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EFFECTS OF DIFFERENT LEVELS OF PRECISION OF KNOWLEDGE OF RESULTS ON THE ACQUISITION OF A MOTOR SKILL

A Thesis

Presented to

the Faculty of the Department of

Physical Education and Recreation

Western Kentucky University

Bowl'ng Green, Kentucky

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

by

Wenda D. Johnson

May 1975

EFFECTS OF DIFFERENT LEVELS OF PRECISION
OF KNOWLEDGE OF RESULTS ON THE
ACQUISITION OF A MOTOR SKILL

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W.D.J.

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Wenda D. Johnson May 1975 30 pages

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Students enrolled in two beginning bowling classes received the same basic instruction on bowling techniques, but practiced under two different levels of precision of knowledge of results (KOR). The experimental group practiced by rolling at a full set of ten bowling pins with each ball (precise KOR). The control group practiced by shadow bowling (general KOR). There were no significant differences between groups in the effects of the two practice conditions upon the acquisition of skills. There were no significant groups by tests interaction either. There was, however, a significant trials effect across groups. It was concluded that although both practice conditions resulted in skill acquisition, neither level of precision of knowledge of results was superior to the other.

CHAPTER ONE

INTRODUCTION

A great deal of research has been done to investigate the effects of precision of knowledge of results upon the acquisition and retention of motor skills. There has been, however, no general agreement as to the direction of that effectiveness. A major portion of the research investigating the effects of precise knowledge of results has supported the hypothesis that precise knowledge of results leads to a higher level of learning. A smaller portion of the research has supported the idea that increasing precision of knowledge of results beyond a certain limit does not significantly improve learning or performance. A few studies have added credence to the concept that increased precision of knowledge of results beyond an optimal level may actually lead to deterioration of learning and performance.

STATEMENT OF THE PROBLEM

Based on a review of the literature, it was concluded that there seems to be no general agreement as to the effectiveness of precision of knowledge of results upon acquisition and retention of motor skills. Although the majority of the literature supported the hypothesis that more precise knowl-

edge of results leads more rapidly to a higher level of learning and performance, there were studies which rejected that hypothesis.

PURPOSE AND JUSTIFICATION OF THE STUDY

It has been the common practice of bowling instructors to have beginning bowlers practice approach and delivery skills without the bowling pins in position on the lane, a process known as shadow bowling. The reasoning has been that the presence of pins distracts the students from concentrating on the proper form to be used when bowling, and lack of concentration will delay skill acquisition. It would seem that a target consisting of a full set of pins would provide more precise knowledge of results for the bowlers about the accuracy and effectiveness of their skill than would the total absence of pins. It would also seem that more precise knowledhe of results would result in a higher level of skill acquisition.

The bulk of the literature dealing with knowledge of results has employed simple motor tasks and in general has avoided the more complex motor skills utilized by sports participants. Even so, the literature has failed to agree as to the relative effectiveness of precise and general knowledge of results. It was the intent of this study to investigate the differences in the effects of general knowledge of results (shadow bowling) and precise knowledge of results (full set of pins present) upon the acquisition of a motor skill (bowling).

LIMITATIONS AND DELIMITATIONS OF THE STUDY

Limitations and delimitations of the study were that (1) it was requested that bowling outside of class be avoided, but this could not be controlled by the experimenter, (2) assignment of subjects to groups was not random and groups were not equal on the basis of age, sex, etc., and (3) it could not be guaranteed that each subject would be able to use the same equipment at each class meeting.

DEFINITION OF TERMS

feedback: information about one's performance or the consequences of the performance[1]

intrinsic feedback: all changes within the internal and external environment that normally occur as a consequence of the movement[2]

knowledge of performance: intrinsic feedback concerning the movement itself[3]

knowledge of results: intrinsic feedback concerning the outcome produced by the movement[4]

HYPOTHESIS

The use of precise knowledge of results does not lead to a level of motor skill learning or acquisition that is

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[1]Loretta Stallings. 1973. Motor Skills: Development and Learning. Dubuque: Wm. C. Brown. p. 108.

[2]A. M. Gentile. 1972. A working model of skill acquisition with application to teaching. Quest. 17:8.

[3]Ibid.

[4]Ibid.

different from that obtainable through the use of general knowledge of results.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

Although a great deal of research has been done to investigate the effects of precision of knowledge of results upon the acquisition and retention of motor skills, there is some question about the extent of those effects. There are studies which support the generalization that precise knowledge of results leads to a higher level of learning than general knowledge of results. However, some studies suggest that increasing the precision of knowledge of results produces results no different from those that can be obtained with general knowledge of results. In addition, a few studies have been done by people who believe that increasing the precision of knowledge of results may actually lead to a deterioration in learning and performance.

The majority of the literature seems to support the generalization that efficiency of motor learning and performance increases with the precision of knowledge of results that is given. Ammons[5] surveyed the literature dealing with the effects of knowledge of performance and formulated several em-

[5]R. B. Ammons. 1956. Effects of knowledge of performance: a survey and tentative theoretical formulation. Journal of General Psychology. 54:290.

pirical generalizations. After stating that knowledge of performance affects rate and level of learning, he further explained that if an individual has specific knowledge of his performance, he can make more rapid improvements and attain a higher level of performance. He also stated that on the basis of information about direction and amount of error, a performer can make corrections for his performances of the future.

Annett and Kay[6] proposed that the most common example of knowledge of results is the end score. They stated that if performance of a task involves a certain degree of accuracy, the end score gives the results of that performance, but the actual end score does not, however, give particular information about responses on the part of the individual that brought about that end score, nor does mere knowledge that an individual has failed to reach a criterion score give particular information about performance either. Annett and Kay explained that end scores, and knowledge that a criterion score was not reached, do give an individual a more exact indication of how well he has done than other sources of information would. They further explained that such scores are presented in terms of known scales which are easy to interpret and easy to remember. They stated that the giving of scores probably stimulates both social and self competition and thus becomes a motivating factor in the learning process.

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[6]John Annett and Harry Kay. 1957. Knowledge of results and "skilled performance." Occupational Psychology. 31:69-79.

Schmidt[7] proposed that beyond the importance of knowing whether a performance is right or wrong, there is further gain in performance or learning when the accuracy of error information is increased. The added benefit becomes smaller and smaller as the accuracy increases, however.

Oxendine[8] reported that authorities have recognized for a long time that receiving specific knowledge of results improves learning. In support of his statement, he suggested consideration of questions such as "How far did I miss?" and "What did I get right?" that are often asked by students. He proposed that answers to such questions are often instrumental in helping a student to improve future efforts. Oxendine also stated that knowledge of results must be meaningful to the learner and specific in nature. To be effective, teachers should provide as much feedback as possible for their students.

To further support the use of precise knowledge of results, Morgan and King[9] stated that, ideally, a person should know exactly how well he has done on each trial. If shooting at a target, for example, the performer should know after each shot just how close he came to the target and in what direction he was off the goal. They did state that if knowledge of re-

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[7]Richard Schmidt. 1975. Motor Skills. New York: Harper and Row. p. 90.

[8]J. B. Oxendine. 1968. Psychology of Motor Learning. New York: Appleton-Century-Crofts. p. 57-8.

[9]Clifford Morgan and Richard King. 1966. Introduction to Psychology. New York: McGraw-Hill. p. 126.

sults in precise form is not possible, a general level of knowledge is next best, and better than no knowledge of results at all.

In a study involving precision of knowledge of results, Smoll[10] had subjects attempt to roll a duckpin bowling ball at 70% of their maximum velocity. Subjects in one group were told the results of their performance correct to the nearest hundreths-of-a-second. Another group of subjects was given knowledge of results correct to the nearest tenths-of-a-second. A third group was given knowledge of results by being informed if their attempt was too slow, too fast, etc. Practice involving more precise knowledge of results produced a level of performance significantly higher than that produced by the less specific feedback. The results of the study supported results he had obtained previously in a similar study.[11]

Trowbridge and Cason[12] performed a study to test Thorndike's theory of learning. Their subjects were blindfolded and seated at a table. The table top was covered with a sheet of paper marked off in a grid for easy scoring.. A veneer strip provided a common starting point for all subjects who were in-

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[10]Frank Smoll. 1972. Effects of precision of information feedback upon acquisition of a motor skill. Research Quarterly. 43:489-93.

[11]Idem. 1970. Specificity of information feedback as factors in learning of a motor skill. Ph. D. Dissertation, University of Wisconsin.

[12]Margery Trowbridge and Hulsey Cason. 1932. An experimental study of Thorndike's theory of learning. Journal of General Psychology. 7:245-60.

structed to draw either a 3 inch, 4 inch, 5 inch, or 6 inch line using a quick, continuous motion. After each trial, the subject was told one of four things by the experimenters. In one set of trials, after each attempt subjects were told they were right if they were within 1/8 inch of the command. During another set of trials, subjects were told a nonsense syllable such as "vup" after each attempt. During a third set of trials, subjects were told the length of the line they had drawn in terms of how much off the command they were, i.e., plus 2/8 inch, minus 3/8 inch, etc. After a fourth set of trials, the subjects were given no knowledge of results as a control measure. Subjects drew 100 lines with one of the four feedback conditions, rested five minutes,and drew another 100 lines with a different knowledge of results condition. When subjects were told the precise correctness of their efforts, they exhibited the most efficient performance. The right-wrong, no knowledge, and nonsense conditions followed in effectiveness in respective order. The experimenters suggested that telling the subjects the correct length of lines they had drawn made it possible for them to make adjustments on later trials. It was further stated that simply being told right or wrong was not enough and that improvement was conditioned by the kind and amount of information a subject receives about the task he is performing.

McGuigan[13] also conducted an experiment employing the

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[13]F. J. McGuigan. 1959. The effect of precision, delay, and schedule of knowledge of results on performance. Journal of Experimental Psychology. 58:79-84.

task of drawing lines of designated length. To test for the effects of precision of knowledge of results, subjects were asked to draw 6 inch lines. There were 70 learning trials followed by a five minute rest, and then there were 70 extinction trials. Subjects in one group were told they were correct if they came within 1/8 inch of the desired 6 inch line. Subjects in a second group were told they were correct if they came within 5/8 inch of the command. Subjects in a third group were told they were correct if they came within 10/8 inch of the desired goal. In all cases if the subjects did not draw a line of "correct" length, they were told how much they deviated from the 6 inch goal. As a whole, the more precise feedback group (1/8 inch) had lower mean deviations during the learning and extinction trials.

To determine the effectiveness of general and specific knowledge of results, Lavery[14] had twenty subjects facing away from the target throw magnetized pellets at a target lying flat on a table top. The target was marked in a manner similar to an archery target. Subjects in one group were told their score only. Subjects in a second group were told their score plus the position of the hit in terms of a clock face. Improvement was more marked for those subjects who received the more precise knowledge of results.

The effects of knowledge of results on the development of velocity in the overhand softball throw were investigated by

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[14]J. J. Lavery. 1964. The effects of one-trial delay of knowledge of results on the acquisition and retention of a tossing skill. American Journal of Psychology. 77:437-43.

Dameron.[15] Two regular classes of physical education were taught to throw by traditional methods and two other classes were taught with the subjects being told immediately the specific velocity of each throw. Subjects who received the specific velocities performed significantly better than the subjects who were taught by traditional methods.

Ross[16] had subjects perform the simple task of making tally marks in order to investigate the relationship between knowledge of progress and achievement. One group was given full knowledge of results. A second group was given partial knowledge of results, i.e., above, below, but not how much so. A third group was given no knowledge of results. Ross found that the group working with full knowledge gained the most in terms of both speed and accuracy. In addition, he found that when knowledge was withheld, performance dropped. He further stated that the degree of superiority of performance was proportional to the amount of information processed by the subject.

Payne and Hauty[17] had 144 subjects perform the USAF SAM Multidimensional Pursuit Test under three levels of incen-

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[15]Mary Jane Dameron. 1971. Augmented KOR as an aid to the development of velocity in the overhand softball throw. M.S. Thesis, Southern Illinois University. As cited in Robert Singer and Raymond Weiss. 1973. Completed Research in Health, Physical Education and Recreation. 15:214-5.

[16]C. C. Ross. 1927. An experiment in motivation. Journal of Educational Psychology. 18:337-46.

[17]R. B. Payne and G. T. Hauty. 1955. Effect of psychological feedback upon work decrement. Journal of Experimental Psychology. 50:343-51.

tive feedback and tuition. Tuition (T) consisted of telling subjects when any of four instruments drifted from their null zone. Incentive feedback (M) consisted of providing subjects with varying amounts of information concerning progress at the conclusion of each cycle of tests. T_1 involved no prescribed warning with deviations only detectable by the subject's own scanning procedure. T_2 involved T_1 plus a single peripheral signal whenever a deviation occurred, but it did not specify which instrument was deviating. T_3 provided signals that specified both fact and locus of deviations in addition to T_1. M_1 consisted of no prescribed information other than a hazy notion of progress which the subject could form spontaneously. M_2 provided the subject with knowledge of his standing relative to a performance level presented to him as a group norm. M_3 included M_2 and allowed the subject's standing on previous trials to remain in view for subsequent trials. Results were that T_3 was superior to T_2 which was superior to T_1. M_3 and M_2 were superior to M_1 but were not significantly different from each other.

Hunt[18] paid 64 subjects to perform a tracking test under two levels of task difficulty, easy and difficult. Four degrees of specificity of knowledge of results employed were (a) three categories - only information concerning existence and direction of error which was displayed to the subject, (b)

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[18]Darwin Hunt. 1961. The effect of the precision of informational feedback on human tracking performance. Human Factors. 3:77-85.

seven categories - information about direction of error and three indices of error magnitude in either direction, (c) thirteen categories - information similar to (b) but six indices of error magnitude were presented to the subject, and (d) continuous - error dot moved continuously in either direction from zero position in direct relation to tracking error. The precision levels ranged from the least precise condition (a) to the most precise condition (d). Hunt found that increasing the number of categories of information, and thus increasing precision of information feedback, seemed to result in improved performance, and the relative improvement was associated with increasing the number of informational categories which appeared to be different depending upon the stage of practice. The tracking error decreased with increases in the number of informational categories with the major reduction in error associated with increasing the number of categories from three to seven. Improvement was not influenced by the difficulty of the task.

Rothstein[19] had 48 young boys attempt to space the timing of a key press in a manner that would light up a clown's nose on a display board. One group of boys received magnitudinal feedback consisting of telling them how much they were off but not the direction of the error. Another group got directional feedback but not magnitudinal feedback. A third group

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[19]A. L. Rothstein. 1972. Effect of age, feedback, and practice on ability to respond within a fixed time interval. Journal of Motor Behavior. 4:113-9.

got specific information about the amount and direction of the error. A fourth group received no knowledge of results as a control measure. The mean number of correct responses was 3.6 for the magnitudinal feedback group, 10.43 for the directional feedback group, and 10.95 for the specific feedback group. It was explained that subjects under specific and directional feedback had less trouble emitting correct responses that did the subjects under magnitudunal feedback. Rothstein cautioned that performance on timing tasks such as this may be due to ability to solve problems, and not actually due to the effects of feedback conditions.

Although the results of the previously surveyed studies supported the use of precise knowledge of results to obtain a higher level of performance, there were studies which have not accepted that procedure. Those studies supported the contention that increasing the precision of knowledge of results beyond a certain level produces no significantly different effects on learning than does general knowledge of results.

Bilodeau and Rosenbach[20] reported scores rounded to the nearest unit in multiples of 5, 10. ...50 to subjects who turned a knob without visual cues. They found that only the severest rounding (steps of 40 and 50 units) was detrimental

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[20]E. A. Bilodeau and J. H. Rosenbach. 1953. Acquisition of response proficiency as a function of rounding error in information feedback. USAF Human Resources Research Center Research Bulletin. Lackland Air Force Base, San Antonio. No. 53-21. As cited in Ina McD. Bilodeau. 1969. Information feedback. In E. A. Bilodeau and Ina McD. Bilodeau. Principles of Skill Acquisition. New York: Academic Press. p. 290.

to performance, and only early in practice.

In an unpublished study, Bilodeau[21] used the same task of knob turning to illustrate both the effectiveness and limitations of rounding score reports. One group received magnitudinal and directional feedback about their scores. Another group got directional feedback only, while a third group got magnitudinal feedback only. The directional feedback was as effective as the more specific condition of both magnitudinal and directional feedback, but the magnitudinal information alone was inferior. She explained that optimal positioning accuracy does not require carefully refined information feedback.

Bell[22] had subjects practice the badminton long serve twenty times for eight days under four knowledge of results conditions. A rope was placed 15 inches above and 14 feet beyond the net away from the subjects. Subjects in one group had a partner who called out over, under, in or out after each serve. Subjects in the quantitative group had the direction of error recorded for them after each trial. Subjects in the qualitative group were told to try to correct their most common error from results of twenty trials that were recorded on a

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[21]Ina McD. Bilodeau. 1966. Information feedback. In E. A. Bilodeau. Acquisition of Skill. New York: Academic Press. p. 264-6.

[22]Virginia Bell. 1966. Augmented KOR related to constant and variable errors and its effects upon acquisition of a gross motor skill. Doctoral Dissertation, University of Southern California; Idem. 1968. Augmented knowledge of results and its effect upon acquisition and retention of a gross motor skill. Research Quarterly. 39:25-30.

diagram that the subject was allowed to examine. A fourth group practiced with no rope present as a control measure. There were no significant differences in the effects of having the rope present or not having it present on either the retention or acquisition of the badminton long serve. Thus, increased precision made available due to the presence of the rope did not increase performance over that obtainable without a rope present.

Ross[23] had subjects perform the task of making tally marks under four knowledge of results conditions. This was an extension of his 1927 experiment.[24] In this experiment, one group of subjects received full knowledge of results, a second group received only partial knowledge, and a third group reveived only vague knowledge. A control group received no knowledge of results. He found no significant differences in the achievement of the four groups. As a possible explanation of these results, he offered that the condition of no knowledge of results in this task is impossible because there is always some knowledge available to the performer. He also cautioned that it be remembered that this experiment was conducted in a classroom situation rather than in a laboratory setting where differences have been found.

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[23]C. C. Ross, 1933. The influence upon achievement of knowledge of progress. Journal of Educational Psychology. 24: 609-19.

[24]Idem. An experiment in motivation. p. 337-46.

Chapanis[25] had subjects in four different knowledge of performance groups punch a computer tape in order to measure differences in output levels under various knowledge of results conditions. One group did not have a counter present to give information about work output. A second group had a counter present but it was not set back to zero at the beginning of each day's session. Another group had the counter present, and for them it was always set back to zero at the beginning of each session. In addition to having the counter present and set back to zero each day, subjects in a fourth group were asked to write down their outputs with their names and the date at 15, 30 and 45 minutes during the hour sessions. No significant differences were found in the output levels of the four groups. To explain his results, Chapanis merely stated that perhaps information per se does not serve as incentive. In addition, he proposed that conditions of the experiment might not have been sensitive enough to pick up differences that may have actually been present.

Crafts and Gilbert[26] had subjects try to learn a stylus maze. Subjects of one group were told control group scores against which they were asked to compete. Scores were reported to subjects in a second group in the form of number of trials,

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[25]Alphonse Chapanis. 1964. Knowledge of performance as an incentive in repetitive, monotonous tasks. Journal of Applied Psychology. 48:263-7.

[26]Leland Crafts and Ralph Gilbert. 1935. The effect of knowledge of results on maze learning and retention. Journal of Educational Psychology. 26:177-87.

number of errors, and time spent on trials. The so-called knowledge of results group was not superior in performance. Members of the knowledge of results group were reported to be confused by the complexity of the scores given to them. When interviewed by the experimenters after completion of trials, subjects reported that they had concentrated on one aspect of the task, such as number of trials, and had failed to pay adequate attention to the other factors.

Robb[27] summarized the ineffectiveness of precise knowledge of results by stating that man is limited in his capacity to process information, and cannot handle all available information so he must learn to sort out irrelevant information. Skilled players know which information to process and which to ignore, whereas unskilled players cannot always make that distinction accurately. Robb stated that information for a beginner should be limited and directly related to the sequential order of events. She further stated that the amount of information a learner can process is task specific. Robb also explained that because a beginner cannot process the same information that a more advanced player can, additional or augmented feedback may not be helpful to the beginner.

There were additional studies in the area of feedback which contradicted the previously surveyed studies by proposing that increasing specificity of knowledge of results beyond a

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[27]Margaret Robb. 1972. Task analysis: a consideration for teachers of skills. Research Quarterly. 43:362-73.

criterion level actually leads to a deterioration of both performance and learning. It is interesting to note, however, that none of the studies actually specified any kind of limit, but merely theorized that the limits existed.

Bilodeau and Morin[28] had Air Force trainees perform the Pedestal Sight Manipulation Test with the tracking pipper removed from the sight, thus providing less specific feedback for the subjects. The trainees scored better with the pipper removed than they did with it present.

Annett[29] also discovered evidence to contradict the hypothesis that increases in precision of knowledge of results lead to superior retention. Three precision levels of verbal knowledge of results were used in a line positioning task. No significant differences were found between the three groups during learning trials, but the least precise feedback group outperformed the other groups during the retention trials.

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[28] E. A. Bilodeau and R. E. Morin. 1951. A preleminary investigation of the effect of the removal of the pipper from the projected reticle pattern of the Pedestal Sight Manipulation Test. USAF Human Resources Research Center Research Bulletin. Lackland Air Force Base, San Antonio. No. 51-2; Idem. 1951. Proficiency on the Pedestal Sight Manipulation Test with and without the tracking pipper. USAF Human Resources Research Center Research Bulletin. Lackland Air Force Base, San Antonio. No. 1-27.

[29] J. Annett. 1959. Some aspects of the acquisition of simple sensori-motor skills. Ph. D. Dissertation, University of Oxford. As cited in R. W. Tomlinson. 1972. Control impedance and precision of feedback as parameters in sensori-motor learning. Ergonomics. 15:33.

SUMMARY

Although a great deal of research has been done to investigate the effects of precision of knowledge of results upon the acquisition and retention of motor skills, there is no general agreement about those effects. The majority of the literature has supported the use of increased precision of knowledge of results in order to obtain the highest possible level of learning. A smaller portion of the research has indicated that increasing precision of knowledge of results beyond a certain level does not significantly improve either learning or performance. A few studies have indicated that increased precision of knowledge of results beyond an optimal level may actually lead to a deterioration of both learning and performance.

CHAPTER THREE

METHODS AND PROCEDURES

Subjects for the study were students enrolled in two beginning bowling classes. The experimental group consisted of 24 subjects and the control group consisted of 23 subjects. A coin was flipped to determine which group would receive the experimental treatment. Both classes met at 12:40 P.M. for one hour on alternate days. The equipment at the Dero Downing University Center at Western Kentucky University was used by both groups.

The control group practiced under the commonly used feedback condition of shadow bowling. This was considered to be general knowledge of results. Subjects in the experimental group practiced under the feedback condition that involved a full set of ten bowling pins as a target each time they rolled a ball. This was considered to be precise knowledge of results. Every attempt was made to equate the amount of practice each group received. Subjects practiced on the same lanes on which they were tested.

Both groups received the same basic instruction in the fundamentals of bowling. Topics covered, in order, were the selection of proper equipment, stance, trial swing, one-step delivery, four-step approach, rolling for strikes and spares

using a straight ball delivery, and rolling for strikes and spares using a hook ball delivery. Members of both groups were given individual assistance by the instructor.

The measuring instrument that was used in all test situations consisted of twenty balls rolled by each student. Each time a ball was rolled, the target was a full set of ten bowling pins in their normal position on the lane. On regular bowling score sheets, the subjects recorded the number of pins they knocked down with each ball. The criterion score consisted of the total number of pins knocked down by each individual with twenty balls.

The test was administered on four different occasions to each group of subjects. On each occasion, the test was taken by subjects on the same lanes on which they had been practicing. After instruction and help was given in the selection of equipment, a Pretest was administered the first day of class. Subjects were then given instruction and practice on the one-step delivery, and the four-step approach. Then, after the instruction and initial day's practice in rolling a strike using a straight ball delivery, the test was given a second time (Test S) on the fourth day of class. Subjects were then given instruction and practice in making spares using a straight ball delivery. Instruction was then given regarding the rolling of strikes using a hook ball delivery, followed by two days of practice. After the practice with the hook ball delivery was given, on the eighth day of class the test was administered for a third time (Test H).

Students were then given instruction and two days of practice in making spares using the hook ball delivery. On the twelth day of class, the test was administered a fourth time (Post-test) after three additional days of practice under normal bowling conditions with pins present for strike and spare attempts.

A one-way analysis of variance with repeated measures ($P < .05$) was used on the test data to test for significance of effects. The facilities of the Western Kentucky University Computer Center were used for the statistical analysis.

CHAPTER FOUR

ANALYSIS OF DATA

A one-way analysis of variance with repeated measures was used to test the null hypothesis of no significant differences in the effects of bowling with precise knowledge of results and general knowledge of results upon the acquisition of bowling skill (Table 1). A probability level of .05 was the basis for rejection of the null hypothesis. The criterion measure on each test was the total number of pins knocked down with twenty balls rolled by each subject.

Bsed on a mean score of 134.66 over all tests for the control group and 126.14 for the experimental group, there were no statistically significant differences between the level of skill acquired by the experimental group which practiced with precise knowledge of results and that obtained by the control group which practiced with general knowledge of results. In addition, there was no significant groups by test interaction (Table 2). However, the mean score across groups of 136.26 on the Posttest was significantly better ($P < .05$) than the mean score across groups of 124.47 on the Pretest (Table 3). This indicated that both treatment procedures resulted in skill acquisition, but neither practice condition was superior to the other.

TABLE 1

ANALYSIS OF VARIANCE WITH REPEATED MEASURES OF PERFORMANCE DURING ACQUISITION OF BOWLING SKILLS

Source	D.F.	M.S.	F	P
Between	46	1560.00		
Groups	1	3417.00	2.25	>.05
Error (G)	45	1519.24		
Within	141	222.11		
Tests	3	1093.00	5.40	<.05
G X T	3	269.33	1.34	>.05
Error (T)	135	201.70		
Total	187	551.34		

TABLE 2

MEAN SCORES OF GROUPS BY TESTS

	Pretest	Test S	Test H	Posttest
Experimental	116.79	127.38	127.17	133.21
Control	132.48	134.00	132.74	139.43

TABLE 3

MEAN SCORES OF TESTS ACROSS GROUPS

Pretest	Test S	Test H	Posttest
124.47	130.62	129.89	136.26

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Based on the results of this study, it would appear that precise knowledge of results is not beneficial to beginning bowlers. Perhaps beginners are not capable of properly utilizing the more precise information. Ammons[30] reported that at the start of the learning process the subject can use little information, but as learning proceeds the subject is able to make use of more and more information.

The finer distinctions that accompany increased precision of knowledge of results may be too complex for the beginning bowlers to recognize and deal with appropriately. Robb[31] explained this phenomenon by stating that because man is limited in his capacity to process information he cannot handle all available information and must learn to sort out that which is relevant and that which is not. The more skilled players learn which information to process and utilize, and which to disregard, but unskilled beginners cannot always make that distinction accurately. It may also be that too much information is confusing to a beginner rather than helpful

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[30] Ammons, p. 287.

[31] Robb, p. 367.

as Crafts and Gilbert[32] discovered.

Gentile[33] has hypothesized that the fixation of a specific motor pattern is essential in learning a closed skill such as bowling. Effective utilization of proprioceptive feedback appears to be extremely important in the fixation of a motor pattern. It may be that proprioceptive feedback, and sounds that are associated with ball actions, both of which are inherent in the task of bowling, are of such importance in the acquisition of bowling skills that the increased precision of knowledge of results may not add significantly to the effects of these other sources of information for beginning bowlers. Additional practice and familiarity with the task may make precise knowledge of results more meaningful and allow for proper adjustments to be made by the bowlers as the movement pattern becomes more refined.

Although the study failed to support a need for increased precision of knowledge of results, it should be recalled that several studies[34] utilizing simple motor tasks found that increased precision of knowledge of results was beneficial to the subjects involved. It may be that precise knowledge of results is of more significant importance in simple motor tasks than in complex tasks such as those that are involved in a sports activity. It is possible that the

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[32]Crafts and Gilbert, p. 185.

[33]Gentile, p. 12-3.

[34]Ammons, p. 287; Trowbridge and Cason, p. 245-60; McGuigan, p. 79-84; Lavery, p. 437-43.

effectiveness of precision of knowledge of results is actually task specific as Robb[35] proposed.

RECOMMENDATIONS

Although the results of this study indicated that increasing precision of knowledge of results was not beneficial to beginning bowlers, it did not rule out the possibility that more advanced bowlers might benefit from more precise knowledge of results. A future study might involve more advanced bowlers practicing under each of the two feedback conditions to test for differences of effects at more advanced stages of learning. A followup test could also be given six to eight weeks after the posttest in order to test for effects of the two practice conditions upon retention of skill, which might differ from effects on skill acquisition.

It was observed that the control procedure took less time than did the experimental procedure. This might need to be taken into consideration when decisions on which method to use are to be made if time or class size is a factor.

SUMMARY

Although a great deal of research has been done to investigate the effects of precision of knowledge of results upon the acquisition and retention of motor skills, there is no general agreement as to the extent of those effects. It was the purpose of this study to investigate the differences

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[35]Robb, p. 362-3.

in the effects of precise knowledge of results (bowling at pins) and general knowledge of results (shadow bowling) on the acquisition of a motor skill (bowling).

Subjects for the study were 47 students enrolled in two beginning bowling classes. The experimental group contained 24 subjects and the control group contained 23 subjects. Both classes met at 12:40 P.M. for one hour on alternate days and utilized the same equipment.

Both groups were given the same basic instruction. The experimental group practiced with a full set of ten bowling pins present each time a ball was rolled. The control group practiced by shadow bowling.

The measuring instrument used in all test situations consisted of twenty balls rolled by each subject. Each time a ball was rolled, the target was a full set of ten pins in their normal position on the lane. The subjects recorded on regular bowling score sheets the number of pins they knocked down with each ball. The criterion score was the total number of pins knocked down with twenty balls. A pretest, two intermediate tests, and a posttest were administered to all subjects.

A one-way analysis of variance with repeated measures ($P < .05$) was used to test for significance of effects. The facilities at the Western Kentucky University Computer Center were used for the statistical analysis.

There were no significant differences across tests in the skill level exhibited by the two groups. There was no

significant groups by tests interaction either. There was a significant trials effect across groups, however. This indicated that both knowledge of results conditions produced some skill acquisition, but neither condition was superior to the other.

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