	5	1.08	4.17	40.89	56.66	20.5	102.5
21-22	1	1	1.08	.83	41.97	57.49	21.5	21.5
22-23		3		2.50		59.99		67.5
23-24		1		.83		60.82		23.5
24-25	2	2	2.15	1.67	44.12	62.49	49.	49.
25-26								
26-27	1		1.08		45.20		26.5	
27-28		1		.83		63.32		27.5
28-29		2		1.67		64.99		57.
29-30		1		.83		65.82		29.5
30-35	4	4	4.30	3.33	49.50	69.15	130.	130.
35-40	3	6	3.23	5.00	52.73	74.15	112.5	225.
40-45	4	3	4.30	2.50	57.03	76.65	170.	127.5
45-50	1	1	1.08	.83	58.11	77.48	47.5	47.5

Time Categories	A Number of Parkings		B Percentage of Total		C Cumulative Percentage		D Parking Minutes Used	
	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.
50-55		2		1.67		79.15		105.
55-60	1		1.08		59.19		57.5	
60-65	2	2	2.15	1.67	61.34	80.82	125.	125.
65-70		2		1.67		82.49		135.
70-75	2	5	2.15	4.17	63.49	86.66	145.	362.5
75-80	1		1.08		64.57		77.5	
80-85	1		1.08		65.65		82.5	
85-90	2	2	2.15	1.67	67.80	88.33	175.	175.
90-95		1		.83		89.16		92.5
95-100		1		.83		89.99		97.5
100-110	3	2	3.23	1.67	71.03	91.66	315.	210.
110-120	2	3	2.15	2.50	73.18	94.16	230.	345.
120-130								
130-140	2	1	2.15	.83	75.33	94.99	270.	135.
140-150	1	1	1.08	.83	76.41	95.82	145.	145.
150-160	2	2	2.15	1.67	78.56	97.49	310.	310.
160-170	7	1	7.53	.83	86.09	98.32	1155.	165.
170-180	2	1	2.15	.83	88.24	99.15	350.	175.
180-190	1		1.08		89.32		185.	
190-200	2		2.15		91.47		340.	
200-210	2		2.15		93.62		410.	
210-220	3		3.23		96.85		645.	
220-230								
230-240	2		2.15		99.00		470.	
240-250	1		1.08		100.08		245.	
.								
.								
.								
370-380		1		.83		99.98		375.
TOTAL	93	120	100.08	99.98			6632.	4458.

PARKING STUDY IX
Prospect Street, East Side

Time Categories	A Number of Parkings		B Percentage of Total		C Cumulative Percentage		D Parking Minutes Used	
	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.
0-1	25	22	2.70	2.95	2.70	2.95	12.5	11.
1-2	26	31	2.81	4.15	5.51	7.10	39.	46.5
2-3	21	13	2.27	1.74	7.78	8.84	52.5	32.5
3-4	10	16	1.08	2.14	8.86	10.98	35.	56.
4-5	20	13	2.16	1.74	11.02	12.72	90.	58.5
5-6	12	22	1.30	2.95	12.32	15.67	66.	121.
6-7	12	13	1.30	1.74	13.62	17.41	78.	84.5
7-8	6	17	.65	2.28	14.27	19.69	45.	127.5

Time Categories	A Number of Parkings		B Percentage of Total		C Cumulative Percentage		D Parking Minutes Used	
	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.
8-9	12	11	1.30	1.47	15.57	21.16	102.	93.5
9-10	4	3	.43	.40	16.	21.56	38.	28.5
10-11	11	11	1.19	1.47	17.19	23.03	115.5	115.5
11-12	3	13	.32	1.74	17.51	24.77	34.5	149.5
12-13	5	6	.54	.80	18.05	25.57	62.5	75.
13-14	3	9	.32	1.20	18.37	26.77	40.5	121.5
14-15	5	10	.54	1.34	18.91	28.11	72.5	145.
15-16	5	3	.54	.40	19.45	28.51	77.5	46.5
16-17	3	7	.32	.94	19.77	29.45	49.5	115.5
17-18	8	4	.86	.54	20.63	29.99	140.	70.
18-19	5	3	.54	.40	21.17	30.39	92.5	55.5
19-20	4	1	.43	.13	21.60	30.52	78.	19.5
20-21	1	2	.11	.27	21.71	30.79	20.5	41.
21-22	2	3	.22	.40	21.93	31.19	43.	64.5
22-23								
23-24	1	4	.11	.54	22.04	31.73	23.5	94.
24-25	2	3	.22	.40	22.26	32.13	49.	73.5
25-26	3	3	.32	.40	22.58	32.53	76.5	76.5
26-27	1	2	.11	.27	22.69	32.80	26.5	53.
27-28	1	3	.11	.40	22.80	33.20	27.5	82.5
28-29	3	5	.32	.67	23.12	33.87	85.5	142.5
29-30	1	1	.11	.13	23.23	34.00	29.5	29.5
30-35	12	19	1.30	2.54	24.53	36.54	390.	617.5
35-40	9	4	.97	.54	25.50	37.08	337.5	150.
40-45	6	7	.65	.94	26.15	38.02	255.	297.5
45-50	9	10	.97	1.34	27.12	39.36	427.5	475.
50-55	14	14	1.51	1.87	28.63	41.23	735.	735.
55-60	38	40	4.10	5.35	32.73	46.58	2185.	2300.
60-65	42	67	4.54	8.97	37.27	55.55	2625.	4187.5
65-70	35	40	3.78	5.35	41.05	60.90	2362.5	2700.
70-75	25	25	2.70	3.35	43.75	64.25	1812.5	1812.5
75-80	11	19	1.19	2.54	44.94	66.79	852.5	1472.5
80-85	12	17	1.30	2.28	46.24	69.07	990.	1402.5
85-90	13	12	1.40	1.61	47.64	70.68	1137.5	1050.
90-95	6	10	.65	1.34	48.29	77.02	555.	925.
95-100	11	3	1.19	.40	49.48	72.42	1072.5	292.5
100-110	20	20	2.16	2.68	51.64	75.10	2100.	2100.
110-120	12	20	1.30	2.68	52.94	77.78	1380.	2300.
120-130	24	14	2.59	1.87	55.53	79.65	3000.	1750.
130-140	20	16	2.16	2.14	57.69	81.79	2700.	2160.
140-150	25	12	2.70	1.61	60.39	83.40	3625.	1740.
150-160	25	14	2.70	1.87	63.09	85.27	3875.	2170.
160-170	26	20	2.81	2.68	65.90	87.95	4290.	3300.
170-180	26	15	2.81	2.01	68.71	89.96	4550.	2625.
180-190	36	13	3.89	1.74	72.60	91.70	6660.	2405.
190-200	23	9	2.48	1.20	75.08	92.90	4485.	1755.
200-210	27	3	2.92	.40	78.	93.30	5535.	615.

Time Categories	A Number of Parkings		B Percentage of Total		C Cumulative Percentage		D Parking Minutes Used	
	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.	Unreg.	Reg.
210-220	19	3	2.05	.40	80.05	93.70	4085.	645.
220-230	20	6	2.16	.80	82.21	94.50	4500.	1350.
230-240	29	9	3.13	1.20	85.34	95.70	6815.	2115.
240-250	24	9	2.59	1.20	87.93	96.90	5880.	2205.
250-260	19	5	2.05	.67	89.98	97.57	4845.	1275.
260-270	20	6	2.16	.80	92.14	98.37	5300.	1590.
270-280	13	3	1.40	.40	93.54	98.77	3575.	825.
280-290	6	1	.65	.13	94.19	98.90	1710.	285.
290-300	9	2	.97	.27	95.16	99.17	2655.	590.
300-310	4	1	.43	.13	95.59	99.30	1220.	305.
310-320	3	3	.32	.40	95.91	99.70	945.	945.
320-330	6		.65		95.56		1950.	
330-340	4		.43		96.99		1340.	
340-350	1		.11		97.10		345.	
350-360	1		.11		97.21		355.	
360-370								
370-380								
380-390								
390-400								
400-410								
410-420								
420-430								
430-440	2		.22		97.43		870.	
440-450	1		.11		97.54		445.	
450-460		1		.13		99.83		455.
460-470								
470-480								
480-490								
490-500	1	1	.11	.13	97.65	99.96	495.	495.
500-510	1		.11		97.76		505.	
510-520	1		.11		97.87		515.	
520-530	1		.11		97.98		525.	
530-540	4		.43		98.41		2140.	
540-550	3		.32		98.73		1635.	
550-560	6		.65		99.38		3330.	
560-570	1		.11		99.49		565.	
570-580	1		.11		99.60		575.	
580-590	2		.22		99.82		1170.	
590-600	1		.11		99.93		595.	
600-610								
610-620	1		.11		100.04		615.	
TOTAL	926	747	100.04	99.96			119,140.	56,647.5

PARKING STUDY X
Prospect Street, West Side

<i>Time Categories</i>	A <i>Number of Parkings</i>		B <i>Percentage of Total</i>		C <i>Cumulative Percentage</i>		D <i>Parking Minutes Used</i>	
	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>
0-1	60	71	4.80	6.57	4.80	6.57	30.	35.5
1-2	65	94	5.20	8.70	10.	15.27	97.5	141.
2-3	50	54	4.00	5.00	14.	20.27	125.	135.
3-4	45	37	3.60	3.42	17.60	23.69	157.5	129.5
4-5	23	26	1.84	2.41	19.44	26.10	103.5	117.
5-6	20	20	1.60	1.85	21.04	27.95	110.	110.
6-7	17	19	1.36	1.76	22.40	29.71	110.5	123.5
7-8	16	12	1.28	1.11	23.68	30.82	120.	90.
8-9	16	14	1.28	1.30	24.96	32.12	136.	119.
9-10	12	11	.96	1.02	25.92	33.14	114.	104.5
10-11	7	16	.56	1.48	26.48	34.62	73.5	168.
11-12	9	10	.72	.93	27.20	35.55	103.5	115.
12-13	7	13	.56	1.20	27.76	36.75	87.5	162.5
13-14	12	8	.96	.74	28.72	37.49	162.	108.
14-15	1	6	.08	.56	28.80	38.05	14.5	87.
15-16	6	5	.48	.46	29.28	38.51	93.	77.5
16-17	8	8	.64	.74	29.92	39.25	132.	132.
17-18	11	7	.88	.65	30.80	39.90	192.5	122.5
18-19	4	7	.32	.65	31.12	40.55	74.	129.5
19-20	4	8	.32	.74	31.44	41.29	78.	156.
20-21	9	6	.72	.56	32.16	41.85	184.5	123.
21-22	5	2	.40	.19	32.56	42.04	107.5	43.
22-23	2	3	.16	.28	32.72	42.32	45.	67.5
23-24	6	4	.48	.37	33.20	42.69	141.	94.
24-25	3	1	.24	.09	33.44	42.78	73.5	24.5
25-26	3	9	.24	.83	33.68	43.61	76.5	229.5
26-27	5	8	.40	.74	34.08	44.35	132.5	212.
27-28	3	5	.24	.46	34.32	44.81	82.5	137.5
28-29	9	7	.72	.65	35.04	45.46	256.5	199.5
29-30	2	3	.16	.28	35.20	45.74	59.	88.5
30-35	19	19	1.52	1.76	36.72	47.50	617.5	617.5
35-40	14	12	1.12	1.11	37.84	48.61	525.	450.
40-45	13	20	1.04	1.85	38.88	50.46	552.5	850.
45-50	11	8	.88	.74	39.76	51.20	522.5	380.
50-55	18	20	1.44	1.85	41.20	53.05	945.	1050.
55-60	37	40	2.96	3.70	44.16	56.75	2127.5	2300.
60-65	54	61	4.32	5.64	48.48	62.39	3375.	3812.5
65-70	51	55	4.08	5.09	52.56	67.49	3442.5	3712.5
70-75	33	42	2.64	3.89	55.20	71.37	2392.5	3045.
75-80	21	26	1.68	2.41	56.88	73.78	1627.5	2015.
80-85	29	21	2.32	1.94	59.20	75.72	2392.5	1732.5
85-90	17	20	1.36	1.85	60.56	77.57	1487.5	1750.
90-95	12	5	.96	.46	61.52	78.03	1110.	462.5
95-100	17	19	1.36	1.76	62.88	79.79	1657.5	1852.5
100-110	28	21	2.24	1.94	65.12	81.73	2940.	2205.
110-120	31	30	2.48	2.78	67.60	84.51	3565.	3450.
120-130	29	21	2.32	1.94	69.92	86.45	3625.	2625.

<i>Time Categories</i>	<i>A Number of Parkings</i>		<i>B Percentage of Total</i>		<i>C Cumulative Percentage</i>		<i>D Parking Minutes Used</i>	
	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>	<i>Unreg.</i>	<i>Reg.</i>
130-140	30	11	2.40	1.02	72.32	87.47	4050.	1485.
140-150	22	14	1.76	1.30	74.08	88.77	3190.	2030.
150-160	25	9	2.00	.83	76.08	89.60	3875.	1395.
160-170	15	11	1.20	1.02	77.28	90.62	2475.	1815.
170-180	29	18	2.32	1.67	79.60	92.29	5075.	3150.
180-190	20	23	1.60	2.13	81.20	94.42	3700.	4255.
190-200	32	9	2.56	.83	83.76	95.25	6240.	1755.
200-210	30	9	2.40	.83	86.16	96.08	6150.	1845.
210-220	21	7	1.68	.65	87.84	96.73	4515.	1505.
220-230	26	5	2.08	.46	89.92	97.19	5850.	1125.
230-240	21	8	1.68	.74	91.60	97.93	4935.	1880.
240-250	20	3	1.60	.28	93.20	98.21	4900.	735.
250-260	26	4	2.08	.37	95.28	98.58	6630.	1020.
260-270	7	2	.56	.19	95.84	98.77	1855.	530.
270-280	7	2	.56	.19	96.40	98.96	1925.	550.
280-290	7	1	.56	.09	96.96	99.05	1995.	285.
290-300	4	4	.32	.37	97.28	99.42	1180.	1180.
300-310	6	1	.48	.09	97.76	99.51	1830.	305.
310-320	2		.16		97.92		630.	
320-330		2		.19		99.70		650.
330-340	2	1	.16	.09	98.08	99.79	670.	335.
340-350	1		.08		98.16		345.	
350-360		2		.19		99.98		710.
360-370	2		.16		98.32		730.	
370-380	1		.08		98.40		375.	
380-390								
390-400								
400-410								
410-420								
420-430								
430-440	1	1	.08	.09	98.48	100.07	435.	435.
440-450								
450-460	3		.24		98.72		1365.	
460-470	1		.08		98.80		465.	
470-480								
480-490	1		.08		98.88		485.	
490-500	3		.24		99.12		1485.	
500-510	1		.08		99.20		505.	
510-520	1		.08		99.28		515.	
520-530	3		.24		99.52		1575.	
530-540	2		.16		99.68		1070.	
540-550	2		.16		99.84		1090.	
550-560	1		.08		99.92		555.	
560-570								
570-580								
580-590	1		.08		100.00		585.	
590-600								
600-610								
TOTAL	1250	1081	100.00	100.07			119,428.	64,867.

Comparison of First and Second Halves of Single Periods

The following graphs show a comparison, in one of the studies, Church Street (Area A), between the numbers distributions obtained in the first half of an unregulated or a

regulated period and the numbers distribution obtained during the second half of the period.

APPENDIX C. THE ADMINISTRATIVE STUDIES

The dates of the administrative studies, all made on the same area on Water Street, were as follows:

Pre-Eighty Minute Tagging	March 16-19, 1937	4 days
Eighty Minute Tagging	March 22-April 26, 1937	25 days
Post-Eighty Minute Tagging	April 27-30; May 3-7; June 1-4, June 7, 1937	14 days
Pre-Forty-Five Minute Tagging	July 12-23, 1937	10 days
Forty-Five Minute Tagging	August 2-13, 1937	10 days
Post-Forty-Five Minute Tagging	August 16-20, 1937	5 days

During each day the period of observation was from 8:00 A. M. to 5:00 P. M. The process of observation—the methods of timing and recording, the instructions to ob-

servers, and the supervision—was in every way the same as in the parking studies. The post of observation was located in an unused room of the Railroad Office Building, across the street from the observers' post in the original Water Street parking study. This change was made in order to facilitate the control of the police officer who tagged the cars.

During the two periods in which cars were tagged, an officer of the New Haven Police Department, who was temporarily under the control of the supervisor of the studies, remained in the room with the observers. The observers notified the officer whenever a car had been in the area for a length of time three or four minutes short of the selected tagging time (eighty minutes in one study, forty-five minutes in the other). The officer noted the time at which the eighty minutes or forty-five minutes would expire, left the building, and approached the area by an indirect route. He then placed the tag on the car, attempting to do it at the exact expiration of the eighty or forty-five minutes. The observers recorded the times at which the tags were placed on the cars. There was no significant deviation from the stipulated eighty or forty-five minutes.

The tag placed on each car was the regular tag used at that time by the New Haven Police Department. Each tag was separately numbered and read as follows: "Report to Police Headquarters, 165 Court Street, as this is a SUMMONS for your appearance between 8:00 A.M. and 8:00 P.M. for violation of the Traffic Regulations at the time and place herein noted." There followed spaces for the entry of the date, hour, and place of the violation, the license number of the car, and the officer's shield number. On the back of the tag the type of violation was checked on a printed list. With a very few exceptions the usual fine of \$1.00 was assessed and paid by all of the drivers of the cars of New Haven registry which were so tagged. As was the usual custom at that time, out-of-town drivers were simply warned unless they had already received two or more tags, in which latter case the fine was assessed.

During the tagging periods there was, it is believed, nothing to indicate to a casual observer that anything unusual was happening in the neighborhood. Only a few cars were tagged each day and there was usually a long wait between taggings.

Primary Tables

The primary tables which appear on the following pages give the basic data collected during each period of the administrative studies. The arrangement is the same as that of the parking study tables given in Appendix A:

PRE-EIGHTY MINUTE TAGGING				
Water Street Administrative Study				
<i>Time Categories</i>	<i>A Number of Parkings</i>	<i>B Percentage of Total</i>	<i>C Cumulated Percentage</i>	<i>D Parking Minutes Used</i>
0-1	16	4.43	4.43	8.0
1-2	25	6.93	11.36	37.5
2-3	21	5.82	17.18	52.5
3-4	24	6.65	23.83	84.0
4-5	9	2.49	26.32	40.5
5-6	12	3.32	29.64	66.0
6-7	18	4.99	34.63	117.0
7-8	21	5.82	40.45	157.5
8-9	9	2.49	42.94	76.5

<i>Time Categories</i>	<i>A Number of Parkings</i>	<i>B Percentage of Total</i>	<i>C Cumulated Percentage</i>	<i>D Parking Minutes Used</i>
9-10	12	3.32	46.26	114.0
10-11	14	3.88	50.14	147.0
11-12	7	1.94	52.08	80.5
12-13	9	2.49	54.57	112.5
13-14	6	1.66	56.23	81.0
14-15	5	1.39	57.62	72.5
15-16	7	1.94	59.56	108.5
16-17	5	1.39	60.96	82.5
17-18	8	2.22	63.17	140.0
18-19	3	.83	64.00	55.5
19-20	7	1.94	65.94	136.5
20-21	5	1.39	67.33	102.5
21-22	3	.83	68.16	64.5
22-23	3	.83	68.99	67.5
23-24	1	.28	69.27	23.5
24-25	5	1.39	70.66	122.5
25-26	5	1.39	72.05	127.5
26-27	4	1.11	73.16	106.0
27-28	4	1.11	74.27	110.0
28-29	3	.83	75.10	85.5
29-30	4	1.11	76.21	118.0
30-35	14	3.88	80.09	455.0
35-40	5	1.39	81.48	187.5
40-45	8	2.22	83.70	340.0
45-50	8	2.22	85.92	380.0
50-55	5	1.39	87.31	262.5
55-60	3	.83	88.14	172.5
60-65	4	1.11	89.25	250.0
65-70	7	1.94	91.19	472.5
70-75	3	.83	92.02	217.5
75-80	4	1.11	93.13	310.0
80-85	2	.55	93.68	165.0
85-90	2	.55	94.23	175.0
90-95	1	.28	94.51	92.5
95-100	2	.55	95.06	195.0
100-110	3	.83	95.89	315.0
110-120				
120-130	1	.28	96.17	125.0
130-140	5	1.39	97.56	675.0
140-150	1	.28	97.84	145.0
150-160	1	.28	98.12	155.0
160-170	1	.28	98.40	165.0
170-180	1	.28	98.68	175.0
180-190				
190-200	1	.28	98.96	195.0
200-210				
210-220	1	.28	99.24	215.0

<i>Time Categories</i>	<i>A Number of Parkings</i>	<i>B Percentage of Total</i>	<i>C Cumulated Percentage</i>	<i>D Parking Minutes Used</i>
270-280	1	.28	99.52	275.0
.				
.				
400+	2	.55	100.07	970.0
TOTAL	361	100.07		9782.5

EIGHTY MINUTE TAGGING

Water Street Administrative Study

<i>Time Categories</i>	<i>A Number of Parkings</i>	<i>B Percentage of Total</i>	<i>C Cumulated Percentage</i>	<i>D Parking Minutes Used</i>
0-1	77	3.05	3.05	38.5
1-2	171	6.77	9.82	256.5
2-3	168	6.66	16.48	420.0
3-4	147	5.82	22.30	514.5
4-5	141	5.59	27.89	634.5
5-6	119	4.71	32.60	654.5
6-7	120	4.75	37.35	780.0
7-8	97	3.84	41.19	727.5
8-9	81	3.21	44.40	688.5
9-10	93	3.68	48.08	883.5
10-11	74	2.93	51.01	777.0
11-12	58	2.30	53.31	667.0
12-13	78	3.09	56.40	975.0
13-14	47	1.86	58.26	634.5
14-15	41	1.62	59.88	594.5
15-16	49	1.94	61.82	759.5
16-17	51	2.02	63.84	841.5
17-18	60	2.38	66.22	1050.0
18-19	50	1.98	68.20	925.0
19-20	21	.83	69.03	409.5
20-21	35	1.39	70.42	717.5
21-22	35	1.39	71.81	752.5
22-23	33	1.31	73.12	742.5
23-24	38	1.51	74.63	893.0
24-25	23	.91	75.54	563.5
25-26	26	1.03	76.57	663.0
26-27	28	1.11	77.68	742.0
27-28	22	.87	78.55	605.0
28-29	20	.79	79.34	570.0
29-30	24	.95	80.29	708.0
30-35	91	3.60	83.89	2957.5
35-40	59	2.34	86.23	2212.5
40-45	73	2.89	89.12	3102.5
45-50	60	2.38	91.50	2850.0
50-55	37	1.47	92.97	1942.5

<i>Time Categories</i>	<i>A Number of Parkings</i>	<i>B Percentage of Total</i>	<i>C Cumulated Percentage</i>	<i>D Parking Minutes Used</i>
55-60	38	1.51	94.48	2185.0
60-65	23	.91	95.39	1437.5
65-70	22	.87	96.26	1485.0
70-75	14	.55	96.81	1015.0
75-80	17	.67	97.48	1317.5
80-85	7	.28	97.76	577.5
85-90	15	.59	98.35	1312.5
90-95	5	.20	98.55	462.5
95-100				
100-110	8	.32	98.87	840.0
110-120	8	.32	99.19	920.0
120-130	6	.24	99.43	750.0
130-140	1	.04	99.47	135.0
140-150	1	.04	99.51	145.0
150-160	1	.04	99.55	155.0
160-170	1	.04	99.59	165.0
170-180	2	.08	99.67	350.0
180-190				
190-200	2	.08	99.75	390.0
200-210	2	.08	99.83	410.0
210-220	1	.04	99.87	215.0
220-230				
230-240	1	.04	99.91	235.0
240-250				
250-260				
260-270	1	.04	99.95	265.0
.				
.				
.				
510-520	1	.04	99.99	515.0
TOTAL	2524	99.99	99.99	48,536.0

POST-EIGHTY MINUTE TAGGING
Water Street Administrative Study

<i>Time Categories</i>	<i>A Number of Parkings</i>	<i>B Percentage of Total</i>	<i>C Cumulated Percentage</i>	<i>D Parking Minutes Used</i>
0-1	45	2.92	2.92	22.5
1-2	118	7.67	10.59	177.0
2-3	107	6.95	17.54	267.5
3-4	74	4.81	22.35	259.0
4-5	84	5.46	27.81	378.0
5-6	90	5.85	33.66	495.0
6-7	61	3.96	37.62	396.5
7-8	63	4.09	41.71	472.5
8-9	64	4.16	45.87	544.0

<i>Time Categories</i>	<i>A Number of Parkings</i>	<i>B Percentage of Total</i>	<i>C Cumulated Percentage</i>	<i>D Parking Minutes Used</i>
9-10	48	3.12	48.99	456.0
10-11	48	3.12	52.11	504.0
11-12	41	2.66	54.77	471.5
12-13	30	1.95	56.72	375.0
13-14	35	2.27	58.99	472.5
14-15	25	1.62	60.61	362.5
15-16	32	2.08	62.69	496.0
16-17	33	2.14	64.83	544.5
17-18	24	1.56	66.39	420.0
18-19	24	1.56	67.95	444.0
19-20	21	1.36	69.31	409.5
20-21	22	1.43	70.74	451.0
21-22	20	1.30	72.04	430.0
22-23	18	1.17	73.21	405.0
23-24	22	1.43	74.64	517.0
24-25	22	1.43	76.07	539.0
25-26	20	1.30	77.37	510.0
26-27	13	.84	78.21	344.5
27-28	18	1.17	79.38	495.0
28-29	11	.71	80.09	313.5
29-30	15	.97	81.06	442.5
30-35	65	4.22	85.28	2112.5
35-40	46	2.99	88.27	1725.0
40-45	31	2.01	90.28	1317.5
45-50	27	1.75	92.03	1282.5
50-55	23	1.49	93.52	1207.5
55-60	14	.91	94.43	805.0
60-65	14	.91	95.34	875.0
65-70	13	.84	96.18	877.5
70-75	11	.71	96.89	797.5
75-80	7	.45	97.34	542.5
80-85	7	.45	97.79	577.5
85-90	4	.26	98.05	350.5
90-95	3	.19	98.24	277.5
95-100	3	.19	98.43	292.5
100-110	3	.19	98.62	315.0
110-120	3	.19	98.81	345.0
120-130	3	.19	99.00	375.0
130-140	1	.06	99.06	135.0
140-150				
150-160	2	.13	99.19	310.0
160-170				
170-180	1	.06	99.25	175.0
180-190	1	.06	99.31	185.0
190-200	2	.13	99.44	390.0
200-210	1	.06	99.50	205.0
210-220	1	.06	99.56	215.0
220-230				
230-240				

<i>Time Categories</i>	<i>A Number of Parkings</i>	<i>B Percentage of Total</i>	<i>C Cumulated Percentage</i>	<i>D Parking Minutes Used</i>
240-250				
250-260	1	.06	99.62	255.0
260-270	1	.06	99.68	265.0
270-280				
280-290				
290-300				
300-310				
310-320	2	.13	99.81	630.0
320-330	1	.06	99.87	325.0
TOTAL	1539	99.87		29,580.0

PRE-FORTY-FIVE MINUTE TAGGING

Water Street Administrative Study

<i>Time Categories</i>	<i>A Number of Parkings</i>	<i>B Percentage of Total</i>	<i>C Cumulated Percentage</i>	<i>D Parking Minutes Used</i>
0-1	52	5.37	5.37	26.0
1-2	62	6.40	11.77	93.0
2-3	60	6.19	17.96	150.0
3-4	55	5.68	23.64	192.5
4-5	62	6.40	30.04	279.0
5-6	49	5.06	35.10	269.5
6-7	43	4.44	39.54	279.5
7-8	32	3.30	42.84	240.5
8-9	40	4.13	46.97	340.0
9-10	34	3.51	50.48	323.0
10-11	24	2.48	52.96	252.0
11-12	23	2.37	55.33	264.5
12-13	20	2.06	57.39	250.0
13-14	16	1.65	59.04	216.5
14-15	15	1.55	60.59	217.5
15-16	16	1.65	62.24	248.0
16-17	18	1.86	64.10	297.0
17-18	19	1.96	66.06	332.5
18-19	15	1.55	67.61	277.5
19-20	13	1.34	68.95	253.5
20-21	4	.41	69.36	82.0
21-22	8	.83	70.19	172.0
22-23	14	1.44	71.63	315.0
23-24	10	1.03	72.66	235.0
24-25	8	.83	73.49	196.0
25-26	11	1.14	74.63	280.5
26-27	11	1.14	75.77	291.5
27-28	9	.93	76.70	247.5
28-29	9	.93	77.63	256.5
29-30	9	.93	78.56	265.5
30-35	37	3.82	82.38	1202.5

<i>Time Categories</i>	<i>A Number of Parkings</i>	<i>B Percentage of Total</i>	<i>C Cumulated Percentage</i>	<i>D Parking Minutes Used</i>
35-40	24	2.48	84.86	900.0
40-45	12	1.24	86.10	510.0
45-50	26	2.68	88.78	1235.0
50-55	17	1.75	90.53	892.5
55-60	8	.83	91.36	460.0
60-65	6	.62	91.98	375.0
65-70	5	.52	92.50	337.5
70-75	8	.83	93.33	580.0
75-80	7	.72	94.05	542.5
80-85	5	.52	94.57	412.5
85-90	10	1.03	95.60	875.0
90-95	2	.21	95.81	185.0
95-100	2	.21	96.02	195.0
100-110	5	.52	96.54	525.0
110-120	5	.52	97.06	575.0
120-130	6	.62	97.68	750.0
130-140	1	.10	97.78	135.0
140-150				
150-160	1	.10	97.88	155.0
160-170	2	.21	98.09	330.0
170-180				
180-190	2	.21	98.30	370.0
190-200	2	.21	98.51	390.0
200-210	1	.10	98.61	205.0
210-220	1	.10	98.71	215.0
220-230	1	.10	98.81	225.0
230-240	3	.31	99.12	705.0
240-250	1	.10	99.22	245.0
250-260	1	.10	99.32	255.0
260-270	1	.10	99.42	265.0
270-280				
280-290	1	.10	99.52	285.0
290-300	1	.10	99.62	295.0
.				
.				
.				
.				
400+	4	.41	100.03	2310.0
TOTAL	969	100.03		24,080.0

FORTY-FIVE MINUTE TAGGING

Water Street Administrative Study

<i>Time Categories</i>	<i>A Number of Parkings</i>	<i>B Percentage of Total</i>	<i>C Cumulated Percentage</i>	<i>D Parking Minutes Used</i>
0-1	31	3.21	3.21	15.5
1-2	74	7.65	10.86	110.0
2-3	85	8.79	19.65	212.5

<i>Time Categories</i>	A <i>Number of Parkings</i>	B <i>Percentage of Total</i>	C <i>Cumulated Percentage</i>	D <i>Parking Minutes Used</i>
3-4	72	7.44	27.09	252.0
4-5	57	5.89	32.98	256.5
5-6	51	5.27	38.25	280.5
6-7	38	3.93	42.18	247.0
7-8	35	3.62	45.80	262.5
8-9	40	4.14	49.94	340.0
9-10	31	3.21	53.15	294.5
10-11	33	3.41	56.56	346.5
11-12	24	2.48	59.04	276.0
12-13	15	1.55	60.59	187.5
13-14	20	2.07	62.66	270.0
14-15	21	2.17	64.83	304.5
15-16	22	2.28	67.11	341.0
16-17	18	1.86	68.97	297.0
17-18	21	2.17	71.14	367.5
18-19	21	2.17	73.31	388.5
19-20	24	2.48	75.79	468.0
20-21	14	1.45	77.24	287.0
21-22	10	1.03	78.27	215.0
22-23	14	1.45	79.72	315.0
23-24	10	1.03	80.75	235.0
24-25	10	1.03	81.78	245.0
25-26	14	1.45	83.23	357.0
26-27	6	.62	83.85	159.0
27-28	7	.72	84.57	192.5
28-29	8	.83	85.40	228.5
29-30	4	.41	85.81	118.0
30-35	40	4.14	89.95	1300.0
35-40	22	2.28	92.23	825.0
40-45	31	3.21	95.44	1317.5
45-50	3	.31	95.75	142.5
50-55	8	.83	96.58	420.0
55-60	10	1.03	97.61	575.0
60-65	1	.10	97.71	62.5
65-70	3	.31	98.02	202.5
70-75	2	.21	98.23	145.0
75-80	5	.52	98.75	387.5
80-85	2	.21	98.96	165.0
85-90				
90-95				
95-100	2	.21	99.17	195.0
100-110	3	.31	99.48	315.0
110-120	1	.10	99.58	115.0
120-130				
130-140				
140-150	1	.10	99.68	145.0
150-160				
160-170				
170-180				

<i>Time Categories</i>	<i>A Number of Parkings</i>	<i>B Percentage of Total</i>	<i>C Cumulated Percentage</i>	<i>D Parking Minutes Used</i>
180-190	1	.10	99.78	185.0
190-200				
200-210				
210-220				
220-230				
230-240				
240-250				
250-260				
260-270				
270-280	1	.10	99.88	275.0
.				
.				
.				
400+	1	.10	99.98	455.0
TOTAL	967	99.98		15,098.0

POST-FORTY-FIVE MINUTE TAGGING

Water Street Administrative Study

<i>Time Categories</i>	<i>A Number of Parkings</i>	<i>B Percentage of Total</i>	<i>C Cumulated Percentage</i>	<i>D Parking Minutes Used</i>
0-1	22	4.52	4.52	11.0
1-2	49	10.06	14.58	73.5
2-3	32	6.57	21.15	80.0
3-4	29	5.95	27.10	101.5
4-5	38	7.80	34.90	171.5
5-6	19	3.90	38.80	104.5
6-7	17	3.49	42.29	110.5
7-8	18	3.70	45.99	135.0
8-9	10	2.05	48.04	85.0
9-10	17	3.49	51.53	161.5
10-11	15	3.08	54.61	157.5
11-12	10	2.05	56.66	115.0
12-13	11	2.26	58.92	137.5
13-14	16	3.29	62.21	216.0
14-15	13	2.67	64.88	188.5
15-16	11	2.26	67.14	170.5
16-17	7	1.44	68.58	115.5
17-18	6	1.23	69.81	105.5
18-19	8	1.64	71.45	148.0
19-20	7	1.44	72.89	136.5
20-21	7	1.44	74.33	143.5
21-22	6	1.23	75.56	129.0
22-23	2	.41	75.97	45.0
23-24	8	1.64	77.61	188.0
24-25	8	1.64	79.25	196.0

<i>Time Categories</i>	A <i>Number of Parkings</i>	B <i>Percentage of Total</i>	C <i>Cumulated Percentage</i>	D <i>Parking Minutes Used</i>
25-26	6	1.23	80.48	153.0
26-27	6	1.23	81.71	159.0
27-28	2	.41	82.12	55.0
28-29	5	1.03	83.15	142.5
29-30	4	.82	83.97	118.0
30-35	20	4.11	88.08	650.0
35-40	14	2.87	90.95	525.0
40-45	8	1.64	92.59	340.0
45-50	9	1.85	94.44	427.5
50-55	2	.41	94.85	105.0
55-60	4	.82	95.67	230.0
60-65	3	.62	96.29	187.0
65-70	3	.62	96.91	202.5
70-75	2	.41	97.32	145.0
75-80	1	.21	97.53	77.5
80-85				
85-90	1	.21	97.74	87.5
90-95				
95-100	4	.82	98.56	390.0
100-110	1	.21	98.77	105.0
110-120	3	.62	99.39	345.0
120-130	2	.41	99.80	250.0
.				
150-160	1	.21	100.01	155.0
TOTAL	487	100.01		8,075.0

Method of Determining Number of Parkings by Repeaters:

In Original Regulated Parking Study (for comparison with Eighty Minute Tagging Study)

Total number observed over eighty minutes	90
Total number identified	80
Unidentified	10
Number of parkings by repeaters in identified group	44
Percentage of identified parkings which are parkings by repeaters	55%
Number of parkings by repeaters in unidentified group (55% of 10)	5.50
Total number of parkings by repeaters in categories over eighty minutes	49.50

The number thus determined was distributed among the categories over eighty minutes in accordance with the distribution of the identified parkings by repeaters.

In Eighty Minute Tagging Study (for comparison with Forty-Five Minute Tagging Study, see page 49 supra)

Total number observed between forty-five and eighty minutes (including parkers who went to office later vacated)	211
Total number identified	187
Unidentified	24
Number of parkings by repeaters in identified group	59
Percentage of identified parkings which are parkings by repeaters	31.55%
Ratio between identified and total cars, including office parkers..	187/211
<i>Assumption:</i> Ratio between identified and unidentified would be the same if office parkers were excluded.	
Total number observed between forty-five and eighty minutes, excluding office cars	180
Number unidentified (24/211)	20.47
Total number of parkings by repeaters in identified group	51
Number of parkings by repeaters in unidentified group, excluding office parkers (31.55% of 20.47)	6.458
Total number of parkings by repeaters in categories between forty-five and eighty minutes, excluding office parkers	57.458

The number thus determined was distributed among the categories between forty-five and eighty minutes in accordance with the distribution of the identified parkings by repeaters, excluding office parkers.

APPENDIX D. THE ROTARY TRAFFIC STUDIES

The rotary traffic studies were made in five separate stages. During each stage four classes of automobile traffic were observed, and each class is here regarded as a separate study. The four classes were: (1) traffic from Broad Street to Davenport Avenue; (2) traffic from Davenport Avenue to Broad Street; (3) traffic from Davenport Avenue making a left turn into either Oak Street or Dow Street; and (4) traffic from either Oak Street or Dow Street into Davenport Avenue. The observers were located on the street and recorded each class of traffic with respect to the number of cars passing across the intersection in each of seven defined paths.

Each stage of the observations covered three days. The five separate stages were as follows:

Stage I, January 16, 17, and 18, 1934. During this stage no ordinance with respect to traffic at the intersection was in force (except the general requirement of keeping to the right). There were no marks of any kind on the pavement, or elsewhere, to indicate the direction that traffic through the intersection should take. Inconspicuous marks were placed on the pavement to aid the observers in determining the lane, or path, through which each car passed.

Stage II, January 24, 25, and 30, 1934. During this stage the oval was painted on the pavement, and the words "Keep Right" were painted at the point of entrance of each street to the intersection. However, the ordinance establishing rotary traffic at the intersection had not yet been enacted.

Stage III, March 21, 22, and 23, 1934. During this stage the symbols present in Stage II were present, and the ordinance establishing rotary traffic had been enacted and was in force.

Stage IV, April 5, 6, and 18, 1934. During this stage the symbols and ordinance were present as in Stage III. In addition physical barriers—the usual traffic stanchions—were

placed around the painted oval in such a way as to make it virtually impossible to drive through the oval without knocking them over.

Stage V, April 10, 11, and 12, 1934. During this stage the ordinance was in force as in Stages III and IV; but there were no symbols of any kind, signifying such ordinance, on the site. Neither the stanchions, the painted oval, nor the painted words were present. Thus Stage V was like Stage I with the exception of the presence of the official ordinance in the police traffic regulations.

During all stages in which symbols were used they were removed from the site immediately after the conclusion of the period of observation of that stage.

On each day observations were made from 9:00 A. M. to 5:00 P. M. In the final tabulation of the Broad to Davenport class the first morning's observations were excluded from each stage. It was judged that these observations in Stage I were unreliable and it was necessary to make comparable exclusions from each stage.

The various lanes among which each of the separate classes of traffic are distributed in each of the following tables were designated ("near side" and "far side") with reference to the position of the observer observing each class. In the case of Davenport to Broad, Broad to Davenport, and Oak-Dow to Davenport these positions were such that the categories nearest to the bottom of each of the above tables represent traffic keeping farthest to *its* right. Thus, in these studies, the cars in the categories, "Passing 0-20 Feet from Oval," "Intersecting Two Lanes," and "Passing 0-20 Feet from Curb," were conforming to the painted direction to "Keep Right" of the oval. However, in the case of the Davenport to Oak-Dow study, the observer was so posted that the categories nearest to the top in the above tables represent traffic keeping to *its* right. Accordingly, in that study only the cars in the category, "Passing Beyond Oval—Far Side," were conforming to the painted direction, "Keep Right."

The number of cars observed in each stage, in each direction class, and in each defined lane or path, and the percentage distribution of these cars among lanes appears in the tables below:

Numbers Tables

DAVENPORT TO BROAD					
	Stage				
	I	II	III	IV	V
Passing Beyond Oval—Far Side	7	0	0	0	1
Intersecting Oval—Far Side...	20	6	0	0	11
Passing Through Oval	3110	305	399	0	3495
Intersecting Oval—Near Side..	23	420	575	0	136
Passing 0-20 Feet From Oval..	7	2783	2576	4001	41
Intersecting Two Lanes	0	4	3	20	2
Passing 0-20 Feet From Curb..	0	2	0	5	2
TOTAL	3167	3520	3553	4026	3688

BROAD TO DAVENPORT					
	Stage				
	I	II	III	IV	V
Passing Beyond Oval—Far Side	1	0	0	0	0
Intersecting Oval—Far Side ...	1	0	0	0	0
Passing Through Oval	64	3	1	0	36
Intersecting Oval—Near Side...	596	74	50	0	364
Passing 0-20 Feet From Oval..	1369	1562	1621	693	1927
Intersecting Two Lanes	114	755	800	2041	283
Passing 0-20 Feet From Curb...	23	51	35	73	26
TOTAL	2168	2445	2507	2807	2636

DAVENPORT TO OAK-DOW

	Stage				
	I	II	III	IV	V
Passing Beyond Oval—Far Side	0	63	51	181	6
Intersecting Oval—Far Side ...	0	61	36	0	1
Passing Through Oval	11	0	1	0	22
Intersecting Oval—Near Side...	7	6	4	0	8
Passing 0-20 Feet From Oval ..	44	5	16	0	36
Intersecting Two Lanes	42	12	13	1	49
Passing 0-20 Feet From Curb..	41	14	8	3	53
TOTAL	145	161	129	185	175

OAK-DOW TO DAVENPORT

	Stage				
	I	II	III	IV	V
Passing Beyond Oval—Far Side	0	0	0	0	0
Intersecting Oval—Far Side ...	0	0	0	0	0
Passing Through Oval	1	0	0	0	0
Intersecting Oval—Near Side..	0	0	1	0	0
Passing 0-20 Feet From Oval..	4	0	1	2	1
Intersecting Two Lanes	9	9	12	6	13
Passing 0-20 Feet From Curb ..	191	183	184	203	188
TOTAL	205	192	198	211	202

Percentage Tables

DAVENPORT TO BROAD

	Stage				
	I	II	III	IV	V
Passing Beyond Oval—Far Side	.22	0	0	0	.02
Intersecting Oval—Far Side ...	.63	.17	0	0	.29
Passing Through Oval	98.20	8.66	11.22	0	94.76
Intersecting Oval—Near Side..	.72	11.93	16.18	0	3.68
Passing 0-20 Feet From Oval ..	.22	79.06	72.50	99.37	1.11
Intersecting Two Lanes	0	.11	.08	.49	.05
Passing 0-20 Feet From Curb...	0	.05	0	.12	.05
TOTAL	99.99	99.98	99.98	99.98	99.97

BROAD TO DAVENPORT

	Stage				
	I	II	III	IV	V
Passing Beyond Oval—Far Side	.04	0	0	0	0
Intersecting Oval—Far Side ...	.04	0	0	0	0
Passing Through Oval	2.95	.12	.03	0	1.36
Intersecting Oval—Near Side...	27.49	3.02	1.99	0	13.80
Passing 0-20 Feet From Oval ..	63.14	63.88	64.65	24.68	73.10
Intersecting Two Lanes	5.25	30.87	31.91	72.71	10.73
Passing 0-20 Feet From Curb ..	1.06	2.08	1.39	2.60	.98
TOTAL	99.97	99.97	99.97	99.99	99.97

DAVENPORT TO OAK-DOW

	Stage				
	I	II	III	IV	V
Passing Beyond Oval—Far Side	0	39.13	39.53	97.83	3.42
Intersecting Oval—Far Side ...	0	37.88	27.90	0	.57
Passing Through Oval	7.58	0	.77	0	12.57
Intersecting Oval—Near Side ..	4.82	3.72	3.10	0	4.57
Passing 0-20 Feet From Oval ..	30.34	3.10	12.40	0	20.57
Intersecting Two Lanes	28.96	7.45	10.07	.54	28.00
Passing 0-20 Feet From Curb ..	28.27	8.69	6.20	1.62	30.28
TOTAL	99.97	99.99	99.98	99.98	99.98

OAK-DOW TO DAVENPORT

	Stage				
	I	II	III	IV	V
Passing Beyond Oval—Far Side	0	0	0	0	0
Intersecting Oval—Far Side ...	0	0	0	0	0
Passing Through Oval	.48	0	0	0	0
Intersecting Oval—Near Side ..	0	0	.50	0	0
Passing 0-20 Feet From Oval ..	1.95	0	.50	.94	.49
Intersecting Two Lanes	4.39	4.68	6.06	2.84	6.43
Passing 0-20 Feet From Curb ..	93.17	95.31	92.92	96.20	93.06
TOTAL	99.99	99.99	99.98	99.98	99.98

APPENDIX E. SUMMARY OF ANALYTICAL METHODS *

Mathematical representations of the relationship between “cumulative percentage unregulated” and “cumulative percentage regulated” in the parking studies have been obtained for the ten sets of observations considered in this report. These representations take the form of equations and are listed in Table I. Their derivation is outlined below and illustrated by Table II.

After much experimentation the following type of representation was found acceptable. Here “cumulative percentage unregulated” is denoted by x and “cumulative percentage regulated” by y .

$$(1) \quad y = \begin{cases} \frac{s}{p} x, & 0 \leq x \leq p \\ m(1 - 10^{-(kx)^n}), & p \leq x \leq q \\ 100, & q \leq x \leq 100 \end{cases}$$

Using (1) we were able to express the quantities involved, k , m , n , p , q , and s , as functions of the variable “percentage to the left of ordinance time” which we denote by r and which depends on the particular set of observations we consider.

The graphs of observed y in terms of x all exhibit a sharp bend at a value of x which we refer to as “the Point” and denote by p . To find reasonably unbiased crude values of p we computed $d = d(x)$, the difference in slope of two straight lines fitted to

* This appendix is the work of Bengt G. Carlson, Instructor, Department of Mathematics, Yale University.

the values of y in the intervals $(x-12, x)$ and $(x, x+12)$ respectively. Crude p was then defined as the value of x which maximized d , and a graduation yielded:

$$(2) \quad p = 14.5 + r$$

After the asymptotic value m of y had been fixed graphically at 102, crude n were obtained as averages of three or four values of n_1 computed from:

$$(3) \quad n_1 = \frac{g_1 x_1}{2.3(102 - y_1)} - \log \frac{102}{102 - y_1},$$

a formula derived from (1) by differentiation. Here y_1 and g_1 are estimates, obtained from the graphs, of y and its rate of change as to x for $x = x_1$. Crude n thus computed were found well approximated by:

$$(4) \quad n = 1.10 + .02r$$

Finally observed y were approximated by the function $y = 102 (1 - 10^{-(kx)^n})$ with n from (4) and in the process of finding the "best" approximation crude values of k emerged. A satisfactory representation of these k -values was then found in:

$$(5) \quad 100k = 2.10 \cdot 10^{-.05r} + 1.35$$

Since (1) is to be continuous s and q must satisfy:

$$(6) \quad s = 102(1 - 10^{-(kp)^n})$$

$$(7) \quad 100 = 102(1 - 10^{-(kq)^n})$$

We have thus obtained a solution to the problem of finding a representation of y as a function of x with parameters dependent on r .

TABLE I

Name of Study	y in (O, p)	y in (p, q)	y in $(q, 100)$
I. Crown A North	$y = 2.74x$	$y = 102(1 - 10^{-.00797x^{1.26}})$	$y = 100$
II. Crown A South	$y = 2.78x$	$y = 102(1 - 10^{-.00816x^{1.26}})$	$y = 100$
III. Crown A North and South (1936)	$y = 2.76x$	$y = 102(1 - 10^{-.00806x^{1.26}})$	$y = 100$
IV. Crown A North and South (1935)	$y = 2.56x$	$y = 102(1 - 10^{-.00664x^{1.29}})$	$y = 100$
V. Church A	$y = 1.41x$	$y = 102(1 - 10^{-.000412x^{1.82}})$	$y = 100$
VI. Church B	$y = 1.22x$	$y = 102(1 - 10^{-.0000404x^{2.35}})$	$y = 100$
VII. Water	$y = 1.24x$	$y = 102(1 - 10^{-.0000501x^{2.30}})$	$y = 100$
VIII. College	$y = 1.33x$	$y = 102(1 - 10^{-.000185x^{2.00}})$	$y = 100$
IX. Prospect East	$y = 1.45x$	$y = 102(1 - 10^{-.000570x^{1.75}})$	$y = 100$
X. Prospect West	$y = 1.34x$	$y = 102(1 - 10^{-.000202x^{1.98}})$	$y = 100$

TABLE II

<i>Name of Study</i>	<i>r</i>	<i>Crude p</i>	<i>p</i>	<i>Crude n</i>	<i>n</i>	<i>Crude k</i>	<i>k</i>	<i>s</i>	<i>q</i>
I. Crown A North	8.23	19.8	22.7	1.35	1.26	.0224	.0216	62.1	70.8
II. Crown A South	7.85	25.5	22.4	1.23	1.26	.0222	.0220	62.3	69.5
III. Crown A North and South (1936)	8.04	27.2	22.5	1.33	1.26	.0225	.0218	62.1	70.1
IV. Crown A North and South (1935)	9.55	19.0	24.0	1.40	1.29	.0183	.0205	61.4	73.8
V. Church A	35.87	53.8	50.4	1.50	1.82	.0139	.0138	71.0	97.2
VI. Church B	62.37	69.7	76.9	2.09	2.35	.0123	.0135	93.7	93.0
VII. Water	59.99	80.2	74.5	2.65	2.30	.0136	.0135	92.1	93.5
VIII. College	45.20	43.3	59.7	2.03	2.00	.0141	.0136	79.6	96.1
IX. Prospect East	32.73	51.2	47.2	1.75	1.75	.0138	.0140	68.6	97.0
X. Prospect West	44.16	66.8	58.7	2.07	1.98	.0129	.0136	78.6	96.3

APPENDIX F. METHOD OF COMPUTING PERCENTAGE OF AVAILABLE PARKING MINUTES USED BY PARKERS IN THE UNREGULATED PERIODS

The total number of parking minutes available to parkers during each of the unregulated periods was computed by first multiplying the total number of minutes during which observations were made by the length of the observed area. The product was then divided by fifteen, the average number of feet assumed to be occupied by each parking. The resulting figure is the number of parking minutes available during the unregulated period and is the figure which appears first in each of the computations below.

The computation of the number of parking minutes used (taken up by cars parking in the area) was complicated by the fact that some of the cars actually parked in the area during the period of observation were not included in the primary tabulations, for example, the cars that were present in the area when the period of observation began. (See Appendix A). However, for the most part, this information had been recorded by the observers, and an effort was made to incorporate it in the computation. In the few instances in which estimates were required the estimates were made on the basis of data available from other observations covering periods judged roughly comparable. The figures estimated are so marked in the following detailed computations.

I. *Crown Street—North Side*

Total available parking minutes, 8:00 A. M.-5:00 P.M.	106,596
Parking minutes used, 8:00-5:00	
Total used by cars observed	72,906
Less: parking minutes used after 5:00	10,097
	62,809
Less: parking minutes used before 8:00	254
Total used	62,555
Percentage of available used	58.68

II. *Crown Street—South Side*

Total available parking minutes, 8:00 A. M.-5:00 P.M.	106,272
Parking minutes used, 8:00-5:00	
Total used by cars observed	72,776
Less: parking minutes used after 5:00	11,273
	61,503
Less: parking minutes used before 8:00	232
Total used	61,271
Percentage of available used	57.66

III. *Crown Street—North and South Combined—1936*

Total available parking minutes, 8:00 A. M.-5:00 P. M.	218,781
Parking minutes used, 8:00-5:00	
Total used by cars observed	149,493
Less: parking minutes used after 5:00	21,693
	127,800
Less: parking minutes used before 8:00	498
Total used	127,302
Percentage of available used	58.19

IV. *Crown Street—North and South Combined—1935*

Total available parking minutes, 8:00 A. M.-5:00 P. M.	47,304
Parking minutes used, 8:00-5:00	
Total used by cars observed	23,458
Less: parking minutes used after 5:00	2,157
	21,301
Plus: parking minutes used after 8:00 by cars parking before 8:00 *	1,583
Total used	22,884
Percentage of available used	48.38

V. *Church Street—Area A*

Total available parking minutes, 7:00 P. M.-8:00 P. M.	38,258
Parking minutes used, 7:00-8:00	
Total used by cars observed	39,170.5
Less: parking minutes used after 8:00 by cars observed.....	28,944
	10,226.5
Plus: parking minutes used, 7:00-8:00, by cars parking before 7:00	
by cars parking 5:30 to 6:30	4,625.5
by cars parking 6:30-7:00	3,999.5
by cars in area at 5:30	2,131.5
	10,756.5
Total used	20,983
Percentage of available used	54.85

* In the 1935 Crown Street study cars parking before 8:00 were not included in the distribution. Such cars *are* included in the 1936 study. Total time parked cannot be determined for such cars in the 1935 study because time of parking is not recorded. Time of leaving *is* recorded, however, so time consumed by such cars after 8:00 can be calculated.

VI. *Church Street—Area B*

Total available parking minutes, 7:00 P. M.-8:00 P. M.	7,248
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Parking minutes used, 7:00-8:00	
Total used by cars observed	6,544
Less: parking minutes used after 8:00 by cars observed	4,179
	<hr/>
	2,365
Plus: parking minutes used, 7:00-8:00 by cars parking before 7:00:	
by cars parking 5:30-6:30	537
by cars parking 6:30-7:00 (estimate)	576
by cars in area at 5:30	244
	<hr/>
	1,357
Total used	<hr/>
	3,722
Percentage of available used	<hr/>
	51.35

VII. *Water Street*

Total available parking minutes, 8:00 A. M.-5:00 P. M.	98,820
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Parking minutes used, 8:00-5:00:	
Total used by cars observed (cars leaving before 7:00)	58,974
Less: parking minutes used after 5:00 by cars observed	4,510
	<hr/>
	54,464
Plus: parking minutes used, 8:00-5:00, by cars parking before 8:00	4,791
Plus: parking minutes used, 8:00-5:00, by cars staying after 7:00	4,995
	<hr/>
Total used	64,250
Percentage of available used	<hr/>
	65.02

VIII. *College Street*

Total available parking minutes, 7:00 P. M.-7:30 P. M.	8,244
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Parking minutes used, 7:00-7:30	
Total used by cars observed	6,632
Less: parking minutes used after 7:30 by cars observed	3,503
	<hr/>
	3,129
Plus: parking minutes used, 7:00-7:30, by cars parking 4:30-5:00	89
by cars parking 5:00-7:00 (estimate) ...	3,596
	<hr/>
	3,685
Total used	<hr/>
	6,814
Percentage of available used	<hr/>
	82.65

IX. *Prospect Street—East Side*

Total available parking minutes, 8:00 A. M.-5:00 P. M.	308,160
Parking minutes used, 8:00-5:00	
Total used by cars observed (cars leaving before 7:00)	119,140
Less: parking minutes used after 5:00 by cars observed	8,891
	110,249
Plus: parking minutes used, 8:00-5:00, by cars parking before 8:00	30,962
Plus: parking minutes used, 8:00-5:00, by cars staying after 7:00	1,321
Total used	142,532
Percentage of available used	46.25

X. *Prospect Street—West Side*

Total available parking minutes, 8:00 A. M.-5:00 P. M.	388,080
Parking minutes used, 8:00-5:00	
Total used by cars observed (cars leaving before 7:00)	119,428
Less: parking minutes used after 5:00 by cars observed	6,453
	112,975
Plus: parking minutes used, 8:00-5:00, by cars parking before 8:00	25,942
Plus: parking minutes used, 8:00-5:00, by cars staying after 7:00	2,050
Total used	140,967
Percentage of available used	36.32