Generalization of an Academic Response Rate under Self and Externally Determined Reinforcement

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GENERALIZATION OF AN ACADEMIC RESPONSE RATE UNDER SELF- AND EXTERNALLY DETERMINED REINFORCEMENT

by

Samuel James Gitchel

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment
of the
Degree of Master of Arts

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In preparing this thesis I have received the very useful advice, encouragement, and constructive criticisms of Dr. Kathleen Lockhart. In collecting the data, the help of Jerry Skillings was indispensable. My thanks go to them as my major sources of support in carrying out this research. Nevertheless, I claim sole responsibility for what is written here.

Samuel James Gitchel
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INTRODUCTION

All "normal" American children undergo years of training in public schools, where their behavior is managed by others. In fact, the processes of direct reward and punishment of students' behavior consume a major portion of teachers' time. Even when behavior modification systems are used, a major problem is the time and effort required of behavior managers. Often they must maintain a watch for certain behaviors to occur, keep accurate records of the occurrence of the behavior, and administer consequences at the appropriate times. When a number of subjects and a number of behaviors are involved in the program, these duties become prodigious in scope and frequency.

The potential benefits of systems of self-management in such situations are tremendous. First, students may take over a large portion of the duties of monitoring, recording, and consequating behavior, leaving educators with more time in which to plan and provide specialized attention. Also, Thoreson and Mahoney (1974) have speculated that the skill of self-management may transfer to other areas of the students' lives, enabling them to manage other problems. A most important advantage of self-management, as mentioned by Thoreson and Mahoney (p. 7) is that "the person may be the best possible agent to change his own behavior--he certainly has much more frequent access to it than anyone else."

The terms self-control, self-regulation, and self-management
have often been used interchangeably. In this paper self-management will be used because of the connotations of inherent willpower which often accompany self-control and the general infrequency of the use of self-regulation. Many writers have defined self-management (Bolstad & Johnson, 1972; Cautel, 1969; Goldiamond, 1973; Kanfer, 1970; Skinner, 1953). Thoreson and Mahoney have derived an eclectic definition:

A person displays self-control when in the relative absence of immediate external constraints, he engages in behavior whose previous probability has been less than that of alternatively available behaviors involving lesser or delayed reward, greater exertion or aversive properties, and so on. (p. 12)

Self-control techniques can be roughly divided into two categories: stimulus control and behavior consequence control. Self-consequation has been subclassified into four general types of techniques (Mahoney, 1972):

1. Positive self-reward: the contingent self-administration or consumption of a freely available reinforcer.

The appropriate category for many behavior change processes may be unclear. For example, a self-management program for controlling on-task behavior might emphasize either an increase in on-task behavior or a decrease in competitive behaviors. The
classification depends largely on one's procedural emphasis. Nevertheless, Mahoney's framework provides a broader perspective for the examination of self-reinforcement.

Even the somewhat restrictive term positive self-reinforcement subsumes a great variety of self-management techniques (e.g., Bandura & Mahoney, 1974; Bandura & Perloff, 1967; Felixbrod & O'Leary, 1973; Glynn, 1970; Glynn, Thomas & Shee, 1973; Johnson, 1970; Johnson & Martin, 1972; Kanfer & Duerfeldt, 1967; Liebert, Spiegler, & Hall, 1970; Lovitt & Curtiss, 1969). In order to most clearly examine the positive self-reinforcement process, it can be analyzed in terms of the subprocesses which compose it.

Bandura and Perloff (1967) broke down the self-reinforcement process into the following components:

(1) self-prescription of a standard for reward,

(2) social comparison, which provides a norm by which to guage self-evaluative responses,

(3) control over reinforcers,

(4) self-administration of reinforcement.

Social comparison is not a necessary component, but, as Bandura and Perloff point out, in the absence of objective criteria the attainments of others may be useful as a norm. Other criteria, such as previous personal performance, personal performance at somewhat similar tasks or, of course, objective criteria may be used instead. It might be noted that the theme of Bandura's writings at this time emphasized social influences on self-evaluation (Bandura, Grusec, & Menlove, 1967; Bandura & Kupers, 1964;
Bandura & Whalen, 1966). In consideration of the fact that Bandura and Perloff do not explicitly mention self-evaluation as one of the subprocesses, social comparison might be considered as one of several methods of self-evaluation.

Lovitt and Curtiss (1969), in a pioneer study of self-management of academic responses, analyzed the self-management process into three subprocesses. Translated to our present terminology, the components they identified were:

1. self-assessment,
2. self-setting of standards for reinforcement,
3. self-determination and self-administration of reinforcement.

They combine self-administration and self-determination as one subprocess by rather vaguely saying that the self-managing individual can "specify a contingency system whereby he might obtain these (self-set) objectives" and going on to say he "could grant himself reinforcers on a prearranged schedule to accomplish certain behavioral sequences," (p. 49).

Lovitt and Curtiss assume that the self-managing individual "knew his academic capabilities in terms of skill level and performance," verifying the notion that social comparison serves primarily as a tool for self-assessment of performance. If Bandura and Perloff's social comparison is considered to correspond to Lovitt and Curtiss' self-assessment in the two paradigms, we find concurrence on the four basic components of self-management.

Glynn, Thomas, and Shee (1973) have analyzed self-reinforcement...
in a manner which differs on several points, and which includes explicit descriptions of the subprocesses. Their components are:

1. self-assessment, in which the individual decides whether or not he has performed a given class of behavior;
2. self-recording, in which the individual objectively records the frequency of that behavior;
3. self-determination of reinforcement, in which the individual may choose the nature and amount of reinforcement, contingent on his performance;
4. self-administration of reinforcement, in which the individual dispenses his own reinforcement.

This formulation does not include the setting of a standard for reinforcement, although the reciprocal subprocess of self-determination of reinforcement type and amount is included. Self-determination is reciprocal in the sense that the individual can compensate for rewards not received due to a high criterion by increasing reinforcement magnitude. Conversely, dense reinforcement resulting from a large magnitude of reward could be reduced by raising the criterion for reward. Of course, in cases in which the individual could not meet the self-set criterion at all, there would be no opportunities to compensate, and self-determination could not serve a compensatory function. These two components were blended together by Glynn (1970). In a study of self-management of academic responses, each student was simply asked how many tokens she deserved after she knew how many of her answers were correct.

Another discrepancy brought out by Glynn et al.'s descriptions
lies between their component called self-assessment and Bandura and Perloff's term social comparison. To recap, Bandura and Perloff's term social comparison has been generalized to refer to self-evaluation. For Bandura and Perloff the important aspect of social comparison was the self-punishing and self-reinforcing covert responses made by the individual. As will be seen, these responses are of primary concern in some investigations of resistance to extinction. Glynn et al.'s emphasis was on deciding whether or not the experimental response was performed. Although the two responses are closely associated, and seldom appear individually, they exhibit conceptual differences. Glynn et al. take no account of the secondary reinforcement conditioned to either choice when an individual meets criterion: their main interest is in deciding whether a response is correct. Bandura and Perloff do not mention the act of deciding whether a response is correct; their concern is in the individual's self-evaluative responses concerning how his performance compared with that of others.

The difference in these investigators' approaches is reflected in the experimental tasks they chose: Bandura and Perloff used a simple discrete response, wheel cranking, and mechanically provided feedback on progress toward criterion. This procedures, which requires little attention for determining whether or not a response has occurred, allows the subjects to focus on the self-evaluative aspects of the situation. Glynn et al.'s subjects assessed and recorded their own on-task behavior, a relatively complex,
nondiscrete behavior. This more complex task requires that the subjects' attention be focused on simply deciding whether or not the response has occurred.

In the study by Lovitt and Curtiss (1969), self-assessment was dealt with briefly and rather vaguely. They say that the self-managing individual "would...know his academic capabilities in terms of skill level and rate of performance" and "has the ability to assess his own competencies," (p. 12). They appear to believe that self-assessment would involve self-evaluative covert responses, although it is not clear that the reason for the inclusion of knowing one's own capabilities was for the purpose of setting useful standards or for making covert self-evaluative responses. Again, it is important to keep in mind the intermeshed nature of self-evaluative responses and self-assessment in most naturalistic situations.

Finally, an obvious difference between the component formulations of Glynn et al. and both Bandura and Perloff (1967) and Lovitt and Curtiss (1969) is Glynn et al.'s self recording component. Self-recording might be regarded as a concretion of self-assessment, but its effectiveness in changing behavior makes it a valuable component in its own right (Broden, Hall, & Mitts, 1971; Kazdin, 1974; McFall & Hamm, 1972). Indeed, data collection is an essential tool of behavioral intervention strategies. The individual's collection of data on his own behavior is at least as important, probably more important, than the collection of the same data by another person.
Despite the discrepancies in the models of self-management posed by these investigators, certain common elements are evident. These elements are:

(1) self-administration of reinforcers: the delivery of freely available reinforcers, contingent on a desired response

(2) self-determination of reinforcement: the choice of the amount of reinforcement delivered when the crucial response meets criterion. Glynn et al. added the nature of reinforcement.

In addition, other subprocesses have emerged. Although these subprocesses were not concurred upon by all the above investigators, they have been effectively utilized in one setting or another:

(3) self-assessment: deciding whether the response meets the criterion for reinforcement

(4) covert self-evaluation: the internal reinforcement and punishment that presumably often accompany self-assessment. The relative importance of this component, compared with self-assessment would seem to vary with the task, although such an analysis has not been carried out. In any case, this component has been shown to be a powerful consequence for behavior (Johnson & Martin, 1973). This component may adventitiously creep into any self-reward paradigm; thus its effects are difficult to isolate.

(5) self-recording: the objective recording of the given behavior

(6) self-setting of standards: the selection of a criterion for reinforcement. Although closely associated with self-determination of reinforcement, this component is not always reciprocally related, and, therefore must be studied separately.

Now that the subprocesses of several self-reinforcement paradigms have been reviewed, some of the claims that have been
made for self-reinforcement can be more carefully examined.

A striking assertion made by Lovitt and Curtiss (1969) dealt with only the self-determination of reward. They found that when their single subject was allowed to specify his own reinforcement ratios for academic performance, his response rate was higher than when the contingencies were determined by his teacher, even though the contingencies were identical.

However, their results are open to criticism in several respects, as pointed out by Felixbrod and O'Leary (1973). First, median differences in academic performance between self- and externally determined contingencies were quite small, and no tests of significance were performed. Also their data was based on a single subject who was a member of a class for behaviorally disordered children. This subject showed at least one curiosity of behavior: in a latter phase of the study, in which reward ratios were externally determined, the subject showed higher performance when reinforcement magnitude was at lower levels. Finally, no measure of the proportion of incorrect responses was taken, and the student's contingencies did not require correct problems; it is possible that higher overall response rates were accompanied by higher rates of incorrect responses. Despite these criticisms it is probably safe to say that, for this subject, self-determined and externally determined reward ratios were equally effective in maintaining academic performance.
Other studies have failed to replicate Lovitt and Curtiss' superiority of performance under self-determined reward, but these others were carried out with other subprocesses also operating (Glynn, 1970; Glynn et al., 1973). In very similar studies of self-setting of standards for reinforcement, Felixbrod and O'Leary (1973), with no other self-reinforcement components in effect, and Liebert, Spiegler, and Hall (1970), with self-administration also in effect, both failed to replicate Lovitt and Curtiss.

Another advantage claimed for self-reinforcement is reduced variability of behavior. In a study of self-management of on-task classroom behavior, Glynn et al.'s subjects self-assessed, self-recorded, self-determined reward ratio, and self-administered reward, while the standards for on-task behavior were set by the teacher. The students showed considerably less variability during self-management phases of the study. Unfortunately, the number of self-reward subprocesses included in the treatment package makes it difficult to determine which components or combination of components the effect can be attributed to. This finding is loosely supported by the work of Phares (1955), who showed that subjects who believed their success at a task was a matter of their skill showed smaller and less frequent changes in their expectancies regarding the probability of reinforcement than did subjects who believed their success to be a matter of choice.

Other studies (e.g., Bandura & Mahoney, 1973; Bolstad & Johnson, 1972; Felixbrod & O'Leary, 1973; Glynn, 1970; Weiner &
Dubanoski, 1975) did not analyze their data for variability, although such analyses would have been possible. Such analyses, though not truly replications, might have been useful in following up the phenomenon, since these studies dealt with fewer components of the self-reinforcement process as independent variables. However, eyeball analyses of the data presented in these reports give no indications of reduced variability under any of the various forms of self-reinforcement. In support of Glynn et al.'s results, Bandura and Perloff (p. 116) suggest that self-evaluation responses, which we would expect to be produced in the paradigm of Glynn et al., are responsible for the fact "that persons do not ordinarily behave like weathervanes in the face of conflicting patterns of external contingencies which they repeatedly encounter in their social environment."

Probably the most validated claim of superiority that has been made for self-management is greater resistance to extinction of the controlled behavior (Johnson, 1970; Kanfer & Duerfeldt, 1967; Johnson & Martin, 1972; Weiner & Dubanoski, 1975). The source of superiority has been hypothesized to be the secondary reinforcement conditioned to accompany the chain of responses which precede reinforcement delivery. However, the specific locus, or loci, within the chain is unclear.

Johnson (1970) found slightly, but not significantly, greater resistance to extinction when self-administration was the only subprocess in effect. Johnson attributed this finding to the
secondary reinforcing properties of covert mediating responses, (the equivalent of self-evaluative responses) which intervened between the discrimination response and reinforcement. In a follow-up study, Johnson and Martin (1973) demonstrated significantly greater resistance to extinction for a group of children who stated "I was right" after each correct response in a match-to-sample task. However, the difference was significant only in the first session of extinction. Although this study was not designed to critically test the conditioned reinforcement hypothesis for resistance to extinction, leaving other explanations plausible, it adds positive evidence to this hypothesis.

Kanfer and Duerfeldt (1967) showed clear differences between an externally managed group and a self-managed group which self-assessed and self-administered reward. Their experiment involved a simple match-to-sample task with adult subjects. Although an externally reinforced group showed slightly more accurate performance in a period of differential treatment systems, the self-reinforced group showed slightly more accurate performance in a period of differential treatment systems, the self-reinforced group performed at a significantly more accurate level when both groups were subsequently in extinction. It might be noted that accuracy, not rate, which has been the measure in all other studies mentioned herein, was the dependent measure in Kanfer and Duerfeldt's study.

In a study of resistance to extinction, Weiner and Dubanoski (1975) manipulated only one variable, selection of reward ratio.
Children were differentially reinforced for dropping a rubber ball into an aperature in the top of a box, and extinction consisted of one five-minute session. They found significantly greater resistance to extinction in the self-determined group.

A classroom management procedure employing self-recording, self-assessment, and self-administration was implemented by Bolstad and Johnson (1972). Their procedure, designed to reduce disruptive behavior, was successful, but gave only very weak support to their hypothesis of greater resistance to extinction. However, their results were confounded by two other factors.

First, a difference in magnitude of reinforcement favored the self-reinforcement group. Consequently they would be expected to extinguish more quickly due to the denser schedule of reinforcement. Second, the self-reinforcement group was at a lower level of disruptive behavior before extinction began. To show greater resistance to extinction, it would have been necessary for them to not only maintain this difference, but to increase it. The strong social influence of peers' increasing misbehavior in extinction, which would require the students to increase the difference in levels of disruptive behavior, seems highly unlikely when no reward was given. In light of these considerations, it seems safe to say that Bolstad and Johnson's failure to show a significant difference may have resulted from lack of experimental control.

One effect of self-reinforcement which has received relatively
little attention in the literature is the generalization of self-reinforcement effects to other tasks. Certainly the applied value of self-reinforcement techniques would be greatly enhanced if their effects were shown to generalize to other tasks.

In a very general statement (p. 7), Thoreson and Mahoney conjectured that self-management techniques may transfer more readily than external management techniques. Lovitt and Curtiss (1969) as well as Johnson (1970) have hypothesized an enhancement of generalization under self-reinforcement systems. Lovitt and Curtiss made the conjecture specifically in regard to self-determined reward, but gave no empirical or theoretical support for the idea.

Johnson hypothesized enhancement of generalization would result from the secondary reinforcing properties of covert self-evaluative responses which become secondarily reinforcing through association with the pre-reinforcement response chain. Presumably, these secondary reinforcers increase the probability of the response chain being emitted in varying stimulus conditions.

Johnson found no superiority of generalization when self-administered reward was the only self-reinforcement component in effect. However, he stated that his results were confounded by several powerful extraneous variables which may have masked subtle differences in generalization. The fact that he did find slightly superior resistance to extinction under self-administration, based on essentially the same theoretical reasoning, supports the
idea that the generalization results were of an artifactual nature. A closer examination of the differences of settings across which Johnson attempted to demonstrate generalization lends further support to this notion.

His study involved the self-administration of reward for correct responses on a match-to-sample task. Experimental sessions were carried out in a special room, where the experimenter was seated beside each subject. They were surrounded by toys (reinforcers) and the token delivery and counting apparatus.

For the tests of transfer the children, seated in their regular classroom, were handed the tests by their teacher. She then left them alone at their desks to work on the tests, which consisted of crossing out fives on pages of random numbers. Across these differences in settings and tasks Johnson measured generalization of attentive behavior.

Another factor decreasing the likelihood of generalization was a preceding 30 minute period of the match-to-sample task with no reinforcement, followed by a 15 minute rest period. Furthermore, a time gap of one day intervened between training trials and the first transfer test, and five days intervened between training trials and the second transfer test. In the latter time gap extinction sessions for the match-to-sample task were administered once daily.

Bandura and Mahoney (1974) have tested the generalization of overt self-controlling responses per se. They trained a dog to
perform a low probability behavior, pressing an electric typewriter key while standing on its hind legs, before a high probability behavior, eating a meat-flavored cube. After over-learning this task, the dog was completely extinguished, and then taught the same response chain except with a telegraph key instead of a typewriter. Next the dog was trained to jump through a hoop and to press a treadle. In subsequent tests of carryover of the self-management response chain, the dog continued to perform one of the experimental tasks, depending on which stimulus was present, before self-administering reward in over 90% of the 60 trials.

This study brings up a distinction made by Skinner (1953). He wrote (p. 231) "one response, the controlling response, effects variables in such a way as to change the probability of the other, the controlled response." Bandura and Mahoney clearly altered the controlling response (eating a meat-flavored cube), while the other studies mentioned herein have focused on changes in the controlled response (on-task behavior, cranking a lever, etc.). However, the differences are not as great as they might appear. It is important to remember that when controlling behavior is increased, the probability of the controlled behavior changes. Thus Bandura and Mahoney altered the controlled behaviors as well as the controlling behavior. Johnson, as well as investigators in the other self-management studies mentioned, also attempted to alter the controlled behavior by manipulating the controlling behavior,
but these investigators' interest has been in the effects on the controlled behavior.

Bandura and Mahoney assessed generalization by counting the generalized controlling responses in the presence of the new stimuli; Johnson assessed generalization by counting the controlled responses. A change in the rate of controlled responses is a reflection of generalization of the controlling responses, assuming other variables are equal. Presumably, Johnson took the latter tack for two reasons. An applied approach emphasizes the effects on the controlled, self-managed behavior. Second, the hypothesized controlling behavior, covert self-evaluation, was unobservable. Bandura and Mahoney were taking a basic research approach, and the controlling response chain contained an observable element, the consumption of the meat-flavored cube. Thus they counted directly the rate of controlling responses.

The clear-cut generalization demonstrated by Bandura and Mahoney indicates that Johnson's negative results may have been a result of extraneous variables or the specific tasks involved. It appears that an attempt to demonstrate generalization might be facilitated by the use of more similar tasks and settings. In light of the paucity of research dealing with the self-determination of reinforcement, and the likelihood and practical value of showing generalization, these variables were chosen as the primary variables...
in the present study. Specifically, the effects of self- versus 
external determination of reward for one behavior on the performance 
of a similar behavior will be examined.

The significantly superior resistance to extinction for a 
self-determined reward group, demonstrated by Weiner and Dubanoski, 
provides good reason to expect greater generalization for the self-
determined condition of the present study. With other factors 
being equal, generalization would be expected to parallel 
resistance to extinction because they are influenced similarly 
by conditioned reinforcement. Just as there is a higher probability 
that a secondarily reinforced response will occur under conditions 
of extinction, there is a higher probability that a secondarily 
reinforced response will occur under conditions of stimulus 
generalization.

In the present experiment, the cues for self-determination of 
reinforcement might gain secondary reinforcement value through 
their association with choosing a favorite reward ratio. It is 
important to note that the choice itself, not the magnitude or 
type of reinforcement, would be responsible for such a difference. 
Magnitude and type of reinforcement will be held equal for self- 
and externally determined reinforcement conditions.

An alternative basis for predicting superior generalization 
deals with long-term learning history. Weiner and Dubanoski 
suggest that children are often differentially reinforced by 
parents and others for their self-reward as it relates to their
performance. Parents may informally set a given amount of reinforcement, or a reward criterion, for a task, and reinforce the children upon completion of the task. Subsequently the children might have been rewarded for selecting a similar magnitude or type of reinforcement for the same task.

In the present experiment, since the reinforced task is more closely associated, temporally and cognitively, with the self-determining response than the generalization task is, it appears that the effect of self-determination would be at least as great on the reinforced task. Therefore, it might be expected that any difference of performance on the generalization measure would correspond with an equal or greater difference on the reinforced task. However, performance on the original task is influenced by direct reinforcement as well as by the opportunity for choosing. If the students work at a maximal level for direct reinforcement alone, the effects of self-determining their reward ratios would not be evident. Therefore superior performance on the generalization measure might occur without a corresponding superiority on the reinforced task.

Aside from empirical expectations, several theoretical approaches would predict superior performance under self-determined reward. Rotter's construct of locus of control appears to be a relevant consideration of considerable import. Rotter (1967, p. 493) has defined internal locus of control as a "generalized expectancy that one's own behavior is determined by forces outside
one's control, such as luck, fate, or powerful others."

Expectancy is defined by Rotter as "a probability held by the individual that a particular reinforcer will occur as a function of specific behavior on his part in a specific situation."

Rotter's social learning theory postulates that locus of control is determined by reinforcement history, and Rotter, Liverant, and Crowne (1961) have shown that a single experience under a given contingency can affect one's perceived locus of control. Thus we might expect an instance of self-determination of reinforcement to do so. Such a change might affect performance in two ways. First, control of the environment may simply be reinforcing. Several studies have indicated that subjects who are allowed control over some feature of their environment show more liking and persistence for tasks performed in that environment (Chaikin, 1971; Glass, Singer & Friedman, 1969; Kanfer & Seidner, 1973). These studies dealt with tasks which were performed, by humans, under conditions of mild aversive stimulation (white noise or immersion of the hand in ice water). The generalizability of such findings to a classroom task is unclear. However, it may be worth noting that, anecdotally speaking, many students in the present study considered the task, working mathematics problems, an aversive experience.

Weiner and Dubanoski have stated a similar theoretical explanation in terms of White's (1959) theory of competence.
Competence is defined as a characteristic of all species to attempt to master their environment. The drive for competence supposedly leads to behaviors such as exploration, curiosity, and manipulation of the surroundings. Control of reinforcement, or for that matter any self-management subprocess, might produce a perception of greater competence, which has been shown to be reinforcing in the studies cited immediately above.

Another manner in which self-determination of reward might influence performance is through increasing attending behavior. A tendency of people who perceive their own locus of control as being primarily internal is to attend to information that will affect their future goals (Seeman, 1963; Seeman & Evans, 1962) or the task at hand (Glass, Singer, & Friedman, 1969; Rotter & Mulry, 1965) more than those who perceive their locus of control as primarily external.

Following this line of reasoning, we would expect to produce differences in attention to relevant stimuli by experimentally manipulating locus of control. The effect of greater attending to relevant stimuli would be, in effect, to bring the individual under tighter stimulus control. In the academic task utilized in the present study, greater stimulus control would be evidenced by a higher academic response rate.

Rotter (1967) has assumed that generalization of expectancies does occur, although the variables are unspecified. A certain degree of generalization would be intuitively expected since no
two situations are exactly identical. Glass et al., (1969) substantiated this claim when they gave their subjects control over white noise in the experimental room and subsequently administered proofreading and insoluble puzzle tasks. They found that subjects who had the option of stopping the intermittent white noise, even though they never exercised this control, showed superior attending and persistence on tasks administered after the noise had ceased. Therefore we might predict an experimentally manipulated change in an individual's perceived locus of control to generalize to another task of similar stimulus properties. In terms of the present experiment, we would expect subjects to produce a higher academic response rate on the generalization measure in the self-determined condition than in the externally determined condition.

A different theoretical explanation for superior generalization under self-determined reinforcement comes from cognitive dissonance theory. As suggested by Weiner and Dubanoski, based on Brehm and Cohen (1962), a choice between attractive alternatives creates dissonance which has a motivational effect. This situation might occur when a subject wanted to receive maximum reinforcement, but had a learning history favoring minimal self-reward. Individuals who choose between ratios of reinforcement would be subject to such an effect, which would likely be evidenced in their subsequent performance.

Another aspect of dissonance theory suggests that subjects
who commit their efforts to a task will subsequently rate it more positively (Gerard, 1968; Glass et al., 1969) and demonstrate superior performance (Aronson, 1968; Glass et al., 1969) to those who do not. If we consider the act of choosing a reinforcement ratio as an act of commitment to the task, we would expect a boost in performance under self-determination of reinforcement. Again, such an effect may be evident on the generalization measure without being evident on the reinforced task.

The idea that the choice of reinforcement ratio would function as an act of commitment is supported by Bem's closely related theory of self-perception (Bandler, Madaras, & Bem, 1966; Bem, 1967). He has proposed that an individual's perception of the distastefulness of aversive stimuli is based on his observation of his own overt responses to those stimuli. Thus, a subject who has observed himself making the response of choosing might infer that the stimulus is not so aversive. In such instances he would probably experience the stimulus as being less aversive than those instances in which he does not make the positive response of choosing. To relate this notion to dissonance theory, we can look at the situation in terms of commitment: under self-determination the subject might infer that he has greater commitment to the task. The act of self-determining a reward ratio would thus increase the probability of a higher response rate.

The above theoretical lines of reasoning give more support to the hypothesis that generalization of performance should be
superior when reward is self-determined rather than externally
determined.

A second question the present study investigated regards the
subjects' maximization of reinforcement. Several studies of self-
reinforcement (Bandura & Perloff, 1969; Glynn, 1970; Glynn et al.,
1973) have reported that, given the opportunity to choose, children
did not select maximally dense ratios of reinforcement. These
findings are of considerable interest since others (Felixbrod &
O'Leary, 1973; Lovitt & Curtiss, 1969) have shown the contrary,
and our intuitive expectations favor maximization. In the face of
these generalities, it might be said that one consistent finding
across studies is considerable intersubject variability.

If we examine the studies reporting nonmaximization, possible
causes for the children's failure to maximize reinforcement appear.
In Bandura and Perloff's one-shot study, dense reward ratios were
represented by lower numbers. Such an arrangement by Felixbrod
and O'Leary (1973) resulted in confusion about the meaning of the
choices by several children. The subjects for the two studies
were of approximately equal age: Bandura and Perloff described
their subjects as seven to ten years old while Felixbrod and
O'Leary simply said that they used second-graders.

Partial compensation for this possible misunderstanding was
provided by an opportunity for the subjects to change their chosen
ratio, in which increases and decreases occurred with approximately
equal frequency. However, the nature of the task may have been
responsible for the children's not maximizing: the apparatus included flashing lights and a bell, and the children were told the experiment was a test of some game equipment. Under these circumstances, some of the children may have been inclined to decline maximum external reinforcement. The applicability of these findings to less intrinsically rewarding tasks, performed over long periods, is at best questionable.

Glynn's (1970) data showed that ninth grade girls did not choose maximum reinforcement for an academic task. However, two factors in this study indicate that the effects of reinforcement were quite weak. First back-up reinforcers were delivered only twice during the fifty day study. Felixbrod and O'Leary (p. 242) criticized these authors for the use of "promise of reward" rather than "receipt of reward" as an inducement to work. Furthermore, the back-up reinforcers consisted of a variety of inexpensive New Zealand souvenir items. The value of these reinforcers to ninth grade girls is questionable. These ideas are supported by rather small differences between the reinforced groups and a non-reinforced group; in the second token phase no significant differences were found. In light of these considerations, the subjects' failure to maximize reinforcement is understandable; it was not important to them.

Second, the subjects were described by the teacher and by the experimenter as "well motivated" to learn and interested in the subject matter," indicating that they found the task intrinsically
reinforcing. Under these conditions, the external reinforcement they were offered was probably reduced in efficacy. This observa-
tion aligns with the hypothesis above: the reinforcers were not potent and thus not of great interest to the students.

Also, Glynn et al. (1973) reported that their subjects, grade two children, did not consistently maximize their reinforcement. However, the procedure did not allow the children to legitimately determine reinforcement magnitude. They could take more reinforce-
ment than the amount externally specified since they self-
administered, so the experimenters measured their accuracy. In a sample of 49 accuracy checks, 76% were correct, with the remainder taking too little more commonly than too much. However, since the children could only self-determine their reward by cheating, a response with a probable history of punishment, these data do not bear on the present question of self-determination, as the term has been defined.

Lovitt and Curtiss (1969) allowed their subject to self-
determine only once. On this occasion he approximately doubled the magnitude over teacher-specified contingencies. He was allowed to choose after twelve days of teacher-specified reinforcement and daily experience in a behaviorally managed special classroom.

Weiner and Dubanoski (1975) as well as Liebert et al., (1970) failed to report the frequencies of choices for the various ratios their subjects chose from. Liebert et al. did mention, however, that subjects in a yoked, noncontingently rewarded group changed
their choice significantly more frequently, apparently in an attempt to understand the contingencies.

Felixbrod and O'Leary (1973) made the most complete study of changes in self-reward ratios for academic behavior. Their subjects were allowed to choose a reward ratio at the beginning of each of the six experimental sessions, and extraneous variables were carefully controlled. Subjects began with leaner ratios, but showed a steady and highly significant change toward more lenient schedules.

It appears that the failure of subjects to maximize reward in Bandura and Perloff (1967) and Glynn (1970) may have been a function of artifactual details rather than the general process of self-determination. Felixbrod and O'Leary, when they controlled for factors such as latency of reward and clarity of the representation of ratio choices, showed a consistent and significant trend toward maximization, although many students initially chose minimally dense schedules.

The initial choices of lean ratios by most subjects may have been influenced by history of reward and/or modeling. Bandura and Kupers (1964) and Bandura and Whalen (1966) have shown modeling cues to be of great importance in children's subsequent patterns of self-reward. Glynn found children's rate of self-reinforcement to be greatly influenced by rate of previously experienced externally imposed reward. Felixbrod and O'Leary controlled for both of these factors, except in regard to long-term history.
These two influences offer an explanation as to why subjects have generally not initially maximized their reward. Of course, this explanation assumes that previous modeling cues and reinforcement have favored modest self-reward.

The above findings and reflections led to the hypothesis that children would maximize reward after initial experience with the task. Many children were expected to maximize initially and to continue to do so throughout the study, since some of the confounds of earlier studies were avoided.

Finally, this study examined the relative number of responses made by males and females. Weiner and Dubanoski found significantly more responses made in extinction by boys than girls when reinforcement was intermittent (FR 4 for repeatedly dropping a rubber ball into a hole in a box.) Between-sex differences under denser ratios of reinforcement were not significant. Bandura and Perloff reported significantly more responses made by boys during reinforcement, which was intermittent.

Both of these studies utilized immediate token reward for simple motor tasks in which boys may have been favored by physical capabilities and/or reinforcement history. Therefore the present investigation sought to determine if these between-sex differences extend to an academic task with delayed reward, under conditions of reward and of generalization.
METHOD

Subjects and Setting

Twenty-two children comprising a sixth-grade classroom in a public elementary school served as subjects. The children ranged in age from 11.0 to 13.4 years, with a mean of 12.2 years at the end of the study. All data were collected in the classroom with the teacher present but nonparticipatory. During the scoring period between tasks she sometimes told students to be quieter and reminded them of current assignments they could work on.

Materials for Dependent Measures

The major dependent variable was academic response rate, based on correct binaries per minute in (1) multiplication and (2) addition problems solved using Hutchings' "low fatigue" algorithms. Each addition problem consisted of a five column by seven row matrix of randomly generated digits, producing 34 binaries in a correctly solved problem. Each multiplication problem consisted of a three column by two row matrix, producing nine binaries. In each session the children were given two pages of each type of problems, with six problems on each page (see Figures 1 and 2).

Although correct problems required that all binaries be correct, it was possible for a problem to be incorrect, yet have all the individual binaries correctly solved. This discrepancy
arises because operations other than binary computations are included in these addition and multiplication algorithms. (Addition problems include the operations of carrying between columns and bringing down the last numbers in the columns. Multiplication problems entail both of these operations plus the apparently difficult response of writing binary products in the correct columns.)

Students were rewarded for correct problems, a more stringent requirement. Although the rates for the two ways of measuring performance are not perfectly correlated, correct binaries seems to be a more accurate measure of the students' work rate. In the five minute period allotted to solving each type of problem, the number of problems solved each day by individual students was generally low. The use of correct binary rate as a dependent measure was found to be desirable due to its sensitivity. Although other responses are also involved in problem solving, binary computation is by far the most frequent response included.

Reinforcement and Reinforcement Materials

Free time, which could be spent on the playground or in the library, was the back-up reinforcer. On days when free time was earned, a "free time list" was carried from desk to desk and filled in as each pupil's problems were scored and his free time calculated by the experimenter. The lists were simply sheets of lined paper with each child's name and two columns for the two amounts of free
time that could be taken in the next free time period.

Beginning on day 16 a similar free time list was also written on the blackboard in front of the class. The two amounts of free time applying to the next free time period were written beside each student's name. The list was erased on no-reward days.

Beginning on day 13 "free time coupons" were given to the subjects for the free time they earned. These coupons were introduced to maximize reinforcement effects: therefore they were not given on no-reward days. These tokens were 7.3 by 5.4 cm slips of paper with the words "Good for ___ minutes for the next free time period" mimeographed in standard typewriter lettering. They were printed on five colors of paper, a different color being used for every two sessions in which free time was earned. Different colors were used to identify which coupons applied to each free time period, since subjects were instructed to save all their coupons for a bonus free time period after completion of the study. The bonus period was announced on day 14, and was introduced as a result of a scheduling conflict. Several students asked that they be allowed to accumulate their free time by not taking it at the standard times, but time limitations dictated adherence to the standard periods. The bonus period hopefully served as partial fulfillment of their requests. As a result, the coupons were actually used twice, once in the free time period following the session in which they were earned and again after termination of the study. In the bonus period each earned minute was worth 12 seconds
of free time, in effect averaging the children's previously earned free time.

Procedure and Design

First the subjects learned to use Hutchings' addition algorithm in two lessons (Alessi, 1974) taught by the experimenter. Two similar lessons on Hutchings' multiplication algorithm were then taught, and proved sufficient for all subjects to independently obtain at least one correct answer on practice problems. Time limitations and the relatively high success of most students precluded further practice time for the low rate students.

Data were collected in all subsequent sessions. A multi-element baseline design was employed. This design involves the repeated measure of the response under a predetermined sequence of randomly alternating conditions of the independent variable. The class was in one of three reinforcement conditions every session: self-determined ratio of reward (SD); externally determined ratio of reward (ED); or no reward, baseline (B). The students received free time in ED and SD. Multiplication performance never earned free time.

Under the SD reinforcement condition, the children chose one of four ratios of free time, ranging from one half minute to two minutes per correct problem. The ratios were printed on a pink cover sheet with instructions for choosing, as shown in Figure 3.
Under ED a white cover sheet stated a ratio of reinforcement, as shown in Figure 4. These ratios were yoked, for each child, to the ratio he had chosen on the most recent SD day. This step was taken to eliminate differential magnitude of reinforcement across conditions.

Under B the children were given no reward for their performance. Addition problems included a yellow cover sheet stating that no free time would be given for correct answers (see Figure 5).

The sessions were ordered by grouping them in triads, composed of one session under each reinforcement system, and randomizing the order of the sessions within each triad. Two exceptions occurred. In the first triad the SD condition was implemented first, to avoid initial effects of modeling and previous history on the children's choice of a ratio. On day 14 the experimenter incorrectly administered one reinforcement system, SD, out of place in the sequence. The planned sequence was continued on the following day, in effect inserting an extra data point for the SD condition at day 14, with all succeeding sessions moved forward one day.

Daily sessions proceeded as follows: The experimenter, at approximately the same time every morning, passed out two pages of addition problems, announced twice the contingencies for these problems, and whether free time would be taken after that session. After coupons were introduced, in session 13, he also announced whether coupons would be given. Although these variables were
specified, questions asked by students indicated that some of them benefited from such clarification.

After working five minutes on the addition problems, the children were stopped, and their papers scored. The experimenter wrote "C" beside correct problems and "X" beside incorrect ones. Unfinished problems were not marked. The number of correct problems was written on the cover sheet. In the ED and SD sessions a free time list was marked with the free time each child earned. After the blackboard free time list was introduced, it was filled in immediately after completion of scoring addition problems on ED and SD days.

Next, multiplication problems were handed out. After five minutes working time the experimenter scored these problems similarly to the addition problems. The papers were collected as they were scored, and on free time days children with the most free time began to take it immediately after the multiplication was scored.
RESULTS

The data of three children who were frequently absent for portions of the data collection and/or free time (reinforcement) period were excluded, although they had participated normally when present. These students were absent for tutoring, but their incomplete data indicate that they did not represent an extreme in performance in either direction. The number of subjects included in the data of daily sessions ranged from 15 to 19.

Reinforcement Effectiveness

Figure 6 shows the comparative rates of correct addition binaries for the SD, ED, and B conditions. To test the effectiveness of reinforcement, a one-way ANOVA indicated at least one significant difference among the three conditions (F=12.91, df=2, 27, p=.001). A series of Fisher's Least Significant Difference Tests showed significant differences between SD and B as well as between ED and B (p=.001).

Generalized Effects of Reinforcement Systems

Performance level on the generalization measure was approximately equal under SD, ED, and B, with respective class means of 9.37, 9.73, and 9.63 correct binaries per minute (see Figure 7). The differences between these means were far from significant (F=.174, df=2, p=.842). Similarly, mean incorrect
binary rates yielded no significant differences across conditions (\(F=.725, \text{df}=2.27, p=.493\)). Means were .153 for SD, .199 for ED, and .199 for B.

Maximization of Reward

In 189 choices, made in 11 SD sessions, only one student on one occasion chose a ratio which was not maximally dense. This single choice was made on the last day of the study, for one minute per correct problem rather than the maximum of two minutes per problem.

Sex Differences in Performance Level

Females performed at a significantly (\(F=37.67, \text{df}=1, p=.001\)) higher rate of correct binaries than males on the generalization measure, as illustrated in Figure 8. Also, females produced fewer errors on multiplication, with a mean of .14 incorrect binaries per minute, compared with the males' rate of .27 per minute (\(F=12.11, \text{df}=1, p=.001\)).

On the reinforced task males and females performed at approximately the same rate, except under B (see Figure 9). In this condition females performed at a higher level. A two way ANOVA showed the difference in B to be great enough to produce a significant interaction (\(F=6.88, \text{df}=2.54, p=.002\)). Rate of incorrect addition binaries was significantly lower for females, with a mean of .12, while males had a mean of .58 (\(F=5.65, \text{df}=1.54, p=.021\)).
DISCUSSION

The present study sought to demonstrate that when sixth-grade students self-determined their reinforcement ratio for correct addition problems, they would subsequently work at a higher rate on multiplication problems. Conditions of self-determination, external determination, and no-reward had no consistent differential effects on multiplication performance level. Approximately equal multiplication performance levels corresponded with the three reinforcement systems (see Figure 7).

It was hypothesized that secondary reinforcement, conditioned through association with the pre-reinforcement response chain for addition, would increase multiplication performance in the SD condition. The failure to confirm this hypothesis raises questions about what actually took place.

First, it is possible that choosing reinforcement ratios was not more reinforcing than having the same ratios externally imposed. Consequently, generalization was undifferentiated because none of the conditions was superior in reinforcement value on the reinforced task. Therefore no difference would be expected to transfer to the generalization measure. However, this explanation fails to account for the no-reward condition, which was clearly lower in addition but equal on multiplication.

The failure of the lower response rate of B to generalize suggests a second explanation. Perhaps the stimulus differences
between tasks was too broad for generalization to take place.

(These differences consisted of the differences in format of the two types of printed problems [see Figures 1 and 2], the announcement of contingencies before addition, and the scoring, recording, and coupon-giving for addition problems which took place before multiplication.) Thus, no difference in response rate would be expected on the generalization measure. A true superiority of self-determination could exist without being indicated by either measure; high rates resulting from direct reinforcement might mask its superiority in addition, and stimulus differences could prevent its generalization to multiplication.

Of course, a third possibility is that self-determination was not more reinforcing than external determination, and even if it had been, generalization would not take place due to stimulus differences.

Both possibilities, failure to generalize and failure to have an initial effect, are supported by certain previous research. Johnson (1970) reported that a clearly established increase in attention on a discrimination task under self-administration of reward did not generalize to the classroom, although extraneous variables and large differences of stimuli appear to have interfered.

On the other hand, Felixbrod and O'Leary (1973) and Glynn (1970) found that self-determination of reward led to equal but not higher performance rates. Lovitt and Curtiss (1969) found just the opposite, that self-determination did increase performance, but
many aspects of their study have since been criticized.

The inconclusive findings of the present study leave many questions unanswered. After Johnson's negative results, the present study attempted to minimize the differences between the two tasks. However, the failure to demonstrate generalization of effects suggests that future investigations might further reduce stimulus differences along a number of dimensions. One factor which might have interfered with generalization was the frequent practice of studying required assignments during the between-task interval. In the future experimenters might further reduce this interval and prevent negative transfer from extraneous stimuli. Another factor might have been the multielement design utilized; if subjects remained in particular conditions over many repeated sessions, it is possible that generalization would have been enhanced. Other variables of possible relevance include the length of individual sessions, the nature of the task, and the characteristics of the setting and population.

Other questions regarding self-determination of reinforcement are also unanswered. Would a wider range of choices increase the potency of self-determination as a reinforcer? Would the results differ if other self-reinforcement components were also in effect? Considering that SD was as efficacious as ED in all regards of the present study, the variables involved in the generalization of self-determination effects certainly seem worthy of further investigation.
The various theoretical approaches mentioned previously offer essentially the same explanations as the operant approach, masked by different terminologies. Rotter might say that, under SD, either a perception of stronger internal locus of control was not induced, or perhaps that this perception was initially induced but failed to generalize. A cognitive dissonance theorist would maintain that either dissonance was not aroused at all, or that it was aroused but failed to carry over. Similar explanations could be stated in terms of competence or commitment.

These theories were not employed to support the generalization hypothesis; rather, they offer hypothetical explanations of mechanisms which might improve performance on a task with SD reward. Unfortunately the pure effects of choice alone were confounded by direct reinforcement on the addition problems. Consequently, no conclusions regarding these constructs can be drawn.

This study also sought to determine whether sixth-grade students, when given a choice of reinforcement ratios, would choose maximally dense ratios. The results show overwhelmingly that the students maximized their reinforcement ratios when possible. It might be noted that the single choice of a lower than optimally dense ratio was made by a student who had a very low success rate and had been observed to comment "It doesn't matter which one I pick because I don't get any right anyway." This change might be viewed as an increase in response variability resulting from partial extinction.
The clear difference between this finding and those of previous investigators might be attributed to various factors. The subjects of the present study were older than those in most previous studies (Bandura & Perloff, 1967; Johnson, 1970; Lovitt & Curtiss, 1969; Weiner and Dubanski, 1975). Also, modeling influences were carefully avoided when the SD condition was explained to the students. The fact that the second (ED) session was yoked to the first meant that all students' ratios were the same, which in this case was maximally dense. Receiving maximally dense ratios in the second session may have confirmed for many children their original choice, and led to the continuance of such ratios.

The subjects' long-term reinforcement history and the nature of the task are other factors of possible import. Little can be said regarding their long-term history. For an academic task, though, Felixbrod and O'Leary did not find immediate maximization. This discrepancy might be explained by the present study's four pre-experimental sessions in which Hutchings' algorithms were taught to the students. Thus, the children already had experience with the task on the first session of data collection.

A final question investigated by the present study was whether between-sex differences in response rate of sixth-graders would favor males when an academic task was used and rewards were delayed. Boys made significantly more errors and worked at a significantly lower rate on multiplication problems. However, on addition problems
an interaction of sex and reward condition was highly significant (see Figure 3). This finding points to the generality that females performed at higher levels than males when external reinforcement was not in effect, while males performed at equal levels when free time was given. This statement can be summarized by saying boys were more susceptible to external reinforcement. Girls apparently obtained their reinforcement from another source, possibly conditioned internal responses.

Previous results (Bandura & Perloff, 1967; Weiner & Dubanowski, 1975) are in direct contrast to this finding. As suggested, this superiority by females was perhaps a function of the academic tasks involved, or the delay of reinforcement. The question of sex differences and effectiveness of reinforcement appears to be a variable of major importance for consideration in future investigations of self-reinforcement.

In conclusion, although the present study did not demonstrate the hypothesized superiority of generalization under SD, it showed that self-determination had no detrimental effect on the generalization measure. Also it supported earlier findings of equal efficacy in the acquisition and maintenance of the academic response (Felixbrod & O'Leary, 1973; Glynn, 1970). Future investigations might pursue the controlling variables and consider the feasibility of their classroom application, with the goal of placing greater responsibility for behavior on the individual students.
Figure 1. Sample addition problem sheet, with problems at progressing stages of completion. Binary calculations and sums are indicated by enclosures.
Figure 2. Sample multiplication problem sheet with problems at progressing stages of completion. Binary calculations and products are indicated by enclosures.
CHOICE DAY

TODAY YOU CAN EARN TIME FOR CORRECT ANSWERS TO THE ADDITION PROBLEMS. YOU CAN PICK HOW MUCH FREE TIME YOU WILL GET FOR EACH CORRECT ANSWER. CIRCLE THE NUMBER IN FRONT OF THE SENTENCE THAT TELLS HOW MUCH FREE TIME YOU WILL GET. THIS CHOICE IS UP TO YOU: PLEASE MAKE IT ON YOUR OWN.

FOR EACH CORRECT ANSWER YOU GET 2 MINUTES OF FREE TIME.
FOR EACH CORRECT ANSWER YOU GET 1 1/2 MINUTES OF FREE TIME.
FOR EACH CORRECT ANSWER YOU GET 1 MINUTE OF FREE TIME.
FOR EACH CORRECT ANSWER YOU GET 1/2 MINUTE OF FREE TIME.

NAME

DATE

Figure 3. Sample cover sheet for addition problems in SD. These sheets were pink in color.
TODAY YOU WILL EARN ______ MINUTES OF FREE TIME FOR EACH CORRECT ANSWER TO THE ADDITION PROBLEMS.

NAME ________________________________________

DATE ________________________________________

Figure 4. Sample cover sheet for addition problems in ED. These sheets were white in color.
TODAY YOU WILL NOT EARN ANY FREE TIME FOR YOUR CORRECT ANSWERS TO THE ADDITION PROBLEMS.

NAME ________________________________

DATE ________________________________

Figure 5. Sample cover sheet used for addition problems in B. These sheets were yellow in color.
Figure 6. Daily class means on the reinforced task, graphed according to experimental condition.
Figure 7. Daily class means on the generalization measure, graphed according to experimental condition.
Figure 8. Relative mean rates of correct multiplication binary calculations for males and females, across the three reinforcement conditions.
Figure 9. Relative mean rates of males and females, showing interaction of sex and reinforcement condition.
REFERENCES


