SECONDARY REINFORCEMENT STRENGTH IN RELATION TO THE NUMBER OF REINFORCEMENTS

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Chapter 1

INTRODUCTION

Much attention has been paid to the phenomenon of secondary reinforcement. A large share of the work has concerned the relationship between secondary reinforcement and primary reinforcement. Most of the studies have used Hull's concept of secondary reinforcement as the basis for the study.[1] This concept was so attractive that is was used as an explanation for a very wide range of studies.[2] Spence and Kendler used it to explain latent learning.[3] It was even used by Denny to explain partial reinforcement.[4] This same concept has been used in this study.

In general there have been many studies that have been related to secondary reinforcement. Relatively few of the studies have specifically tried to find out why and how

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[1] C. L. Hull, A Behavior System (New Haven: Yale University Press, 1952), p. 6.

[2] J. F. Hall, "Studies in Secondary Reinforcement: Secondary Reinforcement as a Function of the Frequency of Primary Reinforcement," J. Comp. Physiol. Psychol., 44:246-251, September, 1951.

[3] K. W. Spence and H. H. Kendler, "The Speculations of Leeper with Respect to the Iowa Test of the Sign-gestalt Theory of Learning," J. Exp. Psychol., 38:109, February, 1948.

[4] M. R. Denny, "The Role of Secondary Reinforcement in a Partial Reinforcement Learning Situation," J. Exp. Psychol., 36:375, October, 1946.

secondary reinforcement worked.[5] Almost always the rat has been used as the subject rather than a human. While this does not necessarily make those studies invalid for human learning conditions, it would appear that a more valid study would have resulted if humans had been used. Humans were used in this study in order to meet the conditions that were required for the specific purpose of the study. The specific purpose was to determine the effectiveness of a neutral stimulus as a function of the number of times that it had been paired with verbal reinforcement in the experimental setting.

THE PROBLEM

The statement of the problem, the statement of the hypothesis, and the assumptions are listed in this section.

Statement of the Problem

Is there any difference between the strength of secondary reinforcement established under different numbers of reinforcements?

Statement of the Hypothesis

There is no significant difference in the strenth of secondary reinforcement established under different numbers of reinforcements.

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[5]Hall, op. cit., p. 246.

Assumptions

As was previously mentioned, most studies have used rats rather than humans as subjects. Also primary reinforcement rather than verbal reinforcement was used. For the purposes of this study, it was assumed that human subjects under verbal reinforcement would show the same results as do rats under primary reinforcement. Maslow's theory of motivation was used as the basis for this assumption. He postulated a need for achievement as an elemental human need.[6] This need for achievement of humans and the hunger drive of rats were considered to be similar. The verbal reinforcement would have the same effect for humans as does primary reinforcement for rats. All measures of extinction rates for rats were assumed to be measures of secondary reinforcement for humans since basic needs of each were being measured. It was also assumed that there would be no significant differences as a function of the sex or age of the subjects. For this reason no effort was made to separate the data by age or sex.

DEFINITION OF TERMS

In this section a list of terms used throughout the study are defined.

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[6] C. N. Cofer and M. H. Appley, Motivation: Theory and Research (New York: John Wiley and Sons, Inc., 1964), pp. 684-685.

Reinforcement

"Any circumstance or event that increases the probability that a response will recur in a situation like that in which the reinforcing condition originally occured."[7]

Secondary Reinforcement

"Any reinforcing or rewarding event or state that derives its effectiveness from a previous process of learning or conditioning."[8]

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[7]Horace B. English and Ava C. English, A Comprehensive Dictionary of Psychological and Psychoanalytical Terms (New York: David McKay Company, Inc., 1958), p. 452.

[8]Ibid., p. 454.

Chapter 2

REVIEW OF THE LITERATURE

In a review of the literature related to this study, several types of results were found. Some of the studies reported very positive findings, others were quite negative, and still others reported ambiguous results. Because the positive studies were the most numerous, these are presented first. In all of the studies, both positive and negative, Hull's theory of secondary reinforcement was used. He stated that as the number of reinforced acquisition trials increased, the resistance to extinction also increased.[9] This corresponded with the relationship Pavlov stated when he wrote:

> . . . It is clear that the more vigorous a conditioned reflex, or in other words, the greater the intensity of the excitatory process, the more intense must be the inhibitory process in order to overcome it; and therefore the greater the number of unreinforced repetitions necessary to bring about complete extinction.[10]

The positive studies were in full agreement with Hull's and Pavlov's theories.

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[9]Hull, op. cit., p. 23.

[10]I. P. Pavlov, Conditioned Reflexes: An Investigation of the Physiological Activity of the Cerebral Cortex (London: Oxford University Press, 1927), p. 430.

In a study by Hall, 72 rats were placed in groups that received either 25, 50, or 75 pairings of the neutral stimulus and the reinforcement. The rats were trained in a straight alley. Half of the animals ran to a white goal box, the other half to a black goal box. A significant difference was found between the group that received 25 pairings and the group that received 75 pairings. The group that received 75 pairings had a significantly larger number of extinction responses. As a result of this study he concluded ". . . that the strength of a secondary reinforced stimulus increases as a function of the number of times that it has been associated with primary reinforcement."[11] The effects of varying numbers of reinforcement on extinction following deprivation was studied by Miles. In his study, 480 rats were randomly assigned to groups that received either 0, 10, 20, 40, 80, or 160 pairings of the stimulus and the reinforcement. The reinforcements used were food pellets. A light and the click of the light were used as the secondary reinforcers. A significantly larger number of extinction responses was recorded for the experimental groups than for the control group. This finding was significant at the .05 level.[12] In another positive study,

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[11] Hall, op. cit., p. 250.

[12] R. C. Miles, "The Relative Effectiveness of Secondary Reinforcers Throughout Deprivation and Habit Strength Parameters," J. Comp. Physiol. Psychol., 49:127, February, 1956.

Williams used the bar pressing responses of rats to measure secondary reinforcement. All responses were reinforced by food pellets. The rats were assigned to groups that received either 5, 10, 30, or 90 pairings of the stimulus and the reinforcement. Those groups that received the highest number of pairings required the greatest number of unreinforced responses to obtain extinction. The extinction phase was conducted again after time for spontaneous recovery had been allowed. The animals that gave the most extinction responses were again the ones that had received the most pairings.[13] Similar results were found by Perin in his study of the relationship between reinforced responses and extinction responses. After 23 hours of food deprivation, he reinforced rats for bar pressing responses. They were reinforced by food pellets and by the sound of the mechanism working. The rats were divided into groups that received either 5, 8, 30, or 70 reinforcements. For all groups, as the number of reinforced responses increased, the number of extinction responses also increased.[14] Bar pressing responses and the click of the mechanism were also used by Youtz. He divided his rats into groups that were given either 10 or 40 reinforcements. The groups that

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[13] S. B. Williams, "Resistance to Extinction as a Function of the Number of Reinforcements," J. Exp. Psychol., 23:509, November, 1938.

[14] C. T. Perin, "Behavior Potentiality as a Joint Function of the Amount of Training and Degree of Hunger at the Time of Extinction," J. Exp. Psychol., 30:97, February, 1942.

received 40 reinforcements required the most nonreinforced responses to reach extinction.[15] Lewis and Cotton used a straight runway with reinforcement available at the end. Food pellets were used as the reinforcement. They used rats that received either 16 or 60 partially reinforced trials. Greater resistance to extinction was found for the rats that received the 60 partially reinforced trials.[16] In a similar study by Lawrence and Miller, 32 rats were placed in a straight runway following 24 hours of food deprivation. The rats were reinforced either 8 or 16 times with food pellets. The group that received reinforcement 16 times was more resistant to extinction than was the group that received only 8 reinforcements.[17] Hill and Spear used a 30 inch runway for a study in which the rats were given either 8, 16, 32, 64, or 128 pairings of the neutral stimulus and the reinforcement. The groups that received the least number of pairings also showed the least number of responses during extinction. For all groups as the number

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[15] R. E. P. Youtz, "Reinforcement, Extinction, and Spontaneous Recovery, in a Non-Pavlovian Reaction," J. Exp. Psychol., 22:312, April, 1938.

[16] D. J. Lewis and J. W. Cotton, "The Effect of Intertrial Interval and Number of Acquisition Trials with Partial Reinforcement on Performance," J. Comp. Physiol. Psychol., 52:600, December, 1959.

[17] D. H. Lawrence and N. E. Miller, "A Positive Relationship between Reinforcement and Resistance to Extinction Produced by Removing a Source of Confusion from a Technique that had Produced Opposite Results," J. Exp. Psychol., 37: 496, December, 1947.

of reinforced trials decreased, the number of extinction responses decreased also.[18] Ison also used rats in a straight runway. He placed the rats in groups that were given either 10, 20, 40, 60, 80, or 100 pairings of the stimulus and the reinforcement. He found a tendency for animals in the higher number groups to give more responses during extinction. The two highest groups clearly showed a higher acquisition of secondary reinforcement.[19] Bersh used bar pressing responses as the criterion for conditioning rats. The rats were divided into groups that received either 0, 10, 20, 40, 80, or 120 pairings of the stimulus and the reinforcement. After each bar press a light came on for 3 seconds. After being on for a second, a food pellet was released. During extinction the strength of secondary reinforcement increased for all numbers of pairings, however, significant differences were found between only two of the group combinations that were compared. Those two were the 120 and the 0 (control) groups and the 120 and the 20 groups.

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[18] W. F. Hill and N. E. Spear, "Extinction in a Runway as a Function of Acquisition Level and Reinforcement Percentage," J. Exp. Psychol., 65:496, May, 1963.

[19] J. R. Ison, "Experimental Extinction as a Function of the Number of Reinforcements," J. Exp. Psychol., 64:314, September, 1962.

[20] P. J. Bersh, "The Influence of Two Variables upon the Establishment of a Secondary Reinforcer for Operant Responses," J. Exp. Psychol., 41:64-65, January, 1951.

Of those studies not showing a positive relationship between secondary reinforcement and the number of reinforcements, the study by North and Stimmel was the most significant. That study was another in which rats were run in a straight runway. Rats given 90 or 135 acquisition trials were found to extinguish faster than rats that only received 45 acquisition trials. The evidence from that study was in direct opposition to the general assumption that more trials produced stronger secondary reinforcement.[21] Siegel and Wagner used the same methods and procedures as Hill and Spear. They gave acquisition trials of 64 and 184 reinforcements. The rats that received the most reinforcements were the ones that obtained extinction the quickest.[22] College students were used as subjects by Lewis and Duncan. In a situation resembling a poker game, the subjects were dealt four cards face up. They were required to guess if their hands were winners or not. They were paid for the hands that won, but not for any other hands. They were allowed to play the game as long as they wished. They were given the reinforcement of winning either 4, 8, or 16 times. The players who won the most number of hands took the

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[21]A. J. North and D. T. Stimmel, "Extinction of an Instrumental Response Following a Large Number of Reinforcements," Psychol. Rep., 6:228, August, 1960.

[22]S. Siegel and A. R. Wagner, "Extended Acquisition Training and Resistance to Extinction," J. Exp. Psychol., 66:308, September, 1963.

longest time to extinguish. The extinction was to quit playing the game.[23] In another study using human subjects, Murillo and Capaldi had college students guess whether or not a piece of cloth was in a lid covered tray. The pattern of reinforcement during acquisition was two negatives (out) followed by one positive (in). The criterion for extinction was eight consecutive negative responses. The groups received either 12, 24, 48, or 60 pairings of the reinforcement with the neutral stimulus. The results were similar to those found by North and Stimmel except that none of the differences was significant.[24] Using children as subjects, Myers, Craig, and Myers gave the reinforcement in groups of either 2, 4, 8, or 16 training trials. This study did not find any significant differences between any combination of reinforcement groups. The factor of secondary reinforcement was not even found to be significant.[25]

The basic difference between the studies was that only those studies that used rats showed positive results.

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[23] D. J. Lewis and C. P. Duncan, "The Effect of Partial Reinforcement and Length of Acquisition-series upon Resistance to Extinction of a Motor and a Verbal Response," Amer. J. Psychol., 69:645, December, 1956.

[24] N. R. Murillo and E. J. Capaldi, "The Role of Overlearning Trials in Determining Resistance to Extinction," J. Exp. Psychol., 61:346, April, 1961.

[25] N. A. Myers, G. J. Craig, and J. L. Myers, "Secondary Reinforcement as a Function of the Number of Reinforced Trials," Chld. Develpm., 32:768, December, 1961.

None of the studies using humans as subjects showed positive results. Differences were found between secondary reinforcement strengths, but none of those differences were significant.

Chapter 3

METHODS AND PROCEDURES

It was necessary first to provide a means of varying the number of reinforcements in order to compare secondary reinforcement strengths. A guessing game was believed to be the simplest way of doing that. Because other studies had used guessing games, it made it easier to compare the results of those studies with the present study.

DESCRIPTION OF THE STUDY

The following section is a description of the subjects, the procedures used, and other information pertinent to the study.

Subjects

The study population consisted of 80 children from the 3rd, 4th, and 5th grades of Butcher Children's School on the campus of Kansas State Teachers College of Emporia, Kansas.

Assignment to Reinforcement Groups

The subjects were randomly assigned to groups that received either 0 (control), 10, 20, or 30 pairings of the neutral stimulus and the reinforcement.

Apparatus

The apparatus used in the study consisted of a key and a pen as the objects to be guessed. Also used were the prepared reinforcement lists (Appendix), a tally sheet, a pencil, and a divider to prevent the subjects from seeing the pencil tap used as the secondary reinforcer.

Statistical Procedure

As only the number of reinforcements was under consideration, a one-way classification for simple analysis of variance was used to evaluate the data.

METHOD OF GIVING REINFORCEMENT

When the subject was seated, he was presented with two objects, a key and a pen. He was told to try to guess which of the two objects that the experimenter was thinking. Instructions were given to the subject to make his guess after the experimenter said "Guess." He was told that during the first part of the game he would be told of all correct guesses, but that in the second part he would not be told. When the second part began he was notified.

During the acquisition stage all correct answers were given the response of "Right." For the experimental groups only, the secondary reinforcer of a pencil tap was given at the same time that the experimenter said "Right." This was done for the correct desired guesses of "key." The control group did not receive the pencil tap. This was the

only secondary reinforcement given. The control group had to guess until they had given 50 guesses. The experimental groups guessed until they had given the number of correct desired guesses for the reinforcement group they were in.

During the extinction stage of the study, 50 trials were given to all of the groups. The subjects were told at that time that they would not know whether or not their guesses were correct. In the control group no secondary reinforcement was given during extinction. In the experimental groups, the secondary reinforcer of the pencil tap was given. This was done at the same time that the experimenter said "Guess." No other reinforcement was given during either of these stages. A prepared randomly ordered reinforcement list was used to determine whether or not the guesses were correct.

Chapter 4

ANALYSIS OF DATA

Data were collected from 80 subjects in order to determine whether or not the secondary reinforcement strengths of various numbers of pencil taps were significantly different. The data that were compiled were computed by using a simple one-way classification of analysis of variance. The results of the study did not show any significant differences between the secondary reinforcement strengths formed under different numbers of reinforcements.

The F ratio for the data was computed to be .8959. (See the summary of analysis of variance in Table 1.) It was obvious that it was not a significant value without even consulting the proper tables, since it was less than 1.00. It followed then, that there were no significant differences between secondary reinforcement strengths formed under different numbers of reinforcements. With the degrees of freedom used in the study, an F ratio of at least 2.74 or 4.08 would have been needed to be significant at the .05 ($p<.05$) or the .01 ($p<.01$) levels respectively. As was found, the population variances turned out to be very nearly equal. Even at a much lower level of probability, the F ratio would not have been large enough to be significant.

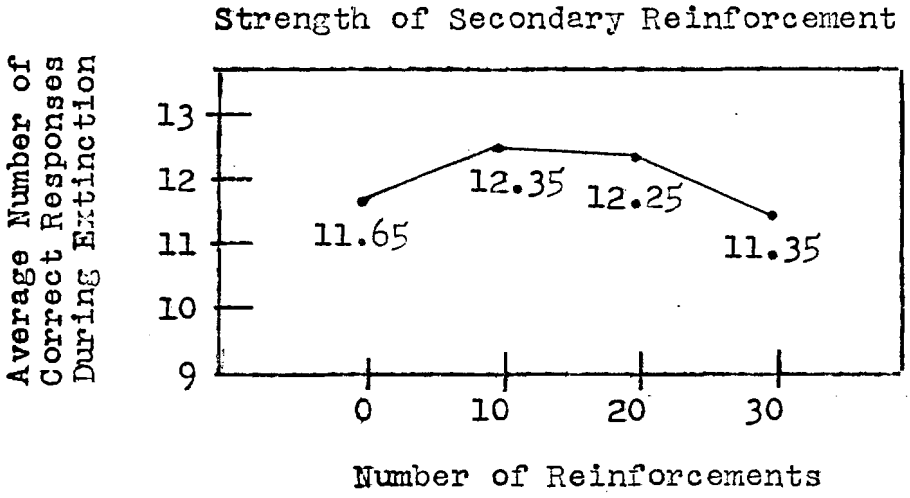
Table 1

Summary of Analysis of Variance

Source of Variance	Degrees of Freedom	F Ratio
Between	3	———
Within	76	———
Total	79	.8959

Even though no significant differences were found, a general pattern was noted. The pattern was similar to the results of studies that have shown significant differences. This pattern is shown in Graph 1.

Graph 1



Chapter 5

CONCLUSIONS, RECOMMENDATIONS FOR FURTHER STUDY, AND SUMMARY

Although significant differences between the different reinforcement groups were expected, this was not the case. Several reasons for the negative results have been theorized. In the following sections, conclusions about the study and recommendations for further study are discussed.

CONCLUSIONS

None of the studies using human subjects reported positive results. This raises some doubts as to the application of animal studies to humans. The greater majority of studies that used rats found positive results. The only study that used humans that came close to significant results was the one by Murillo and Capaldi.[26] It may be that humans do not acquire secondary reinforcement as readily as rats. The verbal reinforcement used for humans may not have had as much reinforcing value as did the primary reinforcement for the rats. It also may not have been correct to assume that the methods for measuring secondary reinforcement are the same for a man as they are for a rat. It is also possible

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[26] Murillo and Capaldi, loc. cit.

that the differences between a rat's nervous system and a human's nervous system make it easier for a rat to respond to secondary reinforcement. Psychological factors may be part of the reason too.

In other studies the possibility of overlearning because of too many trials has been considered.[27] The detrimental effect of overlearning was supported in this study by the fact that the secondary reinforcement strength was lower for the group that received 30 reinforcements than for the control group which went through only about half as many trials. It was suggested that the relationship between the number of reinforced trials and the number of extinction trials may be a curvilinear function with the upper section decreasing in value.[28] This would at least partially explain why the resistance to extinction was sometimes less for greater numbers of reinforcements. From this it can be theorized that there is a certain point at which secondary reinforcement strength begins to decrease.

Secondary reinforcement should be applicable to the field of programmed learning. The guessing game is similar to a programmed text in that it also gives reinforcement for the correct answer. The main area of difference between the two is that of the type of reinforcement. The reinforcement for the guessing game is an extrinsic reinforcement. A

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[27]Ibid. [28]Ibid.

programmed text needs an intrinsic reinforcer to be effective. Assuming that an intrinsic reinforcer is possible, it is then a matter of how many reinforcements should be given. While there is not a specific point at which secondary reinforcement decreases, it is believed that a general range can be determined. It would be necessary to determine a range for each subject matter taught. If both of these things can be accomplished, it is believed that a great deal of progress can be made in that area. This is believed in spite of the negative results since a general pattern of secondary reinforcement was obtained.

RECOMMENDATIONS FOR FURTHER STUDY

Several recommendations that may be helpful for further studies are listed in this section.

Strength of Incentive

The subjects were told that the reason for the guessing game was to see whether boys or girls were the better guessers. It was believed that rivalry between the sexes would be an incentive to guess. Apparently this incentive was not strong enough since several subjects in each reinforcement group made no effort at guessing. Those subjects gave a set pattern of responses by alternating "key" and "pen" as guesses. Those subjects came mainly from the lowest grade level used, although subjects from the other grades also showed this pattern to a lesser degree. The

incentive needed to be stronger in order to induce actual guessing. The study would probably have shown better results if the incentive had been stronger.

Age Differences

One possible reason for the negative results was the age level of the subjects. It would have been better if the subjects had been separated and compared by age level. That would have told whether or not there were any significant differences because of age. By having all grade levels together in the study, any differences because of age were cancelled.

Sex of the Subject

The sex of the subjects may have been another explanation for the negative results. It would have been better if they had been separated into reinforcement groups on the basis of sex. Again, because they were not separated, any differences because of sex were cancelled.

Number of Reinforcements

The other explanation for the negative results was the number of reinforcements. Although only 30 reinforcements were given at the most, this involved as many as 180 trials when both acquisition and extinction stages had been conducted. That was possibly too many trials. Subjects of this age level, especially those who were in the 3rd grade, may have become bored after that many trials.

SUMMARY

This study attempted to show that there are significant differences between secondary reinforcement strengths formed under different numbers of reinforcements. The results did not show any significant differences. Results were given and recommendations for further studies were suggested. Whether these recommendations will improve the chances of finding significant differences does not appear to be the main question any more. The main question seems to be whether or not it is possible to measure secondary reinforcement strength in humans by the use of this type of study.

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APPENDIX

Reinforcement schedules based upon a random number table[29]

Acquisition					Extinction	
KEY	KEY	PEN	PEN	PEN	PEN	PEN
PEN	PEN	KEY	PEN	KEY	PEN	KEY
KEY	PEN	KEY	PEN	KEY	PEN	PEN
PEN	KEY	PEN	KEY	PEN	KEY	KEY
KEY	KEY	KEY	KEY	PEN	KEY	PEN
KEY	PEN	KEY	PEN	KEY	PEN	KEY
PEN	KEY	PEN	PEN	PEN	KEY	KEY
PEN	PEN	KEY	PEN	PEN	KEY	KEY
KEY	KEY	PEN	KEY	KEY	PEN	PEN
KEY	KEY	PEN	PEN	PEN	KEY	PEN
PEN	PEN	PEN	PEN	KEY	PEN	KEY
KEY	PEN	KEY	KEY	KEY	PEN	PEN
PEN	PEN	PEN	PEN	PEN	KEY	PEN
PEN	KEY	KEY	PEN	PEN	PEN	PEN
PEN	PEN	KEY	KEY	KEY	KEY	KEY
KEY	PEN	PEN	PEN	PEN	PEN	KEY
KEY	PEN	PEN	PEN	KEY	KEY	KEY
PEN	PEN	KEY	KEY	KEY	KEY	
KEY	KEY	PEN	PEN		PEN	
KEY	PEN	PEN	KEY		PEN	
KEY	PEN	KEY	KEY		PEN	
KEY	KEY	KEY	KEY		KEY	
PEN	KEY	PEN	PEN		KEY	
PEN	PEN	KEY	KEY		PEN	
KEY	KEY	KEY	PEN		KEY	
KEY	KEY	PEN	PEN		PEN	
KEY	PEN	PEN	KEY		PEN	
PEN	KEY	PEN	KEY		PEN	
KEY	PEN	KEY	PEN		KEY	
KEY	KEY	KEY	KEY		PEN	
KEY	KEY	PEN	KEY		KEY	
PEN	PEN	PEN	KEY		KEY	
PEN	KEY	KEY	PEN		PEN	

[29] Ronald A. Fisher and Frank Yates, Statistical Tables for Biological, Agricultural, and Medical Research (New York: Hafner Publishing Co., 1953), pp. 114-115.