1967

Effects Of Reward Schedule, Type Of Reward, And Isolation Condition On Children's Lever-pulling Performance

Peter Watson

EFFECTS OF REWARD SCHEDULE, TYPE OF REWARD, AND ISOLATION CONDITION ON CHILDREN'S LEVER-PULLING PERFORMANCE

by

Peter Watson

Department of Psychology

Submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy

Faculty of Graduate Studies
The University of Western Ontario
London, Canada

October 1967

ABSTRACT

Seventy-one male and 79 female kindergarten children were administered a series of 40 lever-pulling trials following either 10 minutes of social isolation or no isolation. Thirty of the Ss received no reward (0%) during the lever-pulling trials; the remainder received either 50% social reward, 50% candy reward, 100% social reward, or 100% candy reward. Response measures on each trial were starting time, from the onset of a stimulus light to initial movement of the lever, and movement time, the duration of the lever-pull itself.

All times were converted to speeds by means of a reciprocal transformation. Initial analyses on the first-trial data indicated a near-significant difference in favor of the isolated Ss, relative to the nonisolated Ss, on starting speed but not movement speed. Subsequent analyses were performed on the data of the whole 40 trials which were combined into five blocks of eight trials per block, with each block corrected for first-trial speed.

Analyses of the corrected starting speeds suggested a general tendency for 50% reward to produce speeds faster

than those produced by 100% reward. Subsequent analyses performed separately for the social-reward and candy-reward groups indicated that 50% reward was superior to 100% reward only when social reward was employed. By the end of training, the group given 50% social reward was faster than groups given 100% social reward or 0% reward; the relationship between asymptotic performance and percentage of social reward was reliably nonlinear. Reward schedule had no effects on the corrected starting speeds of the candy-reward groups; no effects of isolation were observed in any of the analyses.

On corrected movement speeds, the 50% group again tended to respond faster than the 100% group. This tendency was attributable only to those Ss given candy reward, where 50% speeds by the end of training were faster than those of the 0% and 100% groups. Movement speeds of the socially-rewarded Ss were not affected by reward schedule. Again, isolation effects were nonsignificant.

The results were interpreted as showing that both the omission of an expected social reward for a response initiating a sequence, and the omission of an expected tangible reward for a response terminating a sequence, lead to increments in frustration-produced motivation and hence in performance. The response-specific nature of the reward schedule x type of reward effects was tentatively related to the child's past history of reinforcement as well as to possible individual differences in reaction to nonreward. It was suggested that previous research on reward schedules in children is consistent with the present results. The extremely weak support for the notion that social isolation enhances subsequent performance is inconsistent with much earlier research, and indicates the need for parametric studies of isolation effects as related to age, duration of the isolation period, and nature of the subsequent experimental task.

ACKNOWLEDGMENTS

The author wishes to express his thanks to Dr. Morton Rieber, for his advice throughout the course of the investigation; to Dr. T. J. Ryan, for helpful suggestions during the early stages; to Drs. D. R. Pederson and R. M. Knights, for making computor facilities available; to the principals and teachers of Riverside, Prince Charles and Princess Elizabeth public schools, for their patience and cooperation; finally, and perhaps most of all, to my wife for her constant encouragement and understanding.

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INTRODUCTION

The concept of reward has played a role in most theoretical formulations of behavioral phenomena (see Hilgard, 1956; Kimble, 1961). The notion that omission of an expected reward may also have important behavioral consequences, however, has received little theoretical attention until quite recently. The assignment of active motivational properties to nonreward when reward is expected has stimulated a great deal of research with both rats (see Amsel, 1958, 1962; Amsel and Ward, 1965; Spence, 1960, Ch. 6) and humans. The major goal of the research employing infrahuman *S*s has been to test and modify the theoretical assumptions underlying what has come to be called the "frustrative-nonreward" hypothesis; the research dealing with human *S*s, particularly children, has tended to take as its ultimate goal the application of these assumptions to behaviors more complex than those encountered in the laboratory. The first step toward this goal is, of course, to determine to what extent the frustrative-nonreward hypothesis can account for children's behavior in situations as much alike as possible to those used with rats. This has largely been accomplished, and material to be reviewed in the next section, concerned with the effects of reward schedule on children's lever-pulling response speeds, suggests that the frustrative-nonreward hypothesis may, without major modification, be applied to the simple behavior of children.

Subsequent phases in this program of research involve changes in the experimental situation so that it comes to approximate the real world. One of the major differences between the real world and the experimental situations employed in the study of frustrative nonreward in children is the nature of the rewards encountered by the child. Thus, where rewards employed in the laboratory tend to be simple, discrete events such as delivery of a candy or a marble, real-life rewards are generally a whole complex of stimuli, mainly social in nature. The logical next step in the research program is to determine the degree of correspondence between the effects of omission of a tangible reward, such as a candy, and omission of a social reward. This was the major purpose of the present study.

A second purpose was to investigate the effects of a preceding brief period of social isolation on children's lever-pulling behavior. The technique of isolating children has long been used as a method of discipline. Evidence to be cited in a later section suggests that, in addition to serving as a punishment for preceding behavior, isolation can also function as a drive-inducing operation which affects subsequent behavior. Since the frustrative-nonreward hypothesis deals mainly in motivational constructs, it is of interest to examine how social isolation and omission of reward are related in their effects on behavior. Before proceeding to a description of the specific hypotheses of the study, research on the effects of reward schedule, type of reward, and social isolation will be reviewed; the frustrative-nonreward hypothesis will first be discussed briefly.

The Frustrative-Nonreward Hypothesis

A number of theories or hypotheses of frustration have appeared in the psychological literature of the past few decades. It is, however, beyond the scope of this review to do more than mention the major theories briefly. For a more thorough treatment, the reader is referred to Lawson and Marx (1958) and Yates (1962).

Perhaps the current best-known frustration theory is the "frustration-aggression" hypothesis of Dollard, Doob, Miller, Mowrer and Sears (1939), who assumed that frustration resulted from blocking of a goal-directed response. One result of frustration was an instigation to aggression. The boundary conditions of this hypothesis were sufficiently vague to make empirical testing of it difficult; a somewhat more well-defined notion was the "frustration-fixation" hypothesis (Maier, 1949). In this hypothesis, frustration is a result of conditions which prevent the organism reacting adaptively to the situation; the organism then adopts an objectively-maladaptive, fixated behavior pattern. A third prominent frustration hypothesis was proposed by Barker, Dembo and Lewin (1941), who assumed, like Dollard et al (1939), that blocking of a goal response elicited frustration; a consequence of frustration was regression, a decrease in the quality of behavior. This position is similar to Child and Waterhouse' (1953) later statement.

The majority of these theoretical positions were conceived within a psychoanalytic framework. More recent hypotheses have been more or less integrated into more general behavior theory, particularly of the Hull-Spence variety. For example, Brown and Farber (1951) view frustration as one intervening variable within a general behavior system. On the stimulus side, frustration is related to a number of factors, such as partial or complete blocking of the goal response, delay of reward, nonreward, reduced reward, or the evocation of a response tendency incompatible with the goal response. Frustration is assumed to elicit an irrelevant drive which combines with other sources of motivation to produce general drive level, and thus frustration can have either facilitatory or inhibitory effects on performance, depending on the habit strength of the on-going response. If the response is low in the habit heirarchy, a frustrating event will hinder performance, while if the response is well-learned, it will be enhanced by frustration.

A more recent extension of the original Brown and

Farber (1951) notions has been made by Amsel (1958) and later elaborated by both Amsel (1962) and Spence (1960, Ch. 6). Termed the "frustrative-nonreward" hypothesis by its advocates, it limits, for the time being at least, the definition of frustration to an emotional response elicited only by nonreward in situations where reward has been experienced in the past. This hypothesis is similar to Brown and Farber's in that frustration contributes to general motivational level and can enhance performance. The two conceptualizations differ in that Amsel and Spence assume that fractional components of the frustration response can become conditioned to cues early in the response sequence. The major consequence of the addition of this "fractional anticipatory frustration" mechanism (r_F-s_F) is that the frustrative-nonreward hypothesis can then account for increased resistance to extinction following partial as opposed to continuous reward (see Jenkins and Stanley, 1950; Lewis, 1960), the asymptotic superiority of partial relative to continuous reward in acquisition (Wagner, 1961; see also Spence, 1960, p. 109), and certain prediscrimination-learning phenomena (Amsel, 1962; Amsel and Ward, 1965).

The portions of the frustrative-nonreward hypothesis which are relevant to the present study may be described as follows. Early in training, expectancy of reward develops as a function of the number of rewards. Since nonreward is assumed to have no effect on performance until reward expectancy has attained a certain minimum level, a group rewarded on every trial is expected to perform somewhat better early in training, relative to a group rewarded on less than 100% of the trials. After the reward expectancy of the partially-rewarded group has reached this minimum level, nonreward begins to elicit an emotional response termed frustration, which leads to an increment in drive level immediately following nonreward. If trials are massed, the heightened motivation resulting from nonreward has the effect of incrementing performance on trials following non-reward. The group given 100% reward does not respond under this condition of increased motivation. Thus, it is expected that a group given partial reward should ultimately demonstrate better performance than a group given continuous reward. Evidence bearing on this theoretical expectation will be reviewed in the next section.

Reward Schedule Effects in Children

Although a number of studies have investigated the effects of schedule of reward with children in free-operant situations (e.g., Long, 1963; Orlando and Bijou, 1960), the present review will be restricted to discrete-trial situations. Most studies reviewed employed a lever-pulling apparatus in which the onset of a light was the signal for S to initiate the lever-pulling response. Response measures have generally been starting speed, the reciprocal of the time to initiate the response, and movement speed, the reciprocal of the time taken to complete the lever-pulling response. Exceptions to this scheme will be noted where appropriate.

The first study to be reviewed failed to support the notion that partial reward produces faster responding than continuous reward. Cantor and Ryan (1964; see also Ryan and Cantor, 1962) had two groups of preschool Ss perform a series of lever-pulling responses under 50% or 100% reward conditions; rewards were marbles which were later traded for a toy. On starting speed, Group 50 was initially slower than Group 100, while by the end of training, both groups were performing at the same level. No significant differences between groups were observed on movement speeds. Failure to confirm the prediction derived from the frustrative-nonreward hypothesis was attributed to the absence of a "ready" signal preceding the "start" light. Bruning (1964) performed a somewhat similar study with kindergarten Ss who received either 50% or 100% reward, when the rewards were either one of five candies. On movement speeds, Group 50 responded consistently faster than Group 100, with the difference increasing as training progressed. In contrast, starting speed results were nonsignificant. Magnitude of reward did not affect response speeds.

A later study (Ryan, 1965) using marble rewards essentially replicated Bruning's results, with the exception that Group 50 was significantly faster than Group 100 on both starting and movement speed, for all but the first block of training. Similar results were obtained by Ryan and Moffitt (1966) for both preschool and kindergarten Ss, and Pederson (1966, 1967) who used Grade 1 Ss. In the latter two studies, rewards were marbles which enabled S to view colored slides; Group 50 was faster than Group 100 on a reaction speed measure as well as on starting and movement speed. An interesting study by Semler and Pederson (1966) employed discriminative stimuli to vary reward schedule within Ss: a "start" light of one color (S+) signalled the 100% schedule, while another color ($S^{\pm}$) signalled the 50% schedule. $S^{\pm}$ (50%) produced faster movement speeds than was the case for S+, while no differences were observed on reaction speed or starting speed. The Semler and Pederson results seem to suggest that conditioned frustration, resulting from the fractional anticipatory frustration mechanism, as well as primary frustration, is involved in the 50%-100% difference.

Several studies have investigated the effects of reward schedule by employing partial reward schedules other than 50%. Ryan (1966) used schedules of 17%, 33%, 50%, 66%, 83% and 100% with preschool and kindergarten Ss. Again, marble rewards were used. On starting speeds, no significant effects of reward schedule were noted; on movement speeds, Groups 17, 33, 50, and 66 produced faster speeds than Group 100, while Group 83 was not different from either

Group 100 or the other partial-reward groups. By the last block of trials, the mean movement speeds of the six groups described an inverted U-shaped function with fastest responding being produced by Group 50. A similar function has been noted by Weinstock (1958) with rats.

Two studies, one with kindergarten children (Ryan and Voorhoeve, 1966) and the other with retarded children (Watson, Ryan and McEwan, 1967), have replicated the inverted U-shaped relationship between percentage of reward and asymptotic performance. In both studies, reward schedules of 0%, 10%, 30%, 50%, 70% and 100% were employed. Ryan and Voorhoeve's (1966) movement speed results were almost identical to those obtained by Ryan (1966). Asymptotic differences among the various reward-schedule group means were not as clear-cut in the Watson <u>et al</u> (1967) experiment as they were in previous studies, suggesting that retardates may be somewhat less responsive than normals to frustrative nonreward. Ryan (1967) has recently presented evidence which suggests that the motivational effectiveness of frustrative nonreward may vary with chronological age as well as IQ. Children in Grades II, IV and VI received 0%, 10%, 30%, 50%, 70% or 100% marble reward during 40 lever-pulling trials. For the youngest <u>S</u>s, asymptotic movement speed was an inverted U-shaped function of percentage of reward, with 50% reward producing fastest speeds. As age increased, the relationship between percentage of reward and asymptotic performance tended to become less curvilinear, with performance becoming inversely related to percentage. Starting speeds showed the same general pattern as movement speeds.

All the studies cited previously have employed tangible reinforcers such as candies or marbles; to the writer's knowledge, only three experiments have investigated the effects of reward schedule when social as opposed to tangible rewards have been employed. In one (Moffitt, 1965), kindergarten children received either 50% or 100% social reinforcement ("Good") for a series of lever-pulling trials. No differences between Groups 50 and 100 were noted on either starting or movement speeds. In this experiment, E was situated behind S; in a later study (Ryan and Watson, 1966), it was hypothesized that Ss in the Moffitt study might not have been able to discriminate reward and nonreward. Accordingly, the E in the Ryan and Watson study faced S during the testing session. Reward schedules of 33% and 100% were employed. On starting speed, partial reward produced increasingly faster speeds as a function of trial blocks, relative to the continuous reward group, whose performance did not change over blocks. Although the final block means of Group 33 and Group 100 were not significantly different, they appeared to be approaching different asymptotic levels. No significant differences between groups were obtained on movement speeds. A recent unpublished doctoral dissertation (Martinez, 1966) was concerned, in part, with the effects of 0% and random 50% social-reward schedules on simple reaction times of 10-year-old children. While the mean reaction times of both boys and girls for the 50% condition were shorter than for the 0% condition, differences between 0% and 50% schedules did not attain significance.

In summary, a number of investigations with children have demonstrated that random partial reinforcement produces faster response speeds than is the case for continuous reinforcement; of 14 studies reviewed, 11 found some evidence for this proposition. It should be noted that for those 11 studies using tangible rewards, 10 found significant differences in favor of the partial-reward group(s) on movement speed, while only four experiments obtained such differences on starting speeds. On the other hand, with social reward, the partial-continuous difference has been observed only on starting speed. This implied difference between social and tangible rewards necessitates discussion of those studies with children in which type of reward has been a major variable.

Type of Reward

Much recent research has dealt with the effects of reward magnitude on the performance of both animals (see Pubols, 1960) and humans (e.g., Brackbill, Kappy and Starr, 1962; Swingle, Coady and Moors, 1966); a number of studies have been concerned with differences among various types of rewards (see Bijou and Sturges, 1959). The majority of this latter group of experiments have involved what Bijou and Sturges call the "consumable" and "manipulatable" classes of reward, rather than social rewards (e.g., Bisett and Rieber, 1966; Ryan and Moffitt, 1966; Witryol and Fischer, 1960). One interesting study (Witryol and Ormsby, 1961) employed a paired-comparisons method to determine the preferences of kindergarten, Grade III and Grade VI children for both social and nonsocial rewards. Preferences for non-social rewards generally remained the same or decreased as a function of increasing age, while preferences for social rewards increased with age; in kindergarten, candy and social rewards were about equally preferred.

It may be that verbally-expressed preferences, as exemplified in the Witryol and Ormsby (1961) study, and behavioral effects of different types of reward are not contiguous. Several studies have investigated the effects of type of reward in behavioral settings. In an early paper, Abel (1936) found that 9- to 10-year-old children performing in a finger maze made fewest errors when promised 25¢ at the end of the session. Next most efficient conditions for learning were a penny for a correct response, verbal reward, and no reward, in that order. In an investigation of children's discrimination learning, Terrell and Kennedy (1957) found that candy reward for correct responses produced faster learning than either social reward (praise), token reward, knowledge of results, or reproof for incorrect responses. A subsequent study (Terrell, 1958) employed somewhat higher socio-economic status Ss and found faster learning was produced by knowledge of results, relative to candy reward.

The Terrell experiments suggest that the effectiveness of different types of rewards may be influenced by social class; accordingly, Terrell, Durkin and Wiesley (1959) employed candy reward and knowledge of results with middle and lower class Ss in a discrimination task. As predicted, middle class children performed better with knowledge of results as reward, while lower class children learned faster when candy rewards were used. Lewis, Wall and Aronfreed (1963) have shown that chronological age, as well as social class, can be a determinant of the effects of different types of rewards. Grade I and Grade VI children were given a two-choice probability learning task; for half the children at each grade level, choice of the more frequent alternative was signalled with a light-flash (knowledge of results), while for the remainder the reinforcer was a light-flash plus social reward ("Good", "That's fine", etc.). All groups significantly increased in the number of choices of the more frequent alternative over training; the increase was much more marked for the socially-rewarded Grade I children.

A third factor affecting type of reward appears to be the conditions immediately preceding the experimental session. Dorwart, Ezerman, Lewis and Rosenham (1965) subjected Grade III children to either a brief (3-minute) period of social isolation or no isolation, and then administered a probability learning task in which reinforcers were either knowledge of results or social rewards. An interaction between type of reward and isolation condition was obtained, with social isolation enhancing the effectiveness of social reward more than knowledge of results. In a study of verbal conditioning of Grade VI children, Erickson (1962) employed marble and social rewards following 15-minute periods of social isolation or social satiation. For the marble-reward condition, the isolation-satiation variable had no effect on rate of verbal conditioning; for social reward, fastest conditioning was produced following social isolation relative to satiation. Social reward produced generally faster conditioning than was the case for marble reward. Erickson does not state whether or not Ss were allowed to keep the marbles. If the marbles served only to inform S of the correctness of his response, Erickson's results essentially replicate those of Dorwart et al (1965).

The findings of these studies may be summarized briefly. First, there is a tendency for material rewards such as candy to be more effective for lower socio-economic status Ss than is the case for middle-class Ss, who tend to perform better when rewards indicating correctness are employed. Second, age differences have been noted, with social rewards being more facilitative for younger as opposed to older Ss. Finally, social isolation appears to enhance the effectiveness of social but not nonsocial rewards. The next section will discuss more fully the research and theory concerning social isolation.

Social Isolation

The general area of social deprivation has produced many empirical and theoretical papers in recent years (see Baron, 1966; Bowlby, 1952; Gewirtz, 1961, 1967, in press; Stevenson, 1965); the present review will be restricted to one particular variety of social deprivation, the effects of brief social isolation prior to the performance of an experimental task. In the preceding section, studies by Erickson (1962) and Dorwart et al (1965) appeared to suggest that social isolation increased social-reinforcer effectiveness more than it did the effectiveness of nonsocial rewards. These results tend to support Gewirtz and Baer's (1958a, 1958b) hypothesis that social isolation arouses a specifically social drive. In two experiments, Gewirtz and Baer found that social reinforcement following a 20-minute isolation period was more effective in maintaining the rate of marble-dropping of preschool, Grade I and Grade II children than was the case for nonisolation (1958a) or 20 minutes of social satiation (1958b).

Hartup (1958) has proposed that the effectiveness of social isolation is due to frustration of S's dependency behavior. In this study, preschool children who were finger-painting were subjected to five minutes of social interaction with E, followed by five minutes of withdrawal of E's attention. Ss were judged to show significant increases in both the intensity and number of attempts to regain E's approval during the withdrawal period. In a later experiment, Hartup and Himeno (1959) observed S's frequency of aggressive behavior in doll-play following either 10 minutes of isolation or interaction with E. As expected from Dollard et al's (1939) frustration-aggression hypothesis, Ss who were previously isolated showed a greater incidence of aggression than did the non-isolated Ss.

Another hypothesis proposed to account for isolation effects is that isolation produces general stimulus deprivation; thus, a social-isolation condition which provides a variety of stimuli should have less effect on subsequent social reward than an isolation condition involving both social and stimulus deprivation. In one study (Stevenson and Odom, 1962), children in kindergarten, Grade I and Grade II were divided into three groups. A control group (C) was given no isolation; one experimental group (S) was given 15 minutes of social isolation in a room full of attractive toys with which they could play, and the third group (S + S) received 15 minutes of isolation without the toys. In a subsequent socially-reinforced marble-dropping task, both Group S and Group S + S performed better than Group C. It had been predicted from the stimulus-deprivation hypothesis, however, that only Group S + S would perform better than Group C. A later study (Hill and Stevenson, 1964) employed much the same design as that used by Stevenson and Odom, with two exceptions: the isolation condition was reduced to 10 minutes, and Group S watched an abstract movie during the isolation period, rather than playing with toys. Results confirmed the stimulus-deprivation hypothesis: Group S + S subsequently had a higher rate of marble-sorting than either Group C or Group S.

Anxiety has also been claimed to account for increased social-reward effectiveness following isolation. Walters and Ray (1960) combined isolation _vs_ nonisolation and low-anxiety _vs_ high-anxiety in a 2 x 2 factorial arrangement prior to administration of a marble-dropping task; anxiety was manipulated by means of instructions. In the subsequent experimental task, high-anxious _S_s performed better than low-anxious, and isolated _S_s better than nonisolated. Contrary to the anxiety hypothesis, isolation and anxiety did not interact significantly. Paivio (1963) used scores on an "audience-anxiety" questionnaire to differentiate high and low-anxious Grade IV and V children. Half the high-anxious and half the low-anxious _S_s were required to make a speech following 20 minutes of isolation, while the remainder of the Ss gave the speech without prior isolation. It was expected that, if isolation arouses anxiety, high-anxious, isolated Ss should give significantly shorter speeches than other Ss; the results supported this prediction. Paivio has postulated that isolation represents an "incubation" period, in which Ss have time to become anxious about an unknown task. This would be a "drive-induction" as opposed to a deprivation interpretation of isolation effects.

Lewis (1965) attempted to determine the parametric relationship between duration of isolation and subsequent social-reinforcer effectiveness. Following either 0, 3, 6, 9 or 12 minutes of isolation, Grade III Ss performed in a probability learning task with social reward for choice of the more frequent alternative. Only the 3-minute and 12-minute groups performed at a reliably higher level than the group which received no isolation. Lewis concluded that isolation aroused anxiety early in the session, but that as Ss began visually to explore the isolation room, this initial anxiety dissipated. Later in the isolation session, after Ss had exhausted the visual-exploratory potential of the room, anxiety recurred.

Kozma (1967) has replicated and extended Lewis' findings. Ss were high- and low-anxious Grade III children who received either 0, 3, 6, 12 or 18 minutes of isolation. The isolation period was spent in either a bare room or a room containing many interesting pictures; in essence, the rooms were identical except with regard to the amount of visual stimulation provided by each. Performance in the subsequent socially-rewarded probability-learning task, for low-anxious _S_s, was a linear function of length of isolation, while low stimulation _vs_ high stimulation had no effect on low-anxious _S_s. For high-anxious _S_s, on the other hand, the effects of isolation were, in part, determined by stimulation condition. For the low-stimulation condition, only short (3-minute) and long (12- and 18-minute) durations of isolation enhanced subsequent social reinforcer effectiveness in probability learning. Under the high-stimulation condition, the effects of isolation were postponed relative to those effects obtained under low stimulation. Thus, the 6-minute and 18-minute groups demonstrated better performance in subsequent testing than did the other groups.

In summary, a number of theoretical positions have been advanced to explain the effects of isolation. While both supporting and conflicting evidence exists for each of these positions, the empirical fact remains that isolation appears to enhance the effectiveness of subsequent social reinforcement. Some evidence also indicates that isolation does not affect nonsocial-reinforcer effectiveness.

Statement of Problem and Predictions

The variables under investigation in the present study were reward schedule (0% *vs* 50% *vs* 100%), type of reward (candy *vs* social), isolation condition (nonisolation *vs* isolation), and stage of training (trial blocks). Reward schedule may be seen as the central variable in the experiment, since it was expected to reflect the effects of frustrative nonreward. Frustration resulting from nonreward was expected to occur for the 50% reward-schedule group, but not the 100% group. Further, it was hypothesized that frustration would occur only after some unspecified amount of training. The 0% reward-schedule group, which received no reward and thus would have no reward expectancy, was not expected to experience frustration. However, if motivational level is related to reward expectancy *per se*, the 0% group should be less motivated than the 100% group. Because performance is assumed to be a function of motivational level, it was expected that response speeds for the 50% groups should be faster than for the 100% groups, which in turn would be faster than the 0% groups; these differences were expected to increase with training.

If the omission of an expected social reward and the omission of an expected candy reward are equally frustrating, then the type of reward would not be expected to influence any reward-schedule effects obtained. However, previous research with children suggests that differential effects of reward schedule and type of reward might be expected, depending on which response measure is involved.

Previous work on social isolation leads to the prediction that isolated Ss will respond faster than non-isolated Ss. In addition, if the motivational increment resulting from isolation is temporary, the effects of isolation should decrease as training progresses. If isolation effects are attributable to the arousal of a general drive state, no effect of type of reward in interaction with isolation condition would be expected. On the other hand, if isolation elicits a specifically social drive, isolation effects would be expected for the case where social rather than candy rewards are employed.

The relationship between reward schedule and isolation condition is of interest because the bases for isolation and schedule effects are presumed to be motivational. Since the components of drive are assumed to combine additively to produce general drive level, it is expected that reward schedule and isolation condition will not interact.

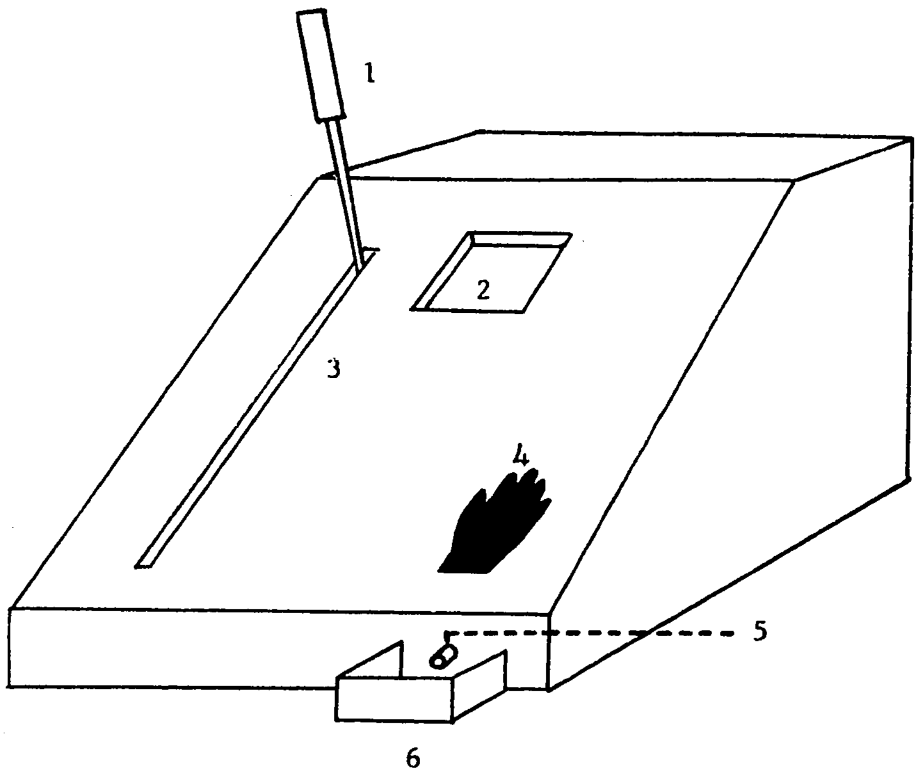
METHOD

Subjects

The Ss were 71 male and 79 female kindergarten children (mean CA = 65.8 months; sd = 4.7 months) obtained from three local elementary schools. None of the Ss had any known physical or visual handicaps.

Apparatus

The apparatus (see Figure 1) consisted of a large, grey lever-box with a 19 x 20-inch front panel inclined at a 45 degree angle from the vertical. A lever protruded from a 15-inch slot located four inches from the left-hand side of the front panel; movement of the lever was in a downward, forward direction. A four-inch square white stimulus light was located three inches from the top centre of the front panel. A black hand pattern at the bottom right of the front panel provided a common starting point for all lever-pulling responses. Directly beneath the hand pattern, a 2 x 4 x 5-inch box served as a receptacle for candy rewards, which could be delivered by means of a tube extending from the front of the lever-box to a point at the back of the box, out of S's line of vision.



1. Lever
2. Stimulus light
3. Lever excursion
4. Hand pattern
5. Delivery tube
6. Candy receptacle

FIGURE 1

Apparatus employed in the experiment

Measures of response time were provided by two Hunter KlocKounters. The first was activated when E pushed a "start" button at the back of the lever-box, thus turning on the stimulus light. A microswitch at the top of the lever excursion terminated the first KlocKounter and started the second when the lever movement began. At the bottom of the excursion, the lever activated a second microswitch which turned off both the second KlocKounter and the stimulus light. Thus, the response measures were starting time, from the onset of the stimulus light to the initial movement of the lever, and movement time, the duration of the lever-pull itself.

The lever-box and the KlocKounters were located on a low table in one room of a two-room mobile laboratory. The other room, which was empty except for a chair in one corner, was used for the isolation procedure. The two rooms were separated by a one-way vision screen, which permitted observation of Ss during the isolation procedure.

Procedure

Ss were addressed as a group in the kindergarten room and invited to the mobile laboratory to "play some games". Volunteers were subsequently brought individually in alphabetical order to the isolation room of the laboratory, and told to sit in the chair and wait until E "got the games ready." E then entered the experimental room and determined from a pre-arranged random list whether that particular S was to be isolated or not. Thus, all Ss were assigned randomly to the various experimental groups. If S was to be isolated, E remained in the experimental room and observed S through the one-way vision screen. At the end of 10 minutes of isolation, S was asked to come into the experimental room. Nonisolated Ss were brought into the experimental room within 10 seconds of being left alone by E.

Upon entering the experimental room, S was told to stand in front of the lever-box and given the following instructions:

> "Here's how you play this first game. When I say 'Ready', put this hand (right hand) on the hand picture and watch for this light (stimulus light) to come on. As soon as the light comes on, reach up with this hand (right hand) and pull this stick (lever) quickly all the way down to here (bottom of excursion)."

After the instructions had been given, S was given two nonrewarded practice trials followed by 40 test trials. Throughout the session, E was seated beside the lever-box, facing S. On each trial, the interval between E's "ready" and the onset of the stimulus light was about 1.5 seconds, while the intertrial interval was about 12 seconds, during which E recorded starting and movement times to the nearest .01 second.

Two types of reward and three reward schedules were employed. For Ss in the 100% reward-schedule condition, E delivered a reward on each of the 40 test trials; Ss in the 50% reward-schedule condition were rewarded on only half of the trials. Arrangement of rewarded and nonrewarded trials (see Appendix A, Table 1) was random, with two restrictions: (a) within every eight consecutive trials, four were rewarded and four were nonrewarded, and (b) no more than three rewarded or three nonrewarded trials occurred consecutively. In the 0% reward-schedule condition, Ss were never rewarded. Ss in the 50% and 100% conditions received either social or candy rewards. A social reward was defined as E smiling and saying "Good" on completion of the lever-pull. For the candy-reward condition, E released a small candy ("Smarties") into the delivery tube at the back of the lever-box on rewarded trials. After the first trial rewarded with a candy, Ss were told that they could keep all the candies they won, but to leave them in the receptacle until the "game" was over.

After completion of the 40 test trials, all Ss played a "drawing game" in which they won enough candy to bring their total winnings to 50 candies. Thus, Ss in the 0% and social-reward conditions received 50 candies, those in the 50% candy-reward condition received 30 candies, and those in the 100% candy-reward condition received 10 candies. This "drawing game" served the double purposes of equating the winnings of all Ss and of reducing inter-S communication about the true nature of the experiment. At the end of the session, E escorted Ss, with their candy, back to the classroom.

Design

The basic plan of the experiment can be represented as a 2 x 3 x 2 incomplete factorial design, with two isolation conditions (nonisolation vs isolation), three reward schedules (0% vs 50% vs 100%), and two types of reward (social vs candy). Since Ss in the 0% condition received neither candy nor social rewards, only two 0% groups were involved. The overall design is presented in Table 1, which also provides the number of male and female Ss and age means and standard deviations for each of the 10 cells of the design.

The overall design can be viewed in two ways. First, if the 0% groups are disregarded, the remainder of the cells constitute a complete 2 x 2 x 2 factorial design, with isolation condition, type of reward, and reward schedule (50% vs 100%) as variables. Second, if the social-reward and candy-reward conditions are considered separately, inclusion of the 0% groups in each of the two type-of-reward conditions results in two complete 2 x 3 factorial designs, one dealing with social reward and the other with candy reward. It should be emphasized that the 0% groups are employed twice in this second case. The obtained data were analyzed in both the 2 x 2 x 2 design and the 2 x 3 designs; in both types of design, trial blocks was included as a within-Ss variable.

TABLE 1

Overall plan of the experiment, with number of males and females, mean ages and standard deviations for each cell

			Social		Candy	
		0%	50%	100%	50%	100%
Nonisolation	Males	7	7	7	7	7
	Females	8	8	8	8	8
	Age $\overline{X}$	67.6	66.6	65.9	66.4	65.1
	Age sd	2.7	4.2	4.6	2.6	3.7
Isolation	Males	9	6	7	7	7
	Females	6	9	8	8	8
	Age $\overline{X}$	64.4	66.1	65.5	65.9	64.7
	Age sd	2.9	4.2	3.4	3.0	3.2

NOTE: Age means and standard deviations in months.

RESULTS

The first analysis was concerned with age differences among the 10 experimental groups. A simple-randomized analysis of variance (Appendix B, Table 1) indicated that the groups did not differ with regard to age (F = 1.0). All starting and movement times for each S were then converted to speeds by means of a reciprocal transformation (1/t sec.).

Because of an apparatus malfunction involving the lever return spring, which occurred after 74 of the 150 Ss had been run, it was necessary to check for any possible distortion of the data due to decreased effort. This distortion would take the form of increased between-Ss variability which could mask the effects of the manipulated variables. Since decreased effort would occur on the first trial as well as all following trials, the first-trial speeds were analyzed in terms of presence vs absence of the return spring; in addition, in order to test for the effects of isolation on initial performance, isolation condition was included, resulting in two 2 x 2 factorial analyses of variance for unequal n, one for starting speed and one for movement speed (Appendix B, Table 2). On movement speed, responses with the spring absent were significantly faster than with the spring present (*F* = 24.22, *df* = 1, 146, $p < .001$). On starting speed, presence or absence of the spring had no effect on performance ($F < 1.0$). On both response measures, isolated *Ss* tended to respond faster than nonisolated *Ss*; the difference, however, was nonsignificant for movement speed (nonisolated $\bar{X}$ = 1.12; isolated $\bar{X}$ = 1.19; $F < 1.0$) and only approached significance for starting speed (nonisolated $\bar{X}$ = .63; isolated $\bar{X}$ = .69; *F* = 3.16, *df* = 1, 146, $p < .10$). Similar analyses (Appendix B, Table 3) performed on the mean starting and movement speeds across the first eight trials of training indicated no significant differences between isolation conditions on either measure ($Fs < 1.0$), although the spring-no spring difference was again significant on movement speed (*F* = 16.50, *df* = 1, 146, $p < .001$). With regard to isolation, it might be concluded that its effects were both unreliable and transient. It may be seen, however, that the presence or absence of the lever return spring contributes to increased between-*Ss* variability; hence, a correction to reduce this effect was necessary. Although the spring-no spring difference did not occur on starting speed, both starting and movement speed were subjected to the same correction. Essentially, the procedure involved combining the data into five blocks of eight trials per block, and then dividing each of the five starting speed blocks and five movement speed blocks by the *first-trial* starting and movement speed, respectively. In essence, this provided a within-Ss correction for differences attributable to the presence or absence of the lever return spring. All subsequent analyses, which will be reported separately for starting and for movement speed, were performed on these corrected speeds.

Starting Speed

Mean corrected starting speeds for all experimental groups over five blocks of trials are presented in Appendix C, Table 1. The first analysis was a 2 x 2 x 2 x 5 factorial design, with isolation condition (nonisolation vs isolation), reward schedule (50% vs 100%) and type of reward (candy vs social) as between-Ss variables, and trial blocks as the within-Ss variable. The 0% groups were not included in this analysis. The results (see Appendix C, Table 2) indicated significant effects for trial blocks (F = 22.60, df = 4, 448, $p < .001$) and for the blocks x schedule interaction (F = 2.47, df = 4, 448, $p < .05$). The data contributing to the interaction are presented in Figure 2, which portrays mean corrected starting speed as a function of reward schedule and trial blocks. The main effect for trial blocks was due to a general increase in speed early in training, followed by more or less stable performance. It should be noted that speeds of the 50% group initially were slower than those of the 100% group, but by the end of training the 50% group had attained an asymptote higher than that of the 100% group. Since follow-up t-tests comparing the

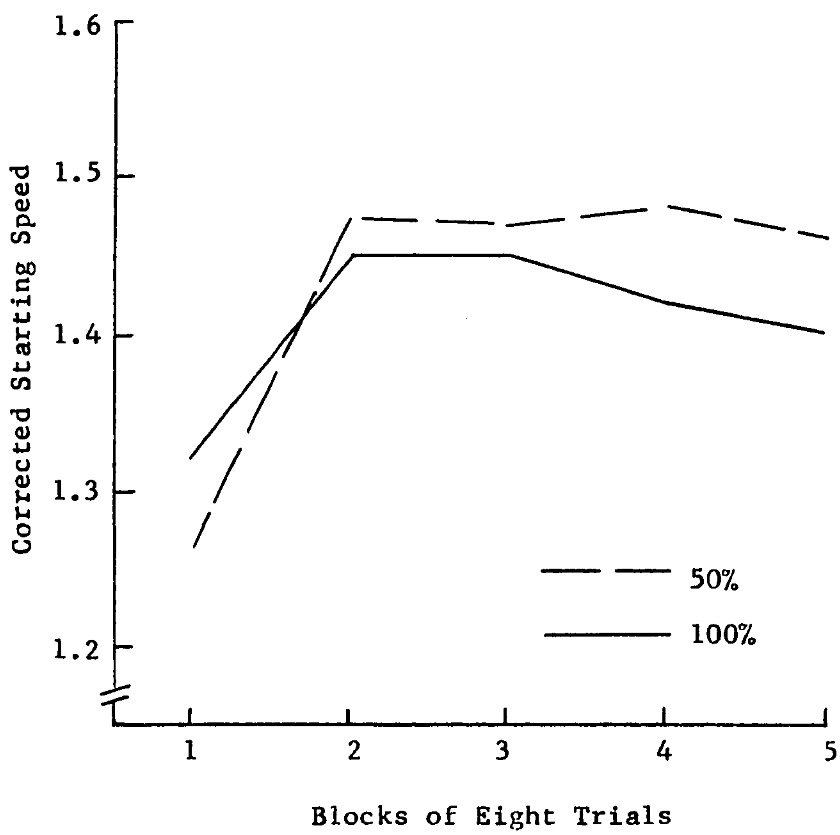


FIGURE 2

Mean corrected starting speed as a function of trial blocks for 50% and 100% groups two groups at each block of trials (see Appendix C, Table 3) failed to reveal significant between-group differences, the most valid conclusion is that 50% reward led to faster response speeds, relative to 100% reward, as training progressed. Type of reward and isolation condition had no effects in this analysis.

The next analyses were performed on the candy- and social-reward groups separately and included the 0% reward-schedule data. That is, the data of the 0% groups were included once in the analysis of the candy-reward groups, and once in the analysis of the social-reward groups. The data involved in these analyses are presented in Figure 3, and the analyses themselves are given in Appendix C, Table 4. For candy reward (bottom panel of Figure 3), the only significant finding was a main effect for trial blocks ($\underline{F}$ = 11.31, $\underline{df}$ = 4, 336, $\underline{p} < .001$), due to increases in performance early in training, followed by asymptotic responding. For social reward (top panel of Figure 3), main effects for trial blocks ($\underline{F}$ = 7.78, $\underline{df}$ = 2, 84, $\underline{p} < .001$) and for reward schedule ($\underline{F}$ = 7.78, $\underline{df}$ = 2, 84, $\underline{p} < .001$), as well as a significant blocks x schedule interaction ($\underline{F}$ = 2.89, $\underline{df}$ = 8, 336, $\underline{p} < .005$), were obtained. None of the main and interaction effects involving isolation condition were significant.

In order to clarify the reward schedule main effect and the blocks x schedule interaction obtained in the analysis of the social-reward data, each reward-schedule group

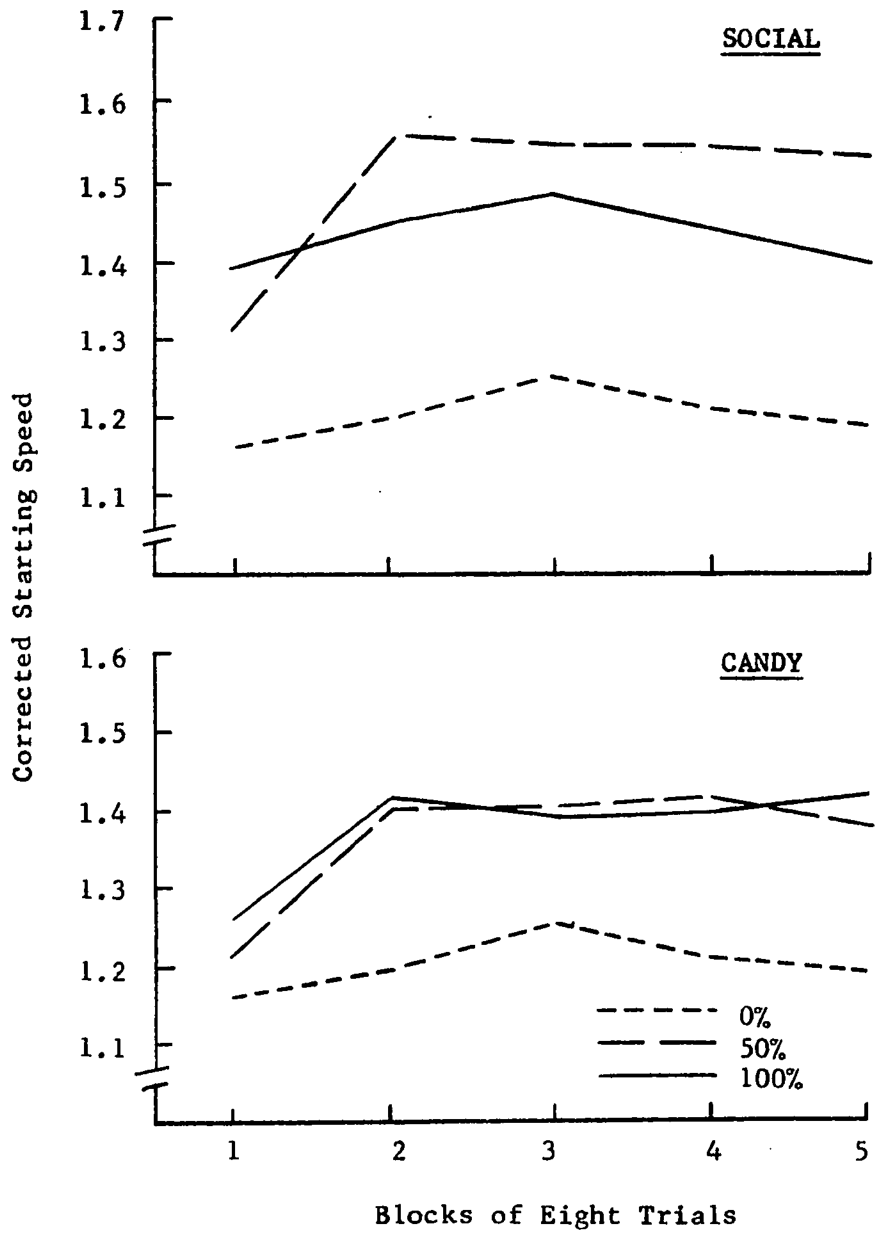


FIGURE 3

Mean corrected starting speed as a function of trial blocks, type of reward, and reward schedule was collapsed across isolation conditions and paired with each of the other reward-schedule groups. This resulted in three separate analyses (see Appendix C, Table 5). The 0% group ($\bar{X}$ = 1.20) performed at a lower level than either the 50% ($\bar{X}$ = 1.50) or the 100% ($\bar{X}$ = 1.43) groups, as evidenced by significant reward schedule main effects in the 0% - 50% ($F = 19.67$, $df = 1, 58$, $p < .001$) and 0% - 100% comparisons ($F = 7.21$, $df = 1, 58$, $p < .01$). The original blocks x schedule interaction is attributable to the fact that the 50% group increased relative to both the 0% ($F = 4.30$, $df = 4, 232$, $p < .005$) and 100% groups ($F = 3.72$, $df = 4, 232$, $p < .01$). Individual t-tests performed at each block (see Appendix C, Table 6), however, revealed that the differences between 50% and 100% social-reward groups were not significant at any point in training.

A final question of interest regarding the corrected starting speed data pertains to the parametric relationship between asymptotic performance and reward schedule for the social-reward groups. Figure 4 presents mean corrected starting speeds on the fifth block for the 0%, 50% and 100% social-reward groups collapsed across isolation conditions; the corresponding data for the candy-reward groups, which are presented for comparison purposes, were not analyzed. The analysis of trend components of the social-reward groups (see Appendix C, Table 7) indicated that both the linear component ($F = 5.20$, $df = 1, 87$, $p < .05$), accounting for

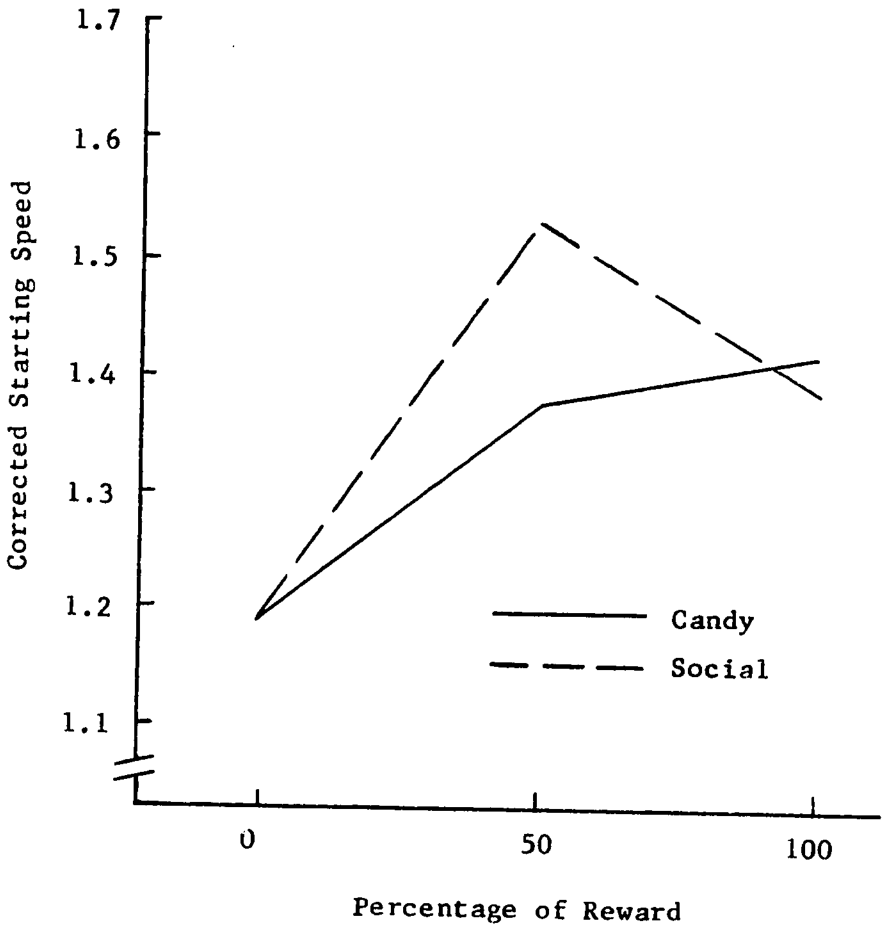


FIGURE 4

Mean corrected starting speed on Block 5 as a function of type of reward and reward schedule

33.5% of the variance among the reward schedule means, and the quadratic component ($\underline{F}$ = 10.23, $\underline{df}$ = 1, 87, $\underline{p} < .01$), accounting for 66.5% of the variance, were significant. Thus, the relationships between asymptotic starting speed and schedule of social reward was essentially nonlinear.

Movement Speed

The corrected movement speed data (see Appendix D, Table 1) were analyzed in a manner similar to that used for the corrected starting speeds. The first analysis (Appendix D, Table 2) dealt with isolation condition (nonisolation vs isolation), reward schedule (50% vs 100%), type of reward (candy vs social), and trial blocks. The trial blocks main effect was significant ($\underline{F}$ = 33.34, $\underline{df}$ = 4, 448, $\underline{p} < .001$), due to a general increase in performance early in training followed by stable performance. The trial blocks x reward schedule interaction approached but did not reach significance ($\underline{F}$ = 2.15, $\underline{df}$ = 4, 448, $\underline{p} < .10$). The data contributing to this interaction are plotted in Figure 5; the general similarity between these results and the corresponding starting speed data (Figure 1) should be noted. None of the other main or interaction effects involved in the first analysis approached significance.

The next analyses included the data of the 0% groups, and were performed separately for the social-reward and candy-reward groups (see Appendix D, Table 3). For social reward

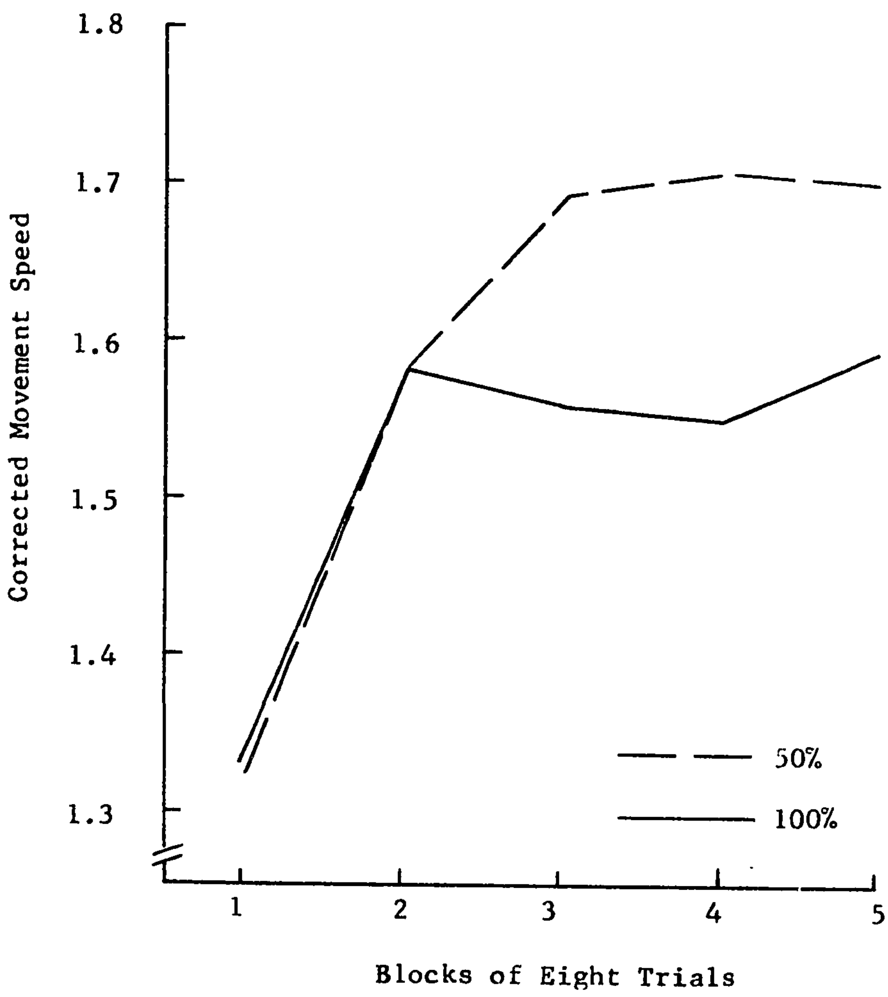


FIGURE 5

Mean corrected movement speed as a function of trial blocks for 50% and 100% groups

(Figure 6, upper panel), only the blocks main effect was significant (F = 17.56, df = 4, 336, $p < .001$); for candy reward (Figure 6, lower panel) significant effects were obtained for both the blocks main effect (F = 22.80, df = 4, 336, $p < .001$) and the interaction between blocks and schedule (F = 3.81, df = 8, 336, $p < .001$). Figure 6 suggests that this interaction is due to the three candy-reward groups having initially similar levels of performance, but appearing to approach different asymptotes by the end of training.

In order to substantiate this observation, three analyses of variance comparing the 0% and 50%, 0% and 100%, and 50% and 100% candy-reward groups were performed (see Appendix D, Table 4); the reward-schedule groups were collapsed across isolation condition, since isolation had no effect in previous analyses. A significant main effect for reward schedule (F = 4.79, df = 1, 58, $p < .05$) in the 0% - 50% comparison indicates that the 50% group was generally faster ($\bar{X}$ = 1.65) than the 0% group ($\bar{X}$ = 1.35). Finally, in both the 0% - 50% and 50% - 100% comparisons, significant blocks x reward schedule interactions were obtained (df = 4, 232; 0% - 50%: F = 6.52, $p < .001$; 50% - 100%: F = 3.34, $p < .025$). Differences between the 50% and 100% candy-reward groups were compared by means of t-tests performed at each trial block (see Appendix D, Table 5). Although these differences were not significant, the original interactions suggest that speeds of the 50% candy-reward group increased relative to

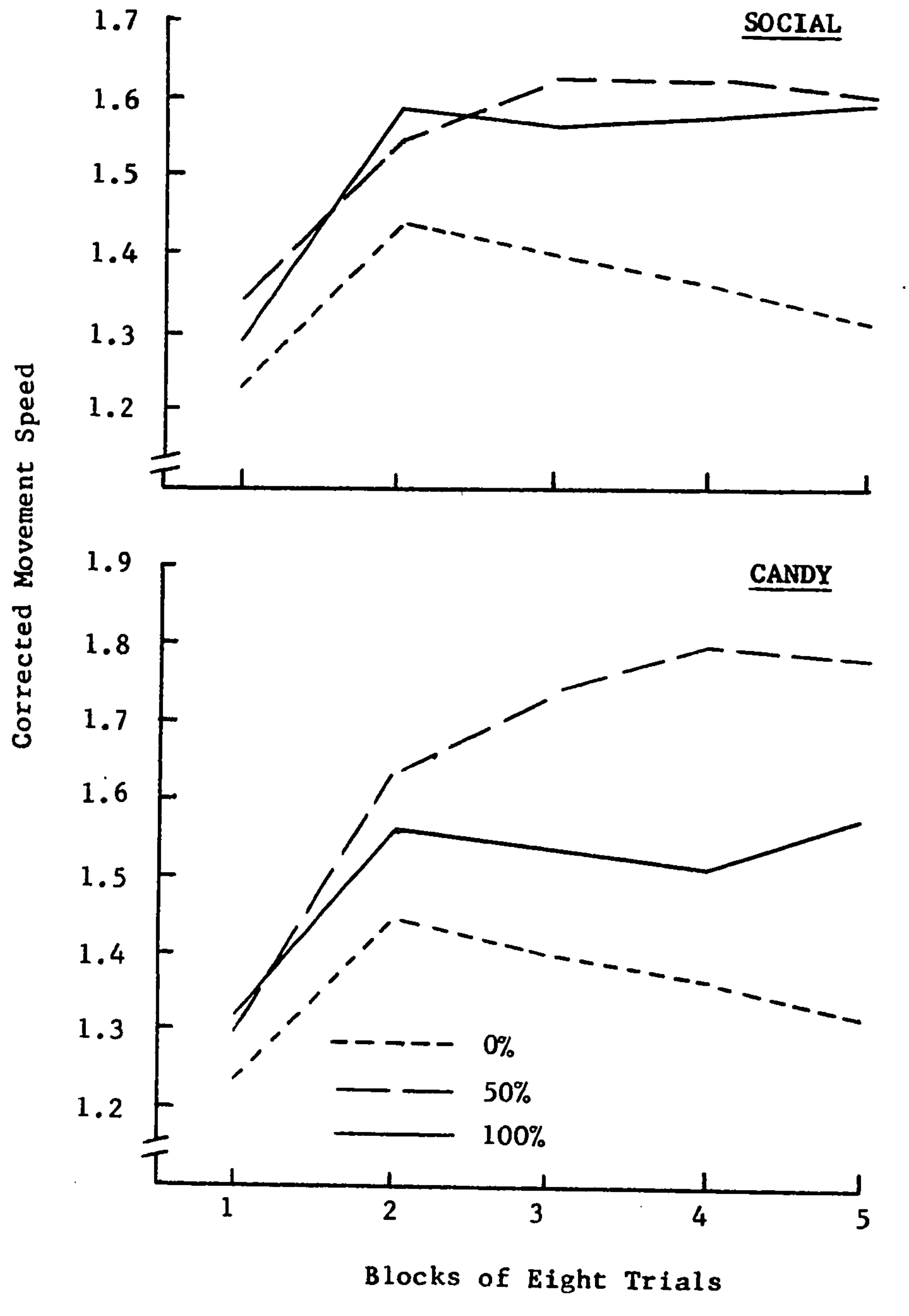


FIGURE 6

Mean corrected movement speed as a function of trial blocks, type of reward, and reward schedule those of the 0% and 100% groups, which did not differ reliably as a function of training.

Figure 7 presents mean corrected movement speeds on the fifth block as a function of reward schedule, for the social-reward and candy-reward groups. In order to test the parametric relationship between asymptotic performance and reward schedule in the candy-reward groups, an analysis of trend components was performed on the fifth-block means (Appendix D, Table 6). Only the quadratic component attained significance ($F = 5.12$, $df = 1, 87$, $p < .05$), indicating a nonlinear relationship between schedule of candy reward and asymptotic movement speed performance.

Summary of Results

Preliminary analyses suggested that the experimental groups did not differ significantly with regard to age. Although differences were not significant, isolated Ss tended to respond faster on the first trial than was the case for nonisolated Ss, particularly on starting speed ($p < .10$). Speeds averaged across the first eight trials did not show this effect of isolation.

Subsequent analyses were performed on starting and movement speeds combined into five blocks of eight trials per block and corrected for first-trial speed. On both starting speed and, to a slightly less reliable extent, on movement speed, the 50% reward-schedule group tended to perform increasingly faster than the 100% group as a function

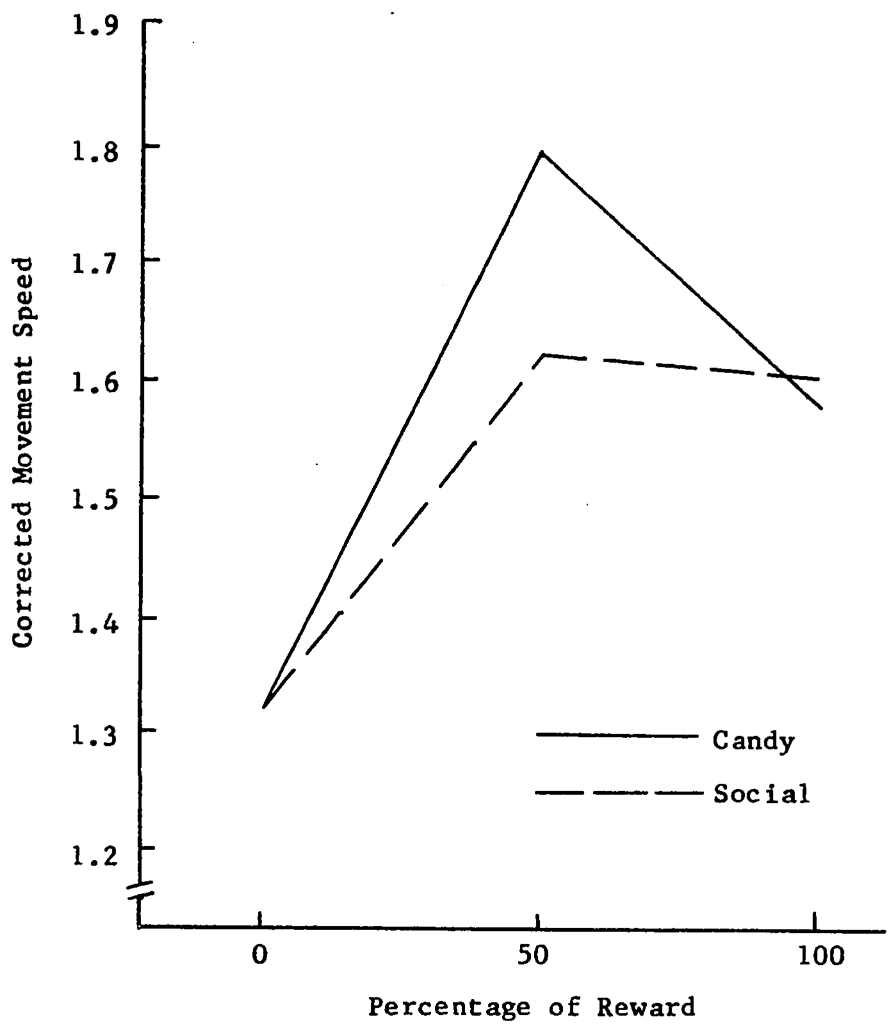


FIGURE 7

Mean corrected movement speed on Block 5 as a function of type of reward and reward schedule of training.

For social reward, the 50% and 100% groups were faster than a 0% group throughout training on both starting and movement speeds. In addition, for starting but not movement speed, the 50% group became increasingly faster than the 100% group throughout training. By the fifth block, the relation between reward schedule and starting speed performance was essentially nonlinear for the social-reward groups.

For candy reward, reward schedule had no effects on starting speeds; the 0%, 50% and 100% groups were not significantly different. On movement speed, however, the 50% group was faster than the 0% group throughout training, and increased significantly relative to both the 0% and 100% groups as training progressed. The 0% and 100% groups were not different. By the end of training, the relationship between movement speed performance and reward schedule for the candy-reward groups was significantly nonlinear. With the exception of the near-significant result reported above, none of the analyses revealed any effects of isolation.

DISCUSSION

The results of the present study, with regard to the effects of brief social isolation on subsequent performance, were generally negative. The only support for the prediction that isolation would lead to superior performance, relative to nonisolation, occurred in the analysis of first-trial starting speeds. While in the predicted direction, the difference between isolated and nonisolated Ss was significant at only the 10% level; further, when the starting speed data of the first block (trials 1-8) were analyzed in terms of isolation condition, no difference was found. Thus, the most valid conclusion which can be made regarding an isolation effect in the present study is that it was relatively unreliable and extremely short-lived.

These results should be contrasted with those of other investigations (e.g., Gewirtz and Baer, 1958a, 1958b; Kozma, 1967; Lewis, 1965), which demonstrated stable isolation effects which tended to persist over relatively long experimental sessions. The present and earlier studies differed on a number of potentially relevant dimensions: the amount of learning involved in the experimental task, the treatment of nonisolated Ss, etc. It should be noted that the particular combination of kindergarten-age Ss and 10 minutes of isolation has not previously been employed. It may be that this combination is not optimal for demonstrating isolation effects; Lewis (1965) has reported a similar phenomenon for the combination of Grade III Ss and a six-minute isolation period preceding the experimental task. In view of the propensity of researchers in the area of social isolation to employ Ss who differ widely in terms of age, parametric data on both age and duration of isolation would be valuable to the design of future studies.

Another possible explanation for the relatively weak isolation effects observed in the present study related to the manner in which Ss approached the experimental task. Stevenson (1965) has described a series of criteria for methodologies used in the study of social reinforcement. One of these criteria, which perhaps equally well applies to the investigation of social isolation effects, is that the task should be, in essence, boring. Presumably, a task which provides little intrinsic motivation is more sensitive to the effects of antecedent manipulations than is the case where the task engenders some amount of enthusiasm. In the present study, Ss tended to enjoy "playing the game", and fairly frequently, Ss who had participated would later ask if they could take part again. Thus, the interest aroused by the experimental task *per se* may have tended to reduce any effects of isolation. This possibility suggests the need to investigate the effects of isolation across a wide variety of experimental tasks, or to design tasks which are differentially interesting to Ss but provide identical response measures.

In contrast to the failure to provide convincing support for the predictions made concerning social isolation, the present results generally confirmed predictions which dealt with the effects of reward schedule. Thus, speeds of Ss given 50% reward became increasingly fast relative to speeds of Ss who received 100% reward; this was more evident on the starting measure than on the movement measure, where the interaction between blocks and schedule was significant at only the 10% level. According to the frustrative-nonreward hypothesis, the gradually-developing superiority of 50% reward relative to 100% reward is due to the elicitation of frustration as expectancy of reward develops.

The absence of reliable main or interaction effects attributable to type of reward in the initial analyses of the data suggests that 50% superiority, relative to 100%, is independent of type of reward. These results support the conclusion that frustration results from the omission of an expected social reward as well as the omission of an expected tangible reward. Separate analyses of the social- and candy-reward data, which were justified by the design of the experiment, suggest, however, that differences in reward-schedule effects do in fact exist as a joint function of type of reward and the particular response measure involved; the 50% reward schedule produced speeds which were faster than those produced by the 100% schedule, on the starting speed measure when social rewards were employed, and on the movement speed measure when candy rewards were used. No difference between 50% and 100% reward schedules were observed on starting speed, for candy reward, or movement speed, for social reward.

It is interesting to speculate on whether similar results would have been obtained had different Ss been employed. Both age and social class have been shown to affect the efficacy of social relative to material rewards (see pp. 11-13). The concensus of evidence indicates that older and/or higher-class Ss tend to value social rewards more than is the case for relatively younger, lower-class Ss. The kindergarten Ss of the present study, with some exceptions, seemed to be drawn predominantly from the lower and lower-middle classes, and the obtained results and conclusions based on them can strictly speaking only be applied to this particular type of S. It is possible that older, higher-class Ss, who are assumed to place a higher value on social rewards, would be relatively more frustrated by nonattainment of an expected social reward than was the case for the present Ss. Thus, if different Ss were used, an interaction between type of reward and reward schedule might be expected.

In those cases where 50% reward led to increasingly fast responding relative to 100% reward, differences between 0% and 50%, in favor of the 50% group, were also observed. The obtained nonlinear relationships between asymptotic performance and percentage of reward in these cases are consistent with previous research with both rats (Weinstock, 1958) and children (Ryan, 1966, 1967; Ryan and Voorhoeve, 1966; Watson _et al_., 1967); fastest responding tends to result from intermediate percentages of reward, rather than from very high (100%) or very low (0%) percentages. It appears, then, that performance in the lever-pulling situation is a joint function of both the number of rewards and the number of nonrewards which are experienced by _S_, at least for starting speed with social reward, and movement speed with candy reward. For the 100% group, frustration resulting from nonreward is absent, and thus cannot contribute to motivation. For the 0% group, reward expectancy is absent, and nonreward does not elicit frustration.

It was hypothesized earlier (p. 20) that the 0% group, having received no rewards, would have a lower expectancy of reward than the 100% group. If performance is related to reward expectancy _per se_, differences between 0% and 100% in favor of the latter group would be anticipated. Since in only one of the four possible comparisons, starting speeds for the social-reward condition, did the difference between the 0% and 100% reward schedules attain significance, the evidence bearing on this prediction is equivocal, and any definitive statement must await further research.

The demonstration of partial-reward superiority, relative to continuous reward, on starting speeds for social reward but movement speed for candy reward, appears entirely consistent with most of the research cited in the review of reward schedule effects in children (see pp. 6-11). It will be recalled that, when tangible rewards such as marbles or candies were used, partial-reward superiority on movement speed was observed in 10 of 11 studies, while only four of 11 studies obtained similar effects for a starting speed measure. With social reward, partial-reward superiority has previously been observed on starting but not on movement speed. In earlier studies (e.g., Bruning, 1964; Ryan and Voorhoeve, 1966; Ryan and Watson, 1966), demonstration of reward schedule effects on only one of two response measures has been generally attributed to the operation of random experimental error with regard to the measure not showing the effect. The present results indicate a degree of predictability in the earlier data, and point to the need for a closer examination of the response measures themselves.

It appears possible to characterize the response measures as follows. Starting speed is concerned with the initiation of the response sequence, and is composed of a number of relatively heterogeneous components, such as perceiving and reacting to the stimulus light, reaching up, taking hold of the lever, and beginning the downward pull.

Movement speed, on the other hand, is concerned with maintenance and termination of a previously-initiated sequence, and consists mainly of sustaining a downward force on the lever. Thus, starting speed is a complex initiation of a response sequence, while movement speed is a relatively simple termination of the sequence. At present, existing evidence does not permit any choice between the simplicity-complexity and the initiation-termination factors as the more potent determinant of a functional difference between the response measures. In terms of this conceptualization of the response measures, the conclusion that reward-schedule effects are independent of type of reward should be modified. It now appears that omission of an expected social reward leads to frustration in the case where the response is complex and/or concerned with initiation of a sequence. The reverse holds for candy reward: omission of an expected candy reward is frustrating only when the response is simple and/or terminates the sequence.

Although any explication of this phenomenon must, in view of the dearth of evidence, be extremely tentative, it is possible, and perhaps fruitful in terms of provoking the necessary research, to speculate briefly concerning the psychological basis of the obtained reward-schedule results as they relate to an interaction between type of reward and response measure. It may be that the roots of this apparent specificity lie somehow in the child's past history. Although a large amount of research has been done on parent-child interaction (see Hoffmann and Lippitt, 1960), little work specifically concerned with the relative frequencies of social and tangible rewards has apparently been performed. In spite of the lack of empirical evidence, common sense suggests that, when a child is performing a task, the parents employ social rewards as needed during the performance; if tangible rewards such as candy are used, they are likely given only on completion of the task. If this is the case, the child might develop an expectancy of social reward for starting a task, and an expectancy of tangible reward for completing the task. Although the experimental situation used in the present study was to some degree different from most every-day circumstances, part of these expectancies would generalize to the experimental setting, and perhaps account for the obtained results. What is needed, at this point, is a series of observational studies of parent-child interaction which attempts to determine the validity of these common-sense assumptions.

An alternative and perhaps complementary interpretation of the apparent type-of-reward/response-measure specificity observed in the present study may be that some types of reward are more effective for some individuals than for others, and that these individual differences are somehow response-specific. It is conceivable, for example, that individuals with a high need for approval, on whom social rewards would have relatively large effects, view initiation of a response as perhaps more crucial than is the case for non-initiative components of the response. Conversely, individuals with a low need for approval might place more emphasis on termination rather than initiation of the response. For these individuals, task completion might provide more motivation than an extrinsic social reward, and a candy reward might serve as an indicator that the task is in fact completed. Although these relationships might account for the present results, they can be verified only by further research on the effects of individual differences.

One underlying theme of the preceding discussion is that the two response measures, starting speed and movement speed, are seen as two discrete responses which form a response sequence, rather than as arbitrarily-divided components of one response. The notion that a behavioral sequence consists of a series of more or less discrete responses, of course, is not new, as witness Skinner's (1938) discussion of response chaining. What is somewhat paradoxical within the present context is that frustration is assumed to occur on one response measure under one set of experimental conditions, but on the other response measure under a different set of conditions. The paradox may be at least partially resolved by reference to frustration in its conditioned rather than primary form (Amsel, 1958, 1962; Spence, 1960, Ch. 6). According to the frustrative-nonreward hypothesis, nonattainment of an expected reward leads to the occurrence of primary frustration which contributes to drive level. After some number of trials on which primary frustration has been experienced, stimuli which occur at the beginning of the response come, through classical conditioning and stimulus generalization, to elicit anticipatory or conditioned frustration, which also increments drive level. Thus, primary frustration occurs at the end of a response and enhances performance on a subsequent response, while conditioned frustration occurs at the beginning of a response and enhances performance on that particular response.

In studies using children, it is generally not possible to determine whether the superiority of partial relative to continuous reward is due to primary or to conditioned frustration, or to both, unless special procedures are adopted (see Moffitt and Ryan, 1966; Semler and Pederson, 1966). Even then, the evidence in favor of one or the other is conflicting. In the present study, where 50% social reward enhanced starting but not movement speed performance while 50% candy reward enhanced movement but not starting speed, it is probable that enhancement of performance under partial-reward conditions was due to conditioned rather than to primary frustration. It is assumed that stimuli at the beginning of the response - e.g., proprioceptive cues resulting from placing the hand on the hand pattern, for the starting response, and beginning the downward pull on the lever, for the movement response - with continued training become conditioned to elicit anticipatory frustration in those cases where primary frustration has occurred. Primary frustration is not present for the 0% and 100% groups, and thus conditioned frustration cannot contribute to the motivational level of these groups.

Although the foregoing might explain how frustration may become conditioned to one response measure but not to the other, the problem still remains of accounting for the absence of any effect of frustration carried over from the starting speed response to movement speed in the social-reward condition. Presumably, frustration-produced motivation has a finite duration, and it might be expected to affect both starting and movement speed performance if evoked at the beginning of the starting response. The present data suggest, of course, that only the starting response is affected. The most parsimonious explanation appears to be that cues occurring at the beginning of the movement response serve somehow to inhibit the frustration elicited on starting speed. Although evidence bearing on this interpretation is at best tangential, investigations of primary frustration in children and lower animals (see Davenport and Thompson, 1965; Ryan, 1965; Staddon and Innis, 1966; Watson and Ryan, 1966) seem to provide support for it: interpolated activity between a frustrated response and a subsequent response tends to reduce the effects of frustration on the subsequent response. Without interpolated activity, performance following frustration tends to be enhanced.

These speculations concerning the possible factors underlying the apparent specificity of reward schedule effects to particular combinations of response measure and type of reward must be seen as extremely tentative in view of the lack of empirical evidence for some of the more crucial notions. In an earlier paragraph, it was suggested that research into the actual frequencies of rewards of different types as they are used in real-life situations would be useful. In essence, this research would proceed from a relatively molecular to a relatively molar level. Research in the opposite direction is also needed; little is known concerning the actual physiological changes, if any, which accompany frustration-produced increments in motivation. Such information would perhaps give a sounder basis for much of the frustrative-nonreward hypothesis, for if correlations between physiological and performance changes subsequent to frustration were found, they would provide a perhaps more independent check on the validity of the speculations advanced in this paper.

SUMMARY

Seventy-one male and 79 female kindergarten children were administered a series of 40 lever-pulling trials following either 10 minutes of social isolation or no isolation. Thirty of the Ss received no reward (0%) during the lever-pulling trials; the remainder received either 50% social reward, 50% candy reward, 100% social reward, or 100% candy reward. Response measures on each trial were starting time, from the onset of a stimulus light to initial movement of the lever, and movement time, the duration of the lever-pull itself.

All times were converted to speeds by means of a reciprocal transformation. Initial analyses on the first-trial data indicated a near-significant difference ($p < .10$) in favor of the isolated Ss, relative to the nonisolated Ss, on starting speed but not movement speed. Subsequent analyses were performed on the data of the whole 40 trials which were combined into five blocks of eight trials per block, with each block corrected for first-trial speed.

Analyses of the corrected starting speeds suggested a general tendency for 50% reward to produce speeds faster than those produced by 100% reward. Subsequent analyses performed

separately for the social-reward and candy-reward groups indicated that 50% reward was superior to 100% reward only when social reward was employed. By the end of training, the group given 50% social reward was faster than groups given 100% social reward or 0% reward; the relationship between asymptotic performance and percentage of social reward was reliably nonlinear. Reward schedule had no effects on the corrected starting speeds of the candy-reward groups; no effects of isolation were observed in any of the analyses.

On corrected movement speeds, the 50% group again tended ($p < .10$) to respond faster than the 100% group. This tendency was attributable only to those Ss given candy reward, where 50% speeds by the end of training were faster than those of the 0% and 100% groups. Movement speeds of the socially-rewarded Ss were not affected by reward schedule. Again, isolation effects were not significant.

The results were interpreted as showing that both the omission of an expected social reward for a response initiating a sequence, and the omission of an expected tangible reward for a response terminating a sequence, lead to increments in frustration-produced motivation and hence in performance. The response-specific nature of the reward schedule x type of reward effects was tentatively related to the child's past history of reinforcement as well as to possible individual differences in reaction to nonreward. It was suggested that previous research on reward schedules in children is consistent with the present results. The extremely weak support for the notion that social isolation enhances subsequent performance is inconsistent with much earlier research, and indicates the need for parametric studies of isolation effects as related to age, duration of the isolation period, and nature of the subsequent experimental task.

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TABLE OF APPENDICES

APPENDIX A

Random 50% Reward Schedule

TABLE 1

Random 50% reward schedule used in the experiment

Block	Trial							
1	1	2	3	4	5	6	7	8
	+	+	−	+	−	−	−	+
2	9	10	11	12	13	14	15	16
	−	−	+	+	+	−	−	+
3	17	18	19	20	21	22	23	24
	+	−	−	−	+	−	+	+
4	25	26	27	28	29	30	31	32
	+	−	+	+	−	−	−	+
5	33	34	35	36	37	38	39	40
	+	−	+	+	−	+	−	+

NOTE: "+" = reward; "−" = nonreward

APPENDIX B

Preliminary Analyses

TABLE 1

Summary of analysis of variance on ages among groups

Source	Sum of Squares	df	Mean Squares	F
Groups	.012	9	.001	1.00
Within Groups	.188	140	.001	

TABLE 2

Summary of analyses of variance on first-trial speeds for isolation x spring-no spring subgroups

Source	df	Starting Speed		Movement Speed	
		MS	F	MS	F
Spring-No Spring (S)	1	.001	-	5.446	24.22**
Isolation (I)	1	.133	3.16*	.095	-
S x I	1	.006	-	.002	-
Within groups	146	.042		.225	

* $p < .10$

** $p < .001$

TABLE 3

Summary of analyses of variance on trial 1-8 speeds for isolation x spring-no spring subgroups

Source	df	Starting Speed MS	Starting Speed F	Movement Speed MS	Movement Speed F
Spring-No Spring (S)	1	.001	-	4.112	16.50*
Isolation (I)	1	.007	-	.001	-
S x I	1	.019	-	.029	-
Within-groups	146	.044		.249	

*$p < .001$

APPENDIX C

Corrected Starting Speeds: Data and Analyses

TABLE 1

Mean corrected starting speeds for all groups as a function of five blocks of eight trials

Group	Block 1	2	3	4	5	Total
NI-0%	1.21	1.26	1.29	1.26	1.23	1.25
I-0%	1.12	1.13	1.21	1.16	1.15	1.15
NI-50%-C	1.28	1.41	1.41	1.45	1.44	1.40
I-50%-C	1.14	1.38	1.38	1.40	1.33	1.33
NI-50%-S	1.32	1.58	1.55	1.51	1.52	1.50
I-50%-S	1.32	1.52	1.54	1.57	1.54	1.50
NI-100%-C	1.28	1.46	1.40	1.37	1.39	1.38
I-100%-C	1.24	1.37	1.38	1.42	1.44	1.37
NI-100%-S	1.44	1.52	1.55	1.49	1.43	1.49
I-100%-S	1.31	1.38	1.40	1.40	1.35	1.37

NOTE: NI = nonisolated; I = isolated; C = candy; S = social

TABLE 2

Summary of analysis of variance of corrected starting speeds, excluding 0% groups

Source	df	MS	F
Isolation (I)	1	.380	-
Type of Reward (R)	1	1.314	2.59
Schedule (S)	1	.123	-
I x R	1	.007	-
I x S	1	.030	-
R x S	1	.268	-
I x R x S	1	.296	-
Within Groups	112	.508	
Blocks (B)	4	.594	22.60**
B x I	4	.028	1.08
B x R	4	.019	-
B x S	4	.065	2.47*
B x I x R	4	.008	-
B x I x S	4	.013	-
B x R x S	4	.031	1.20
B x I x R x S	4	.016	-
Within Ss	448	.026	

*$p < .05$

**$p < .001$

TABLE 3

Tests of significance of differences between 50% and 100% groups on each of five blocks, starting speeds

Group	Block 1	2	3	4	5
50%	1.26	1.47	1.47	1.48	1.46
100%	1.32	1.44	1.44	1.42	1.40
D	-.06	.03	.03	.06	.06
t	1.00	.50	.50	1.00	1.00

NOTE: df = 148

TABLE 4

Summary of analyses of variance of corrected starting speeds, including 0% groups and performed separately for candy and social reward groups

Source	df	Social MS	Social F	Candy MS	Candy F
Isolation (I)	1	.563	1.26	.400	-
Schedule (S)	2	3.491	7.78**	1.346	2.93
I x S	2	.147	-	.067	-
Within Groups	84	.448		.459	
Blocks (B)	4	.255	11.76**	.298	11.31**
B x I	4	.018	-	.014	-
B x S	8	.063	2.89*	.044	1.66
B x I x S	8	.004	-	.017	-
Within Ss	336	.022		.026	

*$p < .005$

**$p < .001$

TABLE 5

Summary of analyses of variance on corrected starting speeds, comparing all reward-schedule groups, social reward groups only

		0%-50%		0%-100%		50%-100%	
Source	df	MS	F	MS	F	MS	F
Schedule (S)	1	6.413	19.67***	3.684	7.21*	.377	-
Within Groups	58	.326		.511		.492	
Blocks (B)	4	.228	9.96**	.077	4.13**	.269	12.01***
B x S	4	.098	4.30**	.007	-	.083	3.72*
Within Ss	232	.023		.019		.022	

* $p < .01$

** $p < .005$

*** $p < .001$

TABLE 6

Tests of significance between 50% and 100% social reward groups on each of five starting speed trial blocks

Group	Block 1	2	3	4	5
50%	1.32	1.55	1.55	1.54	1.53
100%	1.37	1.45	1.48	1.44	1.39
D	-.05	.10	.07	.10	.14
t	.56	1.11	.78	1.11	1.56

NOTE: *df* = 58

TABLE 7

Summary of trend analysis on fifth-block corrected starting speeds, social reward groups

Source	df		MS	F
Schedule	2		.850	7.73***
Linear		1	.572	5.20*
Quadratic		1	1.125	10.23**
Within Groups	87		.110	

* $p < .05$

** $p < .01$

*** $p < .005$

APPENDIX D

Corrected Movement Speeds: Data and Analyses

TABLE 1

Mean corrected movement speeds for all groups as a function of five blocks of eight trials

Group	1	2	3	4	5	Total
NI-0%	1.23	1.44	1.42	1.37	1.30	1.35
I-0%	1.23	1.43	1.38	1.37	1.35	1.31
NI-50%-C	1.27	1.54	1.69	1.75	1.72	1.59
I-50%-C	1.34	1.72	1.80	1.84	1.83	1.71
NI-50%-S	1.45	1.63	1.80	1.76	1.80	1.69
I-50%-S	1.22	1.45	1.46	1.50	1.44	1.41
NI-100%-C	1.36	1.61	1.56	1.49	1.62	1.53
I-100%-C	1.29	1.53	1.53	1.54	1.54	1.49
NI-100%-S	1.30	1.63	1.66	1.69	1.60	1.58
I-100%-S	1.28	1.55	1.49	1.48	1.60	1.48

NOTE: NI = nonisolation; I = isolation; C = candy; S = social

TABLE 2

Summary of analysis of variance of corrected movement speeds, excluding 0% groups

Source	df	MS	F
Isolation (I)	1	.812	-
Type of Reward (R)	1	.217	-
Schedule (S)	1	1.027	-
I x R	1	1.808	1.07
I x S	1	.003	-
R x S	1	.519	-
I x R x S	1	1.053	-
Within Groups	112	1.694	
Blocks (B)	4	2.326	33.34**
B x I	4	.019	-
B x R	4	.016	-
B x S	4	.150	2.15*
B x I x R	4	.048	-
B x I x S	4	.029	-
B x R x S	4	.100	1.43
B x I x R x S	4	.047	-
Within Ss	448	.070	

*$p < .10$

**$p < .001$

TABLE 3

Summary of analyses of variance of corrected movement speeds, including 0% groups and performed separately for candy and social reward groups

Source	df	Social MS	Social F	Candy MS	Candy F
Isolation (I)	1	1.696	1.40	.066	-
Schedule (S)	2	1.788	1.48	3.299	2.32
I x S	2	.718	-	.239	-
Within Groups	84	1.207		1.419	
Blocks (B)	4	1.043	17.56*	1.318	22.80*
B x I	4	.045	-	.007	-
B x S	8	.080	1.34	.220	3.81*
B x I x S	8	.035	-	.019	-
Within Ss	336	.059		.058	

*p $<$ .001

TABLE 4

Summary of analyses of variance on corrected movement speeds, comparing all reward-schedule groups, candy reward groups only

Source	df	0%-50% MS	0%-50% F	0%-100% MS	0%-100% F	50%-100% MS	50%-100% F
Schedule (S)	1	6.593	4.79*	1.800	1.89	1.505	-
Within Groups	58	1.377		.954		1.799	
Blocks (B)	4	1.041	17.43***	.464	10.94***	1.352	20.22***
B x S	4	.389	6.52***	.049	1.16	.233	3.34**
Within Ss	232	.060		.042		.067	

*$p < .05$

**$p < .025$

***$p < .001$

TABLE 5

Tests of significance of differences between 50% and 100% groups on each of five blocks, movement speed

Group	Block 1	2	3	4	5
50%	1.30	1.63	1.74	1.79	1.78
100%	1.32	1.57	1.55	1.52	1.58
D	-.02	.06	.19	.27	.20
t	.12	.35	1.12	1.59	1.18

NOTE: *df* = 58

TABLE 6

Summary of trend analysis on fifth-block corrected movement speeds, candy-reward groups

Source	df	MS	F
Schedule	2	1.520	3.67*
Linear	1	.944	2.28
Quadratic	1	2.120	5.12*
Within Groups	87	.414	

*$p < .05$