A DEVELOPMENTAL ANALYSIS OF THE EFFECTS OF REWARD ON WECHSLER INTELLIGENCE TEST PERFORMANCE

BY

JAMES D. MORAN III

Bachelor of Arts
Duke University
Durham, North Carolina
1973

Master of Science
University of Oklahoma
Norman, Oklahoma
1975

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfilllment of
the requirements for
the degree of
DOCTOR OF PHILOSOPHY
July, 1978

A DEVELOPMENTAL ANALYSIS OF THE EFFECTS OF

REWARD ON WECHSLER INTELLIGENCE

TEST PERFORMANCE

Thesis Approved:

John C. McCullers
Thesis Adviser

Frances Stromberg

Robert S. Schlottmann

Marguerite Scruggs

Norman N. Durham
Dean of the Graduate College

PREFACE

This study was undertaken in an attempt to explore and understand the detrimental effects of reward. At this point in time no adequate explanatory mechanism exists for this phenomenon. A novel concept-- that reward may cause developmental regression-- is introduced and formulated in this paper. Although much of this reasoning behind this model is highly speculative, the data appear to conform to this model and thus this concept may, in the future, prove both interesting and fruitful.

The format of this dissertation deviates from the general thesis style used at Oklahoma Stae University. The purpose of this deviation style is to provide a manuscript suitable for publication as well as fulfilling the traditional thesis requirements. For the most part the style of the American Psychological Association has been used, although some blending of thesis style with APA style has been made. The cooperation of the Graduate College and Dean Norman Durham in the stylistic adaptations is greatly appreciated.

I would like to express my appreciation to Dr. John McCullers, who has served as my major adviser and friend throughout my graduate career. Dr. McCullers' advice, guidance, and support were invaluable. I would like also to take this opportunity to thank Dr. Robert Schlottmann, Dr. Marguerite Scruggs, and Dr, Frances Stromberg for their aid in serving as members of my committee.

Special thanks and appreciation should also go to the late Dr.

Elizabeth Starkweather for her inspiration and aid as a committee member during the initial phases of the study.

Many others have contributed to this project. The study was partially funded by a National Institute for Mental Health grant issued to Dr. McCullers (7-R01-MH 30570-01). A General Foods Fund Fellowship enabled me to devote more time and effort to this research during my final graduate year.

All of the school administrators and teachers were extremely helpful. I would like to express my gratitude to Robert Hale, Superintendent of Stillwater Public Schools, Ms. Barbara Bayless, Principal, Westwood School. Ms. Leone List, Director, Oklahoma State University Child Development Laboratories, and the teachers at these schools for their assistance and cooperation. Also the Oklahoma State University Psychology Department should be acknowledged for their cooperation in making the college students available. Special thanks should go to the children and college students who served as subjects in the experiment.

Nancy Houston, the second experimenter in the study, deserves a great deal of appreciation and praise for all the time and effort she contributed to the final project.

Last, but certainly not least, I would like to thank my wife, Laurette, for her love and understanding.

TABLE OF CONTENTS

LIST OF TABLES

Table Page

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

A	Arithmetic or Age in Anova
AG	Algorithmic
AH	Animal House
ANOVA	Analysis of Variance
AR	Arithmetic
BD	Block Design
BD1	Time for Block Design Trial 1
BD2	Time for Block Design Trial 2
BD3	Time for Block Design Trial 3
BD4	Time for Block Design Trial 4
BD5	Time for Block Design Trial 5
BD6	Time for Block Design Trial 6
BD7	Time for Block Design Trial 7
BD8	Time for Block Design Trial 8
BD9	Time for Block Design Trial 9
BE	Errors on Block Design
BP	Proportional time on Block Design
C	Coding
CD	Coding
CE	Errors on Coding, Digit Symbol, and Animal House
DS	Digit Dymbol

E	Experimenter
EX	Experimenter
F	Female or Factor in Anova
FD	Freedom from Distractibility
GD	Geometric Design
H	High Ability
HE	Heuristic errors
HR	Heuristic
I	Information
IN	Information
IQ	Initial ability
L	Average (lower) ability
M	Male or Mean
MTH	Age in months
NR	Nonreward
OA	Object Assembly
OE	Errors on Object Assembly and Geometric Design
PC	Picture Completion
PO	Perceptual Organization
PT	Pretest; assessment of initial ability
Q	Initial ability in Anova
R	Reward
S	Similarities or Algorithmic-Heuristic dimension in Anova
SD	Standard deviation
SE	Errors on Similarities
SM	Similarities

SX	Sex of Subject
T	Subtests in Anova or Time in Anova
TR	Treatment (i.e., reward or nonreward)
TS	Total score; sum of six target subtests
V	Vocabulary
VC	Verbal Comprehension
WAIS	Wechsler Adult Intelligence Test
WISCR	Wechsler Intelligence Test for Children--Revised
WPPSI	Wechsler Preschool and Primary Scale of Intelligence
X	Sex in Anova

A Developmental Analysis of the Effects of Reward on Wechsler Intelligence Test Performance

The detrimental effects which reward may have on performance has been demonstrated numerous times since researchers first became aware of the phenomenon (McCullers, & Martin, 1971; Miller & Estes, 1961; Spence & Dunton, 1967; Spence & Segner, 1967; Terrell, Durkin, & Wiesley, 1959). For the most part research, in this area has focused on demonstrating that such a phenomenon actually exists. Perhaps this is not surprising given psychology's and society's long history of concentrating only on the positive aspects of reward.

Several hypotheses have been put forward to account for the detrimental effects of reward. Most notably these include the intrinsic motivation suggestion of Lepper and Greene, the distraction hypothesis of Spence, and McGraw's algorithmic-heuristic model. A fourth hypothesis using a developmental regression model based on the work of Lewin and Werner has more recently been proposed. The focus of this study is to provide a test for these models through the use of selected subscales from the Wechsler Intelligence Scales.

The first model to be considered is based on research findings in which reward appears to lower intrinsic motivation for interesting activities (Lepper & Greene, 1975; Lepper, Greene, & Nisbett, 1973). The concern of these researchers has been the effect of reward on subsequent task interest. An extension of this model has been made to account for performance decrements as well (Kruglanski, Freedmen, & Zeevi, 1971). In this case which used noncontingent rewards, it was postulated that due to the decrease in intrinsic motivation resulting from the use of reward, the quality of performance was adversely affected. This model, however, appears to assume that extrinsic incentives are not sufficient to override the decrease in intrinsic motivation in order to produce a net gain in effort on the task.

The distraction model as proposed by Spence (1970, 1971) argues that reward serves to draw the subject's attention from the task and thus cause a performance decrement. As initially proposed by Spence, distraction occurred as the subject looked at and thought about an accumulating pile of rewards. This model, it appears, could also be extended to distraction stemming from the mere thought or expectation of reward.

McGraw's (in press) model suggests that for the detrimental effect of reward to occur the task must be both interesting (i.e. intrinsically motivating) and heuristic. On tasks that are either aversive or algorithmic, reward will facilitate performance. An algorithmic problem is one in which the direction to the solution is straightforward and well-known; whereas the solution to a heuristic task requires discovery and insight. McGraw suggests that reward limits the focus of the subject such that material perceptually or cognitively peripheral is no longer available thereby serving to reduce the potential usefulness of that material. This model grew out of an extensive literature review and at this point in time may be the best predictor of the effect of reward. The explanatory mechanisms underlying this predictive model are not yet fully developed, however.

A more recent notion relies on the work of Lewin (1954) and Werner (1948). The suggestion that reward may lead to developmental regression as envisioned by these two theorists has appeared in one unpublished study (Moran, McCullers, & Fabes, 1978). Regression is a concept that is utilized by a number of developmental theorists.

Werner's (1948) orthogenetic principle states that "whenever development occurs it proceeds from a state of relative globality and lack of differentiation to a state of increasing differentiation, articulation and hierarchic integration" (p. 126). Werner, in looking at perceptual organization, reports evidence for regression via tachistoscopic presentation of inkblots (see Werner, 1957, for a discussion of this work).

Lewin suggests that regression may result from sickness, frustration, insecurity, or emotional tension. Lewin (1954) also suggests that reward can operate much in the same way as these factors.

Regression may provide one explanatory mechanism for the McGraw algorithmic-heuristic model. Regression can lead to increased rigid functioning (Lewin, 1935), thereby enhancing performance on algorithmic tasks and hampering heuristic solutions, as predicted by McGraw's model. At the very early stages of development, however, the predictions are less clear. One is that young children would be similar to older (highly developed) children and adults. A second hypothesis would be that at younger levels of development, regression leads to more diffuse responses (Werner, 1957). If so, regression might hinder algorithmic responses which require direct and rote responding and be facilitative of heuristic solutions which require consideration of the total situation. Thus reward might be facilitative or detrimental for either algorithmic or heuristic tasks depending on the relative stages of developemnt.

To test these various hypotheses, the Wechsler Intelligence Scales: Wechsler Adult Intelligence Scale (WAIS), the Wechsler Intelligence Scale for Children--Revised (WISC-R), and the Wechsler Preschool and Primary Scale of Intelligence (WPPSI) were used. Because the subscales of the Wechsler scales appear to tap both algorithmic processes (rote memory and mechanical skills) and heuristic processes (discovery and insight) and because intelligence tests have long been used to assess both intellectual power or complexity of functioning and level of intellectual maturity or mental age, these tests seemed to offer a potentially useful research instrument. Moreover, factor analytic data have shown that on the WAIS (Cohen, 1957) and on the WISC-R (Kaufman, 1975) a factor labeled "freedom from distractibility" exists, which may prove relevant to the Spence hypothesis. Furthermore, the use of the intelligence scales provides an opportunity to extend the work on the detrimental effect of reward beyond traditional laboratory tasks to situations and settings closer to the everyday environment.

There has been considerble interest in recent years in the effect of reward on intelligence test performance. The results of these investigations, however, have been far from consistent. In some studies reward enhances performance (Clingman & Fowler, 1976; Edlund, 1972; Higgins & Archer, 1968; Sweet & Ringness, 1975), in others reward has had no significant effect (Clingman & Fowler, 1975; Fast, 1967; Tiber & Kennedy, 1964; Quay, 1971). In most of the cases in which a facilitating effect of reward was found the subjects were of low socioeconomic status or of low ability. It is interesting to note that this same result is found in the literature on children's learning (Terrell & Kennedy, 1957; Ward, Kogan, & Pankove, 1972). In addition, most of the studies have centered around the nature-nuture controversy and as a result take a global look at intelligence.

One interesting exception was a study conducted by Maller and Zubin (1932) which found that reward facilitated performance on "speed" tests and hampered performance on "power or analytic" tests, with no significant overall IQ differences in reward and nonreward subjects.

Previous work by the McCullers research group (Moran, McCullers, & Fabes, 1978) also has shown that although reward has no significant overall effect on performance, it may have an impact on selected subtests of the WAIS. In a previous experiment, reward significantly lowered performance on heuristic subtests (Picture Arrangement, Block Design, and Object Assembly) and had little effect on tasks labeled as algorithmic (Information, Picture Completion, and Digit Symbol). These findings were similar regardless of whether the reward was contingent, noncontingent, or involved social competition.

In this effort to investigate the effect of reward on intelligence, the nature-nuture controversy was ignored and IQ tests were used simply as a source of interesting, well-standardized, and reliable tasks. The focus was on the individual subtests and not on overall "IQ" scores. Toward this end, in this study, the Vocabulary and Picture Completion subtests were selected as initial ability indicators and six other subscales (Block Design, Similarities, Information, Arithmetic, Digit Symbol or Coding or Animal House, and Object Assembly or Geometric Design) were selected as the key target variables. The use of the Vocabulary and Picture Completion tests as indicators of initial ability stems from studies on short forms of the WAIS (Maxwell, 1957) which showed this pair to be one of the best duads in predicting Full Scale IQ scores (r = .914). Silverstein's (1967) study on the WISC short forms does not report data for this pair but based on the reported data it was anticipated that these two tests would provide an adequate, though somewhat lower, predictor of ability for elementary students as well. By equating subjects on ability via this matching procedure, any differences between reward and nonreward subjects were attributed to treatment effects.

The factor analytic work of Cohen (1957) and Kaufman (1975) suggests that the six target subtests can be classified according to three factors: verbal comprehension (I, S); perceptual organization (BD, OA); and freedom from distractibility (A, DS or C). Hollenbeck and Kaufman (1973) present factor analytic data that fail to show a freedom from distractibility factor on the WPPSI, however, but do separate the tests on verbal (I, S, A) and perceptual (BD, GD, AH) factors. This procedure provided a means to test Spence's distraction notion, or at least an extension of that model to "mental" distraction.

Based on logical analysis and pilot work, in this experiment, the subtests were further classified into those predominantly algorithmic and those predominantly heuristic. As algorithmic, the Arithmetic, Information, and Digit Symbol (or Coding or Animal House) tasks have been selected. These tasks rely on well-known skills and require the least reorganization of the task stimuli. The Block Design, Similarities and Object Assembly (or Geometric Design) tasks, on the other hand, seem to require more heuristic skills, relying on cognitive reorganization and insight. The viability of the McGraw model was assessed in this manner.

Through analysis of the performance of reward and nonreward subjects at various age levels (5, 10, 18 years) the relative strengths and weaknesses of the developmental regression model, attempting to account for the detrimental effect of reward was evaluated.

Since the focus of this study was on performance decrements due to reward the motivational models of the traditional learning theorists and the intrinsic motivation theorists were not considered.

Method

Subjects and Experimenters

The final 96 subjects used in this study included equal numbers of nursery school children from a University Laboratory School, fourth-grade public school children from Stillwater, Oklahoma, and university undergraduates. College students were selected from introductory psychology classes and received extra credit for their participation. These students averaged 18.99 years of age with a range of 18.33 to 19.83 years. Fourth-graders were taken from two classrooms preselected for comparability and cooperation by the school principal. The elementary school children ranged in age from 9.50 to 10.67 years with a mean age of 10.00. Nursery school children were chosen from three classes and had an average age of 4.90 in a range of 4.00 to 5.58 years.

The final sample was selected from an initial sample consisting of 48 adults, 46 fourth-graders, and 44 nursery school children. Of these children, equal numbers of males and females were randomly assigned to either a reward or a nonreward condition and to a male or female experimenter, with the following exceptions. All foreign students, students who had recently undergone psychometric testing, or students who were selected to receive testing in the near future were excluded. In addition, one five-year-old refused to participate.

All rewarded fourth-graders were selected from one classroom and all nonrewarded students from another classroom. At the nursery school level, in one classroom all students received reward, in a second class all were nonreward subjects, and in the third class half of the children were assigned to the reward condition and half to the nonreward condition. In the latter classroom as with the fourth-graders all nonreward subjects participated prior to any reward subjects. This procedure was followed to prevent students from entering the experiment with misconceptions as to what they would receive for participation.

At each age level, following the completion of the experimental session (consisting of an initial ability pretest and the six target subtests), subjects were matched on initial ability and age for each reward treatment x sex of subject condition. At each age level this post hoc matching procedure yielded 16 reward subjects (8 males and 8 females) and 16 nonreward subjects (8 males and 8 females) closely matched on age and initial ability. The matching procedure was not performed within the sex of experimenter variable due to restricted sample sizes. The data from unmatched subjects was not included in the analyses. These single-session procedures were used in an effort to minimize the disruption of the child's classroom day.

The experimenters were a male and a female graduate student. Both were familiar with Wechsler testing procedures prior to the initiation of the experiment, although the male experimenter was the more experienced tester.

Materials

Standard materials from the Wechsler Intelligence Scales were used in the study. Selected subscales were taken from the Wechsler Adult Intelligence Scale (WAIS) for the adult subjects, from the Wechsler Intelligence Scale for Children--Revised (WISC-R) for the fourth-graders, and from the Wechsler Preschool and Primary Scale of Intelligence (WPPSI) for the nursery school children.

At all ages the Picture Completion (PC) and Vocabulary (V) subscales were utilized to assess initial ability. The six target subtests included Information (I), Simlarities (S), Digit Symbol (DS), Block Design (BD), Arithmetic (A), and Object Assembly (OA). All tests were administered in that order to all subjects. For the nursery school children the Geometric Design (GD) subtest replaced the Object Assembly test and the Animal House (AH) scale replaced the Digit Symbol. At the elementary school level the Digit Symbol task is called Coding (C). Instructions for the administration for all subtests followed the guidelines of the Wechsler Manuals (Wechsler, 1955, 1967, 1974).

Reward procedures varied at the different age levels, although reward instructions were similar. For the college students, two dollars ($2.00) served as the incentive. Elementary school children chose one prize from among twelve alternatives including a jumprope and jacks set, a kite, a jigsaw puzzle, toy cars, a yo-yo, a mechanical puzzle, a design peg-board set, a slinky, a paint set, and books. Nursery school children chose one prize from three alternatives. Included as alternatives at various times were a bubble blowing set, books, crayons, tinker toys, coloring books, a design peg-board set, and jigsaw puzzles.

Procedure

All subjects were tested individually by either a male or female experimenter and each test session lasted approximately 40-50 minutes. The procedures varied slightly according to the age level of the students.

College students. These students were tested in either a seminar room in a classroom building or a research trailer nearby. Students were told that they would participate in two experiments of a similar nature during the test session. In the first "experiment" the Picture Completion and Vocabulary subtests of the WAIS were administered under standard instructions to assess initial ability. The student then received either standard or reward instructions for the second phase of the study. Reward subjects were told that this research was funded by a government grant and that if they "did well enough on this part" they would receive a $2.00 prize, and that they should try to do their best. No other comments about reward were made during the test session unless prompted by the subject. Nonreward subjects were told that this research was funded by a government grant and also were urged to do their best.

During the second phase all subjects received the six target subscales of the WAIS (I, S, DS, BD, A, OA). At the conclusion of the session all reward subjects received $2.00 for their participation, regardless of performance and all subjects were debriefed about the nature of the experiment and cautioned not to communicate the purpose or items on the test to anyone until the study was completed.

<u>Elementary school children</u>. Subjects at this age all participated individually in a research trailer parked on the school grounds. Students were told that the session consisted of two parts and were administered the Picture Completion and Vocabulary subscales of the WISC-R. Following completion of this first part, reward subjects were informed that for the second part if they did well enough they would receive a prize. Students were told that they would receive their prize in about two weeks when all of the tests were scored. The reward subjects were taken into a separate room in the trailer and selected one prize from among 12 alternatives. Students returned to the original room and were administered the six target subtests of the WISC-R (I, S, C, BD, A, OA). Upon completion of these scales the students were cautioned not to discuss the test with classmates.

Following the pretest students in the nonreward group were told to try their best on the second part and administered the six WISC-R subtests with standard instructions. At the conclusion of testing for all of these children, the selected prizes were given to each child in the reward group. In addition, prizes for participation were given to those children in the nonreward group to avoid ill-feelings or jealousy on the part of the children.

Nursery school children. The nursery school children were tested in a room adjacent to their classroom. Each of the examiners spent time in the classroom prior to testing so that the children would be familiar with the experimenters. These subjects were also told that the session consisted of two parts and for the first part were administered the Picture Completion and Vocabulary subtests of the WPPSI. Reward subjects at this age level were informed that if they did well enough on the second part they would receive a prize. Three prizes were presented to the child and the child selected one of these prizes which he or she would like to have. The three prizes presented to the child were arbitrarily taken from the total group of seven possible prizes. Children were told that if they did well enough they would receive their prize in a week, after all the tests were scored. The prizes were then put aside out of the direct line of sight of the child.

Nonreward subjects were simply urged to try to do their best on the second part of the session. All subjects for the second part received the six target subscales from the WPPSI (I, S, AH, BD, A, GD).

In the reward classroom all children received their prize two days following the administration of the tasks to all of the children. In the classroom in which half of the children were reward subjects and half were nonreward subjects, the following procedure was used. All of the nonreward subjects were tested first. Upon completion of the testing of these children, they were brought back to the experimental room and told that if they did well enough on the tasks they would get a prize and that they could choose the prize they wished to have. Only after this procedure was carried out individually for each nonreward subject did the testing of the reward subjects begin. At the end of each individual session the child was cautioned against communication. All of the children in this classroom received the selected prize one day following the testing of the final reward subject.

Due to the length of the session (40-50 minutes) certain special procedures were necessary at this age level. The Wechsler (1967) manual for the WPPSI notes that sometimes children in the normative sample would not sit through the entire test and that standardization procedures took this into account. With some of the preschool children in this experiment, the session had to be halted and continued the next day, others continued after a short (approximately 15 minutes) break. One child refused to continue testing. These breaks in the testing session occurred with approximately equal frequency in the reward and nonreward groups (3 and 4 respectively). With other children the order of the subtests was varied in an effort to maintain interest. This procedure also occurred with about equal frequency in the reward and nonreward conditions. It is felt that since these procedural variations are recognized as appropriate by the Wechsler manual, they would not invalidate the child's performance in this study.

Results and Discussion

Matching Procedures

The matching procedures yielded reward and nonreward groups that were very comparable within each age level. The mean scores of the male and female reward subjects and the male and female nonreward subjects were less than two scaled score points from each other at each age level. The four mean scores ranged from 24.25 to 24.75, 21.63 to 23.00, and 20.88 to 21.62 for the nursery, elementary, and college students respectively.

Subjects were also matched for age at each level. This matching procedure also proved successful for male and female, reward and nonreward groups. Mean ages for the four nursery school groups ranged from 4.80 to 4.99; at the elementary level the range was from 9.84 to 10.12; and mean college ages ranged from 18.77 to 19.14 years.

Analyses of variance revealed no significant reward/nonreward or sex differences in pretest scores or ages. Two cases of reward x experimenter interactions appeared; one on pretest matching for nursery school students, $\underline{p} < .05$, and the other on college student ages, $\underline{p} < .05$. In each case scores for the female experimenter were higher than scores for the male experimenter in the reward group, whereas little differences were found in the nonreward group. Subjects were matched within each age level for the reward and sex variables and not on the experimenter variable, perhaps accounting for these interactions.

Assessment of Initial Ability

The Vocabulary and Picture Completion subtests were revealed by analyses to be adequate predictors of overall performance, especially at the two older age levels. The overall correlation of the summed pretest scores (sum of the scaled scores for V and PC) with the total score (sum of the scaled scores for the six target subscales) was significant, $r = .45$, $p < .0001$. The administration of reward appears to profoundly alter the correlation between the pretests and some of the subtests. At each age level, the correlation between pretests and total score was lower in the reward than in the nonreward group. The respective correlations for nonreward and reward groups were .69 and .54 for adults; .75 and .51 for fourth-graders; and .38 and .11 for young children.

The correlations between pretests and the algorithmic and freedom from distractibility tests appeared to be most affected by reward. For the algorithmic tasks (A, I, DS or C or AH), the correlation with the pretest was highly significant in the nonreward group, $r = .63$, $p < .0001$, but nearly nonexistent in the reward group, $r = .14$. The same was true for the freedom from distractibility (A, DS or C or AH) and pretest correlation; with the nonreward group correlation, $r = .63$, $p < .0001$, much higher than the correlation in the reward group, $r = -.02$. These large downward trends occurred in all three age levels.

These correlational data suggest that the administration of reward does have a major impact on performance. The intercorrelations between subtests were severely disrupted with the promise of reward.

<u>Assessment of Reward Effects</u>

Repeated measures analyses of variance revealed reward to have had differential effects on the various subtests at the three different age levels. An age x reward x subtest interaction appeared when the subscales were grouped on the algorithmic-heuristic dimension, $F(2,72) = 6.71$, $p < .002$, by factor, $F(4,144) = 3.40$, $p < .01$, and by individual subtest, $F(10,360) = 1.89$, $p < .05$. Figures 1, 2, and 3 indicate the mean scaled scores on the six subtests for the adults, elementary school students, and nursery school children respectively.

Insert Figures 1, 2, and 3 about here

At the elementary school level reward did not significantly alter subtest scores. At the nursery school level and with college students significant reward effects were present, but in opposite directions.

In college students a significant reward x subtest interaction existed with the tests grouped on the algorithmic-heuristic dimension, $F(1,24) = 11.87$, $p < .002$, by factor, $F(2,48) = 4.88$, $p < .01$, and individually, $F(5,120) = 2.73$, $p < .05$. Reward at this age significantly hinders performance on heuristic tasks as revealed by Tukey tests, $q(2,30) = 3.51$, $p < .05$. Reward also appeared to facilitate performance on the algorithmic tasks, although this difference was not statistically significant (see Table 1). The data on the factor scores indicated that reward produced a decrement on perceptual organization tasks, $q(2,30) = 4.62$, $p < .01$, appeared to facilitate performance on the freedom from distractibility measures, $q(2,30) = 2.59$, $p < .10$, but had little effect on the verbal comprehension tasks. Reward affected both perceptual tasks about equally, leading to lower performance on both the Object Assembly, q(2,30) = 4.63, $p < .01$, and the Block Design, $q(2,30) = 4.61$, $p < .01$; whereas, the most significant facilitation occurred on the Arithmetic subtest, $q(2,30) = 4.05$, $p < .01$.

Insert Table 1 about here

The performance decrements in the heuristic tasks were more a function of increased numbers of errors than time spent on the problems. Analyses of times to completion on the Block Design subtest revealed no significant differences between reward and nonreward groups. In the repeated measures analyses, any trial that was terminated due to time or any trial which was not attempted due to discontinuation criteria at the subtest level was given the maximum time allotted for that trial. A second time measure was also taken. This measure utilized only the Block Design trials which were attempted and measured the proportion of time used by the subject to the total time allotted for each trial. On this measure analyses also revealed no differences due to reward.

There was, however, a significant difference in the numbers of errors made by rewarded and nonrewarded adults on the heuristic tasks, $F(1,24) = 4.26$, $p < .05$. Reward subjects made significantly more errors on the heuristic tasks, especially on the Block Design, $q(2,30) = 3.51$, $p < .05$, and Similarities, $q(2,30) = 2.70$, $p < .10$. The addition of the Digit Symbol test to the analyses yields the suggestion of a reward x subtest interaction, $F(1,24) = 3.77$, $p < .07$. On the Digit Symbol subtest the reward subjects made significantly fewer errors than nonrewarded subjects, $q(2,30) = 2.96$, $p < .05$.

The data for the adults appeared to be consistent with McGraw's prediction of the selective effect of reward. On tasks which were labeled algorithmic reward facilitated performance (especially on the Arithmetic task) and on tasks classified as heuristic reward led to performance decrements (especially on tasks involving perceptual organization).

The data were also consistent with the predictions stemming from the developmental regression hypothesis. Given that the subjects were matched initially on age, sex, and ability, any decline in scores on these IQ subtests could be interpreted as a decline in intellectual maturity or level of functioning. On the heuristic tasks the decline was not a result of differences in time spent on the items by reward and nonreward subjects but in differences in the numbers of errors these subjects made. If the error differences had resulted from the errors being scattered randomly between and within subscales, it could have been as easily argued that reward produces a general disruption of functioning, rather than a developmental regression. On the contrary, however, errors under reward tended to occur predominantly in the heuristic tasks, requiring greater cognitive ability, and predominantly toward the end of those subscales, requiring the higher level of cognitive functioning. These results give support to the idea that reward may produce some degree of developmental regression.

The distraction hypothesis as proposed by Spence would appear to have some difficulty in accounting for the reward facilitation on the Arithmetic task found in these middle-class subjects.

In the nursery school children the effect of reward on the algorithmic and heuristic tasks was reversed. A significant interaction between reward and type of task was also present, $F(1,24) = 5.45$,

$\underline{p} < .03$, but the means indicate that reward facilitated heuristic performance and hampered performance on the algorithmic tasks (see Table 1). Tukey comparisons of individual subtests indicated that the greatest reward facilitation occurred on the Block Design, $\underline{q}(2,30) = 3.33$, $\underline{p} < .05$, and the greatest detrimental effect occurred on the Animal House subtest, $\underline{q}(2,30) = 3.01$, $\underline{p} < .05$.

At this age, as in the adults no time differences or proportional time differences on the Block Design tests were found. The differences in scaled scores appear to be a function of the numbers of errors. In an analysis of the Animal House errors and the heuristic errors the suggestion of a reward x subtest interaction is present, $\underline{F}(1,24) = 3.81$, $\underline{p} < .07$. For these children, the reward subjects made more errors on the Animal House than the nonrewarded children but fewer errors on the heuristic tasks, especially on the Block Design subtest, $\underline{q}(2,30) = 2.50$, $\underline{p} < .10$.

A number of explanations can be put forward to account for the discrepancies in performance between adults and children. One obvious explanation is that these tasks were mislabeled as algorithmic and heuristic at one age level. There are distinct differences in the various subscales for these age groups, especially on the Animal House, Block Design, and Geometric Design subtests. The Animal House task differs in that errors are much less frequent than on the Digit Symbol and the task is more manipulative. Although the task is supposed to be completed sequentially, it was informally observed that more rewarded children approached the task in a haphazard fashion (which does not necessarily lead to incorrect solutions).

This might indicate some general disruption at this age.

The perceptual subscales are distinctly different on the WAIS and WPPSI. The Block Design on the WPPSI involves many more demonstrated trials and thus may also involve modeling abilities. The Geometric Design test which requires copying skills is not found at the older ages. Furthermore, it may be possible that tasks that draw on certain skills at one age level do not necessarily rely on those same skills at different stages of developemnt. The factor analytic data on the WPPSI failed to find a distractibility factor and on this Wechsler scale the Arithmetic subtest appeared to load equally on performance and verbal factors (Hollenbeck & Kaufman, 1973). Certainly all of the subscale tasks involve components of both algorithmic and heuristic skills and the distinction between subtests in this experiemnt on this dimension is between what are thought to be predominantly algorithmic and predominantly heuristic tasks.

This explanation based on mere mislabeling of the tasks, however, does not seem adequate to deal with all of the data. The McGraw model, however,can only apply if such is the case. Spence's distraction notion would not predict a developmental change nor would it predict the facilitation found in the rewarded nursery schoolers.

A number of procedural differences also existed between the different age groups such as the interval between the testing and the delivery of the rewards. Some previous research (Moran, McCullers, & Fabes, 1978) suggests that subjects promised reward under a variety of procedures performed similarly regardless of the procedures used, thus reducing the possibility that the results are only a function of procedural variations.

The data are consistent with the suggestion that reward leads to regression, which means that at younger ages reward leads to more diffuse responding. It was suggested that diffuse responding might hinder algorithmic solutions and favor heuristic problem-solving. The effect of regression may be a function of the stage of development. Development, as envisioned here, is progressing from diffuse to differentiated, and from rigid to flexible with some organization and integration occurring with each progression. This notion appears to be consistent with the data for the college students and nursery schoolers and suggests that the elementary school children (for whom no significant reward effects were found on the subtests) might be in transition from one type of functioning to another.

The Importance of Initial Ability

One difference that clearly existed between the young children and the students at the older age levels in this study was in the initial ability of the group. All of the nursery schoolers were of high ability, which is not surprising given the subject population, and subjects at the other ages levels reflect both high and medium abilities. The pretest mean for the young children was higher than the means at the other two age levels (24.47 vs. 22.40 and 21.12 for the 5-year-olds, 10-year-olds, and 18-year-olds respectively). It was thought that the initial ability of the subject might be a crucial determinant of the effect of reward and subsequent analyses showed this to be the case.

Subjects at each age level were separated into higher and lower ability groups, via a median split within each age x reward x sex of subject x experimenter condition. Some overlap occurred in the higher and lower ability groupings but sex of subject and experimenter remained controlled. Analysis of the pretest scores showed that this type of division resulted in two significantly different subject populations at each age level ($F(1,30) = 26.87$, $p < .001$, $F(1,30) = 44.22$, $p < .001$, $F(1.30) = 23.10$, $p < .001$, for the adults, fourth-graders, and nursery school pupils respectively). For the adults this resulted in a medium ability and a high ability group (means of 19.94 and 22.31 respectively). For the fourth-graders, an average and a high ability group also were formed with pretest means of 20.25 and 24.56. With five-year-olds, however, both groups were of high ability (means of 22.31 and 26.62).

A repeated measures analysis of variance at the nursery school level revealed no significant effect due to initial ability on subscale performance. This appeared to be the result of the fact that all of the children were above average and some discrimination was lost. It was only in the two older age levels that the subjects in the high ability group performed significantly better than the subjects in the lower ability group, $F(1,28) = 8.09$, $p < .01$ for the adults and $F(1,28) = 5.44$, $p < .03$ for the fourth-graders. As a result of these analyses the elementary students and adults were classified into high ability and average ability groups. Failure to find significant performance differences in the nursery school children following the median split was seen as justification for grouping all of these children into a single high ability group. In the two older age levels, initial ability seemed to be an important variable (see Table 2).

Insert Table 2 about here

Analysis of the elementary school data revealed a significant subtest x reward x ability interaction on the algorithmic-heuristic dimension, $F(1,28) = 4.47$, $p < .05$. From the mean data presented in Table 2, it can be seen that reward had little effect in the average ability subjects and in the high ability subjects on the heuristic tasks. On the algorithmic tasks, however, reward produced a performance decrement in the high ability students. This performance decrement is consistent with the findings for the nursery schoolers and college students. No significant ability x reward interactions were found in the ten-year-olds in the comparisons of individual subtests and scales grouped by factor.

Analysis of the college data for the algorithmic and heuristic dimension in the college students revealed a significant reward x ability interaction, $F(1,28) = 4.50$, $p < .05$, and a nearly significant subtest x reward x ability interaction, $F(1,28) = 4.05$, $p < .06$. Table 2 displays these interactions clearly. High ability subjects showed a decrement due to reward on the algorithmic tasks but an even larger performance decrement on the heuristic subscales, $q(4,28) = 3.82$, $p < .10$. Average ability adults, on the other hand, displayed only a slight and nonsignificant decrement on the heuristic tasks and a significant reward facilitation on the algorithmic tests, $q(4,28) = 4.88$, $p < .01$. Analyses of the factor and individual subscale data further reveal that in the high ability college students a significant performance decrement in the reward group occurred on the perceptual organization factor, $q(4,28) = 4.93$, $p < .01$, and on the Block Design subtest, $q(4,28) = 4.27$, $p < .05$. In addition, a significant performance increment in the average ability reward subjects occurred on the freedom from distractibility subtests, $q(4,28) = 6.68$, $p < .01$, and on the Arithmetic subtest, $q(4,28) = 6.52$, $p < .01$. On this latter test the mean difference between the reward and nonreward lower ability subjects was 3.63 scaled score points and the performance of the medium ability reward subjects was nearly one point higher than that of the high ability nonreward students, and more than 1.5 points higher than the performance of the high ability reward subjects.

The data appear to indicate that for average ability subjects, reward may lead to a slight decrease in performance on the heuristic tasks at all age levels. On the algorithmic tasks no significant reward effects were found for average ability fourth-graders but reward led to significant facilitation in the average ability adults.

In high ability subjects reward leads to a performance decrement on the algorithmic tasks at all age levels. With high ability subjects, the administration of reward on heuristic tasks resulted in facilitation of performance in the young child, had no effect in fourth-graders, and impaired performance in adults.

Within the context of the McGraw model these results can only partially be explained. In general, the classification of tasks as algorithmic and heuristic would need to be restructured. All of the tasks at the adult level need to be classified as heuristic. The algorithmic tests for high ability students would also be seen as attractive (a combination which would predict a detrimental effect of reward) but for average ability adults these tasks, especially the Arithmetic test, would be seen as aversive, thereby resulting in facilitation under reward. This model would need to relabel the task at each age level to properly account for the data. Perhaps the skill requirements for classification as an algorithmic or heuristic task need to be clarified in this model so that mislabeling of tasks would not occur.

These data might be incorporated perhaps more easily into a developmental regression model, although this post hoc reasoning is highly speculative. If development proceeds from diffuse to differentiated, from rigid to flexible, and toward hierarchic integration and organization, the more mature individual should respond with more flexibility and stability. It might be hypothesized that at any age level, high ability individuals possess a greater "maturity" than average ability individuals. Any developmental regression in high ability individuals would lead to greater disruption in cognitive organization and so to greater performance decrements, than in lower ability individuals.

It might also be hypothesized that regression in young children leads more to diffuse responding that facilitates heuristic tasks but produces a detrimental effect on algorithmic tasks. For high ability adults (highly developed organisms) any regression would promote a breakdown in cognitive organization and thus be detrimental on most types of tasks. With lower ability adults, however, without highly developed integration, regression may foster more rigid functioning and thus be facilitative on algorithmic tasks but hamper heuristic problem-solving. The situation for the intermediate developmental level of fourth-graders is more complex. Perhaps some of these children may be functioning in a manner similar to younger children under some conditions but similar to adults under others. Nonetheless, high ability older children would still be expected to show some disruption in integration, and thus regression due to reward should be detrimental. It is possible that since algorithmic functioning is of a lower order, than heuristic reasoning, that organization of these skills would precede heuristic organization. Depending on the age of the children, both higher and lower ability children would be expected to operate in a rigid fashion under regression. If so, this should increase their ability to solve algorithmic problems but hamper heuristic problem-solving capacities.

With a few exceptions, mostly in the elementary students, the data presented here for reward and nonreward, high and average ability students would fit this regression model. These hypotheses present only the beginnings of a more comprehensive model to explore the notion that reward may cause developmental regression.

<u>Sex of Subject and Experimenter Effects</u>

In this study, the aim was to observe the effect of reward with sex of subject and experimenter differences serving as control variables. Some significant differences on these variables were found and these will be presented briefly without much elaboration.

At the nursery school level a significant sex of subject effect was found, $F(1,24) = 6.31$, $p < .02$, with females scoring higher than males on all of the subtests. With all age levels in the analysis, this same trend was evident, $F(1,72) = 3.83$, $p < .06$. The subtest for which this sex difference was most pronounced was the Digit Symbol (Coding, Animal House) task, $q(2,94)$, $p < .01$. The specific comparisons also indicated a significant sex x subtest interaction with the adults, $F(5,120) = 4.90$, $p < .001$. Adult sex differences were most pronounced on the Digit Symbol task on which females performed better, $q(2,30) = 4.69$, $p < .01$, and on the Arithmetic subscale on which males outperformed females, $q(2,30) = 2.78$, $p < .10$. No significant reward x sex interactions were found in the analyses of subscale scores.

Experimenter effects are somewhat difficult to interpret due to a confounding of sex of experimenter with individual examiner effects. In addition, in the complete age x reward x sex of subject x experimenter design (3 x 2 x 2 x 2) there were only four subjects per cell and these were not matched within the experimenter variable.

Overall a significant effect was found, $F(1,72) = 5.83$, $p < .02$, and this effect was most pronounced at the nursery school level, $F(1,24) = 4.49$, $p < .05$. Subjects tested by the female experimenter scored higher overall than subjects tested by the male examiner. A reward x experimenter interaction also was found in the nursery school data, $F(1,24) = 5.18$, $p < .04$. This most likely was due to a significant reward x experimenter pretest difference for this group, $F(1,24) = 6.52$, $p < .02$. In this interaction, the facilitation caused by reward on the heuristic tasks came mostly from subjects tested by the female experimenter and the detrimental effect on the algorithmic tasks was predominantly a function of subjects tested by the male experimenter.

Overall these results are somewhat consistent with the findings of other researchers. Some studies have shown that young children perform better on the WISC with female examiners (Bradbury, Wright, Walker, & Ross, 1975; Quereschi, 1968). These findings might be extended to the findings in this study with the WPPSI. In addition, Quereschi (1968) found that females scored higher than males on the Coding task which also coincides with the present findings. The finding by Bradbury, et al., (1975) that males consistently scored higher than females, on the other hand, would not be consistent with the findings here.

Conclusions and Implications

This study provided further evidence that reward, offered in relatively paltry amounts, can have a detrimental effect on intellectual functioning. No significant effects of reward were found on overall intellectual performance but finer analyses revealed reward's complex impact. On tasks that were identified as "algorithmic", reward resulted in lowered performance among high ability students at all age levels (5-, 10-, and 18-year olds). Average ability adults, however, who received reward performed better on these tasks than nonrewarded subjects. On "heuristic" tasks, reward had a detrimental effect on the performance of college students, little effect on fourth-graders, and facilitated the performance of nursery school children.

The discovery of a detrimental effect of reward on intelligence tests is noteworthy. Some (e.g., O'Conner & Weiss, 1974) have argued that the use of extrinsic incentives is one way to equalize motivational differences in the assessment of intelligence. This argument, however, would appear to have some serious weaknesses. The use of rewards, first of all, would appear to alter the validity of the test, and also this position attributes only motivational properties to extrinsic reward.

The notion that reward may also cause developmental regression was explored in this paper. Although this hypothesis has been suggested before (Lewin, 1954), it has not enjoyed much scientific acceptance or empirical support and the idea runs counter to the concept of reward prevalent in today's society. Why reward should produce regression is still an open question. Perhaps it is bound up in some way with evolutionary survival.

The search for an explanatory mechanism for the detrimental effect of reward needs to continue. The parameters of reward need serious evaluation and attention to the circumstances in which rewards and extrinsic incentives lead to lower quality performances should be of interest to us all and especially to educators. The developmental regression model, coupled with the McGraw algorithmic-heuristic model, would appear to serve as a good starting point for the search for an explanatory mechanism.

References

Bradbury, P. J., Wright, S. D., Walker, C. E., & Ross, J. M. Performance on the WISC as a function of sex of E, sex of S, and age of S. Journal of Psychology, 1975, 90, 51-55.

Clingman, J., & Fowler, R. The effects of contingent and noncontingent reinforcement on the I.Q. scores of children of above-average intelligence. Journal of Applied Behvavior Analysis, 1975, 8, 90.

Clingman, J., & Fowler, R. The effects of primaary reward on the I.Q. performance of grade-school chldren as a function of initial I.Q. level. Journal of Applied Behavior Analysis, 1976, 9, 19-23.

Cohen, J. The factorial structure of the WAIS between early adulthood and old age. Journal of Consulting Psychology, 1957, 21, 283-290.

Edlund, C. V. The effect of the behavior of children, as reflected in the IQ scores, when reinforced after each correct response. Journal of Applied Behavior Analysis, 1972, 5, 317-319.

Fast, R. E. The effects of verbal and monetary reward on the individual intelligence test performance of children with differing socio-economic status. Unpublished doctoral dissertation, Rutgers--The State University, 1967.

Higgins, M. T., & Archer, N. S. Interaction effect of extrinsic rewards and socioeconomic strata. Personnel and Guidance, 1968/9, 47, 318-323.

Hollenbeck, G. P., & Kaufman, A. S. Factor analysis of the Wechsler Preschool and Primary Scale of Intelligence (WPPSI). Journal of Clinical Psychology, 1973, 29, 41-45.

Kaufman, A. S. Factor analysis of the WISC-R at 11 age levels between 6 1/2 and 16 1/2 years. Journal of Consulting and Clinical Psychology, 1975, 43, 135-147.

Kruglanski, A. W., Friedman I., & Zeevi, G. The effects of extrinsic incentive on some qualitative aspects of task performance. Journal of Personality, 1971, 39, 606-607.

Lepper, M. R., & Greene, D. Turning play into work: Effects of adult surveillance and extrinsic rewards on children's intrinsic motivation. Journal of Personality and Social Psychology, 1975, 31, 744-750.

Lepper, M. R., Greene, D., & Nisbett, R. R. Undermining children's intrinsic motivation with extrinsic rewards: A test of the overjustification hypothesis. Journal of Personality and Social Psychology, 1973, 28, 128-137.

Lewin, K. A Dynamic Theory of Personality: Selected Papers by Kurt Lewin. (Trans. by D. K. Adams & K. E. Zener). New York: McGraw-Hill, 1935.

Lewin, K. Behavior and development as a function of the total situation. In L. Carmichael (Ed.), Manual of Child Pyschology. New York: Wiley, 1954.

Maller, J. B., & Zubin, J. The effect of motivation upon intelligence test scores. Journal of Genetic Psychology, 1932, 41, 136-151.

Maxwell, E. Validities of abbreviated WAIS scales. Journal of Consulting Psychology, 1957, 21, 121-126.

McCullers, J. C. & Martin, J. A. G. A reexamination of the role of incentives in children's discrimination learning. *Child Development*, 1971, *42*, 827-837.

McGraw, K. O. The detrimental effects of reward on performance: A literature review and a predictive model. In M. R. Lepper & D. Greene (Eds.), *The hidden costs of reward*. Hillsdale, N.J.: Laurence Erlbaum Associates, in press.

Miller, L. B., & Estes, B. W. Monetary reward and motivation in discrimination learning. *Journal of Experimental Psychology*, 1961, *61*, 501-504.

Moran, J. D., III, McCullers, J. C., & Fabes, R. A. Effects of reward on WAIS subscale performance. In J. C. McCullers (Chair), *Detrimental effect of reward and the cognitive processes*. Symposium presented at the meeting of the Southwestern Psychological Association, New Orleans, 1978.

O'Conner, J. J., & Weiss, F. L. A brief discussion of the efficacy of raising standardized test scores by contingent reinforcement. *Journal of Applied Behavior Analysis*, 1974, *7*, 351-352.

Quay, L. C. Language dialect, reinforcement, and the intelligence test performance of Negro children. *Child Development*, 1971, *42*, 5-15.

Quereschi, M. Y. Intelligence test scores as a function of sex of experimenter and sex of subject. *Journal of Psychology*, 1968, *90*, 277-284.

Silverstein, A. B. Validity of WISC short forms at three age levels. *Journal of Consulting Psychology*, 1967, *31*, 635-636.

Spence, J. T. The distracting effect of material reinforcers in the discrimination learning of lower- and middle-class chilren. Child Development, 1970, 41, 103-111.

Spence, J. T. Do material rewards enhance the performance of lower-class children?. Child Development, 1971, 42, 1461-1470.

Spence, J. T., & Dunton, M. C. The influence of verbal and nonverbal reinforcement combinations in the discrimination learning of middle- and lower-class preschool children. Child Development, 1967, 38, 1177-1186.

Spence, J. T., & Segner, L. L. Verbal versus nonverbal reinforcement combinations in the discrimination of middle- and lower-class children. Child Development, 1967, 38, 29-38.

Sweet, R. C., & Ringness, T. A. Variations in the intelligence test performance of referred boys of differing racial and socio-economic bakgrounds as a function of feedback or monetary reinforcement. Journal of School Psychology, 1971, 9, 399-409.

Terrell, G., Jr., Durkin, K., & Wiesley, M. Social class and the nature of incentives in discrimination learning. Journal of Abnormal and Social Psychology, 1959, 59, 270-272.

Terrell, G., Jr., & Kennedy, W. A. Discrimination learning and transposition in children as a function of the nature of the reward. Journal of Experimental Psychology, 1957, 53, 257-260.

Tiber, N., & Kennedy, W. A. The effects of incentives on the intelligence test performance of different social groups. Journal of Consulting Psychology, 1964, 28, 187.

Ward, W. C., Kogan, N., & Pankove, E. Incentive effects in children's creativity. Child Development, 1972, 43, 669-676.

Wechsler, D. Manual for the Wechsler Adult Intelligence Scale. New York: Psychological Corporation, 1955.

Wechsler, D. Manual for the Wechsler Preschool and Primary Scale of Intelligence. New York: Psychological Corporation, 1967.

Wechsler, D. Manual for the Wechsler Intelligence Scale for Children--Revised. New York: Psychological Corporation, 1974.

Werner, H. Comparative psychology of mental development (rev. ed.). Chicago: Follett, 1948.

Werner, H. The concept of development from a comparative and organismic point of view. In D. B. Harris (Ed.), The concept of development. Minneapolis: University of Minnesota Press, 1957.

Table 1

Mean Algorithmic-Heuristic Scores for Rewarded and Nonrewarded Students

Group	Algorithmic	Heuristic
College		
Nonreward	33.00	36.25
Reward	34.69	32.69
Elementary		
Nonreward	32.81	34.81
Reward	30.94	34.00
Nursery		
Nonreward	37.88	33.62
Reward	35.94	35.81

Table 2

Mean Algorithmic-Heuristic Scores for
Rewarded and Nonrewarded Students
of High and Average Ability

Group	Algorithmic	Heuristic
High Ability		
College		
Nonreward	36.25	38.25
Reward	33.88	33.75
Elementary		
Nonreward	35.25	37.62
Reward	30.88	38.38
Nursery		
Nonreward	37.88	33.62
Reward	35.94	35.81
Average Ability		
College		
Nonreward	29.75	34.25
Reward	35.50	31.62
Elementary		
Nonreward	30.38	32.00
Reward	30.25	29.50

Figure Captions

Figure 1. Mean scaled scores on individual subtests for rewarded and nonrewarded adults.

Figure 2. Mean scaled scores on individual subtests for rewarded and nonrewarded fourth-graders.

Figure 3. Mean scaled scores on individual subtests for rewarded and nonrewarded nursery school children.

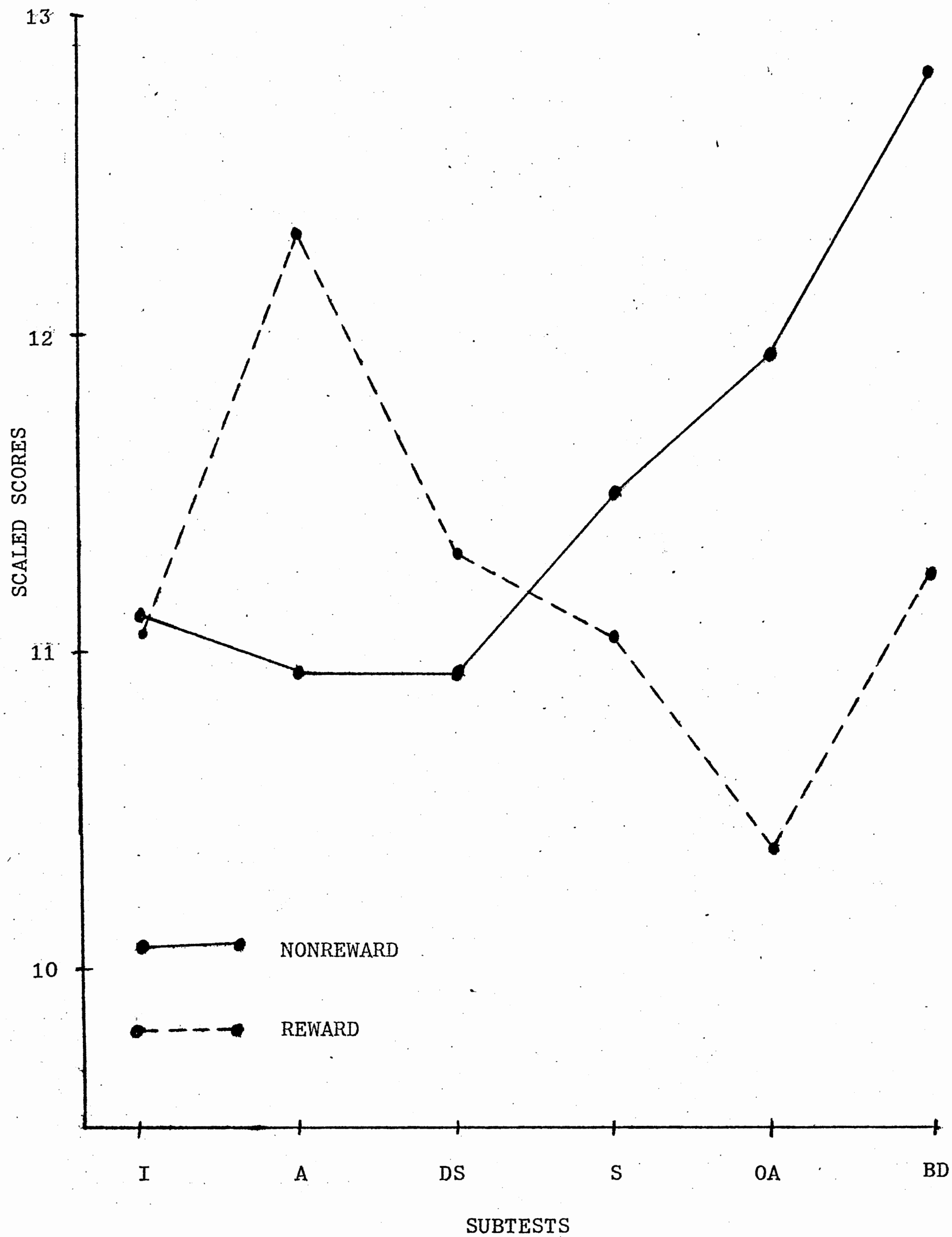
13
12
11
10
SCALED SCORES
NONREWARD
REWARD
I
A
DS
S
OA
BD
SUBTESTS

Figure 1.

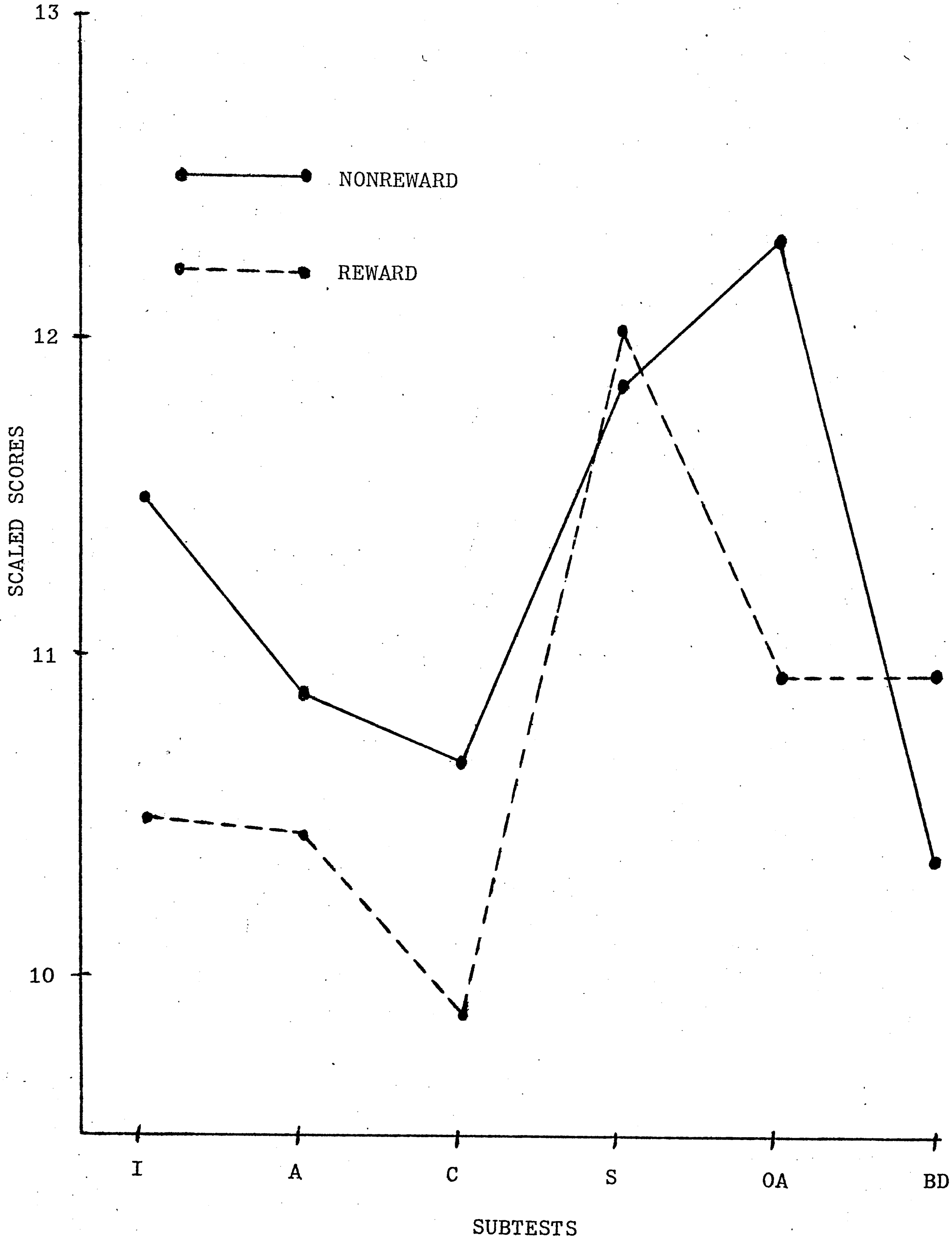
13
12
11
10
SCALED SCORES
NONREWARD
REWARD
I
A
C
S
OA
BD
SUBTESTS

Figure 2.

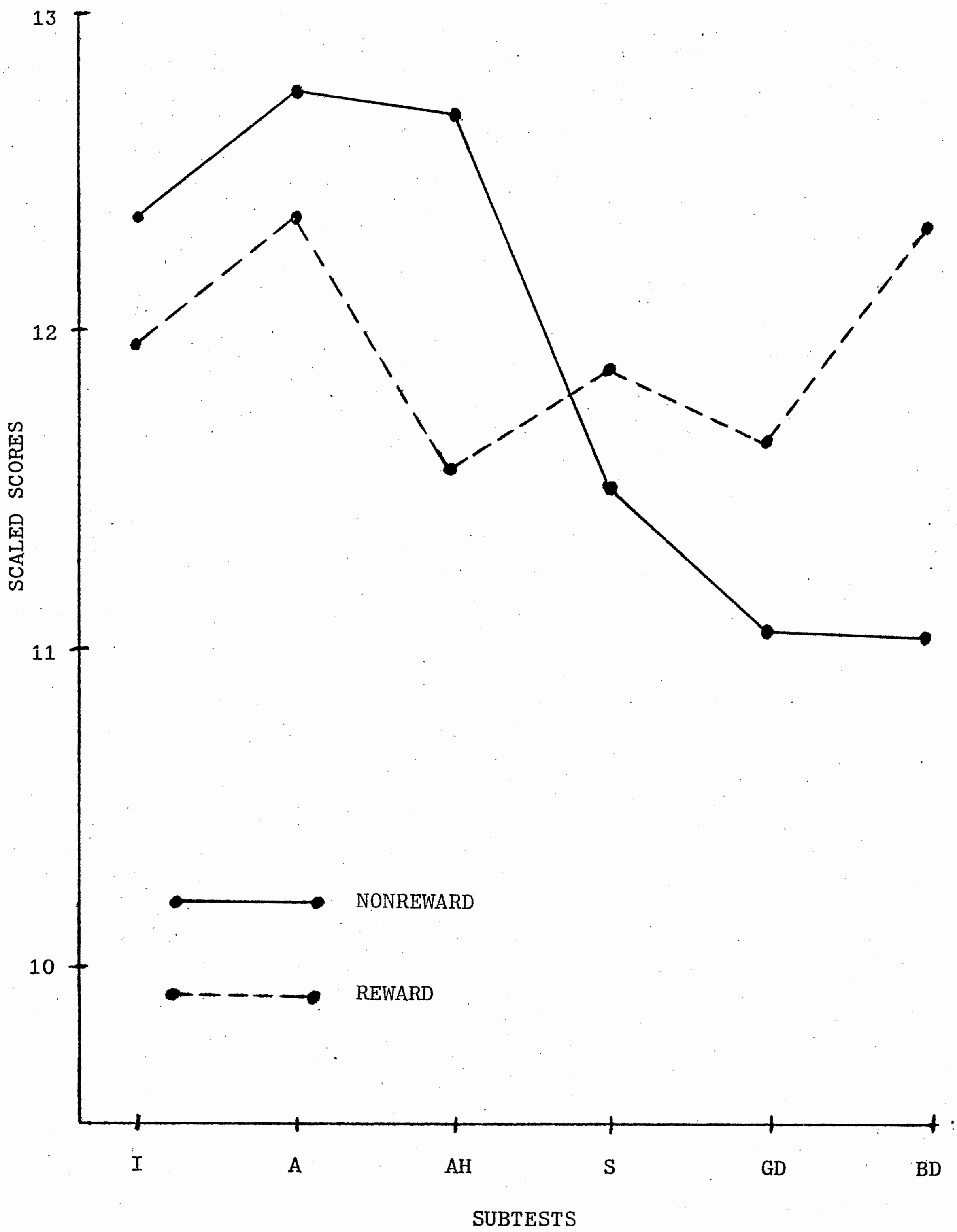
13
12
11
10
SCALED SCORES
NONREWARD
REWARD
I
A
AH
S
GD
BD
SUBTESTS

Figure 3.

APPENDIX A

LITERATURE REVIEW

This review will center on two major areas: the consideration of IQ test administration under incentive conditions and theoretical models attempting to account for the detrimental effects of reward. The present study appears to offer significant contributions to both these research areas.

IQ Test Administration Under Incentive Conditions

Introduction

Intelligence testing has stirred a great deal of controversy in recent years. Questioning the concept of "IQ", psychologists and educators have focused on problems ranging from the very nature of intelligence to factors within the testing setting. One view proposes that the IQ score is subject to a variety of situational influences and thus in any one test setting the score may not accurately reflect the examinee's true ability. One extremist position suggests that intelligence is such a nebulous entity that it cannot adequately be assessed. IQ testing is conceived of as inaccurate and even dangerous by proponents of this position.

Such an extreme judgment, however, is not typical. A more temperate position concludes that the IQ test does not accurately measure ability in all situations. This position does not deny the concept of intelligence nor does it deny that the intelligence test can tap that ability. Rather, this position holds that for many subjects the abilities assessed by testing are not equivalent to the full range or capacities of abilities of the individual. Associated with this position is the belief that through manipulation of the various situational factors surrounding intelligence testing the "true" intellectual capacities of the individual may be uncovered. Although these are but two of the many positions and viewpoints that have emerged from consideration of intelligence tests, they offer a point of reference for discussing the effects of rewards in intelligence testing.

The majority of the research that has used incentives with mental testing has, in one way or another, been concerned with possible motivational differences between socioeconomic or racial groups. The interest in these specific groups of subjects stems from studies which show significant differences between these groups and the test norms and/or society at large (see Jensen, 1969). The basic premise behind much of this research is that IQ scores can be raised through the use of incentives. This notion is consistent with the more temperate position outlined above. It can be reasoned, for example, that an observed difference in scores between children from differing socioeconomic strata is but an artifact of the test materials or situational variables within the test setting. Those who subscribe to this view assume generally equal intellectual capacities in all people and attribute observed intellectual differences to differences in motivation or similar variables. Thus, if one equalized motivational levels, group differences in test scores would disappear.

Testing Considerations

Before consideration of the research findings relevant to this question, it may help to explore some reasons why the issue of test alteration is so important.

Intelligence testing generally requires standardized administration. Test manuals warn the examiner that to stray from the standard instructions brings the validity of the test into question. The very first sentence in the chapter entitled "General Testing Considerations" in the WAIS Manual reads: "The administration ... should conform carefully to the directions in this Manual" (Wechsler, 1955, p. 26). Furthermore, Wechsler states that "the procedures described here were designed to yield an accurate estimate of mental ability, were thoroughly pretested in the development of the sclae and ... valid results from the use of the WAIS depend at least in part on adherence to the established directions" (p. 26). Terman and Merrill (1972) likewise begin the Stanford-Binet Manual by stating that, "it cannot be too strongly emphasized that unless standard procedures are followed the tests lose their significance.... Results are valid for the specific established normative conditions and not otherwise" (p. 47).

Two crucial issues emerge from these statements. First, a large number of psychologists, especially those who adhere to the motivational deficit model of test performance, would take issue with Wechsler's proposal that his procedures "yield an accurate estimate of mental ability". The major argument of this group is in fact just the oppposite: due to problems in motivation, the standard procedures do not reflect the true mental ability of a large group of individuals.

However, the possibility exists that alteration of the testing procedures, as perhaps suggested by the motivational deficit group could affect test validity. Thus, with alterations in the testing procedure, we may no longer be assessing "intelligence" as defined by the creators and users of the specific test in question. If this is true, then the use of incentives with an intelligence test may alter the test to such an extent that comparisons with norms and performance under standard conditions cannot appropriately be made. The truth of this notion, however, has been neither supported nor refuted, nor can it be without restandardization of the tests under incentive conditions. Although this problem is not to be resolved in the present research, the reader should bear this point in mind in considering the experimental findings.

A second issue is that the standard conditions themselves do not entirely avoid incentives. Indeed, they are somewhat liberal with respect to verbal praise, within certain limits. The primary task of the examiner is to establish rapport. According to Wechsler (1974), the accomplishment of this task has the effect of "making the testing experience satisfying to both child and examiner" (p.55), and helps to "obtain the subject's cooperation and maintain his motivation" (Wechsler, 1955, p. 29). Rapport and motivation can also be maintained at an optimal level "in many subtle, friendly ways: by an understanding smile, a spontaneous explanation of approval, an appreciative comment, or just the quiet understanding between equals" (Terman & Merrill, 1972, p. 51). Terman and Merrill (1972) make it a point to state that "it is effective to praise frequently and generously" (p. 51). Standardized testing, with the possible exception of group-administered tests, is far from being rote or impersonal and the verbal support and encouragement of the examiner are sprinkled throughout the session.

the examiner are sprinkled throughout the session.

Strict guidelines and limits on the examiner's remarks do exist, however, Wechsler (1955) clearly states that: "it is not appropriate to make such a remark as, 'That is right', following a response, since a subject may then expect to be informed about the accuracy of his other responses and interpret no comment as an indication of failure" (p. 29). This dictate is echoed by Terman and Merrill (1972) in the Stanford-Binet Manual: "The examiner should remember that he is giving approval for effort rather than success on a particular response. To praise only successful responses may influence effort in succeeding tests" (p. 51). Robb, Bernardoni, and Johnson (1972) more clearly set the limits by stating that: "it is not advisable to offer a 'bribe' or incentive of some sort to effect cooperation" (p. 185).

<u>Issues Concerning Reward on Intelligence Tests</u>

In general, the standardized test considerations imply that positive reinforcement, in the form of verbal praise, is necessary but only to encourage effort and not to provide feedback as to the correctness of the response. Furthermore, no dissatisfaction with the examinee's responses should be expressed, no matter how subtly, by the tester.

Three major concerns emerge from the emphasis on standard practices and rapport establishment. These deal with the problems of contingent reinforcement of the test items, nonreinforcement or punishment of responses, and optimal motivational levels.

In dealing with the problem of contingent reinforcement, the

Stanford-Binet Manual reads as follows: "Praise should seldom be given between items which are part of a particular subtest, but should be withheld until all of the items have been given in order not to encourage persistence in an inferior type of response" (Terman & Merrill, 1972, p. 51). Likewise, it is probably just as important not to encourage any specific type of response and especially not to infuse the tasks with a learning component. The intelligence test attempts to tap the child's abilities on a particular set of tasks. By creating a learning paradigm within the task through the use of contingent rewards, the nature of the task will be considerably altered and perhaps test validity will be lost.

Wechsler (1974) expresses concern about problems associated with punishment and nonreinforcement. In the WISC-R Manual, Wechsler (1974) states that, "in no instance should dissatisfaction be shown with any response the child has given; nor should the child be led to expect approval for correct responses so that no comment might be interpreted as disapproval" (p. 56). Stevenson (1972),in reviewing the literature on children's learning, concludes that "although nonreinforcement may facilitate performance in simple performance tasks, it may interfere with learning in more complex problems" (p. 205). Thus, nonreinforcement may also alter the nature of the intelligence test since nonreinforcement might differentially affect the subject's responding, depending on the complexity of the task. In addition, nonreinforcement may alter the child's motivational level on the intelligence test itself.

The maintenance of optimal motivational levels presents the third concern in looking at the standardized procedures. In instructing examiners on the administration of the Stanford-Binet scales, Terman and Merrill (1972) emphasized that "to elicit the subject's best efforts and maintain both high motivation and optimal performance level throughout the testing session are the *sine qua non* of good testing (p. 50). This issue has been at the center of most of the research on the effects of incentives on intelligence test performance. Because a high motivational level and optimal performance are assumed to go hand in hand, a controversy has centered around the methods by which high motivation is ensured. The standardized test procedures assume that the establishment of rapport will be adequate. However, some investigators question whether good rapport alone will ensure an optimal motivational level in all children. For example, Kubany (1971) and O'Conner and Weiss (1974) have suggested that the use of extrinsic incentives may be one method to attain high motivational levels in all subjects.

The next section of the paper will address itself to the research findings on the use of rewards with intelligence tests. Much of this research was concerned with attempts to answer the motivational question. The research, however, as we shall see, has not been limited to that question but has also concerned itself with the more general effects of reward.

Research Findings on Reward and Intelligence Tests

Attempts to summarize the research on the effects of incentives on intelligence testing are made difficult by the numerous procedures and scales that have been employed. Researchers have used a variety of tests, types of incentives, and modes of reward administration, and a wide range of subject populations. As a result, few clear and consistent patterns emerge from the data.

Previous reviews of the literature have constantly underplayed the effects of incentives and other modifications in procedure. Kirkland (1971) and Cronbach (1970), commenting on the susceptibility of intelligence tests to situational variables, both conclude that the addition of simple incentives does not appreciably alter intelligence scores. Sattler and Theye (1967) agree but qualify that conclusion by noting that specialized groups composed of aged, disturbed, or retarded subjects tend to be affected by departures from standard procedure, although these authors do not specifically mention extrinsic incentives. Most of the earlier reviews, however, were based on a very few studies involving rewards. Since then, during the past decade, a number of studies have been conducted directly on this question.

Some studies that promised reward to the subject for improved performance found that reward did have some impact on measures of intelligence and ability. Several of these studies, however, dealt with achievement tests and several others included social or peer group influences.

Dickstein and Ayers (1973), with female college students of high ability, obtained facilitative effects due to rewards on overall Performance IQ and on the Object Assembly subtest of the WAIS. These researchers promised each subject one dollar if she scored in the top five of those taking the test thus incorporating some social competition with the material incentives. An attempt to replicate these findings, however, produced conflicting results. Moran, McCullers, and Fabes (1978) found reward to be detrimental to performance on the Object Assembly, Picture Arrangement, and Block Design subtests of the WAIS for female college students. Higgins and Archer (1968), in a published paper based on the dissertation of the first author (1967), reported that promising subjects of low socioeconomic status a class party, bus trip, or movie passes, raised their scores on the Cattell Culture-Free Intelligence Test. This result was not obtained with children from higher socioeconomic brackets. The prize, in this case, was also of a social nature rather than purely individualized, and peer pressure (e.g., "you kept us from getting the prize") might have been a factor. Two other studies (Burt & Williams, 1962; Tuinman, Farr & Blanton, 1972) using achievement tests with older children found facilitative effects of a promise of reward for increased performance. Benton (1936), however, failed to find any reward effects after promising 7th and 8th graders prizes on the Otis Self-Administering Test.

A study by Maller and Zubin (1932) using the National Intelligence Scale, is interesting in that these researchers found both facilitative and detrimental effects of reward. Maller and Zubin found that on tests of "speed", the promise of reward enhanced performance.

However, on tests of "analysis or power" (as they referred to them), the effect of reward was in the opposite direction. These authors used "rivalry" as the incentive and only children who improved their rank in the class on the second testing were to receive the prize.

A number of studies have used immediate (trial by trial) and contingent rewards with a variety of intelligence tests but the findings have not been very consistent. In general, few studies have found any facilitative effect of material reward on IQ test performance with middle- and upper-class subjects; whereas the data with the low socioeconomic, low ability, or special population subjects suggest that reward might enhance performance in some situations.

Data is available on middle-class subjects for a variety of tests. The Stanford-Binet has been used in conjunction with contingent rewards with first-graders (Clingman & Fowler, 1975), third-graders (Tiber & Kennedy, 1964) and other elementary school children (Klugman, 1944) but no differences between reward and standard instruction groups were found. Fast (1967) found that middle-class subjects (5th and 6th graders) under reward performed about the same as non-reward subjects on the WISC. Lyle and Johnson (1973), limiting their study to the WISC Coding task, found similar results in 7- and 8-year-olds. In a related study, Hanson (1972) found that material reward, praise, or symbolic feedback did not alter scores on the Metropolitan Achievement Tests administered to primary school age children.

Researchers have noted that lower- and middle-class children react to reward in different ways (e.g., Terrell, Durkin, & Wiesley 1959). Others have questioned the basic assumption of the IQ test concerning maximum motivation for all groups (Sweet, 1970; Tiber, 1963; Wienges, 1972) and have anticipated social class differences on IQ tests under reward administration.

For the most part, studies involving both lower- and middle-class individuals tend to show a facilitative effect of reward (if indeed an effect is found at all) only with the lower-class subjects. Wienges (1972) used an abbreviated form of the WISC and found low socioeconomic children, when given feedback (either material or verbal) raised retest scores higher than did similar children in a standardized instruction condition. With middle-class children, retest scores were similar in all three conditions. Sweet and Ringness (1971) also found this to be the case for white lower-class children in elementary school on the WISC Verbal Scale. These investigators, however, not only failed to find differences in feedback conditions for middle-class students but also for low socioeconomic black students. A study by Sandy clouds the issue even further, Sandy found that kindergarten children, regardless of socioeconomic background, failed to show increases in performance on the Pinter-Cunningham Primary Test with the use of material rewards.

Studies with only low SES groups also yield conflicting results. Edlund (1972) found that lower-class first graders, given contingent tangible incentives (candy) did better on the Stanford-Binet than children with standard procedures. Zontine, Richards, and Strang (1972), working with 8-year-old indigents, found that reward had no effect on IQ testing with the Peabody Picture Vocabulary Test scores; and Quay (1971), using 4-year-old Headstart children, obtained the same result with the Stanford-Binet scales.

Several studies of special population groups generally found support for the contention that reward will improve performance. Mellen's (1969) case study of a "retarded" girl showed that she was capable of performing much higher on the WISC under reward conditions. Husted, Wallin, and Wooden (1971) also found vast improvement on IQ tests with reward using profound retardates and the Cattell Infant Scale. Trainable reardates under a token system, also showed improvement on the Metropolitan Readiness Test (Ayllon & Kelly, 1972).

Clingman and Fowler (9176), in attempting to reconcile many of these conflicting findings, have hypothesized that the crucial variable is not socioeconomic status but rather level of ability. In their study, with first- and second-grade children only the low ability children improved scores on the Peabody Picture Vocabulary Test under contingent reward conditions.

Summary and Conclusions

The end result of a consideration of much of this research is that it has produced few consistent and reliable findings. In general, for middle-class subjects there is little evidence that reward facilitates performance on intelligence tests. For lower-class subjects, however, the evidence yields conflicting results; sometimes reward leads to increased scores and sometimes it does not. For retarded subjects, there does seem to be a tendency for reward to facilitate performance but only a few studies have been conducted in this area.

Even when significant differences are found between reward and standard instruction groups, the magnitude of the differences are usually much less than the test-retest differences. In the Higgins (1967) and Tuinman, et al., (1972) studies, for example, the retest differences were two to three times larger than the between group differences. This would suggest that reward facilitation, when found, is not that impressive. Also, in most cases the increase in scores due to reward administration was not sufficient to appreciably reduce class or racial differences.

If we were merely interested in raising the IQ score of an individual, reward procedures might be advantageous. Even so, we would be creating an artificial situation that might affect the validity of the test. Information gleaned from an intelligence test is not simply reflected in a single score but encompasses an entire range of behaviors and responses within this particular setting.

However, given a more general scientific interest in the relationship between reward and intelligence, the importance of the observed behaviors under these conditions could be better understood. Most of the researchers appear to have focused on the single IQ score and have attributed only motivational properties to reward. Maller and Zubin's (1932) article, however, compartmentalized the different skills involved in intelligence and showed the reward had a differential effect on different types of subtests. This type of analysis appears to be important in light of the research on the effect of reward on other cognitive processes.

Theoretical Models for Reward's Detrimental Effect

Introduction

Offering a prize or money to children and adults can alter task performance. The administration of reward does not, however, change behavior in a consistent and uniform fashion. Under some circumstances reward facilitates performance, under others there is no change, and in still other cases the administration of reward seems to impair performance.

As yet no single model for predicting the detrimental effect of reward has been adequately tested. The search for an adequate theoretical explanation for this phenomenon has only just begun. The detrimental effect that reward may have on performance has been demonstrated numerous times since researchers first became aware of this phenomenon (Glucksberg, 1962; Haddad, McCullers, & Moran, 1976; Kruglanski, Friedman, & Zeevi, 1971; Lepper & Greene, in press; Masters & Mokros, 1973; McCullers & Martin, 1971; McGraw, 1978; McGraw & McCullers, 1974, 1976; Miller & Estes, 1961; Moran, McCullers, & Fabes, 1978; Spence & Dunton, 1967; Spence & Segner, 1967; Staat & McCullers, 1974; Terrell, Durkin, & Wiesley, 1959; Viesti, 1971).

These studies find superior performance by nonrewarded subjects on a variety of tasks including problem-solving, concept identification and concept attainment, functional fixedness, creativity tasks, perceptual recognition, probability learning, discrimination learning, and verbal learning. For the most part, research in this area has focused on the mere demonstration that such an effect actually exists. Perhaps this is not surprising given psychology's long history of concentrating only on the positive aspects of reward. The task of developing a good theoretical model should prove both exciting and critical to our understanding of reward.

Traditional Models

McCullers (in press) has attempted to examine the detrimental effects of reward in relation to some traditional motivational and learning theory models such as those proposed by Yerkes and Dodson (1908) and Kenneth Spence (1956). McCullers notes that both of these theories predict an enhancing effect of reward on simple tasks and a detrimental effect of reward on complex tasks, but for different reasons. The Yerkes-Dodson law suggests that the administration of reward might raise the motivational level beyond an optimal point thereby disrupting behavior and leading to a performance decrement. The Hull-Spence formulation and prediction stems from an increase in incentive motivation which causes the most readily available responses to be elicited. In simple tasks it is these available responses that are correct, whereas in complex tasks (by their very definition) available responses lead to errors.

Although these theoretical positions, which are products of animal laboratories, may be able to cope with some of the findings concerning the detrimental effect of reward on children and adults, McCullers suggests that it is questionable whether they can be modified to adequately deal with all of the data.

Several other hypotheses have been proposed in recent years. Three of these hypotheses directly deal with the detrimental effects of reward on performance: the distraction hypothesis suggested by Janet Spence (1970, 1971), the algorithmic-heuristic model proposed by McGraw (in press), and a developemtnal regression notion based on the work of Werner and Lewin (Moran, McCullers, & Fabes, 1978).

The Motivational Model

A fourth model deals with a decline in performance under reward as a function of motivational decrements (Lepper & Greene, 1975; Lepper, Greene, & Nisbett, 1973).

This latter line of reasoning has focused on decrements in intrinsic motivation that occur following the administration of extrinsic incentives (reward). The major concern of these researchers has been the effect of reward on subsequent interest in the task. An extension of this model has been made to performance decrements as well (Kruglanski, Friedman, & Zeevi, 1971). In this case, which used noncontingent reward, it was postulated that a decrease in intrinsic motivation would adversely affect the quality of performance. This motivational explanation seems to imply that the adminstration of extrinsic incentives cannot override any decrease in intrinsic motivation, and that intrinsic motivation is superior to extrinsic motivation in terms of quality of performance. This work, however, does provide the best contribution thus far toward understanding the adverse properties of reward. The main concern of this paper, however, is to focus on performance decrements due to reward and several other hypotheses must be considered that deal specifically with this issue.

The Distraction Model

In Janet Spence's model, reward is delivered immediately and accumulates before the subject. The rewarded subject is presumably distracted from the task at hand and thus performs less well than subjects who receive no material rewards. This model centers primarily on attention, assuming that the inferior performance of the reward group results from reward distracting their attention from the task stimuli. Evidence for this model was found in several discrimination learning studies (McCullers & Martin, 1971; Miller & Estes, 1961; Spence & Dunton, 1967; Spence & Segner, 1967; Terrell, Durkin, & Wiesley, 1959). Further research, however, has brought the distraction notion into question. Spence conceived of distraction in a quite literal sense, i.e., the physical presence of the accumulating rewards. Recent studies have shown that a detrimental effect of reward can occur even without the physical presence of reward (McGraw & McCullers, 1976; Moran, McCullers, & Fabes, 1978). The distraction model perhaps could be extended to cover "mental" distraction that stems from the mere thought or expectation of reward. Yet this model as it stands lacks the capacity to handle the detrimental effects of a promise of reward or any facilitating effects of reward.

The Algorithmic-Heuristic Model

The McGraw model makes the distinction between algorithmic tasks (requiring rote skills and memory) and heuristic tasks (requiring organizational skills). The solution to an algorithmic task is straightforward and well-rehearsed, whereas discovery and insight are the characteristics of solutions to heuristic problems. It is only on the latter type of task that reward has been shown to have a consistent detrimental effect, and then only if the task is also attractive (i.e., intrinsically motivating). On tasks that are either aversive or algorithmic reward tends to be facilitative.

McGraw speculates that reward may focus the subject such that material perceptually and cognitively peripheral is no longer available serving to reduce the influence of alternate responses. This aids in the solution of algorithmic tasks but is detrimental to heuristic problem-solving.

The McGraw model is the product of an extensive and recent literature search and may offer the best predictor of the effect of reward, as a function of task demands and task attractiveness. The model has some research support (McGraw, 1978; McGraw & McCullers, 1974, 1976; Moran, 1975; Moran & McCullers, 1978; Moran, McCullers, & Fabes, 1978) but it has yet to undergo an adequate empirical verification of the full model or to offer an adequate theoretical basis for the empirical predictions that it makes.

The Developmental Regression Model

A fourth proposal for dealing with the effect of reward on performance, proposed in an unpublished paper by Moran, McCullers, and Fabes (1978), involves developmental regression concepts based on the work of Werner (1948, 1957) and Lewin (1935, 1954).

Developmental regression has been utilized by a number of developmental theorists and thus is a well-known concept. Werner's (1948) orthogenetic principle suggests that: "whenever development occurs it proceeds from a state of relative globality and lack of differentiation to a state of increasing differentiation, articulation and hierarchic integration" (p. 126). Regression, then involves a change in a direction opposite to that which is characteristic of development; a change in the direction of the more primitive and undeveloped state, toward dedifferentiation and disorganization.

Werner, in looking at perceptual organization, reports evidence for regression via tachistoscopic presentation of stimuli (see Werner, 1957, for a discussion of this work). Lewin (1954) suggests that regression may be a byproduct of sickness, frustration, insecurity, or emotional tension. For example, in a classic study, regression was used to explain the altered play behavior of children who had been frustrated (Barker, Dembo, & Lewin, 1941). Lewin (1954) also suggests that reward can operate in much the same manner as these other factors. In discussing level-of-aspiration research, he notes that "if pressure is brought to bear on a child by offering reward ... a procedure is used which is characteristic of a younger age level" (p. 957).

Lewin's concept of regression also appears to be tied to concepts similar to those offered by Yerkes and Dodson and McGraw. Yerkes and Dodson (1908) proposed that performance was optimal when motivation was at an optimal level and any deviation above or below that motivational level hindered performance. Lewin (1954) suggests that "increasing incentives favor the solution of detour and other intellectual problems only up to a certain intensity level. Above this level, however, increasing the forces to the goal makes the restructurization more difficult ... partly because the resultant emotionality leads to primitivation (regression)" (p. 942). Lewin appears to offer a theoretical mechanism for the Yerkes-Dodson law.

McGraw suggested that reward's detrimental effect stemmed from the inacessability of peripheral material. Lewin (1954) using the concept of regression, makes the same point. He notes that "regression, in the sense of a narrowing down of the psychologically present area may result from emotional tension, for instance, if the child is too eager to overcome an obstacle" (pp. 925-6). For the young child, or developmentally regressed individual the immediate situation is less extended. It is possible that the administration of material incentives provides one way for the child to become "too eager". Based on these similarities, it may be possible to combine the predictive model that McGraw has formulated with the theoretical foundations for developmental regression that Lewin and Werner have provided.

Lewin (1954) proposes that emotional tension serves as an intervening variable between reward and performance and that it is strong emotionality that is "detrimental to finding intellectual solutions" (p. 931). The notion that reward evokes emotional responses or arousal has been considered by the present author as an interesting concept. Research has been proposed by John McCullers and Ken McGraw to test this notion but at this point in time the studies have yet to be carried out.

The arousal explanation would suggest that reward leads to a general disruption of normal functioning. The linking of arousal to regression suggests that a shift could occur to a developmentally less mature level without the necessity of an accompanying general disorganization. That is, regression might involve a shift to a more primitive but still well-integrated mode of functioning.

An alternative explanation for the mechanism by which reward can lead to lower developmental stages exists. Given that rewards, particularly primary rewards, are so undeniably associated with the maintenance of life, it can be speculated that the answer may be bound up in some way with evolutionary survival mechanisms. One possibility is that reward may engage primitive adaptive mechanisms in a rather automatic and unconscious way, in much the same fashion that strong emotional stimuli engage the sympathetic nervous system. In this framework subjects acting under reward conditions shift toward a developmentally more primitive stage and orientation to simpler mechanisms that make for the efficient gathering in of rewards. In a great majority of situations of ordinary life such a shift that enhanced reward retrieval would have important survival value. In the sorts of tasks that have uncovered the detrimental effect of reward, however, such a shift would impede optimal performance and thus run counter to the person's best interests.

The concept of regression may provide the theoretical mechanism necessary to predict the detrimental effects of reward on performance in one situation without having to deny that reward on other tasks and by other measures can facilitate performance. For example, if reward can shift an adult to a lower level of functioning then performance should be adversely affected on tasks requiring a higher level of developmental maturity, i.e. on attractive, heuristic sorts of tasks where the detrimental effect of reward is typically found. On the other hand, a more primitive orientation and approach could lead to more efficient performance in many routine, mechanical (algorithmic) tasks.

Although this type of reasoning provides a basis to link regression with the detrimental effects of reward literature, predictions of the effect of regression would appear to be more complex than the simple two factor model discussed earlier.

Lewin (1954), for example, states that developmental change can occur in a number of ways. These include an increase in differentiation, an integration of subregions into a single functional region, a decrease in differentiation, and a breaking up of subregions or a restructuring of regions. In addition he notes that "repetition of a certain activity may lead to a differentiation of a previously undifferentiated region .... However, if continued long enough repetition may have the opposite effect, namely a breaking up of the large units of actions... and disorganization" (p. 932). These complex developmental changes make predictions of regression effects somewhat tenuous until research can clarify some of the variables involved. Nonetheless, some predictions are suggested by this model.

In general,it might be said that regression fosters both rigidity (Lewin, 1935) and diffuse responding (Werner, 1957). For the highly developed orgamism (e.g., adult), regression might serve to increase rigidity thereby enhancing algorithmic responding but hampering heuristic problem-solving, as predicted by the McGraw model. At younger ages, however, predictions are less clear. One possibility would be that the processes involved and the way they would be affected would be similar to those at the highly developed adult level. Another possibility is that at younger levels of development regression may lead to more diffuse responding. If so, this might hinder algorithmic solutions which require direct and rote responding but be facilitative of heuristic responses which require consideration of the total situation. Intermediate age levels might reflect other developmental changes in the nature of regression. Thus regression might be either facilitative or detrimental for either algorithmic or heuristic tasks depending on the relative stages of differentiation of the skills necessary for solving the particular task.

At any point in development, the development of hierarchic organization which allows for stability and flexibility further complicates the predictions. Also, throughout development there exists periods of labile and stable functioning and this may prove to be critical. These variables may lead to different predictions for regression in children and adults at different levals of ability. It has been noted that many studies did not find a detrimental effect of reward, using tasks similar to those that did (Terrell, & Kennedy, 1957; Ward, Kogan, & Pankove, 1972). Studies that found facilitative effects of reward on intelligence tests, have used subject populations of low ability. Perhaps these subjects are in early stages of organization and labile functioning. Reward, through regression, in these cases, may lead to more stable functioning and thus to improved performance. With high ability subjects, on the other hand, regression may inevitably lead to a loss of hierarchic integration and thus poorer performance.

All of these developmental factors may play a part in the prediction of the effect of developmental regression on performance. It appears that these predictions are relatively consistent with some of the findings on the detrimental effect of reward thus providing some encouragement for the idea that reward causes developmental regression. At this point only a simple model that predicts that reward will produce diffuse responding in young children and rigid functioning in adults appears to be manageable.

Summary and Conclusions

Theorizing on developmental regression is highly speculative although its roots lie in the grand theories of development. Some preliminary data, however, suggest that this line of exploration may prove interesting and fruitful with far-reaching implications. Of all the hypotheses attempting to account for the detrimental effect of reward, it is the developmental regression notion which would appear to offer the most comprehensive and interesting line of exploration.

References

Ayllon, T., & Kelly, K. Effects of reinforcement on standardized test performance. Journal of Applied Behavior Analysis, 1972, 5, 477-484.

Barker, R. G., Dembo, T., & Lewin, K. Frustration and regression: An experiment with young children. University of Iowa Studies in Child Welfare, 1941, 18, No. 1, xv-314.

Benton, A. L. Influence of incentives upon intelligence test scores of school children. Journal of Genetic Psychology, 1936, 49, 494-496.

Burt, C., & Williams, E. L. The influence of motivation on the results of intelligence tests. British Journal of Statistical Psychology, 1962, 15, 129-139.

Clingman, J., & Fowler, R. The effects of contingent and noncontingent reinforcement on the I.Q. scores of children of above-average intelligence. Journal of Applied Behavior Analysis, 1975, 8, 90.

Clingman, J., & Fowler, R. The effects of primary reward on the I.Q. performance of grade school children as a function of initial I.Q. level. Journal of Applied Behavior Analysis, 1976, 9, 19-23.

Cronbach, L. J. Essentials of psychological testing (3rd ed.). New York: Harper & Row, 1970.

Dickstein, L. S., & Ayers, J. Effect of incentive upon intelligence test performance. Psychological Reports, 1973, 33, 129-130.

Edlund, C. V. The effect on the behavior of children, as reflected in the IQ scores, when reinforced after each correct response.

Journal of Applied Behavior Analysis, 1972, 5, 317-319.

Fast, R. E. The effects of verbal and monetary reward on the individual intelligence test performance of children of differing socioeconomic status. Unpublished doctoral dissertation, Rutgers--The State University, 1967.

Haddad, N. F., McCullers, J. C., & Moran, J. D., III. Satiation and the detrimental effects of material rewards. Child Development, 1976, 47, 547-550.

Hanson, R. The effects of social, symbolic, and material reinforcers on the Metropolitan Test performance of normal Primary II pupils. Unpublished doctoral dissertation, University of Northern Colorado, 1971.

Higgins, M. T. A comparison of the effects of extrinsic reward on the test performance of sixth-grade students of two socioeconomic groups. Unpublished doctoral dissertation, University of Maryland, 1967.

Higgins, M. T., & Archer, N. S. Interaction effect of extrinsic rewards and socioeconomic strata. Personnel and Guidance Journal, 1968/1969, 47, 318-323.

Husted, J., Wallin, K., & Wooden, H. The psychological evaluation of profoundly retarded children with the use of concrete reinforcers. Journal of Psychology, 1971, 77, 173-179.

Jensen, A. R. How much can we boost IQ and scholastic achievement? Harvard Educational Review, 1969, 39, 1-123.

Kirkland, M. C. The effects of tests on students and schools. Review of Educational Research, 1971, 41, 303-350.

Klugman, S. F. The effect of money incentive versus praise upon the reliability and obtained scores of the revised Stanford-Binet Test. Journal of General Psychology, 1944, 30, 255-269.

Kubany, E. S. The effects of incentives on the test performance of Hawaiians and Caucasians. Unpublished doctoral dissertation, Univeristy of Hawaii, 1971.

Kruglanski, A. W., Friedman, I., & Zeevi, G. The effects of extrinsic incentive on some qualitative aspects of task performance. Journal of Personality, 1971, 39, 606-617.

Lepper, M. R., & Greene, D. (Eds.). The hidden costs of reward. Hillsdale, New Jersey: Laurence Erlbaum Associates, in press.

Lepper, M. R., & Greene, D. Turning play into work: Effects of adult surveillance and extrinsic rewards on children's intrinsic motivation. Journal of Personality and Social Psychology, 1975, 31, 744-750.

Lepper, M. R., Greene, D., & Nisbett, R. R. Undermining children's intrinsic motivation with extrinsic rewards: A test of the overjustification hypothesis. Journal of Personality and Social Psychology, 1973, 28, 128-137.

Lewin, K. A dynamic theory of personality: Selected papers of Kurt Lewin (Trans. by D. K. Adams & K. E Zener). New York: McGraw-Hill, 1935.

Lewin, K. Behavior and development as a function of the total situation. In L. Carmichael (Ed.), Manual of Child Psychology, New York: Wiley, 1954.

Lyle, J. G., & Johnson, E. G. Analysis of WISC Coding: 3. Writing and copying speed, and motivation. Perceptual and Motor Skills, 1973, 36, 211-214.

Maller, J. B., & Zubin, J. The effect of motivation upon intelligence test scores. Journal of Genetic Psychology, 1932, 41, 136-151.

Masters, J. C., & Mokros, J. R. Effects of incentive magnitude upon discrimination learning and choice preference in young children. Child Development, 1973, 44, 225-231.

McCullers, J. C. Issues in learning and motivation. In M.R. Lepper & D. Greene (Eds.), The hidden costs of reward. Hillsdale, New Jersey: Laurence Erlbaum Associates, in press.

McCullers, J. C., & Martin, J. A. G. A reexamination of the role of incentive in children's discrimination learning. Child Development, 1971, 42, 827-837.

McGraw, K. O. A test of a model for predicting detrimental and facilitating effects of reward on performance. In J. C. McCullers (Chair), Detrimental effects of reward and the cognitive processes. Symposium presented at the meeting of the Southwestern Psychological Association, New Orleans, 1978.

McGraw, K. O. The detrimental effects of reward on performance: A literature review and a prediction model. In M. R. Lepper & D. Greene (Eds.), The hidden costs of reward. Hillsdale, New Jersey: Laurence Erlbaum Associates, in press.

McGraw, K. O., & McCullers, J. C. The distracting effect of material reward: An alternative explanation for the superior performance of reward groups in probability learning. Journal of Experimental

Child Psychology, 1974, 18, 149-158.

McGraw, K. O., & McCullers, J. C. Monetary reward and water-jar task performance: Evidence for a detrimental effect of reward in problem-solving. Paper presented at the meeting of the Southeastern Psychological Association, New Orleans, 1976.

Mellen, H. R. WISC performance under incentive conditions : A case report. Psychological Reports, 1969, 24, 835-838.

X Miller, L. B., & Estes, B. W. Monetary reward and motivation in discrimination learning. Journal of Experimental Psychology, 1961, 61, 501-504.

Moran, J. D., III A developmental study of probability learning with two- and three- choice tasks as a function of reward. Unpublished masters thesis. University of Oklahoma, 1975.

Moran, J. D., III, & McCullers, J. C. A neglected factor in children's probability learning. Paper presented at the meeting of the Southwestern Society for Research in Human Development, Dallas, 1978.

Moran, J. D., III, McCullers, J. C., & Fabes, R. A. Effects of reward on WAIS subscale performance. In J. C. McCullers (Chair), Detrimental effect of reward and the cognitive processes. Symposium presented at the meeting of the Southwestern Psychological Association, New Orleans, 1978.

O'Conner, J. J., & Weiss, F. L. A brief discussion of the efficacy of raising standardized test scores by contingent reinforcement. Journal of Applied Behavior Analysis, 1974, 7, 351-352.

Quay, L. C. Language dialect, reinforcement, and the intelligence test performance of Negro children. Child Development, 1971, 42, 5-15.

Robb, G. P., Bernardoni, L. C., & Johnson, R. W. Assessment of individual mental ability. New York: Intext Educational Publishers, 1972.

Sandy, C. A. The effects of material reward, sex, race, and socioeconomic strata on the Pinter-Cunningham Primary Test scores of kindergarten students. Unpublished doctoral dissertation, University of Virginia, 1970.

Sattler, J. M., & Theye, F. Procedural, situational, and interpersonal variables in individual intelligence testing. Psychological Bulletin, 1967, 68, 347-360.

Spence, J. T. The distracting effect of material reinforcers in the discrimination learning of lower- and middle-class children. Child Development, 1970, 41, 103-111.

Spence, J. T. Do material rewards enhance the performance of lower-class children? Child Development, 1971, 42, 1461-1470.

Spence, J. T., & Dunton, M. C. The influence of verbal and nonverbal reinforcement combinations in the discrimination learning of middle- and lower-class preschool children. Child Development, 1967, 38, 1177-1186.

Spence, J. T., & Segner, L. L. Verbal versus nonverbal reinforcement combinations in the discrimination learning of middle- and lower-class children. Child Development, 1967, 38, 29-38.

Spence, K. W. Behavior theory and conditioning. New Haven: Yale University Press, 1956.

Staat, J., & McCullers, J. C. The distracting effect of material reward on the recall of incidentally acquired R-S associations. Paper presented at the meeting of the American Psychological Association, New Orleans, 1974.

Stevenson, H. W. Children's Learning. New York: Appleton-Century-Crofts, 1972.

Sweet, R. C. Variations in the intelligence test performance of lower-class children as a function of feedback or monetary reinforcement. Unpublished doctoral dissertation, University of Wisconsin, 1969.

Sweet, R. C., & Ringness, T. A. Variations in the intelligence test performance of referred boys of differing racial and socioeconomic backgrounds as a function of feedback or monetary reinforcement. Journal of School Psychology, 1971, 9, 399-409.

Terman, L. M., & Merrill, M. Stanford-Binet Intelligence Scale: Manual for the third revision: Form L-M. Boston: Houghton Mifflin, 1972.

Terrell, G., Jr., Durkin, K., & Wiesley, M. Social class and the nature of the incentive in discrimination learning. Journal of Abnormal and Social Psychology, 1959, 59, 270-272.

Terrell, G., Jr., & Kennedy, W. A. Discrimination learning and transposition in children as a function of the nature of the reward. Journal of Experimental Psychology, 1957, 53, 257-260.

Tiber, N. The effects of incentives on intelligence test performance. Unpublished doctoral dissertation, The Florida State University, 1963.

Tiber, N., & Kennedy, W. A. The effects of incentives on the intelligence test performance of different social groups. Journal of Consulting Psychology, 1964, 28, 187.

Tuinman, J. J., Farr, R., & Blanton, B. E. Increases in test scores as a function of material rewards. Journal of Educational Measurement, 1972, 9, 215-223.

X Viesti, C. R., Jr. Effect of monetary rewards on an insight learning task. Psychonomic Science, 1971, 23, 181-182.

Ward, W. C., Kogan, N., & Pankove, E. Incentive effects in children's creativity. Child Development, 1972, 43, 669-676.

Wechsler, D. Manual for the Wechsler Adult Intelligence Scale. New York: Psychological Corporation, 1955.

Wechsler, D. Manual for the Wechsler Intelligence Scale for Children--Revised. New York: Psychological Corporation, 1974.

Werner, H. Comparative psychology of mental development (rev. ed.). Chicago: Follett, 1948.

Werner, H. The concept of development from a comparative and organismic point of view. In D. B. Harris (Ed.), The concept of development. Minneapolis: University of Minnesota Press, 1957.

Wienges, M. A. E. Reinforcement, race, and socioeconomic level as factors in intelligence test performance. Unpublished doctoral dissertation, University of Pittsburg, 1971.

Yerkes, R. M., & Dodson, J. D. The relation of strength of stimulus to rapidity of habit formation. Journal of Comparative Neurology and Psychology, 1908, 18, 459-482.

Zontine, P. L., Richards, H. C., & Strang, H. R. Effect of contingent reinforcement on Peabody Picture Vocabulary Test performance. _Psychological Reports_, 1972, _31_, 615-622.

APPENDIX B

SUPPLEMENTARY TABLES

Table 3

Mean Subtest Scores by Age and Reward

Group	Subtest					
	IN	AR	SM	DS[a]	OA[b]	BD
College						
Nonreward	11.12	10.94	11.50	10.94	11.94	12.81
Reward	11.06	12.31	11.06	11.31	10.38	11.25
Elementary						
Nonreward	11.50	10.88	11.88	10.68	12.31	10.38
Reward	10.50	10.44	12.06	9.88	10.94	10.94
Nursery						
Nonreward	12.44	12.75	11.50	12.69	11.06	11.06
Reward	11.94	12.44	11.88	11.56	11.62	12.31

[a]Indicates scores for Digit Symbol, Coding, and Animal House subtests.

[b]Indicates scores for Object Assembly and Geometric Design subtests.

Table 4

Mean Factor Scores by Age and Reward

Group	Factor VC	Factor FD	Factor PO
College			
Nonreward	22.62	21.88	24.74
Reward	22.12	23.62	21.62
Elementary			
Nonreward	23.38	21.56	22.69
Reward	22.56	20.31	21.88
Nursery			
Nonreward	23.94	25.44	22.12
Reward	23.81	24.00	23.14

Table 5

Mean Subtest Scores by Age,

Reward, and Ability Level

Group	IN	AR	SM	DS[a]	OA[b]	BD
			Subtests			
High Ability						
College						
Nonreward	12.12	12.38	12.25	11.75	12.75	13.25
Reward	11.50	11.50	11.62	10.88	11.25	10.88
Elementary						
Nonreward	13.00	11.62	13.00	11.12	12.88	11.25
Reward	11.25	10.38	14.00	9.25	12.12	12.25
Nursery						
Nonreward	12.44	12.75	11.50	12.69	11.06	11.06
Reward	11.94	12.44	11.88	11.56	11.62	12.31
Average Ability						
College						
Nonreward	10.12	9.50	10.75	10.12	11.12	12.38
Reward	10.62	13.12	10.50	11.75	9.50	11.62
Elementary						
Reward	10.00	10.12	10.75	10.25	11.75	9.50
Nonreward	9.75	10.50	10.12	10.50	9.75	9.62

[a]Scores for Digit Symbol, Coding, and Animal House.

[b]Scores for Object Assembly and Geometric Design.

Table 6

Mean Error Scores by Age and Reward

	Subtest			
Group	DS[a]	SM	OA[b]	BD
College				
Nonreward	9.12	2.94	.25	1.12
Reward	6.50	3.44	.62	1.88
Elementary				
Nonreward	3.25	6.12	.62	4.00
Reward	3.38	5.88	.94	3.75
Nursery				
Nonreward	.19	6.56	4.62	4.56
Reward	1.44	5.88	4.25	3.31

[a]Indicates scores for the Digit Symbol, Coding, and Animal House subtests.

[b]Indicates scores for the Object Assembly and Geometric Design subtests.

Table 7

Mean Block Design Proportional Time Scores[a]

Group	Reward	Nonreward
College	40.88	38.94
Elementary	54.44	54.88
Nursery	55.19	54.38

[a]Refer to Appendix G for the derivation of these percentages.

Table 8

Ability and Age Matching Scores

	Treatment			
	Nonreward		Reward	
Group	PT	MTH [a]	PT	MTH
College				
Male	20.88	229.75	21.62	228.75
Female	21.00	225.25	21.00	227.62
All	20.94	227.50	21.31	228.19
Elementary				
Male	22.12	121.50	22.88	120.38
Female	23.00	119.75	21.62	118.12
All	22.56	120.62	22.25	119.25
Nursery				
Male	24.50	59.75	24.75	59.88
Female	24.38	57.62	24.25	58.00
All	24.45	58.69	24.50	58.94
Total	22.65	135.60	22.69	135.46

[a]Age here is reported in months, whereas in the text the ages are reported in years.

APPENDIX C

TABLES OF CORRELATIONS

Table 9

Correlations Between Subtest Groups for All Ages Combined

Tests:	PT	TS	AG	HR	VC	FD	PO	IN	AR	SM	DS[a]	OA[b]	BD
PT	--	.44"	.37"	.39"	.50"	.27'	.23'	.42"	.34"	.43"	.10	.21'	.17
TS		--	.88"	.84"	.78"	.79"	.69"	.70"	.63"	.65"	.58"	.53"	.60"
AG			--	.47"	.71"	.93"	.33"	.76"	.77"	.47"	.73"	.20'	.35"
HR				--	.66"	.40"	.88"	.44"	.42"	.69"	.23'	.76"	.67"
VC					--	.49"	.31"	.85"	.46"	.87"	.38"	.27'	.24'
FD						--	.28'	.47"	.79"	.38"	.82"	.15	.32"
PO							--	.27'	.33"	.27"	.13	.84"	.79"
IN								--	.46"	.48"	.31"	.22'	.24'
AR									--	.34"	.29"	.23'	.32"
SM										--	.27'	.25'	.18
DS[a]											--	.02	.20
OA[b]												--	.33"

[a]Indicates scores for the Digit Symbol, Coding, and Animal House subtests.

[b]Indicates scores for the Object Assembly and Geometric Design subtests.

' $p < .05$

" $p < .005$

Table 10

Correlations Between Subtest Groups for All Ages

Tests:	PT	TS	AG	HR	VC	FD	PO	IN	AR	SM	DS[a]	OA[b]	BD
							Reward						
PT	--	.38'	.14	.40"	.49"	(.02)	.38'	.39'	.15	.45"	(.15)	.31'	.32'
TS		--	.88"	.85"	.81"	.78"	.72"	.68"	.71"	.71"	.65"	.50"	.67"
AG			--	.50"	.67"	.93"	.38'	.71"	.80"	.46"	.81"	.16	.47"
HR				--	.74"	.40"	.88"	.46"	.41"	.77"	.30'	.72"	.70"
VC					--	.44"	.42"	.83"	.44"	.87"	.33'	.27	.41"
FD						--	.32'	.40'	.84"	.36'	.89"	.13	.41"
PO							--	.33'	.31'	.38'	.25	.83"	.78"
IN								--	.38'	.46"	.31'	.17	.38'
AR									--	.38'	.50"	.11	.41"
SM										--	.26	.29'	.32'
DS[a]											--	.11	.31'
OA[b]													.31'
							Nonreward						
PT	--	.55"	.63"	.28	.51"	.63"	.11	.47"	.53"	.42"	.39'	.13	.04
TS		--	.85"	.82"	.74"	.79"	.68"	.71"	.70"	.58"	.46"	.57"	.55"
AG			--	.44"	.75"	.93"	.28	.81"	.74"	.49"	.63"	.23	.24
HR				--	.57"	.38'	.88"	.41"	.44"	.59"	.18	.79"	.65"
VC					--	.57"	.21	.88"	.49"	.86"	.34'	.26	.08
FD						--	.24	.57"	.74"	.42"	.73"	.18	.22
PO							--	.21	.36'	.15	(.01)	.84"	.80"
IN								--	.54"	.51"	.29'	.22	.16
AR									--	.31'	.08	.35'	.24
SM										--	.30'	.22	.02
DS[a]											--	(.09)	.09
OA[b]												--	.35"

[a] Scores for Digit Symbol, Coding, and Animal House subtests.

[b] Scores for Object Assembly and Geometric Design subtests.

' $p < .05$

" $p < .005$

Note: Parentheses indicate a negative correlation.

Table 11

Correlations Between Subtest Groups for All Adults

Tests:	PT	TS	AG	HR	VC	FD	PO	IN	AR	SM	DS	OA	BD
							Reward						
PT	--	.54'	.11	.74"	.53'	(.10)	.58'	.44	.09	.45	(.26)	.64'	.19
TS		--	.78"	.72"	.23	.59"	.74"	.26	.59'	.12	.30	.42	.70"
AG			--	.14	(.10)	.89"	.28	.04	.76"	(.23)	.58'	(.02)	.47
HR				--	.48	(.05)	.87"	.37	.10	.44	(.17)	.70"	.60'
VC					--	.50	.08	.87"	(.19)	.82"	(.56)'	(.03)	.10
FD						--	.17	(.43)	.77"	(.40)	.75"	(.05)	.32
PO							--	.18	.18	(.06)	.07	.79"	.71"
IN								--	(.18)	.42	(.47)	.05	.23
AR									--	(.18)	.15	(.18)	.49
SM										--	(.48)	(.01)	(.09)
DS											--	.12	(.02)
OA												--	.11
							Nonreward						
PT	--	.69"	.72"	.52'	.69"	.62'	.37	.62'	.57'	.56'	.24	.30	.36
TS		--	.88"	.90"	.80"	.78"	.76"	.71"	.65"	.66"	.36	.64'	.73"
AG			--	.58'	.82"	.93"	.39	.75"	.62'	.66"	.56'	.32	.38
HR				--	.61'	.48	.94"	.52'	.53'	.53'	.10	.79"	.89"
VC					--	.62'	.38	.87"	.47	.84"	.33	.22	.43
FD						--	.30	.44	.59'	.62'	.68"	.24	.30
PO							--	.41	.47	.19	(.06)	.91"	.88"
IN								--	.44	.46	.14	.35	.38
AR									--	.36	(.19)	.44	.40
SM										--	.43	.02	.35
DS											--	(.11)	.01
OA													.61'

Note: Parentheses indicate a negative correlation.

' $p < .05$

" $p < .005$

Table 12

Correlations Between Subtest Groups for Elementary School

Tests:	PT	TS	AG	HR	VC	FD	PO	IN	AR	SM	CD	OA	BD
							Reward						
PT	--	.51'	.07	.69"	.53'	(.05)	.66'	.28	.24	.59'	(.23)	.58'	.64'
TS		--	.77"	.88"	.90"	.69"	.71"	.52'	.65'	.92"	.55'	.82"	.46
AG			--	.38	.74"	.92"	.12	.66"	.77"	.61'	.78"	.32	(.12)
HR				--	.75"	.33	.94"	.27	.36	.88"	.22	.95"	.76"
VC					--	.54'	.51'	.76"	.58'	.91"	.37	.63'	.30
FD						--	.10	.31	.77"	.55'	.90"	.32	(.17)
PO							--	.11	.16	.65'	.03	.93"	.91"
IN								--	.40	.42	.17	.16	.03
AR									--	.55'	.42	.38	(.10)
SM										--	.41	.79"	.40
CD											--	.21	(.17)
OA												--	.69"
							Nonreward						
PT	--	.75"	.64'	.66'	.73"	.55'	.38	.68"	.57'	.69"	.28	.30	.34
TS		--	.91"	.89"	.85"	.84"	.69"	.87"	.76"	.73"	.53'	.70"	.40
AG			--	.71"	.86"	.84"	.48	.91"	.74"	.70"	.71"	.51'	.25
HR				--	.80"	.64'	.79"	.71"	.76"	.78"	.24	.84"	.40
VC					--	.76"	.34	.93"	.71"	.94"	.48	.50'	.00
FD						--	.38	.78"	.76"	.66"	.78"	.42	.17
PO							--	.38	.54'	.26	.06	.87"	.76"
IN								--	.69"	.74"	.51'	.47	.12
AR									--	.63'	.19	.57'	.27
SM										--	.39	.46	(.10)
CD											--	.08	.00
OA												--	.33

Note: Parentheses indicate a negative correlation.

' $p < .05$

" $p < .005$

Table 13

Correlations Between Subtests Groups for Nursery School

Tests:	PT	TS	AG	HR	VC	FD	PO	IN	AR	SM	AH	GD	BD
							Reward						
PT	--	.11	.09	.13	.42	(.10)	(.11)	.38	.06	.35	(.21)	(.11)	(.04)
TS		--	.96"	.92"	.87"	.91"	.73"	.83"	.86"	.70"	.83"	.28	.81"
AG			--	.78"	.83"	.96"	.59'	.86"	.86"	.62'	.90"	.11	.81"
HR				--	.80"	.74"	.81"	.69"	.75"	.73"	.62'	.49	.70"
VC					--	.70"	.39	.87"	.71"	.89"	.59'	.04	.57'
FD						--	.57'	.67"	.90"	.57'	.94"	.06	.83"
PO							--	.51'	.52'	.19	.53'	.76"	.65'
IN								--	.59'	.56'	.63'	.16	.61'
AR									--	.66"	.70"	.11	.68"
SM										--	.42	(.09)	.41
AH											--	.01	.82"
GD												--	.03
							Nonreward						
PT	--	.38	.44	.17	.14	.59'	.10	.02	.39	.21	.48	.12	.02
TS		--	.83"	.82"	.53'	.85"	.75"	.47	.72"	.32	.47	.57'	.62'
AG			--	.36	.64"	.91"	.32	.74"	.80"	.16	.46	.16	.37
HR				--	.24	.48	.92"	.02	.37	.37	.30	.79"	.66'
VC					--	.39	(.03)	.80"	.38	.69"	.15	(.03)	(.01)
FD						--	.45	.40	.80"	.15	.61'	.26	.46
PO							--	(.02)	.38	(.02)	.24	.83"	.74"
IN								--	.48	(.10)	.03	(.08)	.06
AR									--	.04	.02	.35	.25
SM										--	.20	.05	(.09)
AH											--	(.02)	.44
GD												--	.24

Note: Parentheses indicate a negative correlation.

' $p < .05$

" $p < .005$

APPENDIX D

SUMMARY TABLES OF ANALYSES OF VARIANCE

Table 14

Anovas for Pretest Scores for Each Age

		Adult			Elementary			Nursery		
Source	df	MS	F	p	MS	F	p	MS	F	p
Rew	1	1.12	.31	.583	.78	.09	.763	.04	.00	.957
Xsex	1	.50	.14	.714	.28	.03	.853	.78	.07	.758
Exp	1	.12	.03	.858	19.54	2.33	.140	9.03	.85	.365
RX	1	1.12	.31	.583	9.03	1.08	.310	.28	.02	.872
RE	1	.50	.14	.714	9.03	1.08	.310	7.03	.66	.423
XE	1	3.12	.06	.362	.78	.09	.763	1.54	.14	.707
RXE	1	2.00	.55	.465	9.03	1.08	.310	69.03	6.52	.017
Error	24	3.62			8.39			10.59		

Table 15

Anovas for Age Matching for Each Age

		Adults			Elementary			Nursery		
Source	df	MS	F	p	MS	F	p	MS	F	p
Rew	1	3.78	.14	.708	15.12	1.04	.317	.50	.02	.886
Xsex	1	63.78	2.40	.135	32.00	2.21	.150	32.00	1.34	.250
Exp	1	16.53	.67	.436	8.00	.55	.465	66.12	2.78	.109
RX	1	22.78	.86	.362	.50	.03	.854	.12	.01	.943
RE	1	148.78	5.64	.026	8.00	.55	.465	4.50	.19	.668
XE	1	.78	.03	.865	1.12	.08	.783	32.00	1.34	.258
RXE	1	9.03	.34	.564	15.12	1.04	.317	10.12	.43	.521
Error	24	26.39			14.50			23.81		

Table 16

Overall Anova for Algorithmic-Heuristic Scores

		Between					Within		
Source	df	MS	F	p	Source	df	MS	F	p
Age	2	120.15	2.73	.072	Scale	1	5.33	.39	.534
Rew	1	27.00	.61	.436	SA	2	91.27	6.68	.002
Xsex	1	168.75	3.83	.054	SR	1	.00	.00	.999
Exp	1	256.68	5.83	.018	SX	1	12.00	.88	.352
AR	2	10.19	.23	.794	SE	1	35.02	2.56	.114
AX	2	90.19	2.05	.136	SAR	2	91.69	6.71	.002
RX	1	.75	.02	.897	SAX	2	1.69	.12	.884
AE	2	28.56	.65	.526	SRX	1	10.09	.74	.393
RE	1	58.52	1.33	.253	SAE	2	32.14	2.35	.102
XE	1	.02	.00	.983	SRE	1	17.52	1.28	.261
ARX	2	2.31	.05	.949	SXE	1	2.52	.18	.669
ARE	2	106.02	2.27	.110	SARX	2	9.65	.71	.497
AXE	2	49.52	1.13	.330	SARE	2	6.90	.50	.606
RXE	2	7.52	.17	.681	SAXE	2	14.02	1.03	.364
ARXE	2	3.77	.89	.918	SRXE	2	3.52	.26	.613
Error	72	44.02			SARXE	2	28.52	2.09	.132
					Error	72	13.67		

Table 17

Anovas for Algorithmic-Heuristic Scores for Each Age

		Adult			Elementary			Nursery		
Source	df	MS	F	p	MS	F	p	MS	F	p
Rew	1	14.06	.43	.520	33.06	.56	.460	.25	.01	.938
Xsex	1	7.56	.23	.636	85.56	1.46	.228	256.00	6.31	.019
Exp	1	10.56	.32	.577	121.00	2.07	.163	182.25	4.49	.045
RX	1	1.56	.05	.829	1.56	.03	.872	2.25	.06	.816
RE	1	18.06	.55	.477	30.25	.52	.479	210.25	5.18	.032
XE	1	.56	.02	.897	56.25	.96	.337	42.25	1.04	.318
REX	1	14.06	.43	.520	.00	.00	.999	1.00	.02	.877
Error	24	32.96			58.53			40.56		
Scale	1	6.25	.67	.420	105.06	5.46	.028	76.56	6.14	.021
SR	1	110.25	11.87	.002	5.06	.26	.613	68.06	5.45	.028
SX	1	12.25	1.31	.262	1.56	.68	.778	1.56	.14	.727
SE	1	9.00	.97	.335	30.25	1.57	.222	60.06	4.81	.038
SRX	1	12.25	1.31	.262	14.06	.73	.401	3.06	.25	.625
SRE	1	25.00	2.69	.114	6.25	.32	.574	.06	.01	.944
SXE	1	4.00	.44	.518	16.00	.54	.371	10.56	.85	.367
SERX	1	25.00	2.69	.114	25.00	1.30	.266	10.56	.85	.367
Error	24	9.29			19.24			12.48		

Table 18

Overall Anova for Factor Scores

		Between					Within		
Source	df	MS	F	p	Source	df	MS	F	p
Age	2	80.10	2.73	.072	Factor	2	2.11	.21	.812
Rew	1	18.00	.61	.436	FA	4	30.06	2.99	.021
Xsex	1	112.50	3.83	.054	FR	2	.95	.09	.910
Exp	1	171.12	5.83	.018	FX	2	12.32	1.22	.297
AR	2	6.79	.23	.794	FE	2	41.66	4.14	.018
AX	2	60.12	2.04	.136	FAR	4	34.29	3.40	.011
RX	1	.50	.02	.897	FAX	4	8.71	.86	.487
AE	2	19.04	.65	.526	FRX	2	2.26	.22	.799
RE	1	39.01	1.33	.253	FAE	4	22.96	2.28	.064
XE	1	.01	.00	.983	FRE	2	15.85	1.57	.211
ARX	2	1.54	.05	.949	FXE	2	46.15	4.58	.012
ARE	2	66.68	2.27	.110	FARX	4	13.29	1.32	.266
AXE	2	33.01	1.13	.330	FARE	4	4.51	.45	.774
RXE	1	5.01	.17	.681	FAXE	4	2.41	.24	.916
ARXE	2	2.51	.09	.918	FRXE	2	3.34	.33	.719
Error	72	29.34			FARXE	4	10.32	1.02	.397
					Error	144	10.08		

Table 19

Anovas for Factor Scores for Each Age

		Adult			Elementary			Nursery		
Source	df	MS	F	p	MS	F	p	MS	F	p
Rew	1	9.38	.42	.520	22.04	.56	.460	.17	.01	.938
Xsex	1	5.04	.23	.636	57.04	1.46	.238	170.67	6.31	.019
Exp	1	7.04	.32	.577	80.67	2.07	.163	121.50	4.49	.045
RX	1	1.04	.05	.829	1.04	.03	.872	1.50	.06	.816
RE	1	12.04	.55	.466	20.17	.52	.479	140.17	5.18	.032
XE	1	.38	.02	.847	37.50	.96	.337	28.17	1.04	.318
RXE	1	9.38	.43	.520	.00	.00	.999	.67	.02	.877
Error	24	21.97			39.02			27.04		
Factor	2	5.29	.54	.585	34.16	3.13	.053	22.78	2.38	.103
FR	2	47.62	4.88	.012	.51	.05	.954	21.39	2.23	.118
FX	2	51.17	1.56	.222	2.26	.21	.814	12.32	1.29	.285
FE	2	3.04	.31	.734	50.95	4.67	.014	33.59	3.51	.038
FRX	2	17.17	1.76	.183	2.57	.24	.791	9.09	.95	.394
FRE	2	.29	.03	.971	18.76	1.72	.190	5.82	.61	.548
FXE	2	22.87	2.35	.107	15.22	1.40	.258	12.89	1.35	.270
FRXE	2	10.12	1.04	.362	4.16	.38	.685	9.70	1.01	.371
Error	48	9.75			10.91			9.57		

Table 20

Overall Anova for Individual Subtest Scores

	Between					Within			
Source	df	MS	F	p	Source	df	MS	F	p
Age	2	40.05	2.73	.072	Test	5	2.87	.66	.657
Rew	1	9.00	.61	.436	TA	10	10.64	2.43	.008
Xsex	1	56.25	3.83	.054	TR	5	4.06	.93	.463
Exp	1	85.56	5.83	.018	TX	5	15.46	3.53	.004
AR	2	3.39	.23	.794	TE	5	8.89	2.03	.074
AX	2	30.01	2.05	.136	TAR	10	8.26	1.89	.046
RX	1	.25	.02	.897	TAX	10	6.31	1.44	.160
AE	2	.52	.65	.526	TRX	5	1.08	.25	.941
RE	1	19.51	1.33	.253	TAE	10	6.42	1.47	.150
XE	1	.01	.00	.983	TRE	5	4.47	1.02	.405
ARX	2	.77	.05	.949	TXE	5	11.12	2.54	.028
ARE	2	33.34	2.27	.110	TARX	10	7.39	1.69	.082
AXE	2	16.50	1.13	.330	TARE	10	3.73	.85	.580
RXE	1	2.51	.17	.681	TAXE	10	1.48	.34	.970
ARXE	2	1.25	.09	.918	TRXE	5	2.29	.52	.760
Error	72	14.68			TARXE	10	6.52	1.49	.141
					Error	360	4.38		

Table 21

Anovas for Individual Subtest Scores for Each Age

		Adult			Elementary			Nursery		
Source	df	MS	F	p	MS	F	p	MS	F	p
Rew	1	4.68	.43	.520	11.02	.56	.460	.08	.01	.938
Xsex	1	2.52	.23	.636	28.52	1.46	.238	85.33	6.31	.019
Exp	1	3.52	.32	.577	40.33	2.07	.163	60.75	4.49	.045
RX	1	.52	.05	.829	.52	.03	.872	.75	.06	.816
RE	1	6.02	.55	.466	10.08	.52	.479	70.08	5.18	.032
XE	1	.19	.02	.897	18.75	.96	.337	14.08	1.04	.318
RXE	1	4.69	.43	.520	.00	.00	.999	.33	.02	.877
Error	24	10.99			19.51			13.52		
Test	5	4.42	1.15	.336	13.29	3.16	.010	6.44	1.26	.285
TR	5	10.44	2.73	.023	4.35	1.03	.402	5.80	1.14	.345
TX	5	18.75	4.90	.000	5.82	1.38	.236	3.52	.69	.632
TE	5	1.35	.35	.880	11.63	2.76	.021	8.76	1.72	.136
TRX	5	7.70	2.01	.082	4.20	1.10	.423	3.96	.78	.568
TRE	5	4.00	1.04	.395	4.81	1.14	.342	3.12	.61	.691
TXE	5	5.69	1.49	.199	3.40	.81	.546	4.99	.98	.433
TRXE	5	6.14	1.60	.164	5.52	1.31	.263	3.67	.72	.610
Error	120	3.83			4.21			5.10		

Table 22

Anovas for Algorithmic-Heuristic Scores

by Ability for Each Age

		Adult			Elementary			Nursery		
Source	df	MS	F	p	MS	F	p	MS	F	p
Rew	1	14.06	.63	.433	33.07	.70	.409	.25	.00	.948
IQ	1	121.00	5.44	.027	300.25	8.09	.008	36.00	.62	.438
RQ	1	100.00	4.50	.043	2.25	.05	.828	.25	.00	.948
Error	28	22.23			47.03			58.26		
Scale	1	6.25	.65	.427	105.06	7.34	.011	76.56	5.59	.025
SR	1	110.25	11.44	.002	5.04	.35	.557	68.06	4.97	.034
SQ	1	1.56	.16	.690	90.25	6.31	.018	1.56	.11	.738
SQR	1	39.06	4.05	.054	64.00	4.47	.043	.06	.00	.947
Error	28	9.64			14.31			13.71		

Table 23

Anovas for Factor Scores

by Ability for Each Age

		Adult			Elementary			Nursery		
Source	df	MS	F	p	MS	F	p	MS	F	p
Rew	1	9.38	.63	.433	22.04	.70	.409	.17	.00	.948
IQ	1	80.67	5.44	.027	253.50	8.09	.008	24.00	.62	.438
RQ	1	66.67	4.50	.043	1.50	.65	.828	.17	.00	.948
Error	28	14.82			31.35			38.84		
Factor	2	5.29	.54	.588	34.16	3.31	.044	22.78	2.17	.123
FR	2	47.62	4.82	.012	.51	.05	.952	21.39	2.04	.140
FQ	2	6.17	.62	.539	49.16	4.77	.012	3.41	.32	.724
FRQ	2	20.17	2.04	.139	17.84	1.73	.186	16.14	1,54	.224
Error	56	9.87			10.31			10.49		

Table 24

Anovas for Individual Subtest Scores

by Ability for Each Age

		Adult			Elementary			Nursery		
Source	df	MS	F	p	MS	F	p	MS	F	p
Rew	1	9.69	.63	.433	11.02	.70	.409	.08	.00	.948
IQ	1	40.33	5.44	.027	126.75	8.09	.008	12.00	.62	.438
RQ	1	33.33	4.50	.043	.75	.05	.828	.08	.00	.948
Error	28	7.41			15.68			19.42		
Test	5	4.42	.98	.433	13.29	3.11	.011	6.44	1.28	.277
TR	5	10.44	2.31	.047	4.35	1.01	.410	5.80	1.15	.337
TQ	5	3.41	.75	.584	11.12	2.60	.028	1.44	.28	.920
TRQ	5	5.56	1.23	.298	5.60	1.31	.263	8.00	1.59	.167
Error	140	4.52			4.28			5.04		

Table 25

Anovas for Block Design Proportional

Time for Each Age

		Adult			Elementary			Nursery		
Source	df	MS	F	p	MS	F	p	MS	F	p
Rew	1	30.03	.27	.610	1.53	.01	.941	5.28	.04	.849
Xsex	1	148.78	1.32	.262	108.78	.91	.351	.03	.00	.988
Exp	1	5.28	.05	.830	306.28	2.55	.123	850.78	6.00	.022
RX	1	34.03	.30	.588	166.54	1.39	.251	108.78	.77	.390
RE	1	9.03	.08	.779	.28	.00	.962	5.28	.04	.849
XE	1	124.03	1.10	.304	148.78	1.24	.277	306.28	2.16	.155
RXE	1	185.28	1.65	.212	63.28	.53	.475	185.28	1.31	.264
Error	24	112.59			120.16			141.91		

Table 26

Anovas for Block Design Times for Each Age

		Adult			Elementary			Nursery		
Source	df	MS	F	p	MS	F	p	MS	F	p
Rew	1	224.00	.28	.618	586.55	.95	.339	903.14	1.72	.202
Xsex	1	1275.14	1.45	.240	1124.20	1.83	.189	440.04	.84	.369
Exp	1	56.89	.06	.801	935.26	1.52	.230	566.71	1.08	.309
RX	1	249.38	.28	.599	1313.29	2.13	.157	13.35	.03	.875
RE	1	42.00	.05	.829	31.34	.05	.823	806.68	1.54	.227
XE	1	847.34	.97	.336	101.53	.16	.688	2837.55	5.41	.029
RXE	1	1494.22	1.70	.204	993.85	1.61	.216	7.34	.01	.907
Error	24	877.94			615.95			524.93		
Trial	8	35804.61	117.60	.000	60147.5	240.31	.000	9083.84	65.36	.000
TR	8	227.89	.76	.651	124.75	.50	.856	209.79	1.51	.156
TX	8	451.72	1.48	.165	212.75	.85	.560	239.25	1.72	.096
TE	8	122.95	.40	.917	145.65	.58	.792	213.12	1.53	.148
TRX	8	391.54	1.29	.253	340.54	1.36	.216	130.41	.94	.486
TRE	8	96.17	.32	.959	916.17	3.66	.001	284.01	2.04	.043
TXE	8	998.53	3.28	.002	278.95	1.11	.355	315.04	2.27	.024
TRXE	8	255.11	.84	.570	143.13	.57	.800	121.46	.87	.540
Error	192	304.47			250.29			138.99		

Table 27

Anovas for Heuristic Errors at Each Age

		Adult			Elementary			Nursery		
Source	df	MS	F	p	MS	F	p	MS	F	p
Rew	1	7.04	4.26	.050	.09	.02	.896	14.26	1.17	.290
Xsex	1	2.67	1.61	.216	3.01	.56	.463	6.51	.53	.272
Exp	1	2.67	1.61	.216	5.51	.02	.323	27.10	2.22	.149
RX	1	3.38	2.04	.166	.01	.00	.965	.84	.07	.795
RE	1	.38	.23	.638	1.76	.32	.574	27.10	2.22	.149
XE	1	.67	.40	.531	.84	.16	.697	4.59	.38	.545
RXE	1	.04	.03	.875	3.76	.69	.413	1.76	.14	.707
Error	24	1.65			5.42			12.18		
Test	2	61.54	70.61	.000	220.38	115.40	.000	46.00	8.84	.001
TR	2	.29	.33	.717	.84	.44	.645	1.57	.30	.741
TX	2	.54	.62	.541	3.39	1.77	.181	4.13	.79	.458
TE	2	.54	.62	.541	9.20	4.81	.012	1.53	.29	.746
TRX	2	6.00	6.88	.002	1.14	.59	.556	5.91	1.13	.330
TRE	2	2.00	2.19	.112	.95	.50	.612	1.22	.23	.792
TXE	2	7.04	8.08	.001	1.91	1.00	.376	5.91	1.13	.330
TRXE	2	.79	.91	.410	.70	.37	.696	3.13	.60	.552
Error	48	.87			1.91			5.24		

Table 28

Anovas for Algorithmic-Heuristic

Errors at Each Age

		Adult			Elementary			Nursery		
Source	df	MS	F	p	MS	F	p	MS	F	p
Rew	1	4.00	.16	.694	.02	.00	.968	4.52	.13	.720
Xsex	1	.56	.02	.882	21.39	2.28	.144	23.76	.69	.413
Exp	1	9.00	.36	.556	5.64	.60	.446	92.64	2.70	.113
RX	1	12.25	.49	.492	.39	.04	.840	6.89	.20	.658
RE	1	95.06	3.76	.064	3.52	.37	.546	78.76	2.30	.143
XE	1	56.25	2.23	.148	.77	.08	.778	19.14	.56	.462
RXE	1	7.56	.30	.589	21.39	2.28	.144	9.76	.28	.599
Error	24	25.18			9.39			34.31		
Scale	1	115.56	6.03	.022	862.89	68.26	.000	3038.74	228.35	.000
SR	1	72.25	3.77	.064	.39	.03	.862	50.77	3.81	.063
SX	1	22.56	1.78	.289	.14	.01	.917	1.89	.14	.710
SE	1	49.00	2.56	.123	11.39	.90	.352	9.77	.74	.400
SRX	1	1.00	.05	.821	.14	.01	.917	.14	.01	.917
SRE	1	68.06	3.55	.072	26.27	2.08	.162	15.02	1.13	.299
SXE	1	30.25	1.58	.221	1.89	.15	.702	.71	.06	.813
SRXE	1	10.56	.55	.465	.02	.00	.972	.01	.00	.973
Error	24	19.16			12.64			13.31		

APPENDIX E

TABLES OF CELL MEANS

Table 29

Cell Means for Scaled Subtest
Scores in Adults

Treatment:		Reward				Nonreward			
Sex of S:		Male		Female		Male		Female	
Sex of E:		Female	Male	Female	Male	Female	Male	Female	Male
TS	M	70.75	64.75	67.25	66.25	69.25	71.25	68.75	67.75
	SD	5.25	3.95	4.35	4.99	5.44	14.82	3.10	13.58
AG	M	37.00	32.75	34.75	34.25	30.25	35.00	33.50	33.25
	SD	4.97	2.99	.96	2.87	4.35	6.06	1.91	7.50
HR	M	33.75	32.00	33.00	32.00	39.00	36.25	35.25	34.50
	SD	.50	1.63	3.56	5.10	2.16	8.96	3.77	6.24
VC	M	23.25	23.25	22.00	20.00	21.50	24.25	23.25	21.50
	SD	.96	2.36	1.41	4.24	2.38	4.43	3.95	3.87
FD	M	24.75	21.75	23.50	24.50	20.00	22.25	23.00	22.25
	SD	5.50	2.63	1.73	4.43	3.56	4.57	2.71	4.92
PO	M	22.75	19.75	22.25	21.75	27.75	24.75	22.50	24.00
	SD	1.26	2.22	3.30	3.40	2.99	6.65	4.12	5.03
IN	M	12.25	11.00	11.25	9.75	10.25	12.75	10.50	11.00
	SD	.96	1.41	1.71	2.06	1.50	1.50	2.38	2.83
AR	M	13.75	11.75	11.00	12.75	11.50	12.75	9.75	9.75
	SD	3.70	2.22	.82	2.99	2.89	3.30	1.26	3.30
SM	M	11.00	12.25	10.75	10.25	11.25	11.50	12.75	10.50
	SD	1.41	.96	.50	2.22	1.71	3.00	1.71	1.29
DS	M	11.00	10.00	12.50	11.75	8.50	9.50	13.25	12.50
	SD	2.71	1.83	2.08	2.88	3.32	2.08	1.89	2.89
OA	M	9.75	9.75	11.25	10.75	14.25	11.50	10.00	12.00
	SD	1.71	1.71	2.63	1.71	2.22	3.00	2.16	2.94
BD	M	13.00	10.00	11.00	11.00	13.50	13.25	12.50	12.00
	SD	1.41	.82	1.41	1.82	1.73	3.77	2.38	2.71

Table 30

Cell Means for Scaled Subtest
Scores in Fourth-Graders

Treatment:		Reward				Nonreward			
Sex of S:		Male		Female		Male		Female	
Sex of E:		Female	Male	Female	Male	Female	Male	Female	Male
TS	M	62.25	63.25	70.00	63.50	67.25	62.75	73.75	64.25
	SD	6.24	18.28	5.60	11.00	4.11	9.91	9.32	12.20
AG	M	29.75	30.50	35.25	27.75	32.50	29.25	38.00	31.50
	SD	3.77	7.05	5.06	4.57	1.73	5.74	4.54	7.19
HR	M	32.50	32.75	34.75	35.75	34.75	33.50	38.25	32.75
	SD	6.45	12.28	5.12	6.80	2.63	6.61	7.59	5.50
VC	M	21.00	23.00	25.25	21.00	24.00	20.00	28.75	20.75
	SD	3.91	7.75	3.50	4.40	2.83	4.69	6.13	4.92
FD	M	20.50	18.50	23.75	18.50	21.25	20.00	24.25	20.75
	SD	2.84	5.26	4.03	4.04	.96	3.37	2.63	4.27
PO	M	20.75	21.75	21.00	24.00	22.00	22.75	23.25	22.75
	SD	4.35	6.85	3.65	4.32	4.97	4.72	4.79	3.77
IN	M	9.25	12.00	11.50	9.25	12.25	9.25	13.75	10.75
	SD	2.75	2.16	1.73	1.71	.96	2.50	2.87	3.30
AR	M	11.25	10.75	11.00	8.75	11.25	9.75	12.00	10.50
	SD	.96	2.22	2.16	2.22	1.71	.96	2.94	2.08
SM	M	11.75	11.00	13.75	11.75	11.75	10.75	15.00	10.00
	SD	2.22	5.83	2.75	3.20	2.22	2.99	3.37	1.83
CD	M	9.25	7.75	12.75	9.75	10.00	10.25	12.25	10.25
	SD	3.10	3.10	2.36	2.06	1.41	1.99	.50	2.63
OA	M	10.00	11.00	11.25	11.50	12.00	11.25	13.25	12.75
	SD	2.58	3.92	2.06	2.64	2.71	3.50	3.30	2.63
BD	M	10.75	10.75	9.75	12.50	10.00	11.50	10.00	10.00
	SD	1.89	3.30	1.71	2.38	3.37	2.08	2.16	1.15

Table 31

Cell Means for Scaled Subtest Scores
in Nursery School Children

Treatment:		Reward				Nonreward			
Sex of S:		Male		Female		Male		Female	
Sex of E:		Female	Male	Female	Male	Female	Male	Female	Male
TS	M	76.25	58.50	81.25	71.00	69.00	66.75	73.50	76.75
	SD	7.54	13.48	10.24	10.23	5.48	9.03	5.20	7.89
AG	M	38.75	28.00	42.00	35.00	38.50	33.75	39.00	40.75
	SD	3.77	7.39	7.34	6.88	4.43	4.27	2.71	5.44
HR	M	37.50	30.50	39.25	36.00	30.50	33.00	34.50	36.50
	SD	3.45	6.86	2.99	4.40	4.29	7.07	3.00	3.70
VC	M	25.06	20.25	28.25	21.75	25.25	22.50	25.25	22.75
	SD	2.45	7.41	5.91	4.35	1.89	3.70	2.06	2.99
FD	M	25 75	18.50	28.00	23.75	25.00	23.25	25.25	28.25
	SD	2.21	5.45	6.06	3.59	2.00	3.20	2.22	4.65
PO	M	25.50	19.75	25.00	25.00	18.75	21.00	23.00	25.75
	SD	5.74	2.21	.82	3.11	1.71	5.60	2.16	3.50
IN	M	13.00	9.50	14.00	11.25	13.50	10.50	13.75	12.00
	SD	1.63	2.64	3.56	3.40	2.51	2.08	.96	.82
AR	M	13.50	10.00	14.25	12.00	12.00	11.75	12.50	14.75
	SD	.58	2.58	3.50	1.41	2.71	1.26	2.89	3.40
SM	M	12.00	10.75	14.25	10.50	11.75	12.00	11.50	10.75
	SD	2.16	5.12	2.87	2.38	.96	2.16	1.73	2.22
AH	M	12.25	8.50	13.75	11.75	13.00	11.50	12.75	13.50
	SD	1.89	4.36	2.63	2.21	.82	3.11	2.06	1.73
GD	M	12.25	10.00	11.50	12.75	8.50	10.50	12.75	12.50
	SD	4.35	2.16	.58	4.03	.58	2.65	3.50	2.38
BD	M	13.25	9.75	13.50	12.75	10.25	10.50	10.75	13.25
	SD	2.50	2.87	1.29	1.89	2.06	3.42	1.71	1.26

Table 32

Cell Means for Error and Time

Scores in Adults

Treatment:		Reward				Nonreward			
Sex of S:		Male		Female		Male		Female	
Sex of E:		Female	Male	Female	Male	Female	Male	Female	Male
BP	M	35.50	44.00	46.50	37.50	35.25	36.25	40.75	43.50
	SD	6.56	6.32	10.60	14.06	4.65	15.41	5.06	14.94
CE	M	6.75	7.00	4.25	8.00	16.00	4.25	9.25	7.00
	SD	3.59	9.01	6.55	3.46	10.68	4.35	5.38	2.00
OE	M	.75	.50	.25	1.00	00	.25	.50	.25
	SD	.50	.58	.50	.82	00	.50	.58	.50
BE	M	.50	2.75	2.00	2.25	.50	1.00	1.75	1.25
	SD	.58	.96	.82	.96	.58	2.00	1.26	.96
SE	M	3.25	2.00	3.75	4.75	3.75	3.25	1.50	3.25
	SD	.96	00	1.26	1.71	1.71	1.50	1.29	.96
BD2	M	8.00	13.50	6.50	6.50	7.25	7.25	5.75	6.50
	SD	3.37	13.00	2.58	1.91	2.22	2.75	2.06	2.89
BD4	M	8.75	10.75	10.75	7.75	8.75	9.74	7.75	9.25
	SD	2.21	4.35	2.06	.96	3.50	4.86	.96	3.20
BD6	M	30.50	23.25	27.75	23.75	23.00	25.50	27.00	36.50
	SD	10.50	4.65	3.77	4.72	3.56	11.56	4.90	29.24
BD8	M	75.25	101.50	117.50	76.50	54.50	84.00	104.50	72.25
	SD	30.65	31.89	3.00	37.22	13.43	35.92	17.92	37.83

Table 33

Cell Means for Error and Time

Scores in Fourth-Graders

Treatment:		Reward				Nonreward			
Sex of S:		Male		Female		Male		Female	
Sex of E:		Female	Male	Female	Male	Female	Male	Female	Male
BP	M	54.50	55.25	50.75	47.25	53.00	48.50	52.75	55.25
	SD	7.05	3.40	14.52	6.65	8.16	19.64	3.86	13.33
CE	M	2.75	5.50	2.50	2.75	5.25	2.25	3.25	2.25
	SD	1.50	3.11	2.65	3.10	2.72	1.89	2.50	1.71
OE	M	1.00	1.50	.50	.75	.75	1.00	.25	.50
	SD	1.15	1.91	.58	.96	.50	1.41	.50	.58
BE	M	3.75	3.75	4.50	3.00	4.00	3.25	4.25	4.50
	SD	1.71	2.36	1.29	1.83	2.58	2.06	1.71	1.29
SE	M	5.75	6.50	5.00	6.25	6.25	7.25	3.75	7.25
	SD	.96	3.88	1.83	2.06	2.06	2.36	1.26	.96
BD2	M	13.75	12.50	13.75	11.25	17.75	13.25	17.75	15.50
	SD	2.88	5.20	2.88	2.87	18.36	2.63	6.85	7.55
BD4	M	18.00	21.75	36.25	32.50	23.00	18.25	30.75	30.00
	SD	10.67	30.53	25.06	22.37	8.04	3.20	21.11	24.71
BD6	M	40.00	45.25	55.00	32.25	50.50	51.00	54.50	60.75
	SD	20.20	21.39	23.10	28.54	20.14	25.97	20.01	14.57
BD8	M	113.75	120.00	118.00	111.25	116.50	102.00	120.00	120.00
	SD	12.50	00	4.00	17.50	4.73	21.35	00	00

Table 34

Cell Means for Error and Time Scores

in Nursery School Children

Treatment:		Reward				Nonreward			
Sex of S:		Male		Female		Male		Female	
Sex of E:		Female	Male	Female	Male	Female	Male	Female	Male
BP	M	58.25	48.50	63.25	50.75	55.50	57.00	62.75	42.25
	SD	8.77	16.76	16.21	5.25	5.51	17.47	9.64	7.63
CE	M	00	4.50	00	1.25	00	.50	00	.25
	SD	00	9.00	00	2.50	00	1.00	00	.50
OE	M	3.25	5.75	3.75	4.25	5.75	5.50	3.25	4.00
	SD	2.36	2.06	1.26	2.99	.96	2.38	.50	2.16
BE	M	1.75	5.75	2.75	3.00	4.50	4.75	5.25	3.75
	SD	.96	2.75	1.71	1.41	2.65	2.75	2.75	2.50
SE	M	5.25	7.25	3.75	7.25	5.75	6.25	7.00	7.25
	SD	2.87	7.23	3.30	4.57	.96	2.06	2.16	2.22
BD2	M	16.25	11.00	18.25	15.25	15.00	18.25	14.50	14.75
	SD	9.18	6.58	9.54	11.03	6.22	11.93	3.42	2.75
BD4	M	23.25	26.00	34.75	16.50	28.25	36.75	32.25	26.00
	SD	2.99	13.11	9.54	5.07	13.40	15.84	15.95	9.20
BD6	M	36.25	46.25	28.25	32.00	47.00	57.75	54.25	28.50
	SD	13.05	21.36	16.92	18.78	11.52	4.50	11.50	21.44
BD8	M	43.75	58.75	55.25	33.50	56.75	70.50	59.25	40.50
	SD	13.96	18.87	23.84	5.07	21.39	9.00	11.50	23.04

APPENDIX F

DATA TABLES

Table 35

Adult Scaled Score Data

TR	SX	EX	IQ	MTH	PT	TS	AG	HR	VC	FD	PO	IN	AR	SM	DS	OA	BD
R	M	F	H	235	22	71	37	34	24	26	21	11	16	13	16	8	13
			H	231	23	68	34	34	24	21	23	13	11	11	10	12	11
			L	232	20	66	33	33	23	20	23	13	11	10	9	9	14
			L	220	22	78	44	34	22	32	24	12	17	10	15	10	14
		M	H	222	22	66	34	32	25	22	19	12	11	13	11	10	9
			L	231	22	68	36	32	25	24	19	12	15	13	9	9	10
			L	232	19	59	29	30	23	18	18	11	10	12	8	8	10
			H	227	23	66	32	34	20	23	23	9	11	11	12	12	11
	F	F	L	224	19	64	34	30	26	25	19	9	10	11	15	9	10
			H	232	23	72	35	37	22	24	26	11	11	11	13	15	11
			L	233	21	71	36	35	23	24	24	12	12	11	12	11	13
			H	230	22	64	34	30	23	21	20	13	11	10	10	10	10
		M	L	223	18	65	38	27	16	30	19	8	14	8	16	9	10
			H	223	23	73	34	39	25	22	26	12	12	13	10	13	13
			H	223	21	61	31	30	22	20	19	11	9	11	11	10	9
			L	233	21	66	34	32	17	20	23	8	16	9	10	11	12
NR	M	F	L	225	20	71	31	40	24	20	27	11	9	13	11	12	15
			L	228	20	62	26	36	19	18	25	8	14	11	4	13	12
			H	234	21	69	28	41	20	17	32	11	9	9	8	17	15
			H	222	20	75	36	39	23	25	27	11	14	12	11	15	12
		M	L	222	18	52	28	24	20	17	15	11	8	9	9	7	8
			H	234	23	86	41	45	29	27	30	14	15	15	12	13	17
			H	235	23	79	39	40	27	25	27	14	15	13	10	13	14
			L	238	22	68	32	36	21	20	27	12	13	9	7	13	14
	F	F	L	220	22	73	33	40	25	21	27	12	8	13	13	13	14
			H	222	23	69	35	34	28	22	19	13	10	15	12	8	11
			L	223	18	67	31	36	20	22	25	9	10	11	12	10	15
			H	223	23	66	35	31	20	27	19	8	11	12	16	9	10
		M	H	225	22	68	35	33	23	22	23	13	12	16	10	12	11
			H	223	23	84	41	43	25	28	31	13	13	12	15	15	16
			L	232	19	68	34	34	22	23	23	11	8	11	15	13	10
			L	234	18	51	23	28	16	16	19	7	6	9	10	8	11

Table 36

Elementary Scaled Score Data

TR	SX	EX	IQ	MTH	PT	TS	AG	HR	VC	FD	PO	IN	AR	SM	CD	OA	BD
R	M	F	L	126	21	66	35	31	22	24	20	11	12	11	12	9	11
			H	120	27	66	29	37	26	17	23	12	12	14	5	11	12
			L	128	20	53	29	24	17	21	15	8	10	9	11	7	8
			H	115	26	64	26	38	19	20	25	6	11	13	9	13	12
		M	L	115	21	62	28	34	20	18	24	10	10	10	8	13	11
			H	125	26	59	26	33	22	14	23	12	9	10	5	10	12
			L	120	18	44	27	17	16	16	12	11	10	5	6	6	6
			H	114	24	88	41	47	34	26	28	15	14	19	12	15	13
	F	F	H	115	24	78	38	40	29	26	23	12	13	17	13	13	10
			L	118	20	68	31	37	21	22	25	9	11	12	11	13	12
			H	119	22	65	31	34	27	19	19	12	8	15	11	10	9
			L	121	20	69	41	28	24	28	17	13	12	11	16	9	8
		M	L	117	21	66	30	36	23	21	22	9	11	14	10	12	10
			L	117	18	54	25	29	16	18	20	7	8	9	10	9	11
			H	121	22	56	23	33	19	13	24	10	6	9	7	10	14
			H	117	26	78	33	45	26	22	30	11	10	15	12	15	15
NR	M	F	L	125	23	62	31	31	22	20	20	11	9	11	11	11	9
			H	120	26	70	34	36	24	21	25	13	13	11	8	11	14
			L	118	19	71	34	37	22	22	27	12	11	10	11	16	11
			H	121	23	66	31	35	28	22	16	13	12	15	10	10	6
		M	H	125	22	68	34	34	22	22	24	12	9	10	13	10	14
			H	120	24	74	32	42	25	22	27	10	11	15	11	15	12
			L	120	20	56	30	26	19	21	16	9	10	10	11	7	9
			L	123	20	53	21	32	14	15	24	6	9	8	6	13	11
	F	F	H	115	27	76	38	38	32	22	22	16	10	16	12	13	9
			L	123	24	79	43	46	35	27	27	16	15	19	12	17	10
			L	124	21	60	32	28	21	22	17	10	9	11	13	9	8
			H	119	28	80	39	41	27	26	27	13	14	14	12	14	13
		M	H	119	23	78	41	32	25	27	26	14	13	11	14	15	11
			H	115	23	71	33	38	25	20	26	13	11	12	9	15	11
			L	119	18	55	27	28	17	18	20	9	10	8	8	11	9
			L	124	20	53	25	28	16	18	19	7	8	9	10	10	9

Table 37

Nursery Scaled Score Data

TR	SX	EX	IQ	MTH	PT	TS	AG	HR	VC	FD	PO	IN	AR	SM	AH	GD	BD
R	M	F	L	67	24	79	38	41	28	25	26	13	14	15	11	13	13
			H	64	26	80	38	42	23	25	32	13	13	10	12	18	14
			H	58	25	81	44	37	26	29	26	15	14	11	15	10	16
			L	61	23	65	35	30	23	24	18	11	13	12	11	8	10
		M	L	65	22	72	33	39	26	23	23	10	13	16	10	11	12
			H	48	30	45	19	26	16	11	18	8	9	8	2	12	6
			H	56	30	68	35	33	27	22	19	13	11	14	11	7	12
			L	60	18	49	25	24	12	18	19	7	7	5	11	10	9
	F	F	L	60	23	80	42	38	24	30	26	12	16	12	14	11	15
			H	60	28	92	51	43	37	32	25	19	16	18	16	11	14
			L	58	26	82	42	40	26	31	25	11	16	15	15	12	13
			H	52	29	69	33	36	26	19	24	14	9	12	10	12	12
		M	L	52	22	65	34	31	18	23	24	11	12	7	11	11	13
			L	65	21	69	31	38	21	21	27	10	11	11	10	17	10
			H	62	23	64	30	34	20	22	22	8	11	12	11	8	14
			H	55	22	86	45	41	28	29	29	16	14	12	15	15	14
NR	M	F	H	58	29	65	35	30	24	24	17	11	10	13	14	9	8
			L	63	24	77	45	32	28	28	21	17	16	11	12	8	13
			H	62	28	66	37	29	24	24	18	13	11	11	13	8	10
			L	65	24	68	37	31	25	24	19	13	11	12	13	9	10
		M	L	55	21	68	35	33	27	22	19	13	12	14	10	9	10
			H	56	23	55	32	23	19	22	14	10	13	9	9	8	6
			H	60	25	77	39	38	24	28	25	11	12	13	16	11	14
			L	59	22	67	29	38	20	21	26	8	10	12	11	14	12
	F	F	H	55	28	76	40	36	25	27	24	13	12	12	15	14	10
			L	65	17	67	35	32	25	22	20	13	9	12	13	9	11
			L	61	22	72	40	32	23	26	23	14	13	9	13	11	12
			H	55	24	79	41	38	28	26	25	15	16	13	10	17	8
		M	H	60	26	81	40	41	22	28	31	12	16	10	12	16	15
			L	62	23	66	33	33	20	22	24	11	10	9	12	11	13
			L	49	25	76	42	34	22	30	24	12	15	10	15	12	12
			H	54	30	84	46	38	27	33	24	13	18	14	15	11	13

Table 38

Adult Error and Time Data

TR	SX	EX	BP	HE	CE	OE	BE	SE	BD1	BD2	BD3	BD4	BD5	BD6	BD7	BD8	BD9
R	M	F	28	4	10	1	1	2	19	7	7	12	16	24	30	51	65
			44	5	6	0	1	4	12	6	18	8	19	46	45	120	93
			35	5	9	1	0	4	15	13	24	8	23	28	38	62	82
			35	4	2	1	0	3	22	6	6	7	21	24	42	68	97
		M	50	5	0	0	3	2	20	7	9	10	35	29	72	120	120
			48	5	6	1	2	2	15	7	6	7	35	25	77	112	120
			42	7	20	1	4	2	16	7	12	17	21	19	47	120	95
			36	4	2	0	2	2	25	33	7	9	20	20	38	54	93
	F	F	53	8	2	1	3	4	13	8	6	13	60	33	72	120	120
			38	5	14	0	1	4	14	6	5	9	14	25	92	116	37
			37	4	0	0	2	6	11	5	9	12	15	25	45	120	71
			58	7	1	6	2	5	28	10	8	9	46	28	120	114	120
		M	51	11	3	1	3	7	23	8	9	7	23	27	120	95	120
			23	4	11	0	1	3	27	8	7	7	12	17	31	46	45
			48	9	9	2	3	4	17	6	8	9	12	27	114	120	94
			28	8	9	1	2	5	17	4	4	8	10	24	66	45	56
NR	M	F	32	2	7	0	0	2	30	5	5	10	16	26	66	42	72
			37	4	28	0	1	3	26	6	6	13	21	21	44	55	120
			31	6	22	0	0	6	37	10	4	5	11	26	55	48	68
			41	5	7	0	1	4	21	8	7	7	12	19	76	73	120
		M	57	10	10	1	4	5	20	10	11	17	27	39	119	117	120
			20	0	2	0	0	1	10	4	5	7	8	18	36	36	40
			36	2	0	0	0	2	11	9	7	7	13	14	30	105	105
			32	5	5	0	0	5	10	6	4	8	16	31	53	78	59
	F	F	35	2	8	0	0	2	9	8	11	8	33	31	47	90	55
			42	3	10	1	2	0	12	7	6	7	28	25	29	120	120
			39	5	3	0	2	3	29	4	7	7	19	31	26	88	120
			47	5	16	1	3	1	48	4	12	9	13	21	120	120	44
		M	55	5	10	0	1	4	27	9	9	14	34	80	88	82	120
			22	2	6	0	0	2	16	4	4	8	16	18	29	32	62
			52	5	6	0	2	3	20	4	9	7	15	27	113	120	120
			45	7	6	1	2	4	44	9	10	8	20	21	54	55	120

Table 39

Elementary Error and Time Data

TR	SX	EX	BP	HE	CE	OE	BE	SE	BD1	BD2	BD3	BD4	BD5	BD6	BD7	BD8	BD9
R	M	F	58	11	2	2	4	5	9	13	15	9	13	68	120	120	120
			57	7	5	0	2	5	13	16	11	18	28	38	92	95	120
			44	15	2	2	6	7	3	16	25	12	29	20	120	120	120
			59	9	2	0	3	6	12	10	14	33	31	34	120	120	120
		M	54	12	3	0	4	8	8	15	18	13	20	41	42	120	120
			55	9	10	2	2	5	9	6	8	27	14	41	70	120	120
			52	22	4	4	7	11	8	18	75	25	75	75	120	120	120
			60	4	5	0	2	2	16	11	18	22	75	21	53	120	113
	F	F	63	7	1	0	4	3	10	12	23	24	34	75	88	120	120
			76	9	3	0	3	6	9	12	14	70	75	34	118	120	120
			63	10	6	1	5	4	10	13	33	39	31	36	120	112	120
			41	14	0	1	6	7	9	18	26	12	19	75	51	120	120
		M	41	10	0	0	5	10	12	19	18	25	75	120	120	120	120
			42	14	7	2	4	8	6	15	14	41	21	19	47	120	120
			53	10	1	1	1	8	9	9	15	60	19	19	59	85	120
			53	6	3	0	2	4	7	9	9	11	14	16	89	120	120
NR	M	F	53	12	8	1	5	6	45	10	30	19	67	59	42	120	120
			53	8	4	1	1	6	10	11	11	20	24	34	54	116	120
			43	12	3	0	3	9	4	5	11	18	21	34	71	110	120
			63	12	6	1	7	4	8	45	45	35	62	75	120	120	120
		M	47	9	5	1	1	7	8	17	9	21	13	45	43	78	120
			57	7	2	0	3	4	10	12	46	16	12	67	63	96	120
			22	18	1	3	6	9	10	11	14	15	19	17	120	120	120
			68	12	1	0	3	9	10	13	18	21	14	75	118	120	120
	F	F	67	10	3	0	6	4	10	10	51	62	75	52	120	120	120
			59	6	6	0	4	2	6	20	16	19	75	28	37	120	120
			60	11	4	1	5	5	12	26	29	17	75	75	120	120	120
			65	6	0	0	2	4	7	15	14	25	34	63	88	120	120
		M	57	11	2	0	4	7	7	8	9	10	17	70	120	120	120
			73	9	4	0	3	6	10	22	19	66	39	55	120	120	120
			49	14	0	1	5	8	18	22	26	24	76	75	120	120	120
			42	15	3	1	6	8	6	10	28	20	56	43	120	120	120

Table 40

Nursery Error and Time Data

TR	SX	EX	BP	HE	CE	OE	BE	SE	BD1	BD2	BD3	BD4	BD5	BD6	BD7	BD8	BD9
R	M	F	61	6	0	3	2	1	12	12	8	26	45	25	36	58	69
			57	8	0	0	1	7	11	30	16	19	31	34	23	38	66
			47	13	0	5	1	7	25	12	6	24	28	31	43	27	31
			68	14	0	5	3	6	11	11	17	24	33	55	60	52	61
		M	54	7	0	3	3	1	13	18	6	23	45	15	26	40	75
			62	29	18	6	9	14	51	15	9	45	45	60	50	75	75
			54	13	0	8	4	1	24	7	7	21	35	50	30	45	75
			24	26	0	6	7	13	14	4	6	15	45	60	60	75	75
	F	F	49	12	0	4	2	6	19	7	20	37	32	19	52	27	21
			70	5	0	4	1	0	23	30	10	45	45	16	55	75	39
			51	7	0	2	3	2	18	16	18	22	20	25	31	44	51
			83	17	0	5	5	7	41	20	30	35	45	53	60	75	75
		M	46	26	5	7	5	14	26	5	15	13	45	25	26	32	75
			48	8	0	0	3	5	24	17	11	24	34	20	23	41	75
			51	11	0	5	2	4	19	9	4	15	42	60	28	30	38
			58	13	0	5	2	6	16	30	15	14	45	23	31	31	75
NR	M	F	49	20	0	7	8	5	22	24	13	45	45	60	60	75	75
			53	14	0	6	2	6	18	12	9	33	20	35	60	34	34
			61	17	0	5	5	7	18	14	30	19	45	40	60	75	75
			59	13	0	5	3	5	19	10	17	16	19	53	60	43	75
		M	74	18	0	8	6	4	25	30	14	44	42	60	60	75	75
			40	24	2	7	8	9	37	3	8	45	45	60	60	75	75
			44	12	0	4	2	6	9	15	5	13	21	60	17	57	13
			70	12	0	3	3	6	18	25	5	45	33	51	34	75	49
	F	F	50	18	0	3	7	8	14	11	12	45	45	60	60	75	75
			68	12	0	3	2	7	11	15	30	12	33	60	16	75	75
			61	17	0	4	4	9	22	19	17	27	35	37	40	52	75
			72	15	0	3	8	4	57	13	17	45	45	60	60	75	75
		M	51	10	1	1	1	8	26	12	12	38	42	20	22	30	45
			45	15	0	4	3	8	10	18	7	17	45	22	23	27	45
			33	22	0	6	7	9	16	13	8	21	12	60	60	75	75
			40	13	0	5	4	4	27	16	8	28	27	12	12	30	75

APPENDIX G

A GENERAL NOTE ON DERIVATION OF ERROR AND TIME SCORES

A GENERAL NOTE ON DERIVATION OF ERROR AND TIME SCORES

Several of the error and time scores that appear in the text and tables need some clarification.

The Block Design times that are reported are times that were recorded during the testing session. Block Design Trial 1 (BD1) as listed in the tables, is a combination time for block trials 1 and 2 on the WAIS and WPPSI. For the elementary school children, Block Design Trial 1 is actually the time recorded for block 3 on the WISCR which is the point at which testing begins for children of this age. Block Design Trial 2 (BD2) on the WAIS and WPPSI, is then actually block 3; Block Design 3 (BD3) is block 4; etc.. On the WISCR, Block Design Trial 2 (BD2) is actually the time for block 4, the second trial attempted: Block Design 3 (BD3) is for block 5; etc.. In cases in which two attempts or trials per block are allowed, the times reported are the times for the first trial on each block attempted. On attempts that were terminated due to time, the subject received the maximum time allotted for that particular trial. For trials which were not attempted due to termination of the subtest based on discontinuation criteria, the subject also received the maximum time for that trial.

A second time measure, Block Design Proportional Time (BP), is also reported. This measure uses only those trials attempted by the subject and is the percentage of time used by the subject expressed as a percentage of the maximum time allotted for those trials.

To compute error scores slightly different procedures were used for the different subtests at various ages. On the Similarities test, an error is defined as a response that was scored "0". This scoring was consistent at all ages. A response on the Object Assembly on the WAIS or WISCR was scored an error if the puzzle was put together incorrctly within the time limit or the time expired without the proper arrangement. Nursery school children were considered in error on the Geometric Design test if on a trial they received a "0" score. On the Block Design subscale, adults and elementary school children were considered to have made an error if on the first attempt the design was not properly constructed within the time allotted. Nursery school children were in error only if they failed both trials. On the Animal House subtest, errors and omissions were combined into a single error score. On all subtests, if the test was discontinued due to discontinuation criteria, the subject was considered to have made errors on all remaining trials on that particular subtest.

APPENDIX H

INSTRUCTIONS TO SUBJECTS

Instructions to College Students

Today we are going to do two experiments of a similar nature. The first will be fairly short, the second slightly longer but the total time should be less than an hour. We've arranged the research in this way to make it easier to collect the data since both these experiments deal with achievement. Any questions?

I'll need to get some information first.... The first experiment consists of two short tasks. Are you ready? ...

That finishes the first experiment, now we'll go on to the second. This experiment also consists of a few short tasks. For this research we have received a government grant. (R: and if you do well enough on the tasks you will receive a $2.00 prize). Try your best. ....

Instructions to Elementary School Students

What we are going to do today has two parts. The first will be fairly short, the second slightly longer but the total time should be less than an hour. We've done this so we only need to take you from class once, and both parts are pretty much the same. Any questions?

I'll first need to get some information .... This first part is made up of two short tasks. Are you ready? ...

That finishes the first part, now we will go on to the second. The second part is also made up of some short tasks. (R: For this part we have some prizes. If you do well enough you can get one of these prizes. Come next door and select the prize you would like to get. If you do well enough which prize would you like? We will put that one aside for you. In two weeks we will have the results and let you know whether you will get the prize). Try your best. ...

Instructions to Nursery School Students

What we are going to do today has two parts. The first part is short, the second a little longer. Both parts are pretty much the same. Any questions?

This first part is made up of two short activities. Are you ready?

...

That finishes the first part, now we'll go on to the second. The second part is also made up of short questions and activities. (R: For this part we have some prizes. If you do well enough you can get one of these prizes. Here they are. If you do well enough which one would you like? We will put that one aside for you. Next week after we finish I'll tell you if you get the prize). Try your best. ...

APPENDIX I

LISTS OF PRIZES

List of Prizes and Values for Nursery School

Blow Bubbles Lots a' Ways. Chemtoy Corp. ($.69)

Coloring Books: Western Publishing Company.

The Wizard of Oz Color and Activity Book. 1977. ($.69)

Superman in Luthor's Lost Land. 1975. ($.69)

Crayola Crayons: 24 Crayons. Benney & Smith. ($.42)

Golden Books: Western Publishing Company.

Lassie and The Secret Friend. 1972. ($1.50)

Raggedy Andy: The I Can Do It, You Can Do It Book. 1976. ($1.50)

Walt Disney's Cinderella. 1950. ($1.50)

Walt Disney's Snow White and the Seven Dwarfs. 1952. ($1.50)

Peg Board Design Set. Little Big Toys, Target Stores Inc. ($.59)

Tinkertoys Construction Set: Primary 45 pieces. Questor Education Products. ($1.67)

List of Prizes and Values for Elementary School

Books:

Dixon, F. W. The Hardy Boys #52 The Shattered Helmet. New York: Grosset & Dunlap, 1973. ($2.50)

Keene, C. The Nancy Drew Mystery Stories #45 The Spider Sapphire Mystery. New York: Grosset & Dunlap, 1968.($2.50)

Butterfly Kite. Top Flite, Division of Crunden Martin.($2.50)

Croxley Jigsaw Puzzle #4611. Milton Bradley Company.($.74)

Duncan Imperial Yo-Yo. Duncan.($1.39)

Jumprope and Jacks Set. Little Big Toys, Target Stores Inc. ($.99)

Interlocking Pieces 15 Puzzle. Lowe Company, Milton Bradley.($.99)

LeMans Racing Cars. Zee Toys.($.98)

Kopy Kat Paint Set. Dixon, The American Craton Company.($.79)

Peg Board Design Set. Little Big Toys, Target Stores Inc. ($.59)

Ridge Riders (Yamaha 650 Police). Zee Toys.($.59)

Slinky. James Industries.($.98)

APPENDIX J

LETTERS TO PARENTS AND PRINCIPAL

Oklahoma State University

DEPARTMENT OF FAMILY RELATIONS
AND CHILD DEVELOPMENT

STILLWATER, OKLAHOMA 74074
241 HOME ECONOMICS WEST
(405) 624-5061

Dear Parent:

We are preparing a research project sponsored by the Department of Family Relations and Child Development at Oklahoma State University to be conducted with the cooperation of the teachers and administration at your child's school. The full study involves the use of 40 nursery-school children, two fourth-grade classes and also 80 college students.

The study is an attempt to gain some insight in the development of children's thought patterns in the hope of improving education. A few short tasks will be given to your child. These tasks are standard ability tasks which are often given to children in these age groups and will take about 50 minutes to administer.

If for any reason you do not wish your child to participate in the research project please inform the child's teacher. If you require more information please contact the researchers through the FRCD Department at Oklahoma State University. We will be more than happy to share our results with you upon completion of the research project if you wish.

Thank you for your cooperation.

Sincerely,

John C. McCullers

John C. McCullers, Professor
Department of Family Relations and
Child Development

James D. Moran

James D. Moran III
Research Assistant

JCM:JDM/bgm

Oklahoma State University

DEPARTMENT OF FAMILY RELATIONS
AND CHILD DEVELOPMENT

STILLWATER, OKLAHOMA 74074
241 HOME ECONOMICS WEST
(405) 624-5061

Dear Parent:

We would like to thank you and your child for your cooperation in our research efforts. Since our project dealt with an investigation of the effect of reward on the development of children's thought patterns, your child has received a prize for participation in the research.

Our research to date indicates that on some types of tasks reward helps performance, but on other types of tasks (especially those involving creativity, conceptual organization or complex problem-solving) reward may hinder performance.

Once again if you would like to hear more about the research please contact the researchers through the Family Relations and Child Development Department at Oklahoma State University.

Sincerely,

John C. McCullers, Professor
Department of Family Relations and
Child Development

James D. Moran III
Research Assistant

JCM:JDM/bgm

Oklahoma State University

DEPARTMENT OF FAMILY RELATIONS
AND CHILD DEVELOPMENT

STILLWATER, OKLAHOMA 74074
241 HOME ECONOMICS WEST
(405) 624-5057

April 4, 1978

Ms. Barbara Bayless, Principal
Westwood School
502 S. Kings Highway
Stillwater, Oklahoma 74074

Dear Ms. Bayless:

I would like to extend our gratitude for your assistance and cooperation in helping us conduct our research study at Westwood School. I realize that having groups such as ours coming into your classrooms causes some inconveniences and we appreciate your patience. Everyone associated with Westwood including the staff, teachers and students was extremely pleasant and helpful. Special thanks should go to Mrs. White and Mrs. Moore for their cooperation.

Sometime in the near future I hope to provide the school with some feedback as to the results of our investigation. As soon as a written report of the findings is available, we will send a copy to you. Dr. McCullers, Nancy Houston and myself wish you all the best.

Sincerely,

James D. Moran III

JDM/bgm

APPENDIX K

PILOT WORK

The pilot work to be described here has been conducted by Moran, McCullers, and Fabes. Two experiments were conducted prior to the present study. The intent in the pilot studies was to begin to assess the role of reward in intelligence test performance in a research atmosphere where heredity-environment issues were not at stake. We simply wanted to know if reward could be shown to affect performance and, if so, whether that effect would be consistent across subtests.

In the first study, two groups of 10 white, female undergraduates each were administered the full-scale version of the WAIS by white male examiners, one group (R) under reward conditions and the other group (NR) under nonreward. The subjects were matched closely on age and Wide Range Vocabulary (WRVT) scores. The age of the subjects ranged from 18 to 20 years in both groups with a mean of 19.1 years in the group R and 18.9 in NR. The WRVT was used to provide a pre-experimental estimate of intelligence because WRVT scores correlate highly with verbal and total IQ. The mean Wide Range score for group R was 75.3 (range = 63 to 85), and for group NR was 74.8 (range = 62 to 86). Subjects in the NR group were simply tested according to the standard administration procedure.

Subjects in the R group received four dollars each for their participation. We were aware that how and when the money was delivered might be crucial but did not know whether immediate or delayed, or contingent or noncontingent payment, and,-if contingent, whether for mere participation or for good performance would be more likely to yield an effect of reward on IQ. We did not want to try to resolve all these issues in this initial study, but merely wanted to provide an ample opprtunity for reward to show its effect if one were there.

Therefore, subjects were rewarded according to the following rather elaborate procedure: All R subjects were told that they would receive 25 cents for participating in the study, an additional 25 cents for each task (subtest) they completed, and on a few selected tasks they could also earn an additional 25-cent bonus for good performance. Subjects were told that they would not know in advance which tasks carried the bonus. Rewards were delivered and accumulated as testing progressed: a quarter dollar after the instructions, an additional quarter at the conclusion of each of the eleven subtests, and a quarter bonus after four subtests. Six tests were identifued at their conclusion as having been "bonus" tasks. All R subjects were told that they had earned the bonus on four of these (Similarities, Digit Span, Digit Symbol, Picture Arrangement) but had not earned it on two (Arithmetic, Block Design).

The results indicated that reward had a modest detrimental effect. The mean total IQ was 109.7 for the R group and 112.6 for the NR group; performance and verbal IQ scores were essentially the same. These are admittedly not impressive differences but given our small sample size and the presumed difficulty of modifying IQ scores in this way, we found them interesting. The performance trend across subtests was highly similar for both groups. The NR group scored higher than the R group on seven subtests, but the mean difference between groups was less than a scaled-score point in all but three of the eleven subtests. The R group was superior to the NR group by more than a point on Comprehension (R mean = 12.0, NR mean = 10.1); NR was superior to R by more than a point on Digit Span (R mean = 12.2, NR mean = 13.4) and Picture Completion (R mean = 10.3, NR mean = 11.4).

Without making too much of these specific findings, it appeared that reward could affect IQ, that total IQ might be adversely affected but only slightly so, and that reward may have different effects with different subtests.

Our interests in the effects of reward on intelligence test performance expanded and three related research goals were considered. First of all, having found that problem-solving abilities are adversely affected by reward, and assuming that effective problem solving requires insight, discovery, reasoning, and the like, we wanted to know if intelligence might be among the processes involved in reward's detrimental effects. Secondly, we wanted to test the algorithmic-heuristic dimension of the two-factor prediction model outlined by McGraw. And thirdly, we were curious to know if reward's detrimental effects might be detectable as developmental changes in intellectual functioning. Because the various subscales of the Wechsler intelligence tests tap both heuristic processes (i.e., rote memory and simple mechanical skills) and heuristic processes (i.e., discovery and insight), and because intelligence tests have long been used to assess both intellectual power or complexity of functioning, and level of intellectual maturity or mental age, these tests appeared to offer a potentially useful tool for helping us to achieve our threefold goal. We settled on the Wechsler scale also because it is well standardized, widely used, and of known reliability, and because it offered us an opportunity to extend our work beyond the traditional laboratory tasks into settings closer to the everyday environment.

Our second study attempted to determine if the effect of reward would conform to the McGraw prediction model by facilitating performance on algorithmic subtests but having a detrimental effect on more heuristic ones. This study also attempted to resolve some of the issues raised in the first study concerning methods of administering the reward. On purely logical grounds, we selected three subtests of the WAIS as being mainly algorithmic and three as being heuristic. With some reservation concerning our choices, we settled on Information, Digit Symbol, and Picture Completion as the algorithmic tasks, and on Block Design, Picture Arrangement, and Object Assembly as the heuristic tasks. This six-subtest task would, we hoped, provide a means of examining algorithmic and heuristic tasks on a within-subject basis under reward and nonreward conditions.

In order to evaluate the importance of method of administering reward, the design consisted of four treatment groups, one nonreward and three reward groups. These reward groups were contingent reward, noncontingent reward (paid), and social competition reward that competed for a monetary prize. The nonreward group, as before, was given the standard administration procedure. The contingent reward group received a nickel for each correct resonse. Here contingencies were explained to the subject in advance and they were told that they could make between two and three dollars during the session. Rewards were delivered as they were earned and accumlated before the subjects. The contingent reward subjects typically earned between $2.50 and $3.00 each. Paid reward subjects were simply told that we had funds available to pay them for their participation and prior to being presented any of the WAIS materials they were told they would receive $2.50. The social reward subjects were told that they were competing with other students like themselves and that the five highest scorers would receive a $5.00 prize, and that except for the five winners, no one else in the group would receive anything. The subjects were predominantly white female undergraduates of approximately the same age and IQ level as in the first study. There were 19 subjects per group closely matched on age and Ammon's Quick Test Scores. The examiners, as before, were white males.

The results are summarized graphically in Figure 4. It may be seen in the figure that the three reward conditions yield highly comparable results. Also, treatments had no differential effect over the first three subtests (the ones we are calling algorithmic). On the last three subtests (the heuristic tasks) the three reward groups were quite similar and clearly below the NR group. The three reward groups were not significantly different from each other but differed as a group from the NR group, $\underline{p} < .05$. Also, the interaction of the reward-nonreward variable with the algorithmic-heuristic variable was significant, $\underline{p} < .05$, even though the three algorithmic tasks did not differ from significantly from the three heuristic ones. Thus, it appears that reward can affect subtests differentially and the particular way that reward is administered does not seem to matter. In this case where reward had a detrimental effect on subtests but not an offsetting enhancement on others, the net effect of reward on the six-subtest scale was detrimental. The overall mean differences in this second study were roughly comparable to those we found in the first study.

In this study, several rather unusual analyses were performed. One aspect of performance that interested us was the time to task completion. Whether the lower performance of the reward groups was simply a result of differences in time spent on the problems or of differences in errors seemed potentially important to theory formation.

Analysis of the times to completion on the subtests revealed no significant differences. The importance of this finding lies in the fact that these are timed tests and a person's raw scores are based on the time factor. This finding indicates that the lower scores of the reward group were not merely a function of time to completion. In analyzing errors we primarily looked at the heuristic tasks (BD, PA, and OA). On the heuristic tasks, the nonreward subjects made significantly fewer errors than the reward subjects, $p < .006$. Inclusion of the Digit Symbol subtest yields the suggestion of a reward X subscale interaction, $p < .06$, in that the nonreward group made a greater number of errors than the reward groups on this task.

The data appear to offer at least partial support for the prediction model along the algorithmic-heuristic dimension. On the tasks we labeled as heuristic there was a detrimental effect of reward. The performance of the rewarded subjects, regardless of the method of reward (i.e., contingent, payment, or social competition) was poorer than that of the nonrewarded subjects who received standard administration. On the scales we labeled algorithmic, however, no reward facilitation existed as predicted by the model. On these tasks rewarded and nonrewarded subjects performed similarly.

It seems reasonable to conclude at this point that reward does indeed affect intellectual functioning, as measured by standardized intelligence tests. From a purely logical perspective, it should be possible to identify algorithmic subscales that would show enhancement effects of reward. If so, we would expect to find a detrimental effect of reward on heuristic subscales, and an enhancing effect of reward on algorithmic subscales, for a net effect of no overall change.

As concerns our search for possible developmental changes in intellectual functioning, there is some at least suggestive supportive evidence. At a gross level, there is an indication that IQ declines slightly under reward. Given that the subjects were matched initially on age, sex, and IQ, any decline in IQ scores as a function of reward could in this context be interpreted as a decline in intellectual maturity of level of functioning. We know that this decline was not a result of differences in time spent on the items by reward and nonreward subjects, but in differences in the errors these subjects made. If the error difference had resulted from the errors of reward subjects being scattered randomly between and within the subscales, it would have been easier to argue the reward produces a general disruption of functioning rather than developmental regression. On the contrary, however, errors under reward tended to occur predominantly in the heuristic tasks, requiring greater cognitive ability, and predominantly toward the end of those subscales requiring the highest levels of abstract functioning.

Our consideration of the developmental regression notion stems from our search for a mechanism to explain the observed detrimental effect of reward. We feel that by themselves the data of these studies would not offer much support for the idea of developmental regression, but we have found enough additional support elsewhere in our research, to at least entertain this interesting and hopefully fruitful hypothesis.

Figure Caption

Figure 4. Mean scaled scores on individual subtests for rewarded and nonrewarded subjects in pilot study.

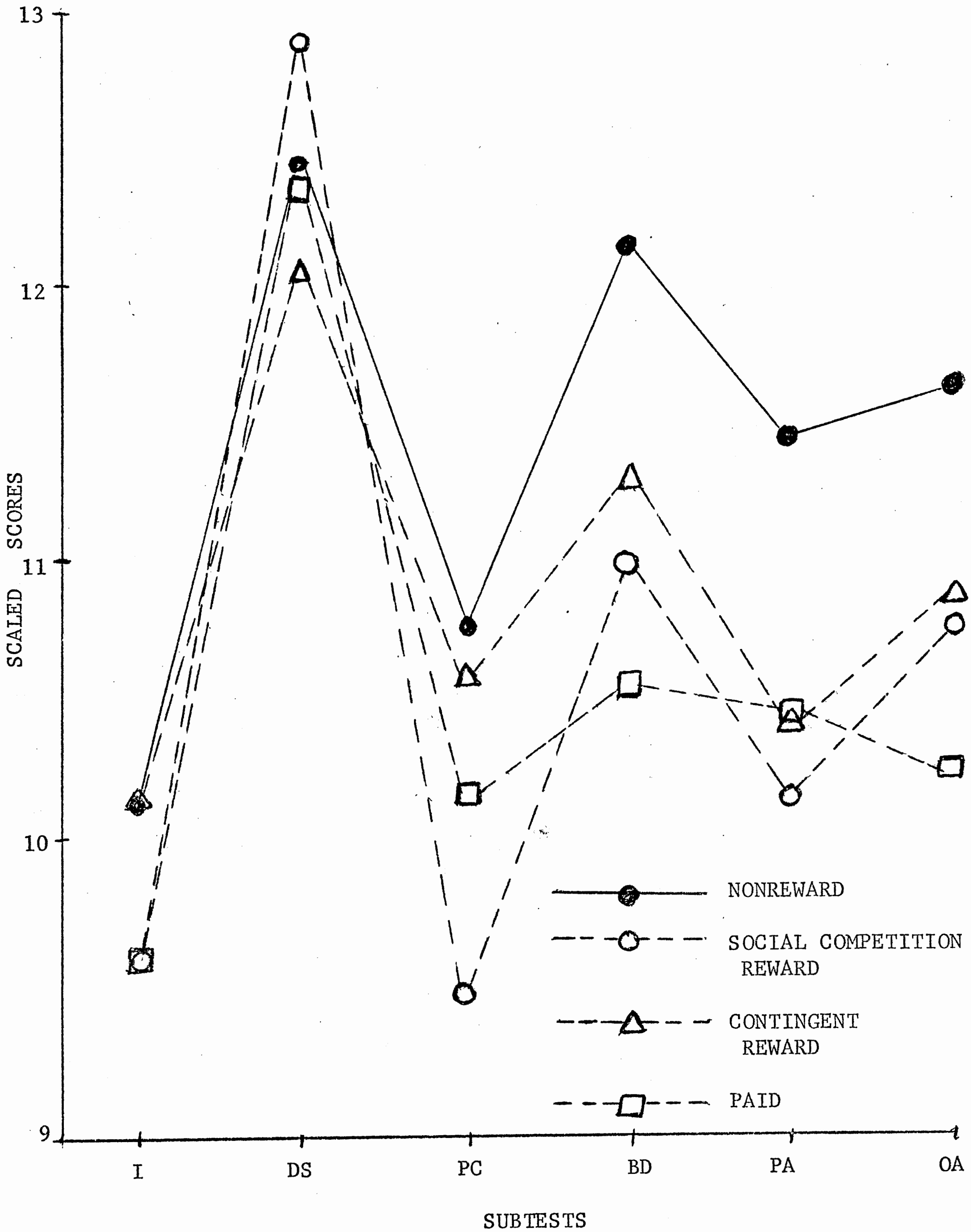
13
12
11
10
9
SCALED SCORES
I
DS
PC
BD
PA
OA
SUBTESTS
NONREWARD
SOCIAL COMPETITION REWARD
CONTINGENT REWARD
PAID

Figure 4.

VITA

James D. Moran III

Candidate for the Degree of

Doctor of Philosophy

Thesis: A DEVELOPMENTAL ANALYSIS OF THE EFFECT OF REWARD ON WECHSLER INTELLIGENCE TEST PERFORMANCE

Major Field: Home Economics--Family Relations and Child Development

Biographical:

Personal Data: Born in Brooklyn, New York, March 2, 1951, the son of James D. and Monica Moran.

Education: Graduated from Fordham Preparatory School, Bronx, New York, in May, 1969; received Bachelors of Arts degree in Psychology and History from Duke University in 1973; received Masters of Science degree in Psychology from the University of Oklahoma in 1975; completed requirements for the Doctor of Philosophy degree at Oklahoma State University in July, 1978.

Professional Experience: Resource staff member, Bancroft School, Owls Head, Maine, 6/73-8/73; teaching and research assistant, Department of Psychology, University of Oklahoma, 9/73-7/75; counselor and Director of Vocational Services, Cheyenne Village, Manitou Springs, Colorado, 9/75-9/76; teaching and research assistant, Department of Family Relations and Child Development, Oklahoma State University, 9/76-7/78.

Professional Affiliations: Kappa Delta Pi; Phi Upsilon Omicron; Sigma Xi; American Home Economics Association; National Council on Family Relations; Oklahoma Home Economics Association; Society for Research in Child Development; Southwestern Psychological Association; Southwestern Society for Research in Human Development.