# KNOWLEDGE AND SKILLS TEST TO MEASURE CURLING ABILITY

# MEASUREMENT OF CURLING ABILITY

# THROUGH A KNOWLEDGE AND SKILLS TEST

by

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TO MY FIRST SKIP

AND MY FIRST FAN

## ABSTRACT

This study was undertaken to develop an objective, valid and reliable means of assessing curling ability through a Curling Shot-Making Ability Test (CSAT) of five different sub-tests and a Knowledge of Curling Strategy (KCS) Test of 20 multiple choice questions.

The subjects were 32 club, and eight superior curlers. The criterion used was the average of three judges' ratings of curling ability.

The CSAT test-retest reliability coefficient was $r = .78$ ($p < .05$). The KCS split-half reliability coefficient was $r = .62$ ($p < .05$). The CSAT validity coefficient was $r = .81$ ($p < .05$). Significant differences ($p < .05$) in the means of all sub-tests were found between the superior and club curlers. The KCS validity coefficient was $r = .86$ ($p < .05$). An item analysis of the KCS Test questions identified differences in choice preferences between superior and club curlers. Two multiple regression equations were computed to predict the judges' average rating. Further intercorrelations revealed relationships between census data, self-assessment, and the KCS Test, CSAT, and the criterion.



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RESUME

Dans cette étude, nous nous proposons de développer des moyens valides, objectifs et fiables pour évaluer dans le sport de curling, la capacité d'un candidat à lancer la pierre, en nous servant d'une part d'une épreuve que nous appellerons "Test CSA" (Curling shot making ability test), comprenant cinq sous-tests, et d'autre part, d'une épreuve "Test KCS" destinée à évaluer pour chaque candidat sa connaissance de la stratégie de curling (20 questions à choix multiples).

Les sujets d'étude: 32 curleurs appartenant à des clubs de curling et huit curleurs de catégorie supérieure. Critère de compétence: l'estimation moyenne des trois juges.

Lors d'une reprise du test CSA, le coefficient de fiabilité était de $r = .78$ ($p < .05$). Dans le test de connaissance (KCS), le coefficient de fiabilité obtenu en comparant la première et la seconde moitié de l'épreuve était de $r = .62$ ($p < .05$). Le coefficient de validité du test CSA était de $r = .81$ ($p < .05$). Une comparaison des moyens de tous les sous-tests révèle, en outre, des différences significatives ($p < .05$) lorsqu'il s'agissait de comparer les curleurs supéreurs et ceux appartenant aux clubs. Dans le cas du test KCS, le coefficient de validité était de $r = .86$ ($p < .05$); de même, une analyse détaillée des questions posées révèle que les deux groupes de curleurs avaient répondu de façon différente. Nous avons formulé deux équations à variables multiples pour prédire l'estimation moyenne des trois juges. Et finalement, nous démontrons qu'il existe des correspondances entre les données statistiques, l'estimation personnel du sujet, les deux tests KCS et CSA, et l'estimation moyenne des juges.

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M.A.M.

# TABLE OF CONTENTS

CHAPTER PAGE

CHAPTER PAGE

# LIST OF TABLES

# LIST OF FIGURES

# CHAPTER I

# THE PROBLEM

## 1.1 Introduction

Curling, a popular winter sport, is played by over 750,000 Canadians (Grescoe, 1968) in private and public clubs across the nation. Curling is also a very competitive activity and Canada is recognized as a world leader in it, having won eight of the last eleven world championships.

Four players make up a curling team and each team member always plays in his respective position of lead, second, third or skip. These positions are named in respect to the order of delivery of the eight rocks which compose an end for that team. Each rock represents a potential point as long as it is anywhere in or touching the rings and closer to the centre of the target than an opponent's stone. Each player handles two stones for his team, each alternately with his opposing player. The skip throws the last two stones for his respective side, at which time there is a possibility of up to 15 stones in play. Consequently, the skip's task is usually more difficult than that of the other players, and calls for more skill and experienced play.

In competitive curling each team member should display strength in certain basic areas. Leads and seconds, in addition to being strong sweepers, are expected to be particularly good on draw shots and take-out shots respectively. Thirds should be adept at a variety of shots. Skips are supposed to be good at all types of shots (raises, draws, take-outs) in addition to being able to "read the ice well" and make wise strategic decisions.

Prior to the undertaking of the present study, no external standards for objectively comparing players' basic playing abilities could be found. Similarly, no objective means was available to enable a curler to diagnose basic weaknesses or guage improvement (or deterioration) in shot-making ability.

The absence of any external standards for determining an individual's ability has been a source of some concern. Some clubs have attempted to rate their members by ability. These attempts typically end in a three or four member committee vote, a decision often based on popularity, or at best, a very subjective rating by judges without any training or aids in this regard. Other clubs simply arbitrarily assign players to positions according to years of curling experience, or years of club membership. This often leads to a situation where a highly competent curler moves to a new club and plays lead for several years until he gains seniority. Often the most popular player is elected skip and the remaining three positions are decided by degree of popularity. These methods of assignment are particularly noticeable in a number of the older eastern Canadian clubs.

Not only is it desirable to be able to rate individual curling ability reasonably accurately, but it is also important to be able to equate teams within a club. During club competition, if teams are not equal in ability, the interest of the members may quickly subside.

As well as the difficulty in determining the best position for a player and in equating teams, there is the matter of measuring progression or deterioration in performance. Often a player who finally reaches a skip's position is never moved to another position until he retires from the game. Again, an objective measurement of curling ability could help a great deal.

Years of curling experience or popularity in a club do not always mean that one is a good curler. Curling is a team sport that demands that each member play a specific position, each requiring different kinds and levels of skills, in addition to some non-skill variables, such as a player's quality of confidence. It would be helpful if the filling of these positions could be determined, at least partly, according to knowledge and ability, but there are no existing methods that will do this. Weyman (1953) has supported this belief, saying,

> Curling Clubs and curlers who desire to be numbered amongst the better class curling clubs and curlers necessitate adoption of a proper system of classification which provides an incentive and ambition for all to reach the best class of curling abilities (p. 78).

## 1.2 Statement of the Problem

The purpose of this study was to develop an objective, valid and reliable means for assessing curling ability. To this end, the development and examination of two tests was undertaken:

(1) A performance test of shot making ability.

(2) A paper and pencil test of knowledge of curling strategy.

The nature of the data collected in the development of these tests also allowed the author to examine several interesting questions related to current practice and belief about curling including: the relationship between curling knowledge and skill, and each of team position, age, sex, years of playing experience and a self-assessment on several curling skills.

## 1.3 Limitations of the Study

The sample for the study was drawn exclusively from English speaking club curlers in the greater Montreal area. Testing was done at the end of the curling season and although thirty-two subjects

reported for the first day of testing, only twenty-three returned for the retesting. Although sweeping was recognized as an important skill, no attempt was made to measure it as such in the performance tests. Some of the team aspects of curling were removed from the performance tests in that each subject delivered his rocks without the normal feedback from teammates.

## 1.4 Definitions

An extensive list of curling terms and their definitions may be found in Appendix A. Several other terms which will be employed frequently in the present study are defined as follows:

Average Rated Curling Ability is operationally defined as the average of three judges' ratings of general curling ability during a four end game.

Average Curling Shot-Making Ability Test Score is operationally defined as the average score a curler receives over two administrations on the Curling Shot-Making Ability Test.

Beginner Curler is operationally defined as any curler who has had a maximum of one season of curling experience.

Club Curler is operationally defined as any curler, with at least one season of curling experience, who belongs to a curling club and curls exclusively within the club.

Superior Curler is operationally defined as any curler who has won a provincial or national title.

## 1.5 Significance of the Study

Curling, by its very nature and unlike many other sports, requires that each player be evaluated and rated. Weyman (1953) is one of the authors who alludes to this difficult and complicated business of rating curlers. On this subject he has stated the following:

> It involves both the politics and the likes and dislikes of the individual members. It will determine both the social and curling abilities of the club as well as the development of the individual member as a skillful curler. Some clubs suffer and never get far on account of domination by a clique; others, due to general dissatisfaction concerning skips, some of whom may not be qualified. Sometimes there are other reasons (p. 65).

He has also stated:

> . . . that ability alone entitles a member to a place or a position on a rink and not length of time a member has been curling. Nothing is more demoralizing to the membership and the players than to have a skip or third or even a second for that matter, who is out of his class due to insufficient skill and ability (p. 64).

Still there are no studies or tests that are based on curling shot-making skill and knowledge of strategy that would provide a suitable method of rating and grouping curlers, comparing their abilities, or measuring progress or deterioration. The present study attempts to overcome this stated lack through the development of an instrument to measure curling ability and therefore to begin to fill this void.

# CHAPTER II

# REVIEW OF THE LITERATURE

## 2.1 Introduction

In contrast to many other sports, very little research has been done on curling. Indeed, there is a dearth of literature on the activity. Therefore, in this study, it was found necessary to examine the more fundamental aspects of curling as a perceptual motor activity. It was hoped that this examination would indicate the similarities of curling to other activities on which some related research had been done.

This chapter includes an overview of curling as a team game played on ice, its history, and its evolution. Also included is an identification of the skills involved in the activity and a synthesis of the limited research and related literature on the game. Curling is then studied as a perceptual-motor activity and the development of skill tests in related activities is examined. A review of test development research in knowledge of sports strategy tests concludes the chapter.

## 2.2 An Overview of the Game of Curling

A curling team consists of four players each handling two stones, making a total of eight stones played by each side, or sixteen stones by both teams during an "end". Stones are played alternately with those of the opposition. The basic aim of the game is to "throw" or slide these stones to a target. The target, in the form of a 12 foot circle at each end of a long narrow sheet of ice, is called the "house". A team's score for one end is determined by counting the number of their rocks closer to the center of the house than any of those of the opponents.

The "lead" (generally the least experienced player on the team), handles the first two stones for his team, each alternately with the opposing lead. After the lead has played his two stones, it is then the "second" player's turn to perform likewise. The lead moves up to take over the sweeping job with the number three player, or "third", who has already assisted on the sweeping of the first two stones for his side. In turn, the "third" plays his stones alternately with the opposing team's third. His two stones are swept by the lead and second. The third then moves to the house and holds the broom as a target while the "skip" delivers his two stones alternately with the opposing skip. The lead and second sweep these stones as well. As each team takes its turn alternately, the opposing four players "give up the ice" to the side whose stone is being played, as neither team is allowed to interfere in any way with the opponent's stone's progress towards the house.

Except while delivering his two stones, the skip remains in the house at the opposite end. It is his responsibility to plan the strategy and direct all of the play for his team. Generally, the skip calls for sweeping on all rocks except draw shots where weight is the only factor. For these rocks, it is the sweepers' responsibility to judge whether or not sweeping is required. The third calls sweeping when the skip is throwing his rocks.

## 2.3 History and Evolution of the Game

The earliest record of the game dates back to 1511. A curling stone, or "Kluting" iron was unearthed in 1890 near Dunblane, Scotland with the date 1511 etched on its surface (Bull, 1934, pp. 234-244; Grant, 1914; Kerr, 1890; Menke, 1960; Watson, 1968). It is generally agreed by the above authors that curling was officially introduced into Canada in 1807 with the founding of the Royal Montreal Curling Club, the first sports

club to be established on the North American continent.

Since its invention around 1511, the game has changed very little. The only distinct changes that have been recorded include the following: the addition of giving a rock a turn or spin; the emergence of the sliding delivery; the emergence of the "take-out game" as compared to the previous "draw" game, and the reduction in the number of players on a team from eight to four sometime before 1914 (Grant, 1914). The first reference to affixing a turn or "Kilmarnock Twist" to the rock is made by Grant (1914). No other reference is made to this except to say that Canadians perfected this skill (Grant, 1914).

The birth of the hack made sliding possible. The old Scottish "crampit" allowed no toe-hold and it was imperative that the stone be delivered from a standing crouch position. Rarely would a curler risk a step forward from the crampit while swinging the stone forward. This would usually lead to a fall on the ice. As well, the weight of older curling stones made it impossible to face the sheet of ice squarely while delivering. Only a crouch stance with a side-arm delivery was used. The new hack allowed a toe-hold, enabling the player to swing the rock freely and gain a sure footing. Faster stones could be thrown and, ultimately, the "running game" or hitting game became a popular alternative to the slower "draw game." The sliding delivery started with moving about 12 inches out of the hack. This movement was caused by the weight of the stone and the follow-through which pulled the curler out of the hack. The early 1900's saw the first successful curler employ a two to three foot slide forward. About 1920, the sliding delivery of Gordon Hudson out to the front rings brought fame and style to the game, especially for the youngsters. The removal of rubbers and the addition of Teflon sliding soles increased the length of the slide considerably to the point where a rule had to be established that limited the length of ice a curler could slide while delivering a stone (Watson, 1950).

The Scots first used water-smoothed stones from the beds of rivers. As time passed, the stones became larger and handles of iron were wedged and pounded into the rock. Some of these giants weighed well over 100 pounds. In Quebec, in the early years, cannon balls provided the best available source of material for rocks. These were melted down and moulded to resemble curling stones. These "stones" were referred to as irons and weighed close to 60 pounds for men and 45 pounds for the ladies. Besides the strength needed to throw these heavier stones and irons, the wider running surface made the take-out style of competition impossible. Three events changed the game: (1) the Canadian western provinces took to the game, (2) artificial ice was installed, and (3) Ailsa Craig granite stones (always 42 pounds) were employed (Richardson, McKee and Maxwell, 1962, p. 21). Until then, the height of the game was reached when most or all of the stones remained in the rings at the completion of an "end." Today a wide open game is very popular, where dead ends (no score) are not uncommon. With well balanced rinks, the scoring is generally one or two points at a time. It is seldom in high level competition that more than a few rocks are in or around the rings.

## 2.4 Identified Curling Skills

A number of authors reviewed, (Duguid, Turnbull and Ursuliak, 1968; Meddaugh, 1965; Moore, 1971; Richardson, McKee and Maxwell, 1962; Watson, 1950; Weyman, 1953), include a variety of isolated skills and argue that they are important to curling ability. Delivery of the rock appears to be the most important skill as it is always emphasized in an instructional program of curling. No actual scientific research has been done in this area, but several authors have tried to analyse part of the skill of delivering a rock. Weyman (1953) illustrates the action of the "foot

pivot" and its co-ordination with a balanced swing. He further explains that "weight and pressure applied to the foot angle or fulcrum creates a source of power propulsion available for use in conjunction with the momentum gained from the swing to secure the desired speed and slide (p. 15)." Watson (1950, p. 15) describes the delivery with the right shoulder as the fulcrum or the hinge for the swing of the stone and says that any motion other than the natural elevation or lowering of the whole body during the swing will alter the direction of that all-important line of delivery. He also describes the mechanics of the sliding delivery and how the use of the right leg and left foot affect the slide (p. 49). He indicates that the length of the slide is determined by the force exerted by the right foot and leg in the drive or push off from the hack, and the friction offered by the left foot on the ice surface.

Amongst the foremost curling authorities in favor of skill breakdown are Duguid, Turnbull and Ursuliak (1968), who, since 1968 have conducted seminars across Canada for curlers. These seminars include the most modern and up-to-date analysis of skill and the game. In their instructional book and teachings, all of the following factors in delivery of the rock are explained in detail and emphasized as necessary for proper delivery -- the grip for the in-turn and out-turn, the stance, body alignment, backswing, forward motion, slide, follow-through and release. Richardson, McKee and Maxwell (1962) describe all but the body alignment and release as necessary for a proper delivery. Both Watson (1950) and Weyman (1953) describe all the same skills except the release. Moore (1971), in developing her instructional manual, asked several authorities to rank, in order of importance, the fundamental skills for the beginner. Her results suggested that delivery in general, the turns, and the grip are considered to be the most important.

Sweeping is also discussed by these authors. Overhand and underhand grip, co-ordination of arm and foot action, how to sweep with a partner, and when to sweep are all considered important skills.

Basic strategy is always included in discussion of skill breakdown. Duguid et al. (1968), Richardson et al. (1962) and Watson (1950) discuss the following: the early ends, the tenth to twelfth ends, and building the big end. Weyman (1953) and Meddaugh (1965) limit their strategy discussion to the draw game versus the take-out game.

Strategy also includes shot making according to Duguid et al. (1968), Richardson et al. (1962), Watson (1950) and Weyman (1953), all of whom discuss when to draw, guard, raise, hit, chap and lie. Duguid et al. (1968) also explain the double take-out and the freeze in their discussion on strategy.

## 2.5 Curling Research

Although a very old and interesting game, there is a paucity of scientific research material available on the skills of curling or the game itself. Three experiments have been done to try to determine the effect of sweeping. All other research in curling has been limited to examinations of what affects the curl or spin of a stone. No literature has been found on the development of tests of skill or knowledge.

The curl or spin of the stone and what affects it: Richardson et al. (1962, p. 97) describe the curl in curling as a product of a number of forces. They state that, according to experts, the direction of curl is a result of the forces of pressure and their effect on the frictional forces influencing the stone. The greater pressure is obtained at the leading edge of the rock, the lesser pressure is found at the trailing edge of the rock. Assuming that an in-turn in a right-handed delivery

has been thrown, there will be a rotational force to the right (at right angles to the line of direction). This force is apparently balanced by a centrifugal force which varies as the square of the force and speed divided by the radius of the curvature of the stone's path. Thus, as the forward speed of the stone decreases, the centrifugal force decreases and the side forces begin to exert their influence. The curling stone begins its characteristic turn to the right.

The amount of the curl of the stone has been proven to be affected by the direction of the freezing pipes. Richardson et al. (1962) describe an experiment made in 1961 in Toronto, Ontario which demonstrated this. The ice was specifically prepared for the experiment. Sweeping assistance was eliminated, and as closely as possible, conditions of the experiment were duplicated on each sheet of ice. A special machine, developed by R. M. Werlich of Werlich Industries Limited, Preston, Ontario, was designed to propel curling stones with a constant amount of weight and with three and one-half turns down the ice. Slow motion picture cameras recorded the path of each stone. In this particular experiment, a stone on a cross-wise piped ice drew an extra four feet beyond that of the length-wise piped ice.

Similarly, Weyman (1953) describes an experiment to determine if a stone rotating slowly with a normal amount of "handle" (turn) curls more or less than a stone rotating rapidly with an excess of handle. Four pairs of stones were used. The first stone of each pair was released with a normal amount of handle (three to four rotations), the second stone was delivered with an excess of handle (7 to 13 rotations from plane to tee). Results indicated that a stone rotating slowly, curls between two and one-half to four feet more than a stone rotating rapidly.

Sweeping: Several theories, based on observation, have been proposed to explain the effect of sweeping, but only a limited number of studies have been made. Weyman (1953) reviewed the results of three experiments. The first two experiments were conducted on natural ice in 1924 in St. Moritz, Switzerland. These tests used a sloping trestle composed of boards covered over with snow and then ice. One end of the trestle was three feet above the ice and the other end finished off even with the ice. The same stone was used throughout and was held in a position at a fixed point at the top-most end of the inclined plane and released without impetus to slide by its own weight down the slope onto the ice. This procedure was employed to provide each stone with approximately the same velocity and momentum each time. When the stone did not follow the same track down the ice, the results were rejected. In experiment one, the swept stones travelled six meters further than the unswept stones. In the second experiment, the swept stones travelled five meters further than the unswept stones.

The ice was particularly keen during the second experiment and a stone released at the top of the plane over-ran the length of the run. It was therefore released lower down on the plane. When it was released from the top of the plane, sweeping added an average of six meters to the distance of the rock. In both cases, the following factors were difficult to keep constant: the smoothness with which the stone took the ice; the difficulty of sliding the stone down absolutely the same track (slight variations retarded the stone); the amount of handle (turn) put on; and the transitory state of the ice.

Another experiment was conducted on specially constructed apparatus and held at two divergent points in Canada. No dates nor details of the

experiment were presented by Weyman (1953), but the results apparently indicated that proper and efficient sweeping enable a stone to travel 12 to 15 feet further than if not swept at all.

Taylor (1971) also describes an experiment on the effect of sweeping that was conducted on indoor artificial ice in Toronto, Ontario in 1961. A machine duplicating a curler's delivery swing, delivered three stones. Only one stone was swept. The results revealed that the second unswept stone travelled 4 feet 6 inches farther than the first, while the swept stone remained closer to the center line than either of the other two, indicating that sweeping holds a stone on a straight line. Taylor (1972) also conducted her own experiment to determine the effect of sweeping on the distance and direction of a moving curling stone in 1970 in Pennsylvania. An aluminum roller conveyor was designed to give constant impetus to each of three stones. Each stone was used in 90 trials; 45 swept and 45 unswept. Results showed a significant difference ($p < .05$) in favor of the swept stone for a linear distance covered. There was also a significant lack of lateral deviation, due to sweeping ($p < .05$). These studies should at least serve to silence any non-curling cynics who believe that curlers only sweep to keep warm, or for lack of anything better to do while awaiting their turns.

## 2.6 Curling as a Perceptual-Motor Activity

In order to further understand curling, the psycho-physical demands of the game and of related activities in terms of Kodym's (1970, pp. 39-45) and Fitts' (1965, pp. 177-197) task taxonomies were analysed. In Kodym's (1970) task taxonomy, curling could possibly be considered in two of his five categories. It seems to be best fitted into his first category -- "sporting activities involving hand-eye co-ordination."

The characteristics of this category, and curling's related peculiarities include the following:

(1) It involves activities requiring a need for finite muscular adjustments to a visual cue while the visual target is a single point in space. In curling this can be related to the delivery of a rock while aiming at the skip's broom. The broom is an important cue and adjustments have to be made in the weight and direction of the rock relative to the broom's placement and the ice surface.

(2) Tension grows towards the completion of the competition. In curling, tension usually increases towards the final ends of a curling game as there is no release for the tension that gradually builds up. If there is an eight point difference or less, any game may be won or lost in the last end.

(3) Attention is usually required over an extensive period of time. In curling, attention is required over a minimum of two hours by any participant in a game.

Sports activities in this category include archery and shooting.

Because curling is a team sport, it can also be described in Kodym's (1970) fifth category -- "sports activities involving the anticipation of the movements of other people." This category has three sub-divisions and curling seems to relate best to activities involving parallel play like golf, bowling, cricket, and baseball. The characteristics include:

(1) Individuals play concurrently or one at a time with no direct aggression exhibited against their opponents. This is inherent in the strict order of play in the game of curling.

(2) Players deal with each other in indirect ways. Curlers throw their rocks before or after their opponents have played.

(3) Participants alternate roles from offensive action to defensive action. The score of a curling game and whether or not a team has possession of the last rock dictates offensive or defensive action in any given end.

Other important characteristics of curling, as a relatively unique perceptual-motor sports activity, are brought out when it is examined in terms of Fitts' (1965) task taxonomy. In Fitts' (1965) terms, curling is a self-initiated and self-paced activity as opposed to being an externally-paced one. That is, the body is at rest prior to the beginning of a response sequence and the individual initiates a behavior pattern which is carried out in relation to a relatively fixed or stable set of environmental objects. In this respect, it is quite different from other sports activities in which an individual's actions are greatly influenced by the pace of his opposition or perhaps partner, or by a moving object.

One of the most important perceptual-motor characteristics of curling involves the nature and extent of the feedback information. As in other activities, there is direct feedback -- kinesthetic knowledge as a player delivers a rock, and visual information as he watches the rock travel down the ice and sees where it stops. However, the difference between this sport and others is found in the forced delay before a new response can be made -- a player must wait before taking his second shot.

This analysis of curling in terms of its psycho-physical demands as a perceptual-motor activity not only helps to better understand the complexities of the game, but also points out its similarities with other sports activities. A further examination of the research literature on these activities may make it easier to identify the best procedures for developing adequate objective tests in curling.

## 2.7 Development of Sports Skill Tests

In order to determine the best method of testing skill in curling, the curling literature was exhausted. The only discussion found on testing skill was that relating to the "Points Game" (Kerr, 1890). It

apparently has been played almost since the origin of curling. It is a game that allegedly measures shot-making ability and is used as a means of competition between individual curlers. Weyman (1953) has stated that "the Points Game is essentially a game of the individual, where he stands or falls on his own efforts and differs from the general game of curling in that it is not 'team play'." He also considers that it is "an excellent game to practice the basic shots and to improve skill and ability which is particularly helpful to a new curler (p. 79)." Watson (1950) also recommends this game as excellent for practising curling, either alone or with a partner. No one mentions using it as a means of assessing curling skill. A more complete description of the "Points Game" may be found in Chapter 3.

Finding no other discussion of curling testing, it was thought desirable to examine available research literature on test development for related sports. Based on the psycho-motor demands of the game discussed earlier, curling appears to be most closely related to golf, archery, bowling, and shooting.

When used as competitive activities, all of these sports are self-scored. It is also perhaps for this reason that the development of any skill tests in archery, bowling, or shooting could not be found. One author, Hyde (1937) developed an achievement scale for college women in archery from scores in a standard archery event -- The Columbia Round. Bowling norms for college men and women were similarly established from the average scores of five lines bowled (Martin, 1960; Martin and Keogh, 1964; Phillips and Summers, 1950). However, none of these researchers reported developing a skill test in any of these activities.

Golf was the only one of these closely related activities found to have skill tests developed upon it. Keliher (1963) analysed two styles of putting in golf using two types of tests -- one for alignment and one for judgment of distance. In the alignment test, putts were scored "in" if they crossed any part of the hole. If the ball missed the hole, the distance it passed to the left or right of the hole was measured in inches. For the judgment of distance test, putts were measured in inches from the ball's stopping point to the hole. There was some evidence, using these tests, that the subjects performed more successfully with the croquet than with the conventional style of putting.

In investigating the effectiveness of the Golf-O-Tron as a teaching aid, Chui (1965) measured golf skill by means of two tests -- one for accuracy and one for quality of contact. The target for the accuracy test consisted of three concentric circles marked around a flagstick. The initial bounce of the ball counted. Points were given for balls landing in the circles -- three for the inner circle, two for the middle circle, and one for the outer circle. Quality of contact was scored by awarding one point if the ball travelled in the air beyond a distance of ten yards from the teeing ground, one point if the ball travelled in a relatively straight line, and one point if the ball travelled in a trajectory arc deemed normal for the specific club used. Each stroke had a maximum score of six points, and each subject executed five strokes with each of a seven iron and a four iron. The results of Chui's study showed a significant improvement of skill for beginning college students with both the Golf-O-Tron and the practise range, after four weeks of instruction.

Using similar accuracy circles, Purdy and Stallard (1968) compared two methods of learning golf in terms of accuracy and general golfing

ability. In measuring accuracy, a 90 yard test with a choice of a five, seven, or nine iron was used. Each subject hit 15 balls to a pin with a flag attached to the top. Around the pin was a circular target of 15 concentric circles, the radius of each circle being 15 feet more than the next inner one. The scoring was done from the center out with the circle nearest the pin receiving 15 points.

In another study of golf stroke accuracy, Alderman (1968) measured distance and deviation right or left of the designated line of flight, to investigate the relative effectiveness of two different methods of gripping a golf club. Before instruction, the subjects were given the Mary Ellen McKee test of the full swing golf shot to determine initial ability level. This test measured four elements in the ability to hit a golf ball. the range, the velocity of the ball, the angle of deviation from the designated line of flight, and the angle of impact (trajectory). Alderman concluded that the spread grip was superior in the accuracy criterion.

It is interesting to note that in all of the above studies, the researchers relied upon graded accuracy circles to measure golfing skill. This appears to be the only logical procedure available at this time for objectively measuring skill in tasks of this nature.

The other approach is that of using a more subjective rating of some aspect or aspects of a participant's performance. One such test was found in golf: West and Thorpe (1968) administered an eight iron approach test. They constructed an accuracy circle on a seven point scale, but the test administrators also included rating on a one to three point scale, the vertical angle of projection of the ball (flight score). Results of the pilot studies showed that the flight scores were the most reliable,

(r = .76) and that the flight and accuracy measures combined were the next highest (r = .75) as reliable measures of ability in this test. The final test was then administered to several groups of college women.

## 2.8 Development of Skill Tests in Less Related Activities

Because such little research was found in the development of skill tests in activities closely related to curling, research in the development of tests in other activities was also studied. There are numerous studies that have been done in these indirectly related activities.

In several of these studies (Broer and Miller, 1950; Digennaro, 1969; Fein, 1965; French and Statler, 1949; Lockhart and McPherson, 1949; Shick, 1970; Waglow, 1953) skill tests were developed in a similar manner. All of the above authors identified the skills involved in the activity, and then constructed test items that seemed to measure these skills. Experts in the activity were asked to subjectively rate all the subjects and the skill test was administered to them. A comparison of the results of the experts' ratings of the subject was then made with the subject's scores on the skill test through a correlation procedure.

Several other researchers (Cornish, 1949; Hewitt, 1965; Miller, 1951; Pennington, Day, Drowatzky and Hanson, 1967) determined a criterion of playing ability by constructing round-robin tournaments among the participants instead of using experts' ratings of them. This obviously is only possible in certain types of activities, notably where each participant can compete directly against another with whom his skill is being compared.

In another approach, Kelson (1953) tested 64 Little Leaguers to establish a baseball classification plan where he used each boy's final batting average for the previous season as the criterion for batting

ability. However, subjects were also subjectively rated on four other qualities by 12 graduate students majoring in Physical Education. The subjects were then tested on three skills thought to be measures of baseball ability. He was able to state that a baseball throw for distance was enough to classify baseball players at this level (r = .85).

Fein (1965) collected scores from an advance, lunge, recovery, and retreat test and judges rated fencing ability in a bout situation. Reliability on the constructed skill tests ranged from r = .88 to r = .77 and validity ranged from r = .13 to r = .39 when the skill tests were correlated to the judge's rating. No other information on these tests was given.

Shick (1970) gave a battery of softball defensive skill tests to 59 female college students. The three tests yielded a battery reliability coefficient of r = .88. A battery validity coefficient of r = .75 was obtained when the test scores were compared to a rating by one judge of the defensive softball ability of the subjects.

Waglow (1953) tested 60 college men and women in order to construct an objective social dance test. The test consisted of a scorer counting the number of steps taken in relation to the nearest basic step in six different dances. Reliability for the test-retest was r = .47. Validity (r = .38) was established by correlating the average subjective rating scores of two instructors with the scores on the objective test.

Cornish (1949) attempted to develop techniques for measuring the ability of handball players. Five tests were administered during a class period to 134 undergraduate university students. Three of the tests contained some form of graded target. The criterion used for correlation with the test scores was the total score of 23 games: that is, the

player's score minus his opponent's score in each game. The best battery for measuring handball ability comprised two of the five tests (R = .67).

Pennington et al. (1967) tested 37 male undergraduate students on 17 strength, motor ability, and handball skill items. The criterion for playing ability was the average score per game obtained in a partial round robin tournament. A multiple correlation (R = .80) was obtained between the criterion and three of the tests. A regression equation was also established.

The racquet sports may be considered related to curling in that they involve hand-eye co-ordination and parallel play, with or without the addition of a net. Skill tests in these activities are numerous.

French and Statler (1949) gave six skill tests in badminton to 59 college women students. Performance by players in a game situation was rated by four judges. Odd-even reliabilities of the skill tests ranged from r = .51 to r = .94. Validity was determined by correlating the total score on each test with the composite rating of the four judges (r = .14 to r = .52). Through the use of multiple correlations, a battery of four tests was determined to be the best method of measuring a player's ability to play badminton (R = .70).

Lockhart and McPherson (1949) used three judges to grade the badminton playing ability of 27 college girls on a one to ten point scale. The sums of the judge's ratings were correlated with the percentage of wins for the 27 players in a round-robin tournament. The ability of the judges to pick winners was indicated in a correlation coefficient of r = .90. The results of this tournament correlated r = .60 with the score on a volleying test they developed. The test-retest reliability of the volleying test was r = .90. The judges then rated 68 girls and their ratings correlated r = .71 with the scores on the volleying test.

Miller (1951) constructed a wall volley test for badminton by the use of cinematographic analysis. On a test-retest of 100 college girls, the reliability was found to be r = .94. In order to determine how much the wall volley test contributed to total playing ability, 20 players were given this test and competed in a round robin tournament. The scores on the test were correlated with the results of the tournament ( r = .83).

Digennaro (1969) developed a battery of three tennis skill tests. A circular target was created to provide an objective method of measuring accuracy in drive and service placement. On the test-retest of 64 male college volunteers, the reliability of the three tests was r = .66, r = .67, and r = .80. In a second testing situation, with 15 male college volunteers, validity was established by correlating the scores of each of the three tests with the scores of raters who evaluated stroke performance during actual play in a round robin tournament (r = .40, r = .78, and r = .66).

Hewitt (1965) revised the Dyer Backboard Tennis Test by adding a 20 foot restraining line because the Dyer test did not sufficiently discriminate at the beginner's level. Hewitt gave his revised test to 122 college students, classified into four classes of beginners and two advanced classes (one semester or more of beginning tennis completed). The results of the test were compared with the rank order of playing ability, determined by the position of the subject after the completion of a round robin tournament. The test-retest reliability was r = .82 for the beginner's group and r = .93 for the advanced group. The validity, test scores correlated with rank order of playing ability, was r = .89 and r = .84 for the two advanced groups, and r = .73, r = .72, r = .71, and r = .68 for the four beginner's groups.

Broer and Miller (1950) developed a tennis test in order to classify and grade female college students. Validity for the test was determined by correlating the test scores with the ratings given by experienced tennis instructors. Three judges rated the 32 students in the beginning tennis class and two judges rated the 27 students in the intermediate class. Validity for the beginning group, test score correlated with the combined judge's ratings, was r = .66. In the intermediate group, the correlation was r = .85. Split-half reliability was r = .80 for both groups.

The preceding two sections have dealt with a review of skill test development research in the related activities of archery, bowling, and golf, and in several less-related activities. This review has helped to identify the best procedure for the development of the curling tests which are described in the next chapter.

## 2.9 Development of Knowledge Tests in the Strategy and Skill Aspects of Sports

An analysis of the literature dealing with the establishment of knowledge tests in the strategy and skill aspects of sport has revealed one most common approach to this task. The topical areas are identified and test items are constructed to examine knowledge in these areas. The provisional test is administered to a sample of individuals similar to those for whom it was prepared and it is given to authorities in the field for their comments. Revisions are then made according to the results obtained and comments received. The test is finally administered to those for whom it was intended and the appropriate statistical and critical analyses are made of the results.

Questions to examine knowledge in the strategy aspects of a sport usually originate from consultation with experts in the field and a scrutiny of prominent texts on the subject. At least the major topic areas are then identified. Kelly and Brown (1952) examined 11 hockey texts in order to choose four major areas in the construction of a field hockey test. Waglow and Rehling (1953) chose topical areas from prominent texts to establish their golf knowledge test. Broer and Miller (1950) conferred and discussed subject matter with various members of the physical eduation teaching staff in order to establish a tennis knowledge test. Miller (1953) analysed textbooks and courses of study, and used the opinions of competent persons in order to construct her tennis test. Fox (1953) used a badminton test compiled by a badminton committee at the University of Wshington. Mood (1971) established 184 experimental test items based on 60 physical fitness facts secured from recent Physical Education literature and the opinions of 73 members of the Research Council of the American Association of Health, Physical Education and Recreation.

The initial battery of questions is then prepared and either administered to a group of volunteers, or submitted to a panel of experts for comments or revisions. Mood (1971) administered his initial test to 1360 Physical Education Majors. Fox (1953) presented her initial test to students in beginning badminton classes. Waglow and Stephens (1955) presented their softball test to three instructors and 15 students for critical analysis. Kelly and Brown (1952) submitted their initial field hockey test to seven national players, coaches, and umpires for review and suggestions. Broer and Miller (1950) gave their experimental tennis test to 87 students.

From the results obtained from these initial tests and discussions, a final test is usually constructed and administered. The reliability of the entire test and the validity and difficulty of each item in relation to the entire test is examined. This same procedure may be continued until a reliable, valid, and discriminating test is formed. Fox (1953) made three revisions before being happy with his test. The final reliability was r = .90. The range of difficulty of the questions was from two to 69.67 per cent. Ninety per cent of the items discriminated ated at the .05 level or better, 82 per cent at the .01 level. The split-half reliability for Form A of Mood's (1971) test of physical fitness was r = .74 and for Form B, r = .77. Forty of the 60 items on Form A and 45 of the 60 items on Form B had indices of difficulty between 30 and 69 per cent. Waglow and Stephens (1955) revised their softball knowledge test twice. Odd-even reliability for the second revision was r = .64. The difficulty rating, index of discrimination, and a norm table were presented for the 100 item test. Miller (1953) made two revisions of her tennis knowledge test to end with a reliability of r = .90, an average difficulty on all 100 items of 50.2 per cent and a range of difficulty from 16.7 to 86.3 per cent. Kelly and Brown (1952) made three revisions of their field hockey test. The odd-even reliability of the final test was r = .89. Correct responses to each of the test items ranged from 10 to 90 per cent with a mean difficulty of 59 per cent. Broer and Miller (1950) made two revisions of their tennis knowledge test. The second test had reliabilities of r = .82 and r = .92 for beginning and advanced groups, respectively. The percentage difficulty of individual questions ranged from 3.7 to 93.9 per cent.

All of the above tests made use of multiple-choice questions, true-false, completion questions, or a combination of these. The present researcher was particularly interested in the use of multiple-choice questions where each answer is correct to some degree and may be given a rated score (one to five points if five choices are available). However, no literature could be found on the use of such multiple-choice tests.

## 2.10 Summary

This chapter has attempted to identify the information necessary and the procedures which might be used to develop an objective means of evaluating curling ability. To this end, the game of curling and the roles of each player are briefly described along with its historical background and a summary of the skills required of its players. The one existing attempt at measuring curling skill, the "Points Game," is described in some detail. The limited research on curling is reviewed, and curling is examined in terms of its psycho-physical demands as a perceptual-motor activity. Through this examination, not only are further characteristics of curling recognized, but also activities most closely related to curling are identified. In these competitive sports activities of golf, archery, bowling, and shooting, only golf was found to have work done on it in the development of skill tests. This would, in part, seem to be due to the self or automatic scoring nature of these activities. The studies on golf give some hints as to the basic procedures which might be used with curling tests and point out the common use of a target of concentric circles in skill testing in this type of activity.

A review of the development of skill tests in other less-related sports activities helped to define further the various procedures used

in this process. From these it became possible to choose those which seemed best suited to measuring skill.

The final section of this chapter provides a review of literature on the development of knowledge tests in the strategy and skill aspects of sports. It is from this review that it becomes possible to arrive at the processes and procedures to be used in this investigation. The results of the studies in this section, as in the preceding ones on the development of skill tests, also provide a basis of comparison for the results obtained in the present study.

# CHAPTER III

## METHODS AND PROCEDURES

### 3.1 Introduction

The problem of this study was to develop a battery of objective, valid and reliable skill and knowledge tests to measure curling ability. It was anticipated that these tests would be of value as tools for:

(1) assigning club members to positions,

(2) equating teams for club sectional competition,

(3) assisting curlers in identifying areas of strength and weakness in their games.

Four procedures were employed in gathering information about curling ability.

1). Rated Curling Ability: An individual subjective rating on a scale of one to one hundred points was made of each subject by each of three judges. Their ratings served as an impressionistic evaluation of over-all curling ability.

2). Curling Shot-making Ability Test (CSAT): Five objective sub-tests, to measure various shot-making skills, were administered to all subjects. Each sub-test was designed to measure a specific skill of curling. All five sub-tests in the CSAT were repeated on a second day of testing.

3). Knowledge Test of Curling Strategy (KCS): A test of twenty multiple choice questions was developed and administered to all subjects.

4). Personal Data Sheet: A questionnaire requesting information on age, sex, years of curling experience, position played, and frequency of practise was given to all subjects. In addition, each

subject was asked to rate himself or herself on a five-point scale on ability to sweep, draw and take-out, hit the broom, read ice, understand strategy and to withstand anxiety. The sum of the scores on these variables is referred to as "Self concept of curling ability".

Prior to undertaking the main study, a pilot study was completed with eight subjects. The methods and procedures which follow are based on those used in that study, with minor modifications made where it seemed advisable.

## 3.2 The Subjects

Thirty-two (16 male and 16 female) English-speaking club curlers from the greater Montreal area served as the main sample. All the subjects had a minimum of one season of curling experience. Their ages ranged between 18 and 46 years.

It was recognized that in the validation of any tests, the items chosen should discriminate highly competent from less competent performers. Therefore, an additional eight English-speaking male "superior curlers" between 29 and 60 years of age were asked to participate in part of the study. Six of these subjects were winners of at least one "Purple Heart", emblematic of a provincial title and participation in the Canadian Brier Championships. The remaining two subjects were members of the National Seniors' Championship Team of 1972.

## 3.3 Indices of Curling Ability

### 3.3.1 Subjective Rating by Experts

A review of the literature indicates that subjective ratings by experts in the field are often used as the criterion against which to measure the validity of new skill and knowledge tests (Broer and Miller, 1950; Digennaro, 1969; Fein, 1965; French and Statler, 1949; Lockhart

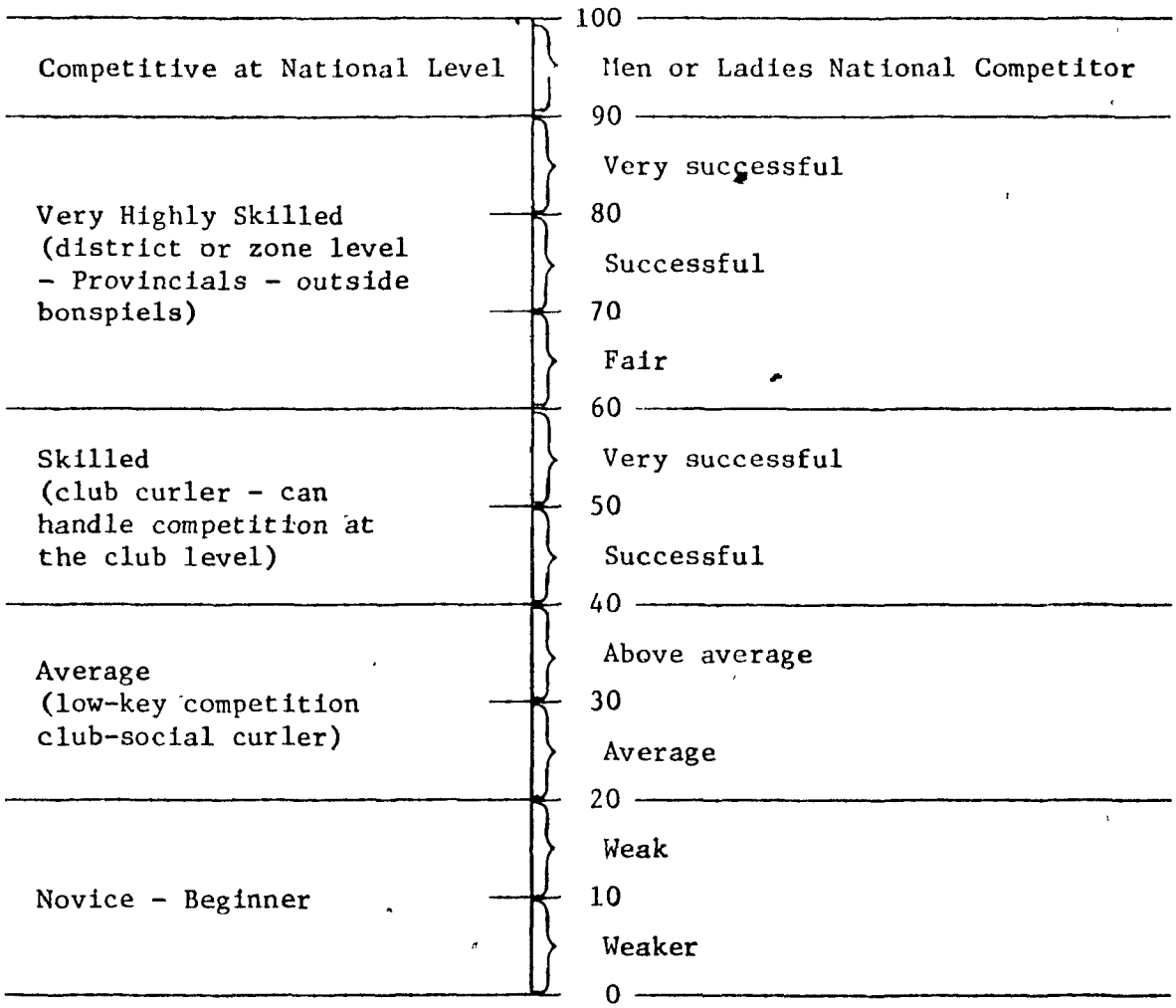
and McPherson, 1949; Shick, 1970; Waglow, 1953; West and Thorpe, 1968). In this study, three judges rated each of the thirty-two subjects for over-all curling ability while he played a four-end game. Subjects were instructed to play as they normally would. The subjects were also told that only the sweepers were to judge weight on free draw shots (any draw shot that did not depend upon line of direction). That is, subjects throwing the rock, or holding the broom, were asked not to call sweeping on these shots.

Only eight subjects at a time were rated by the judges, but the same judges rated all players. Thus there were four four-end games played at different times on the same day. To begin each four-end game, subjects were randomly placed in the positions of skip, third, second and lead. Every end, each subject changed his position within his team. This was accomplished by every subject moving one position forward (skip to lead, lead to second, second to third and third to skip). It is acknowledged that this order may have given some slight advantage to the randomly chosen lead, but there seemed to be no better way of controlling information on ice-reading.

All three judges are considered experts in the field of curling. Two judges, one male and one female, were members of winning provincial teams. One was also a member of a National Seniors' Championship team in 1972. The third judge (male) has been a participant and club manager for over twenty-five years. All three judges proved to be reliable ($r = .95$ to $.97$) and objective ($r = .88$ to $.97$) in the pilot study.

Figure 1 is the one to one hundred point rating scale employed by each of the judges.

Figure 1. Judge's Rating Scale




The three judges were instructed to:

1st) rate each curler for general over-all curling ability on the continuous scale of one to one hundred points, by positioning the subject on the scale according to the description on the left-hand side (therefore positioning the subject within one of the five categories) and then further evaluating each subject within his category according to the description on the right-hand side of the scale.

2nd) rank each subject without consulting the above ratings and compare the results of the two judgements, to come up with the most exact rating possible.

This rating procedure was repeated for all four groups of eight subjects at different times during the day. All subjects were rated on the same sheet of ice fifteen minutes after they had completed the skills test.

3.3.2 Curling Shot-Making Ability Test (CSAT)

The Curling Shot-Making Ability Test was adapted from the "Points Game" as it was found to be the only existing method of beginning to objectively measure curling ability. In the complete "Points Game" (Kerr, 1890, pp. 414-417) each competitor is asked to play four shots, two in-turns and two out-turns in each of the nine sub-tests - Striking, Inwicking, Outwicking, Drawing, Guarding, Chap and Lie, Wick and Curl In, Raising, and Chipping the Winner. A perfect shot scores two points and the possible maximum is therefore 72 points. Any score above 30 is considered very good. No norms for, or research study of, the "Points Game" or any part of it have been found up until the present time.

Of the nine sub-tests in that game, five were selected for this study on the basis of administrative ease and as being most representative of curling situations. The scale of points for each of the five sub-tests chosen was expanded in order to provide for a wider range of scores, and in an attempt to eliminate the possibility of scoring zeros. This quite significantly changed the nature of these sub-tests. The five sub-tests chosen include: (1) The Hit (Striking), (2) The Draw, (3) The Guard, (4) The Raise, and (5) The Chap and Lie. A complete description of each of the five shot-making sub-tests and their scoring systems are found in Appendix B.

The following verbal directions were given to all subjects:

"Broom placement will be indicated by the scorer. Any desired change in the placement of the broom is to be indicated by the subject each time he throws his rock". The initial placement of the broom is indicated in the diagrams of the sub-tests (See Appendix B).

Subjects were asked not to discuss the shots among themselves. Each subject received the following written instructions:

SWEEPING IS NOT ALLOWED

TASK 1 - HIT: Hit the placed stone out of the house with your hitting stone staying in play in the four-foot circle, (three in-turns, three out-turns).

TASK 2 - DRAW: Place the stone in the four-foot circle, (three in-turns, three out-turns).

TASK 3 - GUARD: Place a guard on the placed stone, preferably short of the house by three feet or less and within 12 inches of the centre line, (three in-turns, three out-turns).

TASK 4 - RAISE: Promote the placed stone to the four-foot circle, (three in-turns, three out-turns).

TASK 5 - CHAP AND LIE: Hit the placed stone on the four-foot circle with your hitting stone staying in play within the eight foot circle, (three in-turns, three out-turns).

For each of the five sub-tests, each of the thirty-two subjects threw three in-turns followed by three out-turns. All five tests were repeated during a second day of testing when procedures were exactly the same.

The eight superior curlers also did the sub-tests following the same instructions and procedures except that the sub-tests were not repeated on a second occasion.

3.3.3 Knowledge Test of Curling Strategy (KCS)

The KCS test examined knowledge of basic strategy. Six multiple choice questions were originally devised based on the following situations:

(1) middle ends - down three or more points.

(2) middle ends - up two or more points.

(3) one up with last rock (10th end of a 10-end game).

(4) one down with last rock (10th end of a 10-end game).

(5) one up without last rock (10th end of a 10-end game).

(6) one down without last rock (10th end of a 10-end game).

These six situations are included in the Duguid, Turnbull, Ursuliak instructional book (1968) for their curling seminars as basic strategy for the beginner. The result of the pilot study showed a positive correlation ($r = .77$, $p < .05$) between these KCS scores and the judges subjective evaluation of over-all curling ability. Some questions showed a higher relationship than others. The questions were then circulated to five experts in curling for their comments and ranking of the answers. The test questions were revised accordingly.

Fourteen additional questions of a similar nature were devised by the author from situations explained in a later edition of the Duguid, Turnbull and Ursuliak seminars (1972) and from those described by Ken Watson (1950). It was felt that the addition of these questions would help to make finer differentiations between those to be tested.

The twenty questions were answered by the eight superior curlers who ranked, from one to five, (poorest to best), each of the previously constructed answers to each question. All answers were correct to some degree, but some were better than others. The possible answers to

each question were then rated from poorest to best according to these ratings. Thus each answer was given a value of one to five points according to its merits. With the twenty questions a total of 100 points was possible. A copy of the complete test may be found in Appendix C.

## 3.4 Collection of the Data

### 3.4.1 Subjective Rating

The subjects were identified by numbers worn by them. The judges were not on the ice and had no verbal contact with the subjects, but could see them clearly through a window. The judges had approximately one hour to rate each group of eight subjects. In most instances the judges had no previous acquaintance with the subjects.

Each of the judges was given a piece of paper with all thirty-two subjects' numbers listed. Space was provided by each subjects' number for recording the assigned rating and the rank order.

### 3.4.2 Curling Shot-Making Ability Test (CSAT)

The CSAT was held prior to the subjective ratings being done. The sheets of ice used for the CSAT were not the same as that used for the four-end game. This required all subjects to read a new sheet of ice.

Eight subjects were tested during one 90 minute time period - four on one sheet of ice and four on another. All subjects did the five sub-tests in the same order: (1st) The Hit, (2nd) The Draw, (3rd) The Guard, (4th) The Raise, (5th) The Chap and Lie. The order of individual testing within a sub-test was determined on a randomized basis by having the subjects draw numbers. This randomization occurred each time every subject in a group had thrown three rocks. Each subject delivered one rock at a time. There was one scorer for each

sheet of ice so that each scorer tested sixteen curlers.

The scorers for the CSAT were trained for the placement of the stones, placement of the broom, and the methods of scoring. The author acted as one of the two scorers. The scorers recorded a numerical value for each rock delivered by each subject. Therefore, thirty separate scores were collected for each subject.

Procedures for the collection of the data on the CSAT for the eight superior curlers were identical to those described above.

### 3.4.3 Knowledge Test of Curling Strategy (KCS)

Each subject was given one half-hour to complete the KCS Test after the four-end game was completed. All instructions and possible answers were written in the question booklet. The subjects were supervised but no verbal directions were given. Scoring was then done according to the procedures described earlier in this chapter. (See Appendix C).

### 3.4.4 Personal Data Sheet

A personal data sheet was attached to the written test and completed at the same time as the KCS Test by the subjects. The data requested concerned age, sex, years of curling experience, team position, frequency of practise, and a self-rating on a five point scale on ability to sweep, draw, take-out, hit the broom, read ice, understand strategy and to withstand anxiety. In addition, each subject was requested to form an opinion on his or her club's rating system. (See Appendix D for copy of this data sheet).

## 3.5 Treatment of the Data

### 3.5.1 Objectivity of the Judge's Ratings

Objectivity of the judge's ratings was determined by computing inter-correlations of the subjective ratings by each of the three judges on each of the 32 subjects.

### 3.5.2 Reliability of the Curling Shot-Making Ability Test (CSAT)

Pearson product moment correlations for the CSAT and its five sub-tests were computed by the test-retest method to determine reliability. Test-retest reliabilities were computed for the following:

(1) 1st CSAT administration scores with the 2nd CSAT administration scores.

(2) the scores on each sub-test of the 1st CSAT administration versus the scores of each sub-test of the 2nd CSAT administration.

(3) total scores of the in-turns on the 1st CSAT administration versus total scores of the in-turns on the 2nd CSAT administration.

(4) total scores of the out-turns on the 1st CSAT administration versus total scores of the out-turns on the 2nd CSAT administration.

### 3.5.3 Validity of the Curling Shot-Making Ability Test

Validity coefficients of the CSAT and its sub-tests, using Pearson product moment correlations, were computed for the following:

(1) the CSAT total scores on each of the 1st and 2nd administrations with the judges' average ratings.

(2) the scores of each sub-test with the judges' average ratings (1st CSAT administration only).

An examination of the validity of the CSAT was also made using one-way analysis of variance to determine if the CSAT satisfactorily differentiated between curlers of different levels of ability. The main sample

curlers were divided into four groups - low ability, low middle ability, high middle ability, and high ability - based on their average scores on the two CSAT administrations. The CSAT scores of the superior curlers comprised a fifth group. An analysis of variance was computed to compare each of these groups with each other on the scores of the 2nd CSAT administration and its sub-tests and on all the census and self-reported data. Whenever significant F-ratios were observed, the Student-Newman-Keuls procedure (Cronbach, 1960) was used to determine between which groups the differences existed.

Validity of the CSAT and its sub-tests was also examined by using Pearson product moment correlations between the score of each sub-test with the total CSAT score (both CSAT administrations).

3.5.4 The Knowledge of Curling Strategy (KCS) Test Data

The split-half reliability for the KCS Test was determined by correlating the main sample subjects' scores on the odd-numbered questions with their scores on the even-numbered questions.

A validity check of the KCS Test was made by correlating the total scores on the KCS Test with the judges' average ratings.

An item analysis procedure described by Marshall and Hales (1972, pp. 72-92) was employed to the KCS Test data. An index of discrimination and an index of difficulty for each of the 20 multiple-choice questions was determined. The degree of difficulty indice was the ratio of subjects who get an item right to the total number of subjects. The index of discrimination was a comparison between the highest and lowest 27% of subjects taking the test and was calculated by the following formula: $V = R_U + R_L / N_U + N_L$, where $R_U$ was the number of individuals in the upper group who answered the item correctly, $R_L$ was the number of

individuals in the lower group who answered the item correctly. The denominator was the total number of individuals in the upper and lower groups who took the test.

3.5.5 Multiple Correlation and Regression Equations

Multiple correlation coefficients were computed and multiple regression equations were derived for the following:

(1) prediction of judges' average ratings of curling ability from the average scores on the CSAT administrations, the KCS Test scores, the census data, and self-concept rating.

(2) prediction of judges' average rating of curling ability from scores obtained on the individual CSAT sub-tests and the KCS Test scores.

3.5.6 Inter-Correlations

Inter-correlations were computed among the variables on which data was obtained from the personal data sheet and the curling ability indices (judges' ratings, CSAT scores, and KCS Test scores).

A one-way analysis of variance was also computed to see if significant differences existed in CSAT scores, KCS Test scores, the census data and self-reported data among the self-declared skips, thirds, seconds and leads. Whenever significant F-ratios were observed, the Student-Newman-Keuls procedure (Cronbach, 1960) was used to determine between which groups the differences existed.

For purposes of this study, the accepted level of significance was set at $p < .05$.

# CHAPTER IV

# RESULTS

## 4.1 Introduction

The design of this study was based on methodological principles borrowed from earlier studies which were concerned with the development of knowledge and skill tests for other sports activities. In several of those studies, the researchers compared their subjects' test performance scores with subjective ratings of their skill by experts. This procedure presumably offers some indication of a test's validity, providing that the raters are objective and reliable and that they are indeed rating what they claim to be rating.

A second way of determining whether or not a test has validity involves the comparison of the test scores of unskilled subjects with those of proven highly-skilled performers. Both of the above validation procedures were followed in this study, and the results obtained are reported in this chapter.

A number of correlational analyses pertaining to shot-making performance, knowledge of curling strategy, expert's ratings and several other variables of lesser importance are also presented.

This chapter is restricted to a skeletal presentation of the results, with only a minimal amount of interpretation offered. A more complete discussion of the results is presented in Chapter 5.

## 4.2 Analysis of the Judges' Ratings of Curling Ability

### 4.2.1 General Findings

On the one to one hundred point rating scale used by the judges (described in Chapter 3), eight subjects were rated as "very highly skilled"

(between 61 and 90), eighteen as "skilled" (between 41 and 60), four as "average" (between 21 and 40), and two as "beginners" (up to 20).

Table 1 presents a summary of the means of the ratings given by each judge of the male and female subject groups alone and of the entire group.

TABLE 1

Means of the Ratings of Each Judge

| | Male N = 16 | | Female N = 16 | | Total Group Average N = 32 | |
|---|---|---|---|---|---|---|
| | $\bar{X}$ | S.D. | $\bar{X}$ | S.D. | $\bar{X}$ | S.D. |
| Judge #1 | 61.250 | 12.305 | 47.625 | 26.089 | 56.750 | 19.020 |
| Judge #2 | 55.375 | 10.825 | 43.500 | 20.704 | 51.781 | 15.397 |
| Judge #3 | 53.500 | 8.710 | 32.750 | 18.841 | 45.063 | 16.347 |
| Average Judges' Rating $J_1+J_2+J_3/3$ | 56.708 | 9.598 | 41.292 | 18.372 | 51.198 | 15.742 |

4.2.2 Objectivity of the Judges' Ratings

To determine the degree of objectivity of the three judges, the ratings of each of the 32 subjects given by each judge were compared with those given by each other judge. The resulting Pearson product moment correlations ranged from $r = .75$ to $r = .85$. While these results were interpreted as showing satisfactory judge objectivity for the purposes of this study, it was decided that the best subjective estimate of a given

subject's curling ability would be the mean of the judges' ratings of his/her performance. Table 2 presents a summary of the results of these analyses. For the purposes of this study, the term "objectivity" is used as the equivalent of "inter-rater reliability".

TABLE 2

Pearson Product Moment Correlations Showing Objectivity of the Judges' Ratings (N = 32)

| Judge | 1 | 2 | 3 | Average of Judges' Ratings |
|---|---|---|---|---|
| 1 | | .846* | .799* | .965* |
| 2 | | | .749* | .942* |
| 3 | | | | .929* |

*p < .05

4.3 Analysis of the Curling Shot-Making Ability Test

4.3.1 The Reliability of the Curling Shot-Making Ability Test (CSAT)

To determine the reliability of the CSAT and its five individual sub-tests, the subjects were asked to attend two testing sessions spaced one day apart. On each occasion, the entire CSAT was administered. Twenty-three of the original thirty-two subjects returned and repeated the tests. (The other nine subjects were absent from the second session due to illness, work, or other commitments). The test-retest reliabilities resulting from correlating only the scores obtained by the twenty-three subjects who repeated the test are presented in Table 3. The sub-test with the highest reliability is seen to be the Chap and Lie with an $r = .84$ ($p < .05$) while a total of the five sub-tests gives a test - retest reliability of $r = .78$ ($p < .05$).

TABLE 3

Test-Retest Reliabilities of the
Five Sub-tests of the CSAT
(N = 23)

| Name of Sub-test | Reliability Coefficient |
|---|---|
| #1 The Hit | .625* |
| #2 The Draw | .180 |
| #3 The Guard | .559* |
| #4 The Raise | .214 |
| #5 The Chap and Lie | .837* |
| Total of Five Sub-tests | .784* |
| *p < .05 | |

Because each of the five sub-tests required the subjects to throw three in-turns and three out-turns on each of the two days, it was possible to compute test-retest reliabilities for each turn. That is, the total scores for the in-turns of the first CSAT administration were correlated with the total scores for the in-turns of the second CSAT administration. The in-turns had a reliability coefficient of $r = .66$ ($p < .05$) and the out-turns had a reliability coefficient of $r = .69$ ($p < .05$).

4.3.2 The Concurrent Validity of the Curling Shot-Making Ability Test (CSAT)

An indice of the concurrent validity (Cronbach, 1960) of the CSAT at each administration for the main sample curlers was determined by correlating the total scores obtained on each CSAT administration with the criterion. The criterion of playing ability used was the average

of the three judges' subjective ratings. The Pearson product moment correlations which were obtained were $r = .81$ ($p < .05$) for the first CSAT administration and $r = .71$ ($p < .05$) for the second CSAT administration.

The concurrent validity of each of the sub-tests was also examined by correlating the scores obtained on each of the sub-tests with the criterion (judges' average ratings). These correlations are reported in Table 4.

TABLE 4

Pearson Product Moment Correlations Between Judges' Average Ratings and the CSAT Sub-test Scores

| Name of Sub-test | Correlation Coefficient |
|---|---|
| #1 The Hit | .663* |
| #2 The Draw | .484* |
| #3 The Guard | .701* |
| #4 The Raise | .433* |
| #5 The Chap and Lie | .808* |
| *p < .05 | |

4.3.3 Validity of the CSAT by Comparing Superior Curlers with the Main Sample Curlers

A second way of determining validity of the CSAT employed analysis of variance procedures to examine if the CSAT differentiated between curlers at different levels of ability. The main sample curlers were divided into four groups - low ability through high ability - based on their average scores of the two CSAT administrations. The CSAT scores of the superior curlers comprised the fifth group. Table 5 presents the

analysis of variance results when these five groups were compared.

TABLE 5

Results of the One-Way Analysis of Variance Showing if Differences Exist on all Variables Between Five Levels of Curling Ability

| Variable | F |
|---|---|
| Second CSAT Administration | 6.804* |
| In-turn Total | 6.242* |
| Out-turn Total | 6.413* |
| Sub-test #1 - The Hit | 5.101* |
| Sub-test #2 - The Draw | 8.264* |
| Sub-test #3 - The Guard | 6.998* |
| Sub-test #4 - The Raise | 5.399* |
| Sub-test #5 - The Chap and Lie | 3.087* |
| Age | 1.880 |
| Years of Experience | 3.301* |
| Frequency of Practise | 2.550 |
| Team Position | .698 |
| Sweeping Ability | 4.401* |
| Take-out Ability | 5.138* |
| Draw Ability | 5.250* |
| Style | 3.025* |
| Hitting the Broom | 4.867* |
| Reading the Ice | 7.980* |
| Understanding Strategy | 6.450* |
| Ability to Withstand Anxiety | 1.930 |
| *p < .05 | |

When significant F-ratios ($p < .05$) were observed, the Student-Newman-Keuls procedure was used to determine between which groups there was a significant ($p < .05$) difference. On 90% of the variables, the significant differences were found between the superior curlers group and each of the four main sample groups, between the high ability and

low ability main sample groups, and between the two middle ability groups and the low ability group. In general, there were no significant differences between the two middle ability groups.

### 4.3.4 Validity of the CSAT by a Correlational Analysis of the Five Sub-Tests of the CSAT

In order to further establish the validity of the CSAT and to check the validity of each sub-test, the scores for each sub-test were correlated with the total CSAT scores (first and second administrations respectively). Table 6 displays the correlation coefficients which were calculated. Sub-test #1, The Hit, showed the highest correlation with both administrations of the CSAT ($r = .81$, $p < .05$ and $r = .86$, $p < .05$).

TABLE 6

Pearson Product Moment Correlations Between Performance Scores For Each Sub-test and the Total CSAT Scores

| Name of Sub-test | Total Score 1st CSAT Administration (N = 32) | Total Score 2nd CSAT Administration (N = 23) |
|---|---|---|
| #1 The Hit | .814* | .855* |
| #2 The Draw | .593* | .598* |
| #3 The Guard | .789* | .630* |
| #4 The Raise | .659* | .700* |
| #5 The Chap and Lie | .809* | .771* |

*p < .05

## 4.4 Analysis of the Knowledge of Curling Strategy (KCS) Test Data

The split-half (odd-even) reliability of the 20 item KCS Test computed from the scores of the 32 main sample curlers was $r = .62$ ($p < .05$).

An index of the validity of the KCS Test was determined by correlating the total scores on the KCS Test with the criterion (judges' average rating). The Pearson product moment correlation obtained was $r = .86$ ($p < .05$).

The Pearson product moment correlation between the KCS Test scores and the average CSAT scores was $r = .72$ ($p < .05$). A discussion of the implications that this result suggests with respect to the understanding of the relationship between "knowledge and action" in curling ability will be presented in the next chapter.

Each question on the KCS Test was subjected to an item analysis procedure suggested by Marshall and Hales (1972). Each item was examined with respect to its degree of difficulty and its ability to discriminate between individuals who score high or low on the test. In the present study the indice of difficulty was primarily employed to identify those items where superior curlers differ from main sample curlers in shot preference. This point is developed further in the next chapter. Results of these analyses for each of the 20 KCS Test questions are presented in Table 7.

| Question # | Degree of Difficulty | Discrimination | Interpretation |
|---|---|---|---|
| 1 | .67 | .40 | good discrimination |
| 2 | .31 | .10 | difficult; poor discrimination |
| 3 | .44 | .00 | difficult; poor discrimination |
| 4 | .09 | -.10 | difficult; poor discrimination |
| 5 | .75 | .40 | easy; good discrimination |
| 6 | .72 | .40 | easy; good discrimination |
| 7 | .57 | .10 | poor discrimination |
| 8 | .59 | .30 | good discrimination |
| 9 | .85 | .20 | easy |
| 10 | .28 | .50 | difficult; good discrimination |
| 11 | .59 | .00 | poor discrimination |
| 12 | .65 | .40 | good question |
| 13 | .16 | .30 | very difficult; good discrimination |
| 14 | .19 | .40 | difficult; good discrimination |
| 15 | .15 | .30 | difficult; good discrimination |
| 16 | .91 | .20 | easy; poor discrimination |
| 17 | .47 | .80 | good question |
| 18 | .81 | .40 | easy; good discrimination |
| 19 | .34 | .40 | difficult; good discrimination |
| 20 | .88 | .20 | easy; poor discrimination |

TABLE 7

Item Analysis of KCS Test Data: Indices of Degree of Difficulty and Discrimination of Each Item of the KCS Test

## 4.5 Multiple Correlation Coefficients and Regression Equations to Predict Judges' Ratings of Curling Ability

Multiple correlation coefficients and multiple regression equations were computed to determine the degree of success one might have in predicting the judges' average ratings using a linear combination of the KCS and CSAT scores. The systematic addition of census data such as age, years of curling experience, frequency of practise, and self-concept of curling ability, was done in an attempt to reduce the error of these predictions. The results obtained from these analyses are presented in Tables 8 and 9.

TABLE 8

Multiple Correlation Coefficients (R), Coefficients of Multiple Determination ($R^2$) and Regression Equation for Predicting the Judges' Average Rating of Curling Ability

Dependent Variable = Judges' Average Rating = $R_0$

| Variable | r | R | $R^2$ | Change in $R^2$ |
|---|---|---|---|---|
| $R_1$ Average CSAT Score | .744 | .744 | .553 | .553 |
| $R_2$ KCS Score | .864 | .862 | .742 | .189 |
| $R_3$ Age | -.076 | .868 | .753 | .011 |
| $R_4$ Years of Experience | .224 | .870 | .756 | .003 |
| $R_5$ Frequency of Practise | .620 | .879 | .773 | .017 |
| $R_6$ Self-Concept | .819 | .903 | .815 | .042 |

| Battery | Combination | Regression Equation | F |
|---|---|---|---|
| B | $R_0.12$ | $R_0 = .235R_1+1.460R_2-85.419$ | 41.760 ($p < .05$) |

TABLE 9

Multiple Correlation Coefficients (R), Coefficients of Multiple Determination ($R^2$) and Regression Equation for Predicting Judges' Average Ratings of Curling Ability

Dependent Variable = Judges' Average Rating = $R_0$

| Variable | r | R | $R^2$ | Change in $R^2$ |
|---|---|---|---|---|
| $R_1$ KCS Test Scores | .864 | .724 | .524 | .524 |
| $R_2$ Sub-test #2 The Draw | .484 | .758 | .574 | .050 |
| $R_3$ Sub-test #4 The Raise | .433 | .848 | .719 | .146 |
| $R_4$ Sub-test #3 The Guard | .701 | .881 | .777 | .057 |
| $R_5$ Sub-test #5 The Chap and Lie | .808 | .949 | .900 | .124 |
| $R_6$ Sub-test #1 The Hit | .663 | .962 | .926 | .026 |

| Battery | Combination | Regression Equation | F |
|---|---|---|---|
| F | $R_0.123456$ | $R_0 = .290R_1+.556R_2+.685R_3+.635R_4 +1.294R_5+.878R_6-14.443$ | 52.060 ($p < .05$) |

The implications of both of the regression equations in Tables 8 and 9 as "predictors" of curling ability will be discussed in the next chapter.

## 4.6 Inter-Correlations of Years of Curling Experience, Frequency of Practise, Team Position, Age, and Self-Concept with Judges' Ratings, CSAT Scores and KCS Test Scores

The present study gave the researcher some opportunity to examine a number of other interesting relationships between various self-reported data and the obtained scores for curling ability. It was felt that variables such as age, years of experience, team position, and frequency of practise might be helpful in shedding some light on what factors contribute to curling ability. In addition, each subject in the main sample and the superior curler group was asked to rate himself/herself on several curling skills. The sum of these self ratings provided some measure of each curler's "curling ability self-conc . Little can be said about the validity of these obtained ratings, as they, like most self-report instruments, may be somewhat suspect. However, the observed correlations between these variables, and the curling ability scores (Judges' Ratings, CSAT scores, and the KCS Test scores) seem to have some informative value and are reported for the main sample curlers in Table 10 and for the superior curlers in Table 11.

It is interesting to note that for the main sample curlers (See Table 10) one's self-concept of ability to sweep and hit the broom correlated significantly with more of the curling ability scores than any of the other self-concept variables. The highest intercorrelation was between the judges' average rating and the total self-concept variable ($r = .82$, $p < .05$). The total self-concept variable correlated quite highly with all the curling ability scores (KCS Test scores, Judges' Ratings and CSAT scores). The Raise, Sub-Test #4, correlated the lowest with all the variables.

| Self Report and Evaluation | CSAT Score Admin. #1 | Average CSAT Score | Sub-Test #1 The Hit | Sub-Test #2 The Draw | Sub-Test #3 The Guard | Sub-Test #4 The Raise | Sub-Test #5 The Chap and Lie | KCS Score | KCS and Average CSAT | Judges' Average Rating | Judge #1 Rating | Judge #2 Rating | Judge #3 Rating | Self-Concept |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Years Experience | .379* | .286 | .312* | .439* | .205 | .209 | .246 | .112 | .339 | .224 | .212 | .143 | .336* | .389* |
| Frequency of Practise | .522* | .514* | .330* | .470* | .356* | .419* | .361* | .534* | .641* | .620* | .521* | .557* | .583* | .867* |
| Team Position | .364* | .310 | .355* | .373* | .325* | -.018 | .292 | .242 | .436* | .528* | .535* | .240 | .362* | .612* |
| Sweeping Ability | .680* | .646* | .498* | .610* | .534* | .350* | .512* | .607* | .775* | .728* | .652* | .584* | .602* | .874* |
| Take-Out Ability | .536* | .551* | .465* | .357* | .462* | .165 | .486* | .568* | .668* | .771* | .716* | .559* | .629* | .832* |
| Draw Ability | .488* | .649* | .323* | .382* | .374* | .134 | .526* | .452* | .760* | .670* | .548* | .581* | .576* | .842* |
| Style | .548* | .567* | .281 | .413* | .484* | .324* | .506* | .559* | .696* | .704* | .625* | .626* | .487* | .906* |
| Hitting Broom | .600* | .575* | .369* | .429* | .467* | .378* | .548* | .563* | .681* | .604* | .523* | .601* | .445* | .795* |
| Reading Ice | .635* | .587* | .425* | .547* | .495* | .266 | .582* | .555* | .706* | .780* | .708* | .635* | .700* | .898* |
| Strategy | .602* | .605* | .513* | .558* | .457* | .236 | .450* | .635* | .729* | .807* | .705* | .633* | .711* | .880* |
| Anxiety | .011 | - | -.134 | .047 | -.070 | .026 | .066 | -.204 | -.134 | -.016 | .050 | -.023 | .019 | .173 |
| Age | .026 | - | -.141 | .140 | -.113 | -.003 | .182 | -.258 | -.095 | -.076 | .008 | -.123 | -.116 | .136 |
| Self-Concept | .761* | .653* | .510* | .767* | .584* | .417* | .694* | .720* | .791* | .819* | .788* | .755* | .781* | - |

*p < .05

TABLE 10

Intercorrelations of Years of Curling Experience, Frequency of Practise, Team Position, Age and Self-Concept with Judges' Ratings, CSAT Scores and KCS Test Scores for Main Sample Curlers

TABLE 11

Intercorrelations of Years of Curling Experience, Frequency of Practise, Team Position, Age, and Self-Ratings with CSAT Score and the Scores of Each Sub-Test of the CSAT for the Superior Curlers

| Self Report and Evaluation | Score on CSAT | Sub-Test #1 The Hit | Sub-Test #2 The Draw | Sub-Test #3 The Guard | Sub-Test #4 The Raise | Sub-Test #5 The Chap and Lie |
|---|---|---|---|---|---|---|
| Years of Experience | .357* | .272* | .343* | .331* | .303* | .359* |
| Frequency of Practise | .330* | .271* | .268* | .304* | .248 | .385* |
| Team Position | .145 | .161 | .084 | .072 | .035 | .240 |
| Sweeping Ability | .241 | .269* | .181 | .235 | .110 | .256 |
| Take-Out Ability | .427* | .456* | .404* | .371* | .330* | .368* |
| Draw Ability | .496* | .490* | .376* | .410* | .407* | .534* |
| Style | .370* | .359* | .325* | .351* | .272* | .356* |
| Hitting the Broom | .415* | .396* | .406* | .382* | .302* | .387* |
| Reading Ice | .491* | .527* | .356* | .427* | .372* | .502* |
| Strategy | .521* | .560* | .406* | .409* | .371* | .557* |
| Ability to Withstand Anxiety | .189 | .157 | .106 | .241 | .147 | .207 |
| Age | .064 | -.066 | .113 | .101 | .090 | .066 |

*p < .05

By examining Table 11, one can observe that the superior curlers self-concepts of their ability to draw, read ice and understand strategy show the highest correlations with the curling ability scores (CSAT scores and Sub-Test scores). Again, The Raise, Sub-Test #4, correlated the lowest with all the variables. A further interpretation of these tables is discussed in the next chapter.

## 4.7 One-Way Analysis of Variance to Determine if Differences on Curling Ability Variables Exist Among Team Positions

One further question was asked: do skips, thirds, seconds and leads systematically differ from one another on any of the variables obtained in this study? An analysis of variance procedure was employed and significant F-ratios ($p < .05$) were found on only seven variables when the curlers of different team positions were compared. A significant F-ratio was found on one of the curling ability indices, the subjective ratings by Judge #1. Table 12 presents these analyses. When significant F-ratios were observed, the Student-Newman-Keuls procedure was used to determine which differences between groups were significant ($p < .05$). The significant differences were found between the skips and every other position, and between thirds and every other position. Significant differences were not found between seconds and leads.

TABLE 12

Results of the One-Way Analysis of Variance Comparing Skips, Thirds, Seconds, and Leads on all Variables

| Variable | F-Ratio |
|---|---|
| Sex | .637 |
| Ratings - Judge #1 | 3.750* |
| Ratings - Judge #2 | .626 |
| Ratings - Judge #3 | 1.573 |
| Judges' Average Rating | 2.055 |
| First CSAT Administration | 1.488 |
| Second CSAT Administration | .852 |
| Average CSAT Score | 1.079 |
| In-Turn Total - 1st Administration | 1.072 |
| Out-Turn Total - 1st Administration | 1.459 |
| Sub-Test #1 - The Hit | 2.428 |
| Sub-Test #2 - The Draw | 2.046 |
| Sub=Test #3 - The Guard | 2.150 |
| Sub-Test #4 - The Raise | .260 |
| Sub-Test #5 - The Chap and Lie | .750 |
| Age | 1.536 |
| KCS Test Score | 1.438 |
| Years Experience | 3.794* |
| Frequency of Practise | .942 |
| Sweeping Ability | 2.701 |
| Take-Out Ability | 5.629* |
| Draw Ability | 2.047 |
| Style | 1.792 |
| Hitting the Broom | .638 |
| Reading Ice | 4.142* |
| Strategy Understanding | 3.367* |
| Ability to Withstand Anxiety | 3.399* |
| Self-Concept | 4.581* |

*p < .05

When the means of the four positions were calculated the results in Table 13 were obtained.

TABLE 13

Means on the CSAT and the KCS Test for the Four Team Positions

| Position | Average CSAT Score | Average KCS Score |
|---|---|---|
| Skips | 72 | 84 |
| Thirds | 68 | 88 |
| Seconds | 60 | 82 |
| Leads | 61 | 81 |

4.8 Tables of Means and Standard Deviations for Males and Females

The main sample for this study consisted of 16 male and 16 female curlers. Means were calculated for the males and females on all variables. A complete summary of the differences in these means for all variables may be found in Appendix E.

Tables 14 and 15 display the means for the CSAT and the KCS Test. It is interesting to note that in all instances, the females scored significantly lower ($p < .05$) than the males.

TABLE 14

Table of Means and Standard Deviations for the CSAT Scores

| | 1st CSAT Administration | | | 2nd CSAT Administration | | | Average CSAT Scores | | |
|---|---|---|---|---|---|---|---|---|---|
| | Males | Females | Total | Males | Females | Total | Males | Females | Total |
| $\bar{X}$ | 76.50 | 54.31 | 67.63 | 69.83 | 47.73 | 59.26 | 74.94 | 56.06 | 65.50 |
| S.D. | 14.15 | 25.33 | 19.80 | 31.74 | 26.99 | 20.79 | 13.88 | 19.62 | 19.27 |

TABLE 15

Table of Means and Standard Deviations for the KCS Test Scores

| | Total Scores | Males | Females |
|---|---|---|---|
| $\bar{X}$ | 83.03 | 85.88 | 80.19 |
| S.D. | 6.80 | 5.48 | 6.95 |

# CHAPTER V

# DISCUSSION

## 5.1 Introduction

The results of the present study support the stated purpose which was to develop an objective, valid and reliable means for assessing curling ability. For this sample of subjects the Curling Shot-Making Ability Test (CSAT) and the paper-and-pencil test of Knowledge of Curling Strategy (KCS) were valid measures ($p < .05$) of curling ability when compared to the judges' ratings. In a test-retest situation, the CSAT was reliable ($r = .78$, $p < .05$) and the KCS Test was reliable ($r = .62$, $p < .05$) by the split-half method of correlation. This chapter presents a detailed discussion of the above results. In addition, discussions pertaining to the recommended improvements of the KCS Test and the CSAT, the relationships between the two tests, and the use of the tests in regression equations for predicting curling ability are included. The implications of the item analysis of the KCS Test insofar as differences in strategy preferences between superior and main sample curlers is discussed in some detail. A discussion of the relationships between the census and self reported data and the curling ability indices concludes this chapter.

## 5.2 The Expert Judge's Ratings

The objectivity of the three judges in this study ranged from $r = .75$ to $r = .85$. In the pilot study, the objectivity ranged from $r = .88$ to $r = .97$. There are several reasons for the higher correlations in the pilot study. In the latter study, there were five expert judges, each judge knew all of the eight subjects beforehand, and the subjects

were systematically chosen to provide a continuous scale of ability from low to high. In the present study, Judges 1 and 2 had the highest correlation of agreement ($r = .85$, $p < .05$). Judge 3 consistently rated all the subjects lower on the scale (See Tables 1 and 2). Judges 1 and 2 are both active competitive curlers while Judge 3 is not presently an active participant but a concerned spectator. While it is difficult to know for certain why Judge 3's ratings were lower, at least three explanations seem plausible: (1) Judge 3 had more experience as an "observer" and therefore, was a more competent rater than the other two judges. (2) Observers of sports activities who no longer actively participate may tend, in general, to be more critical than observers who are still involved as participants. (3) Judge 3 simply rated every subject lower on the scale than the other two judges. With respect to problems of systematic differences between raters, Kirk (1968) has argued that the mean of pooled rater scores is likely a better estimate of ability than individual rater scores. With that advice and the results in mind, it was decided that the average of the judges' ratings should be viewed as the best indice of curling ability.

One further aspect of the judges' contributions to the present study needs to be mentioned. Although the judges were asked specifically to rank the subjects after rating them, they chose not to. Instead, they devised their own system. After rating the curlers on the one to one hundred point scale, they formed global subjective impressions of each curler with respect to playing position (skip, third, second, or lead) at a particular level (national, provincial, club, club-social, or novice). The judges then compared the description with their score ratings. They assumed that within each of the five levels of the one to one hundred

point scale, a lead would score in the bottom quartile, a second the next quartile, the third the next quartile, and the skip, the highest quartile. This method seemed beneficial in assisting the judges make what they believed to be "good" subjective ratings. The researcher felt that if this method proved easier for them, it should not be changed.

## 5.3 The Reliability and Validity of the Curling Shot-Making Ability Test (CSAT)

Over the years the game of curling has occasionally been a target for criticism by non-curlers. From those who are only familiar with the game through television one sometimes hears comments such as "It's more luck than skill" or "I think anyone can make that shot". In part, comments such as these have some validity. Luck can help and curling is indeed a sport where anyone can make a given shot some of the time. However, the results of the superior curlers on the CSAT in contrast to the main sample curlers should make us clearly aware of how much skill is involved if one is to consistently make a given shot. The higher mean scores of this sample provides us with some idea of how well one must curl to be able to compete with reasonable success in a national competition (superior curlers $\bar{X} = 96.88$; main sample $\bar{X} = 67.63$). The high validity of the CSAT as an indice of shot-making ability is underlined by the fact that a member of the 1972 National Seniors Championship Team and the skip of a Provincial Championship Team had the two highest scores on this test. Similarly, the other six superior curlers scored significantly higher ($F = 6.80$, $p < .01$) than the main sample curlers. The CSAT scores thus clearly discriminate between superior and regular level curlers. However, the non-random sampling and the small sample size of the superior curler group may make these results somewhat suspect.

The CSAT is considered to be a valid test of curling ability for

this sample of subjects. The results obtained support that statement. When the subjects' scores from the first administration of this test were compared to the judges' average rating, the correlation was r = .81 ($p < .05$). However, two of the sub-tests had low concurrent validity coefficients - The Draw Test (r = .48) and The Raise Test (r = .43) (See Table 4).

The CSAT is also a reliable test of shot-making ability. This statement is supported by the test-retest correlation of r = .78 ($p < .05$). Weber and Lamb (1970) state

> that a reliability coefficient of r = .95 to .99 shows very high reliability, rarely found among present tests; r = .90 to .94 shows high reliability, equaled by a few of the best tests; r = .80 to .89 shows fairly high reliability, fairly adequate for individual measurements; r = .70 to .79 is rather low, adequate for group measurement but not very satisfactory for individual measurement; and r < .70 is low, entirely inadequate for individual measurement, although useful for group averages and school surveys (p. 182).

Two of the sub-tests had very low reliability coefficients - The Draw Test (r = .18) and The Raise Test (r = .21) (See Table 3).

These low validity and reliability coefficients for both these sub-tests may reflect several influences. The most likely reasons that these correlations are low involves a failure of the sub-tests to measure performance or inconsistent performance by the subjects on these two sub-tests. On this matter, Cronbach (1960) has stated that:

> There is a rule which states that reliability limits validity. The correlation between the test and a dependent criterion can never be higher than the square root of correlations between two forms of the test (p. 132).

The ability to make draw shots consistently depends upon delicate weight adjustments. The low reliability correlations may have been partly due to the "spring ice" conditions which are more prone to fluctuations in consistency than earlier-season ice. The Raise Test may have had a low

reliability coefficient due to the inherent difficulty of such a shot. Next to the "Freeze" the Raise is considered to be the most difficult shot in the game. The researcher also suspects that the scoring system may be too rigid for this particular test and should be re-examined. Unfortunately, the testing was done "on the ice" and therefore, performance could not be re-scored. The Chap and Lie sub-test had the highest validity coefficient ($r = .81$, $p < .05$) and reliability coefficient ($r = .84$, $p < .05$). The high correlations observed may be partly due to the fact that it was the last of the five sub-tests. Several of the more experienced subjects commented that this sub-test was the easiest because they knew the ice well by that time. The researcher noted that although this seemed true for most of the more experienced curlers, the novice curlers still made very few appropriate adjustments.

Three of the five sub-tests proved to be important measures of curling shot-making ability. The Draw sub-test and The Raise sub-test had the lowest correlations with the total score of the first CSAT administration ($r = .59$ and $r = .66$, respectively) (See Table 6).

Because The Draw and The Raise sub-tests showed the lowest validity and reliability coefficients and low correlations as measures of curling shot-making ability, it is felt that these sub-tests could be removed from the CSAT. Both sub-tests in their present form add little to the CSAT and their elimination would conserve time and energy in the administration of the entire CSAT.

## 5.4 General Discussion of the CSAT

Two additional points about the CSAT arose from discussions with the subjects after the data was collected. Most subjects indicated that although their own performance on the CSAT was frustrating, the test was

informative and fun to take. Several curlers also expressed the belief that they would have scored higher on the test if they had been provided with the scoring system before making each shot. For example, several of the superior curlers mentioned that they emphasized direction of the rock for The Raise sub-test, although according to the scoring system, weight was the more dominant factor. Future researchers employing this test might consider whether or not this belief has merit.

One further finding regarding the CSAT results was somewhat surprising. It is a commonly held belief amongst curlers that the out-turn is a more difficult shot to make than the in-turn. The results obtained for each turn did not significantly differ [See Appendix E(I)]. Thus, while curlers might believe that the out-turn is more difficult, there is reason to believe that they are just as successful with that turn.

5.5 The Validity of the Knowledge of Curling Strategy Test (KCS)

As the name implies, the KCS Test was designed to measure a curler's understanding of what shots should be played in a number of different situations. The test appeared to have validity as a measure of curling ability, this conclusion being warranted in view of the high correlation ($r = .86$, $p < .05$) observed when scores in that test were compared to the judges' average rating. Other studies (Broer and Miller, 1950; Fox, 1953; Miller, 1953) have used correlations in a similar way as indices of test validity. In addition, the concensus of the superior curlers' opinions had been used to weight each test item on a five-point scale. It is interesting to note that the superior curler group was virtually in unanimous agreement about the best (five points) and poorest (one point) answers to each of the 20 multiple-choice questions.

In their rating of middle value answers, more disagreement was apparent. In the two or so instances where group concensus did not provide a clear rank order difference between items, the present researcher had to break the tie.

The decisive attitudes that these superior curlers displayed about the selection of the best and poorest answers confirmed several suspicions about their approach to strategy. For instance, this group indicated a strong preference for the take-out game over the draw game. In situations which required a choice between a high risk shot to win a game versus an easy shot to tie and force the steal of an extra end to win, this group chose to try the high risk shot. It may be presumed that superior curlers have more confidence in their ability to make a possible shot than in their ability to steal an end. Having identified this particular strategy preference, the present researcher approached the skip of a Quebec Brier team. His comments regarding that finding indicated that, in general, most superior curlers will adopt that strategy unless the opposition is particularly weak and the shot is particularly risky. In the latter instance, the tie and steal strategy is preferable.

## 5.6 A Discussion of the Item Analysis of the KCS Test

The item analysis procedure employed here was that suggested by Marshall and Hales (1972), and consequently indices of difficulty and discrimination were computed for each of the 20 test items. Marshall and Hales (1972) have argued that an indice of difficulty of approximately .50 is ideal with higher ratios being too easy, while lower ratios are too difficult. Therefore, questions 2, 3, 4, 10, 13, 15 and 19 were interpreted as being difficult; while questions 5, 6, 9, 16, 18 and 20 were interpreted as being easy. These authors have also indicated that items which have indices of discrimination between V = 0 to .19 are of little

value; V = .20 to .40 are acceptable; V - .40 + are very good for discriminating between high and low scorers. Therefore, questions 2, 3, 4, 7, 11, 16 and 20 were interpreted as poor discriminators. Questions 1, 8, 12 and 17 proved to be the best questions according to Marshall and Hales' criteria (See Table 7).

With respect to identifying subtle differences in strategy preference between the superior curlers and the main sample curlers, the item analysis data proved to be most enlightening. It may be argued that those items which were identified as being "difficult" according to Marshall and Hales' (1972) criteria actually represent situations where superior curlers and main sample curlers differ in opinions regarding which shot is the best choice.

A careful examination of the KCS item analysis indices (See Table 7) revealed three types of questions:

(1) questions where the superior curlers and the majority of main sample curlers disagreed on the best choice of shot to make. By Marshall and Hales' (1972) criteria these questions were "difficult".

(2) questions where the superior curlers and the majority of main sample curlers agreed on the best choice of shot to make. By Marshall and Hales' (1972) criteria these items were "easy".

(3) questions where some curlers in the main sample agreed with the superior curlers on the best choice of shot to make. The correlation obtained ($r = .72$, $p < .05$) between the KCS scores and CSAT scores suggests that these curlers were, in general, the better curlers of the main sample group. By Marshall and Hales' (1972) criteria these questions were good discriminators.

The first type of question is of most concern to the present discussion because of its value in distinguishing between the thought preferences of "superior" and "regular" curlers. On the KCS test,

questions two, three and four fall into this category. The superior curlers' responses to questions two and three indicated that they felt that the best choice of shot was the double take-out. In contrast, the majority of the main sample curlers said that they would play the draw freeze. In this case, a freeze is the more difficult shot to successfully make than the double take-out for most curlers. Interestingly enough, in question four, when the superior curlers chose to draw, the main sample curlers chose the take-out! Once again the superior curlers had seen and chosen the shot with the highest probability for success.

The different opinions held by these two groups leads to several interesting speculations. It seems plausible that the superior curlers may have a better developed ability than regular curlers for perceiving relationships between angles of incidence and reflection and transfer of momentum as part of their better skill. In this regard, future studies in the area of knowledge of curling strategy might consider the possibility of including some test of spatial relationship awareness as an independent variable. Even a modified version of a simple test such as the formal operations "pool ball" test which has been employed by Inhelder and Piaget (1958) may be of value here. Furthermore, it is hypothesized that superior curlers are more concerned about thinking farther ahead about the consequences of a particular shot than regular curlers. One can wonder how well these groups might fare in a chess or checker match against each other.

Questions which proved to be easy for the majority of curlers in the main sample group have only minimum value in a discussion of thought preference differences with regard to shot-making selection. Their main value in a test of this nature comes through being morale boosters for even the most unknowledgeable curler. Questions 9, 16, 18 and 20 were

in this category with 80 percent or more of the sample choosing the best answer.

The third type of question mentioned above enabled the present researcher to examine the thought preferences of the ten curlers in the main sample who agreed most often with the superior curlers versus the ten curlers who differed most often with the opinions of the superior curlers. This second group of curlers, in general, also tended to score lowest on the CSAT Test (as suggested by the correlation between the CSAT and KCS Test $r = .72$ $p < .001$). Items which had good discrimination ability were examined to identify differences in thought preference between these two groups. Questions ten and seventeen seem to have the highest discrimination ability for separating these two groups ($D = .50$ and $.80$ respectively). In question ten, the superior curlers and high-scoring subjects in the KCS chose to play a double take-out to prevent the possibility of the opposition scoring five points. In contrast, the low-scoring subjects in the KCS indicated that they would risk losing five points by trying a draw shot. Question seventeen was designed to sample opinions about which strategy would be the best to employ for playing the last end when down by one point with last rock. Ninety percent of the high-scoring KCS group and the superior curlers chose the corner guard and draw alternatives. Only ten percent of the low-scoring KCS group made that selection. Two reasons may explain the large difference of opinion between these groups on this question: (1) the lower group may not have understood the terminology used in this question. (2) the high-scoring KCS group and the superior curler group were more familiar with the recent success that the corner guard game has enjoyed since it became popular in the late 1960's and early 1970's.

In addition to the comparisons described above, it was asked whether

or not males and females in this sample differed in their shot selection preferences. The male curlers earned significantly higher scores on the KCS than did the females (Males $\bar{X}$ = 85.9, females $\bar{X}$ = 80.19; $t = 2.57$ $p < .05$). Three explanations for the observed differences seemed plausible:

(1) male curlers really do know more about curling strategy than female curlers.

(2) the KCS Test is biased against females since the values of the various answers were determined by male superior curlers.

(3) males and females "think differently" about shot selection.

All three of these explanations have merit. Perhaps further cross-validation studies of a more extensive nature employing a larger sample along with the opinions of female superior curlers would clarify this matter. In the meanwhile, only the differences observed between males and females in the present study can be reported and speculated upon. Only question seventeen clearly underlined a difference in thought preference between males and females. On that question, 75 percent of the males favored the corner guard game. The female curlers were somewhat divided about which shot would be best. The alternative which they chose most often (37 percent) involved placing all rocks in front of the T-line. The males' choice indicated that they would play to win, whereas the females seemed to be more content to tie the game and steal the win on the extra end. On other questions, thought preferences were not so clear. Males and females in general showed similar selection patterns for each alternative with the males occasionally choosing the best item more often than the females.

The multiple-choice KCS Test is a "recognition" test. In tests of this nature, a number of subjects who might not normally be able to

generate a correct answer were capable of recognizing the best answer. Future research into thought preference differences between superior and regular curlers, or male and female curlers, might profitably study responses obtained from an open-end written test using KCS items. It is anticipated that a study of that nature might also make possible a clearer identification of what factors are given the most attention by superior curlers in shot selection. While it is known that these curlers consider probability and possible consequences associated with a particular shot, very little is known about the structure of the thought processes which are employed in the selection of the shot. It might be possible to gain a better understanding of such thought processes by presenting various KCS situations to superior curlers and asking them to discuss aloud what factors they are considering in the shot selection.

In effect, the present study has identified the fact that superior curlers do indeed choose different shots in certain instances. It now remains to be seen what factors they rely upon to make these different decisions.

## 5.7 General Recommendations for Improvements of the KCS Test

Improvement of the KCS Test could be made in at least two different ways including lengthening of the test to include more items about more curling situations and rewriting those questions with poor discrimination. In particular, questions 2, 3, 4, 7, 11, 16, and 20 need to be improved upon. Too many of these questions are quite easy and therefore result in poor discrimination. Perhaps a sampling of more curling experts would give better choices of answers and therefore improve these questions. The fact that many of the items need improvement was not surprising. Such results were anticipated in view of the fact that most textbooks in

educational testing and measurement emphasize how difficult it is to develop "good" multiple-choice items.

A longer test which identified specific areas of weakness in strategy would be desirable. In designing the KCS Test, the present researcher attempted to include a variety of shot situations representing various strategical problems. More questions representing each type of strategical problem should be developed. Such a test would provide a curler with a clearer profile of weaknesses and strengths in his knowledge of curling strategy. Furthermore, lengthening the test would likely increase the reliability ($r = .62$, $p < .05$).

5.8 The Relationship Between the CSAT and the KCS Test

The present researcher considered the relationship between theoretical ability and performance ability. In other areas the relationship between knowledge and action has been found to be low or even non-apparent (Mahabir, 1972). However, one might hypothesize that a good deal of understanding is a prerequisite to consistent shot-making ability, in view of all the factors that need to be deliberated upon prior to each shot. In the present study, the KCS Test gave some indication of a curler's knowledge of what shot should be played. The CSAT provided curlers with an opportunity to show how well they could make shots. On the surface shot-making and knowledge of strategy appear to be two different abilities. However, two explanations for the significant correlation ($r = .72$, $p < .05$) between the KCS Test score and the average CSAT score seem plausible. Firstly, one might hypothesize that the better shot-makers on the CSAT also do more thinking about their shot-making and various other aspects of the game including strategy. Thus, they become better shot-makers and strategists at the same time. Secondly, Cratty (1971) has reported that

some evidence from European research suggests that better strategists are also better playmakers "on the field". While the findings in this subject are non-definitive, Cratty has implied that some cognitive factor (possibly, a general intelligence factor, g) may unduly affect ability to think about strategy and ability to perform in sports activities. One might also argue that the high correlation ($r = .86$, $p < .05$) between the KCS Test score and the judges' average rating is displaying the same relationship between knowledge and action as that discussed above.

## 5.9 The Use of Regression Equations Involving Indices of Curling Ability to Predict Curling Ability

The present researcher hoped that this study would provide a method for objectively evaluating curling ability and therefore replace or supplement the subjective impressionistic ratings by judges. Replacing the judge's ratings might serve to alleviate the disappointment of many curlers in their club rating systems. In this regard, the main sample curlers in this study were polled as to their opinions of their club rating system. Fifty percent of the subjects did not know anything about their club's rating system. Of the 16 subjects who were familiar with their club's system, 56 percent were very unhappy with the method.

Weber and Lamb (1970) state that a multiple correlation coefficient of $R < .40$ shows a low relationship between the dependent variables and the independent variables taken together; while $R = .40$ to $.69$ indicates a moderate relationship, $R = .69$ to $.89$ shows a high relationship and $R = .90+$ shows a very strong relationship. By those criteria the multiple R obtained when the CSAT average scores and the KCS Test scores were used as independent variables for predicting the judges' average rating was high [(R = 86.15) See Table 8]. These two variables may be

used to account for 74 percent of the variance in the dependent variable, judges' average rating. The regression equation for predicting judges' average rating using CSAT scores and KCS scores is as follows:

$$\text{Judges' Average Rating} = .235\ (\text{Average CSAT Score}) + 1.460\ (\text{KCS Test Score}) - 85.42$$
$$(F = 41.75,\ p < .05)$$

The inclusion of census and self-reported data as independent variables in the linear regression analysis had little effect in reducing error in prediction. This conclusion is drawn from an examination of the "change in $R^2$" column in Table 8. Since the regression equations with these variables as predictors are awkward to employ and add little predictive power they have not been presented.

By the criteria presented by Weber and Lamb (1970) the multiple R obtained when the KCS Test score and the scores of each CSAT sub-test were used as independent variables for predicting the judges' average rating was high [(R = .96) See Table 9]. All six variables may be used to account for 93 percent of the variance in the dependent variable, judges' average rating. The regression equation for predicting judges' average rating using the KCS Test score and the CSAT sub-test scores is as follows:

$$\text{Judges' Average Rating} = .290\ (\text{KCS Test Score}) + .556\ (\text{Draw Score}) + .685\ (\text{Raise Score}) + .635\ (\text{Guard Score}) + 1.294\ (\text{Chap and Lie Score}) + .878\ (\text{Hit Score}) - 14.443$$
$$(F = 52.06,\ p < .05)$$

Until a larger number of subjects is sampled and norms developed, either of the two regression equations might be used in place of the judges' ratings to rate curling ability. While it is realized that very few clubs which use some form of a judges' rating system will be willing to abandon it in favor of objective tests, it is hoped that the tests

provided herein might be useful in supplementing the questionable ratings done in most clubs. In this regard, one can see where T scores which reflect judges' ratings, KCS Test scores, and CSAT scores could be most helpful in assessing curling ability.

5.10 Census and Self-Report Data and Their Relationships to Curling Ability

The intercorrelations obtained by comparing the census and self-report data and the various indices of curling ability unveiled some interesting findings (See Table 10). Years of curling experience did not significantly correlate with the average scores on the skill tests. This result supports the contention made earlier that years of experience do not always make a good curler. The number of times per week that subjects curled showed a significant relationship with all the variables. When the means were calculated, curlers playing four times per week scored an average of 69.7 on the CSAT and 84.7 on the KCS. Those subjects playing three times per week scored an average of 65.3 on the CSAT and 83.2 on the KCS. These results suggest that the motto "practise makes perfect" may be applied to curling, although practise sessions are not popular among curlers. These results could indicate a need for regular planned practises in curling, just as is done in almost any other sport. Team position showed a significant relationship with the self-concept factor and the ability to do all sub-tests but The Raise where team position showed an absence of any significant correlation ($r = -.02$). Team position did not show a significant relationship with the average CSAT total score or the KCS Test score.

Self-confidence appears to be an important consideration in curling ability. This statement is supported by the significant correlations between the self-concept factor and the KCS Test score ($r = .72$, $p < .05$),

the average CSAT score ($r = .65$, $p < .05$), and the judges' average rating ($r = .82$, $p < .05$). One of the most interesting findings reported in the present study is that the skips in the main sample rated themselves significantly higher on various curling skills than curlers in other team positions (See Table 10). However, the performance of skips on the CSAT and the KCS Test was not significantly higher than the performance of the other curlers. The observed results suggest that some skips become skips more because of confidence than because of a greater curling ability or that their self-confidence becomes inflated when they become skips.

The comparison of the means between males and females showed significant differences, with the males being consistently superior, on almost all the variables of curling ability (See Appendix E). The observed differences in shot-making ability between males and females was not surprising. In most sports men display more developed competence than women. Furthermore, the development of women's curling in Canada was somewhat impeded by resistance offered from curlers who advocated the belief that women did not belong in curling clubs. (For instance, it has only been in the last decade that The Thistle Curling Club in Montreal has accepted membership applications from females). The recent increased interest and participation of female curlers in competitive rather than social curling may eventually reduce the present differences in curling ability between the sexes.

# CHAPTER VI

## SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

### 6.1 Summary

The reason for the present study was derived from the stated need for an objective, valid, and reliable means for assessing curling ability. A review of the related literature indicated a lack of any such measurement for curling, but did reveal methods for the development and examination of skill and knowledge tests in other sports activities. Therefore, the development of a performance test of Curling-Shot Making Ability (CSAT) and a Knowledge of Curling Strategy (KCS) Test was undertaken. The Curling Shot-Making Ability Test (CSAT) consisted of five different sub-tests of shot-making ability. The KCS Test consisted of 20 multiple-choice questions.

Sixteen male and sixteen female curlers, ages 16 to 46, were tested on two different days on the CSAT and wrote the KCS Test once. The criterion of curling ability used was the average of the three expert judges' ratings of curling ability displayed by each curler during a four-end game. In addition to this group, eight superior curlers, ages 27 to 60, were tested on the CSAT, and were asked to rate each of the five answers to each of the 20 KCS test questions on a one to five point scale.

The test-retest reliability coefficient for the CSAT was $r = .78$ ($p < .05$). Validity for the KCS Test was established through its method of construction, as well as by correlating the total KCS Test score with the criterion ($r = .86$, $p < .05$). An item analysis was computed for the KCS Test. The indices of discrimination and difficulty for each of the 20 questions revealed interesting differences in strategy preferences

between superior and main sample curlers.

A multiple R of .86 was obtained between the criterion and the total KCS Test score and average CSAT score. A multiple R of .96 was obtained between the criterion and the total KCS Test score and the scores of each sub-test of the CSAT, added separately. The score forms for the regression equations are as follows:

(1) Judges' Average Rating = .235 (Average CSAT Total Score)
+ 1.460 (KCS Test Score) - 85.42
($F = 41.75$, $p < .05$)

(2) Judges' Average Rating = .290 (KCS Test Score) +
.556 (Draw Score) + .685 (Raise Score) +
.635 (Guard Score) + 1.294 (Chap and Lie Score)
+ .878 (Hit Score) - 14.443
($F = 52.06$, $p < .05$)

Inter-correlations were computed between census data variables (age, sex, years of experience, frequency of practise, and team position), the subject's self-ratings on eight curling skills and the curling ability indices (KCS Test Scores, CSAT Scores, and judges' ratings). These inter-correlations showed interesting relationships that contradict several of the traditional beliefs and practices in curling.

## 6.2 Conclusions

With reference to the stated main purpose of the present study and within the confines of its limitations, the following general conclusions seem justified:

(1) The Curling Shot-Making Ability Test as a whole is a valid and reliable test of shot-making ability.

(2) Three of the five sub-tests of the Curling Shot-Making Ability Test are reliable: Sub-Test #1, The Hit; Sub-Test #3, The Guard; and Sub-Test #5, The Chap and Lie.

(3) Each of the five sub-tests of the Curling Shot-Making Ability Test appear to be a valid test of curling ability as rated by expert judges.

(4) Each of the five sub-tests of the Curling Shot-Making Ability Test is an important measure of curling shot-making ability as measured by the Curling Shot-Making Ability Test.

(5) The Knowledge of Curling Strategy Test is a reliable test which appears to be highly related to curling ability as rated by the expert judges and as measured by performance on the Curling Shot-Making Ability Test.

(6) The Knowledge of Curling Strategy Test has enabled the present researcher to identify differences in thought preference between superior curlers and main sample curlers.

(7) Two multiple regression equations have been developed that may be used to predict curling ability, and which might be used to replace or supplement the judges' average rating of curling ability, from the Knowledge of Curling Strategy Test scores and the scores of the Curling Shot-Making Ability Test.

The above conclusions are specifically concerned with the main purpose of this study. In addition to these general findings, a number of other findings and their implications for further research have been included in Chapter 5.

## 6.3 Recommendations

The establishment of the Curling Shot-Making Ability Test (CSAT) and the Knowledge of Curling Strategy (KCS) Test is the first reported attempt to develop an objective method of assessing curling ability. In this respect, the present researcher would recommend the following changes if further research is to be done in this area:

(1) The CSAT or at least three of its five sub-tests and the KCS Test should be administered to a larger random sample of curlers who more adequately represent regional and national abilities. It is recommended that The Draw and The Raise sub-tests could be elim-

inated from the CSAT.

(2) The scoring system for Sub-Test #4, The Raise should be re-examined. For instance, serious consideration should be given to awarding more than one point for rocks raised behind the T-line.

(3) The opinions of a greater number of superior curlers should be elicited with respect to the answers for the Knowledge of Curling Strategy Test questions. In particular, the addition of the strategy preferences of superior female curlers is of most importance.

(4) The number of questions on the Knowledge of Curling Strategy Test should be increased with a view to improving the split-half reliability, the discrimination power of various items, and the test's ability to identify areas of weakness and strength in understanding of strategy.

One final point needs to be made. The present study represents an initial attempt to bring the game of curling closer to a more rational or scientific understanding of what skills are required for successful curling. It is hoped that the tests provided herein will enable lovers of the game to review and assess their acquired skills and therefore gain even more expertise in shot-making and strategy. Certainly, based on this study, the present researcher will play the hit rather than the draw, if the choice is available.

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# APPENDICES

# APPENDIX A

## CURLING TERMS AND DEFINITIONS

| | |
|---|---|
| Back Line: | The horizontal line running behind and just touching the outside of each outer circle. Any end where four or more stones are counting. |
| Centre Line: | The vertical line running from hack to hack and dividing the sheet in equal halves. |
| Chap and Lie: | When a stone played strikes a corner of a stone and rolls to another position on the rings. |
| Crampit: | Scottish form of hack. A metal pad 12 inches by 40 inches, from which the rock is delivered. |
| Crosswise Piping: | Refrigeration pipes below the ice surface running at right angles to the path of the stone. |
| Draw Weight/ Draw Shot: | A stone delivered with sufficient momentum to come to rest within the 12 foot circle. |
| End: | The delivery of two stones by each member of both teams completes an end. |
| Guard: | Any stone in front of another and protecting it from removal by an opposing stone. |
| Hack: | The toe-hold or foot support used by the player in delivering his stone at each end of the ice. |
| Heavy Ice: | Ice that due to water, frost or too much pebble requires a stone to be thrown with extra weight to reach the rings. |
| Hog Line: | Line 105 feet from hack and past which a stone must come to rest in order to remain in play. |
| Hog a Stone: | A stone is considered "out of play" when it does not clear the hog line. |
| House/Head: | The rings or circles toward which the stones are played. |
| In-Turn: | A moving stone whose handle is turning in a clockwise manner. |
| Keen Ice: | Ice that requires a stone to be thrown with less than normal weight to reach the house. |
| Last Rock: | The final stone played during any one end. |
| Lead: | The player who delivers the first two stones for a team. |

| | |
|---|---|
| Lengthwise Piping: | Refrigeration pipes below the ice surface running in the direction of the path of the stone. |
| Out-Turn: | A moving stone whose handle is turning counter clockwise. |
| Pull: | The amount of distance a stone will curl during its journey down the ice. |
| Raise: | When one stone strikes another and moves it further along the ice in the same direction. |
| Rock: | Stone used by players. |
| Second: | The player who delivers the second pair of stones for his team. |
| Sheet: | The ice area on which a game is being played. |
| Skip: | The captain of the team who directs the play of the other three members and who usually (but not always) plays the last two stones for his rink. |
| Slide: | Motion of a player in the act of releasing a rock during delivery. |
| Strategy: | Plan of play conceived in the mind of the skip. |
| Take-Out/ Hit: | A term meaning to hit a stone and remove it from play. |
| Tee Line: | The horizontal line bisecting the rings. |
| Third/ Vice-Skip: | The third player on a team who delivers the third pair of stones on each end. |
| Weight: | The amount of momentum given to a delivered stone. |

# APPENDIX B

## THE CURLING SHOT-MAKING ABILITY TEST (CSAT)

## LEGEND

Broom Placement (assuming right-handed delivery)

In-turn -

Out-turn -

Direction of Play

Scoring System

5 points -

4 points -

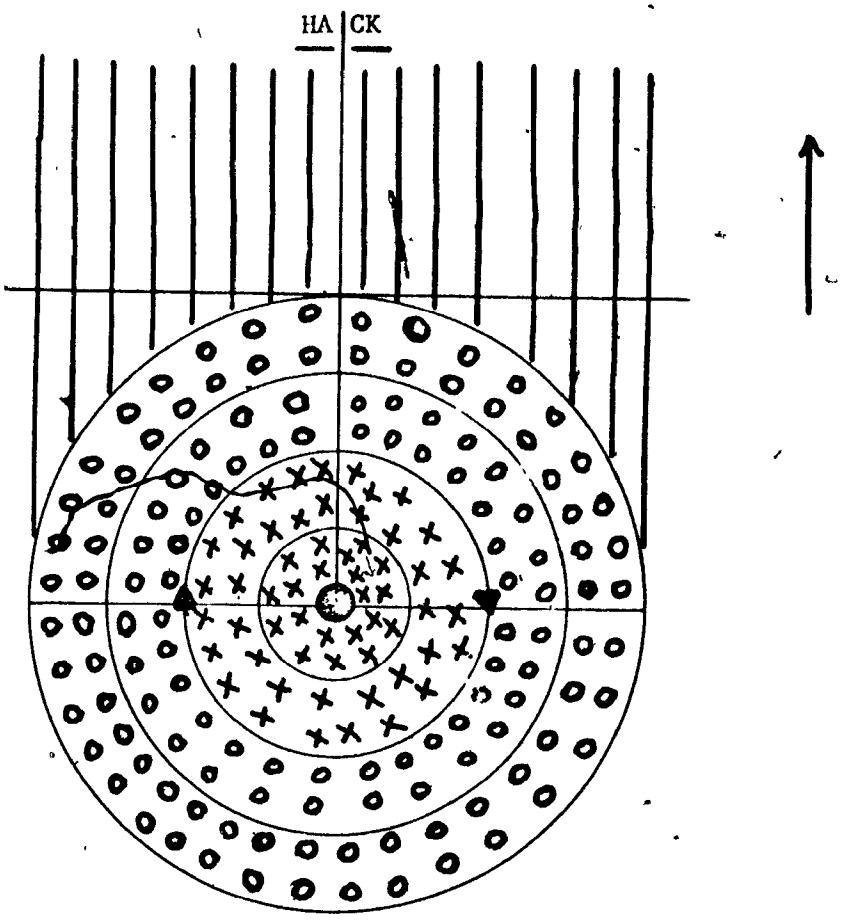
3 points -

2 points -

1 point -

placed stone -

action of stone for 1 point -




SITUATION ONE - HIT  SHADED AREAS INDICATE AREA WHERE HITTING STONE WOULD STAY. DOTTED CIRCLES INDICATE WHERE PLACED STONE WOULD BE AFTER THE HIT.

5 points - Hit the placed stone out of the house with the hitting stone staying in play in the 4 foot circle (on or touching the outer limits of the 4 foot circle included).

4 points - Hit the placed stone out of the house with the hitting stone rolling to the 8 foot or 12 foot circle (on or touching the outer limits of the 12 foot circle included).

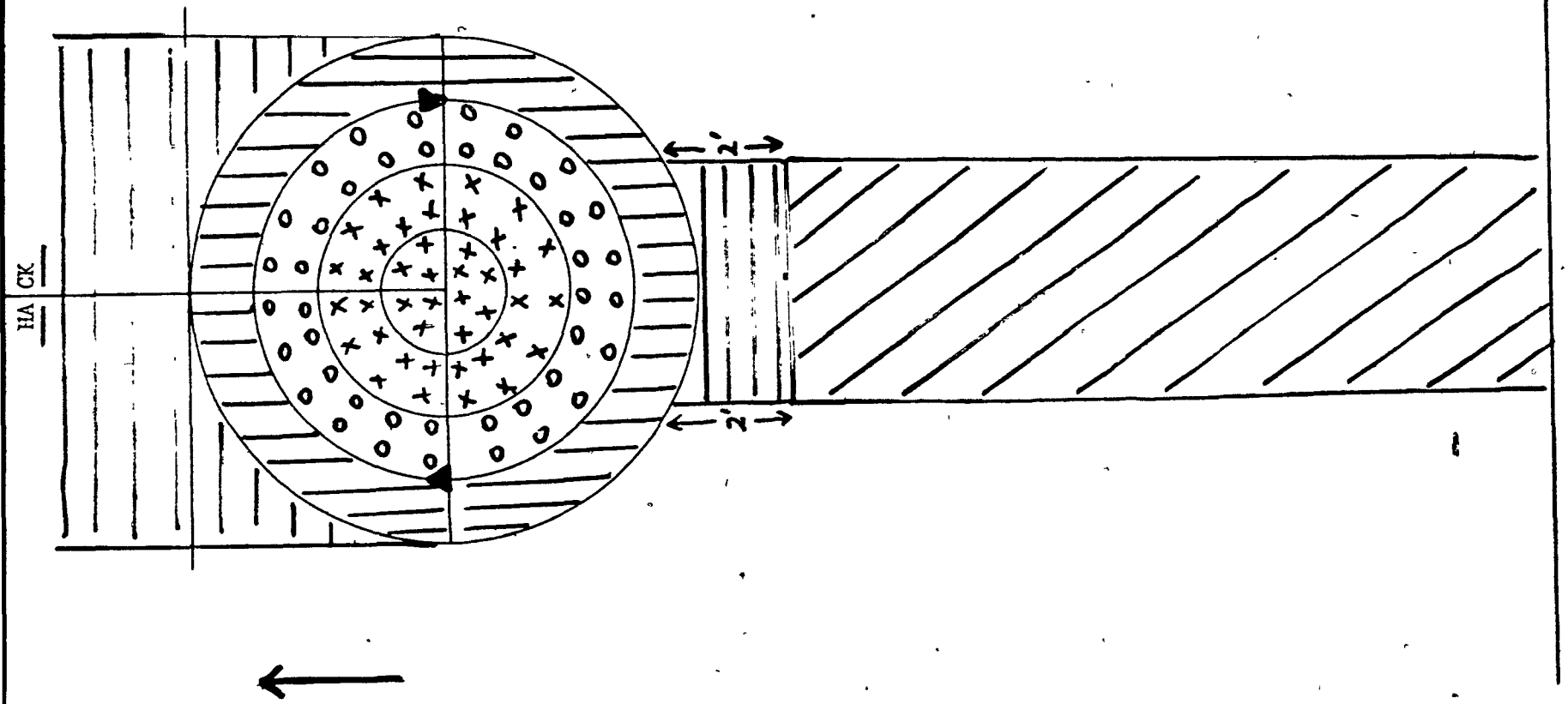
3 points - Hit the placed stone out of the house with the hitting stone rolling completely out of the house too.

2 points - Hit the placed stone but not out of the house with the hitting stone staying in the house (touching any part of the house and closer to the button than the placed stone) - not shown in the diagram.

1 point - Hit the placed stone but not out of the house with the hitting stone staying in the house (touching any part of the house) - not shown in the diagram.

SITUATION TWO - DRAWING SHADED AREAS INDICATE TOTAL AREA THE ROCK COULD LAY. A ROCK TOUCHING ANY PART OF THE SHADED AREA WOULD BE GIVEN THE POINTS OF THE HIGHER SHADED AREA.

5 points - Place the stone in the 4' circle or touching any part of the outer line of the 4' circle.
4 points - Place the stone in the 8' circle or touching any part of the outer line of the 8' circle.
3 points - Place the stone in the 12' circle or touching any part of the outer line of the 12' circle.
2 points - Place the stone between the back of the house and the hack (within the limits of the 12' circle. The stone must not be touching any part of the house.
OR Place the stone 2' or less than 2' short of the house (within the limits of the 4' circle). The stone must not touch any part of the house.
1 point - Place the stone over the hog line within the limits of the 4' circle and more than 2' short of the house.



SITUATION THREE - GUARDING SHADED AREAS INDICATE WHERE THE PLAYED STONE WOULD LAY.

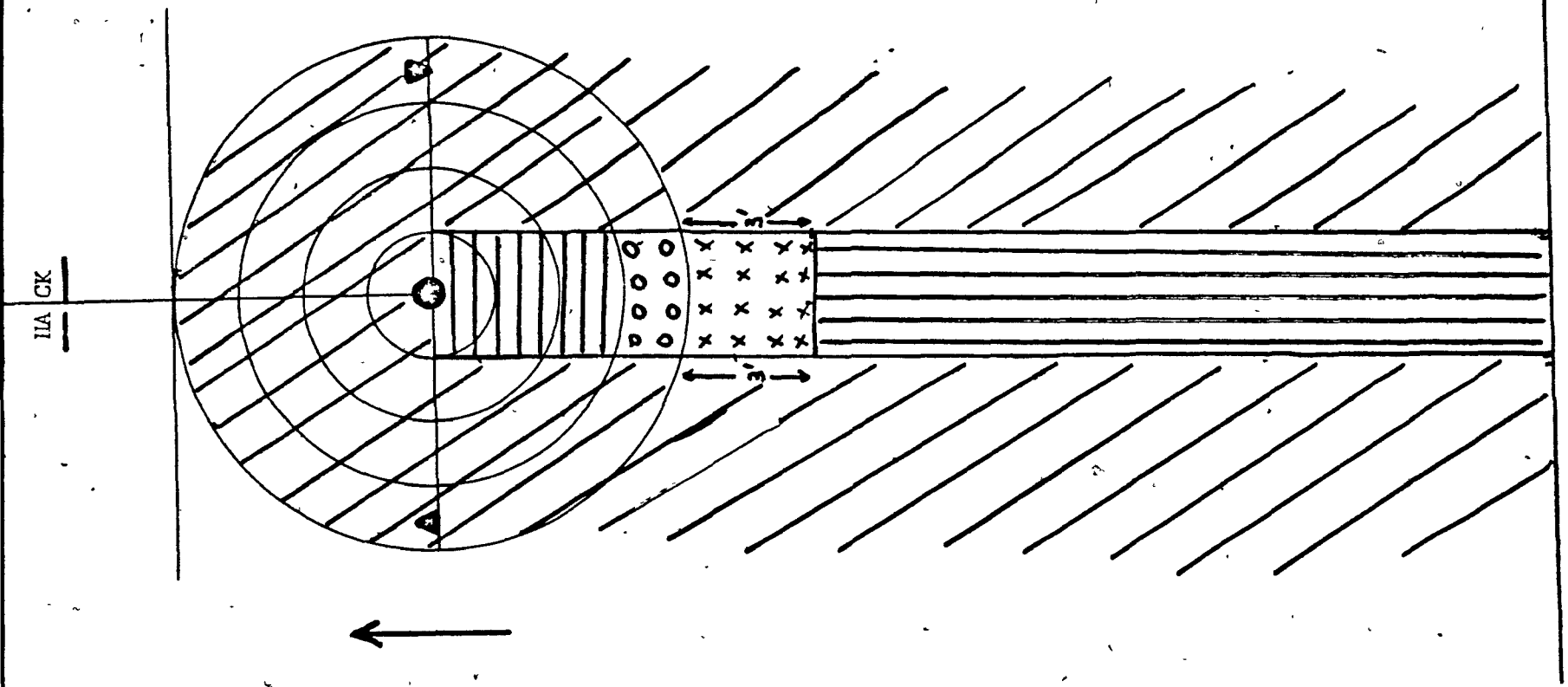
5 points - Played stone to be less than 3' short of the 12' circle and not touching any part of the 12' circle. (Stone must be within 12" of the centre line).

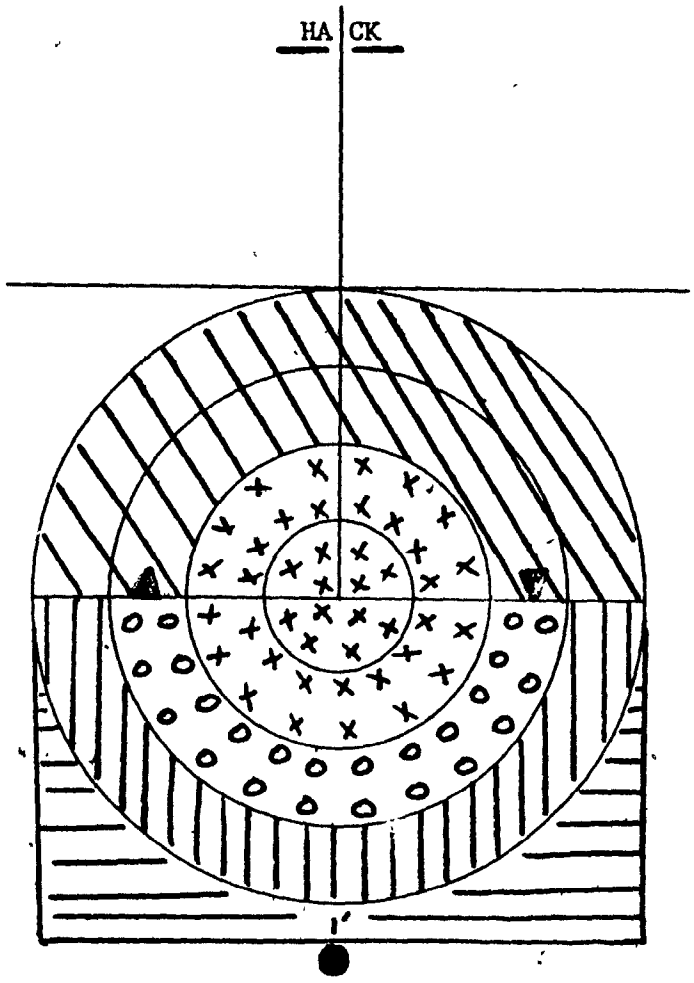
4 points - Played stone to be on or touching the 12' circle within 12" of the centre line.

3 points - Played stone to be over the hog line and more than 3' short of the 12' circle within 12" of the centre line.

2 points - Played stone to be on or touching the 8' or 4' circle within 12" of the centre line in front of the "T"-line (and not touching the placed stone).

1 point - Played stone to be anywhere in front of the house but more than 12" off the centre line.
OR Played stone to be anywhere in the house not specified above.
OR Played stone hits the placed stone (both stones must remain in play in the house).






SITUATION FOUR - RAISING SHADED AREAS INDICATE WHERE THE PLACED STONE WOULD LAY AFTER BEING HIT.

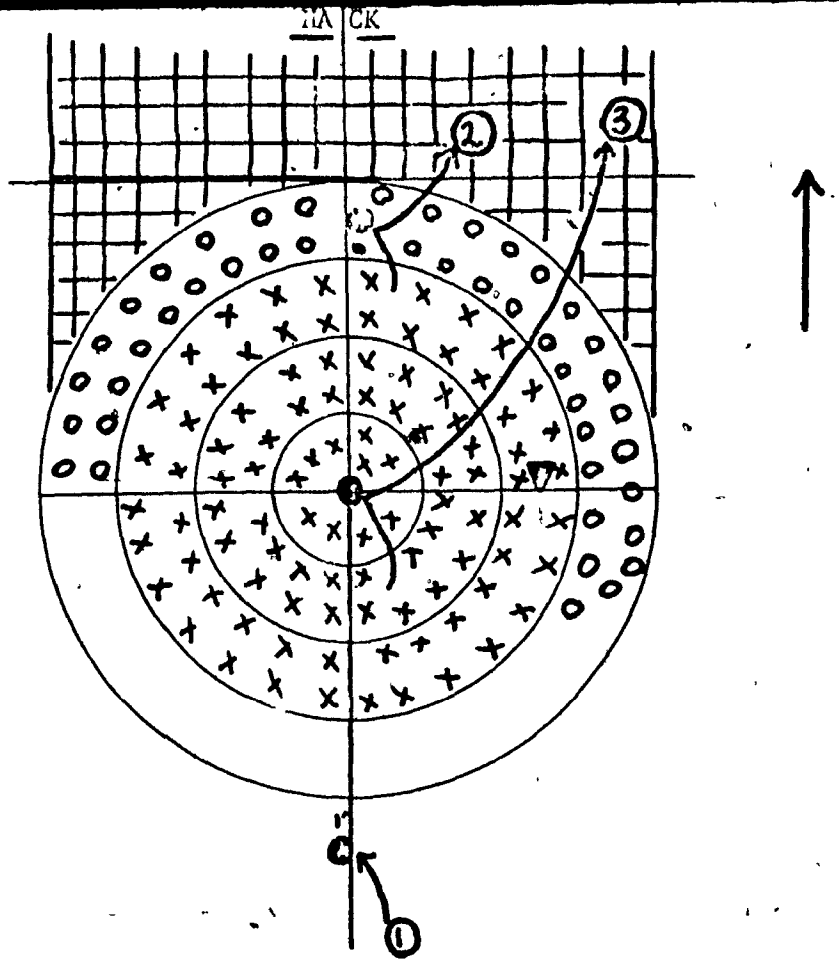
5 points - Promote placed stone to the 4' circle (on or touching the 4' circle or the outer line of the 4' circle).

4 points - Promote placed stone to the 8' circle (in front of the "T"-line) on or touching the outer line of the 8' circle or touching the "T"-line.

3 points - Promote placed stone to the 12' circle (In front of the "T"-line) on or touching outer line of the 12' circle or touching the "T"-line.

2 points - Promote placed stone short of the house (not touching any part of the house).

1 point - Promote placed stone clearly behind the "T"-line in the 8' or 12' circle (or touching the outer line of the 12' circle).




SITUATION FIVE - CHAP AND LIE SHADED AREAS INDICATE AREAS WHERE THE HITTING STONE WOULD LAY - DIAGRAM FOR OUT-TURN ONLY.

5 points - Strike the stone on the 4' circle and stay in play on or touching the 4' circle or 8' circle (or the outer line of the 8' circle).

4 points - Strike the stone on the 4' circle and stay in play on or touching the 12' circle or its outer line.
OR Strike the stone on the 12' circle and stay in play in the house.

3 points - Strike the stone on the 4' circle and roll completely out of the house.

2 points - Strike the stone on the 12' circle and roll completely out of the house.

1 point - Hit the guard.

# APPENDIX C

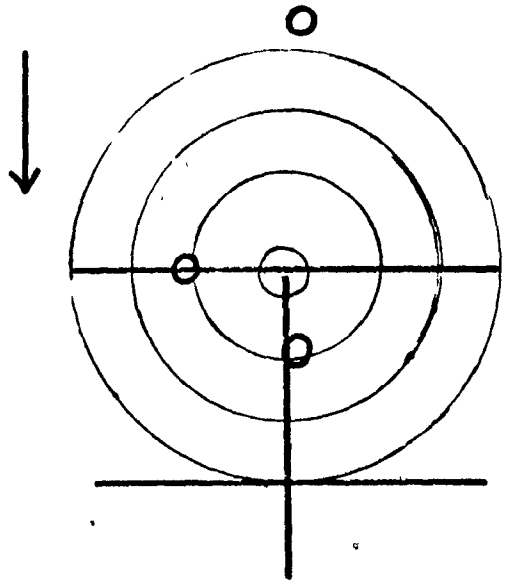
## KNOWLEDGE OF CURLING STRATEGY TEST AND SCORING SYSTEM

THEORY TEST

INSTRUCTIONS: There are twenty questions below describing situations that occur during curling games. Each question is followed by five answers. Each answer is possible. Choose the best answer by circling the proper letter. Please do each question. Do not leave any blanks.

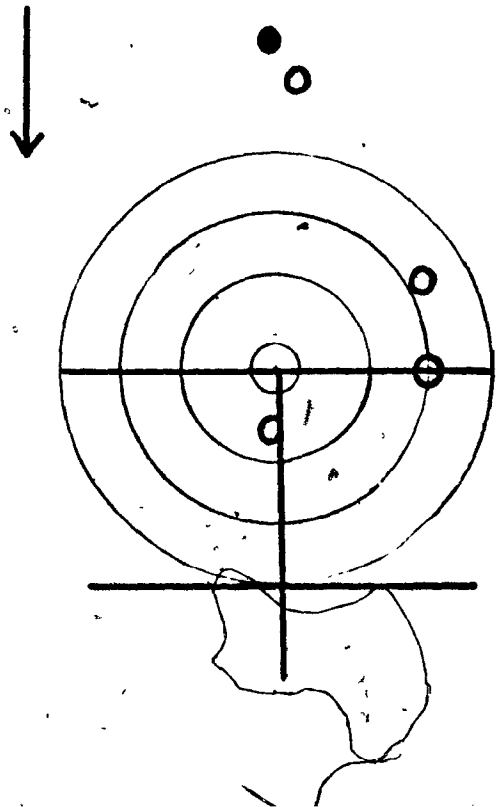
Assume you are a skip curling at the National level. You have good sweeping, good draw weight, and good take-out. All players are making their shots.

IN ALL CASES YOU ARE THROWING THE DARK ROCKS



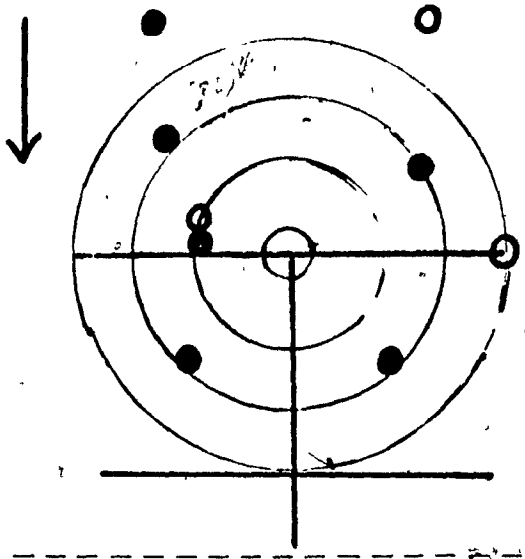
1. You are playing the tenth end of a ten-end game. You are throwing the last rock of the game. You are up by two points. You would:

   a) draw to the back rock.
   b) play the double.
   c) draw to the side rock.
   d) hit the side rock.
   e) draw to the button.



2. The score is tied playing the fourth end of a ten-end game. Your opposition is lying three with last rock advantage. You are throwing your last rock. You would:

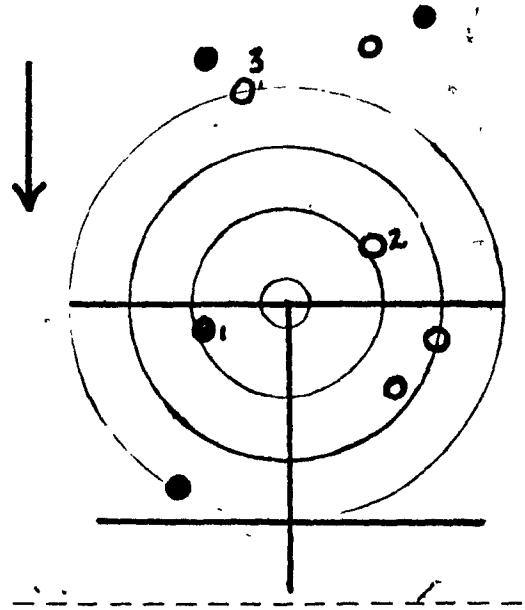
   a) draw to the side rock nearest the button.
   b) attempt the double of the front side rock to the shot rock.
   c) play a hit on the side rock at the front.
   d) freeze to shot rock.
   e) draw to the 4 foot in front of the shot rock.



3. You are two down playing the last end of a ten-end game. This is your last rock (the last of the game). You have shot rock. What would you do:

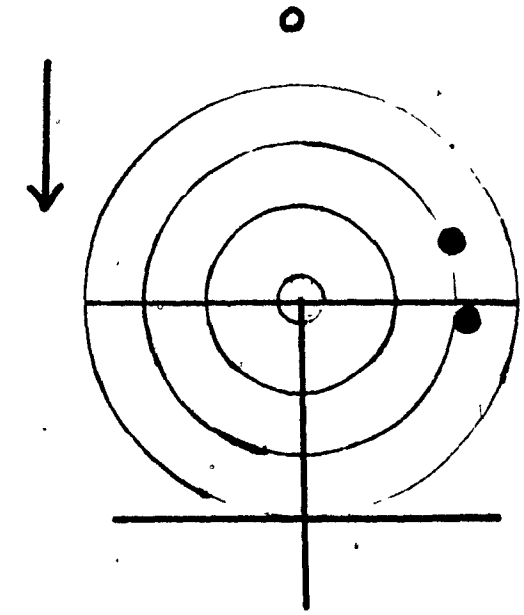
a) draw to the 4 foot for two.
b) guard the shot rock.
c) wick out the black* stone.
d) freeze to the black* rock.
e) attempt the double of the black* and shot rock.

* - refers to your opponent's stone



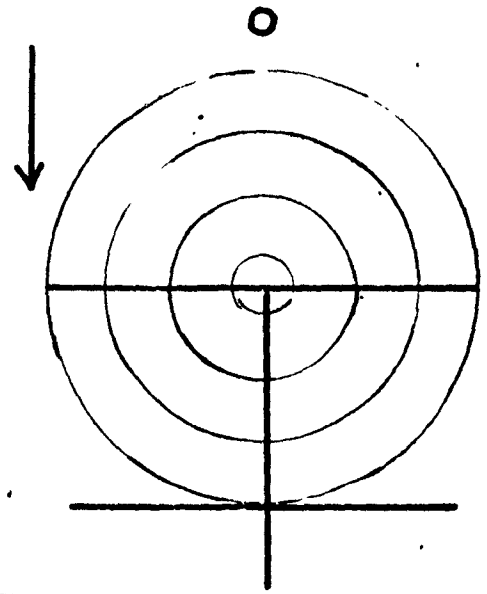

4. You are playing the fourth end of a ten-end game. You are ahead by one point. You do not have last rock. This is your last shot. You would:

a) guard the port at the front of the house.
b) draw for second shot.
c) guard the raise of No. 3 rock.
d) hit rock No. 2 and stay for second shot.
e) draw to No. 2 rock.



5. The score is tied. You are playing the tenth end of a ten-end game. You have last rock. Your third is throwing his last rock. What would you ask him to do:

a) guard your side rocks.
b) draw to the open side.
c) draw to the back 12 foot.
d) draw around the front guard to the 4 foot.
e) run the front guard off.



6. You have won the toss. The first stone has been played in front of the rings on the centre line. Where would you ask your lead to place his first stone.

   a) on the T-line to either side of the house.
   b) split the front guard.
   c) as a guard.
   d) draw behind the guard.
   e) on the front rings to either side of the house.

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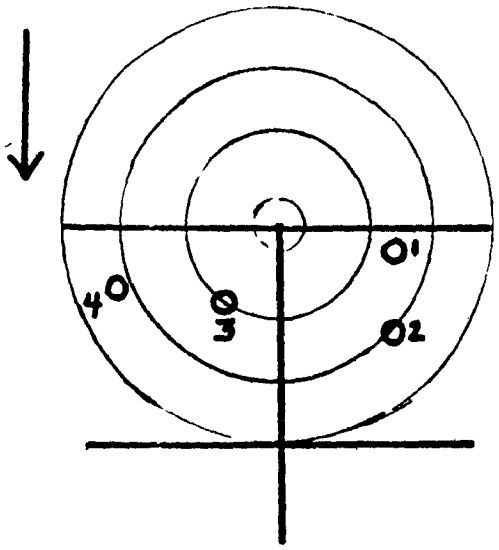


7. You are one up playing the sixth end of a ten-end game. You have last rock. What is your play with your last rock.

   a) attempt the double of No. 1 and No. 2.
   b) draw to the 4 foot.
   c) draw to No. 3 stone.
   d) draw to the No. 1 stone.
   e) play a wick shot from No. 1 stone to No. 3.

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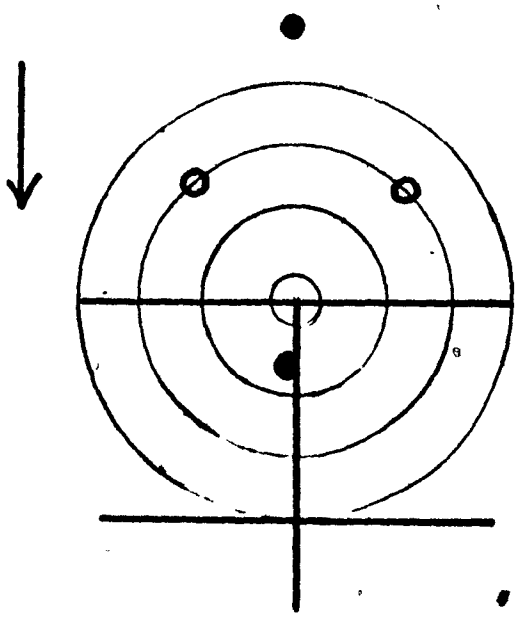
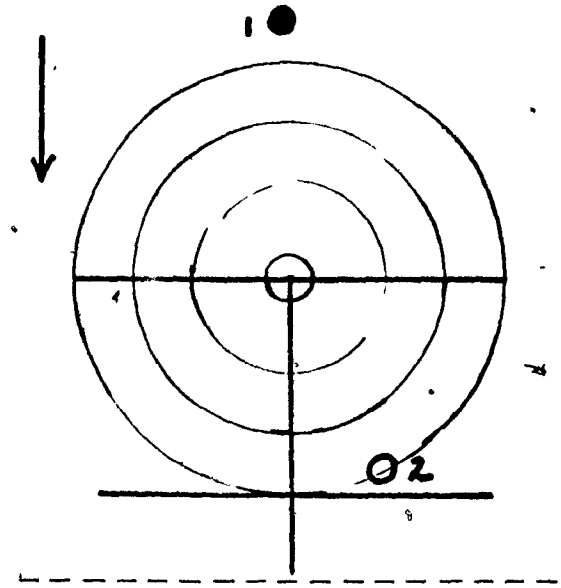


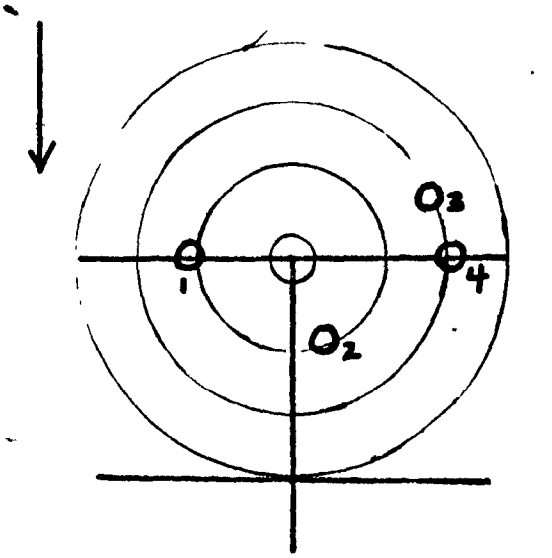
8. You are one up playing the eighth end of a ten-end game. You are throwing the first of your last two rocks. Your opposition has last rock. You would:

   a) hit and roll or stay for second shot.
   b) draw to the sides for second shot.
   c) put up another guard.
   d) draw to the top of the 4 foot for second shot.
   e) raise your front rock into the house for second shot.



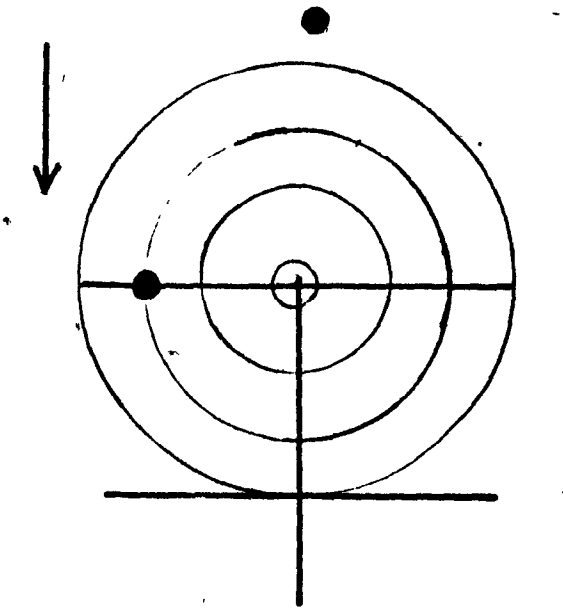

9. You are playing the ninth end of a ten-end game. You have last rock. You are one down. This is your last rock. You would:

a) draw around the guard to the 4 foot.
b) hit and stay on stone No. 2.
c) draw to the front of stone No. 2.
d) draw to the open side.
e) remove stone No. 2 and roll out yourself.



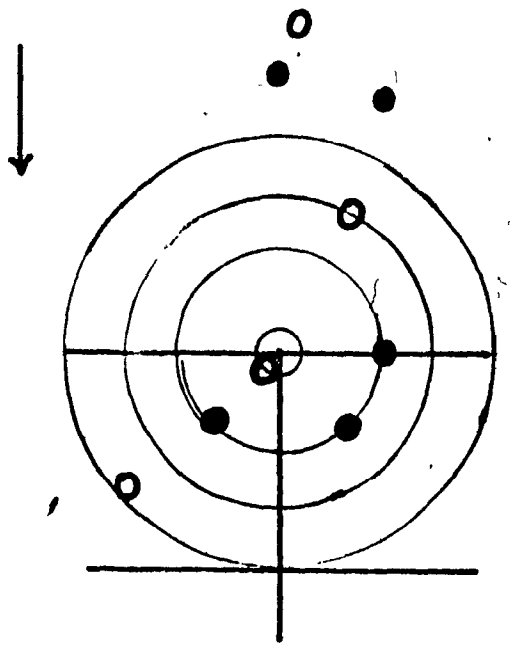

10. You are two up playing the eighth end of a ten-end game. The opposition has last rock. You are playing your first rock. You would:

a) draw to the shot rock (No. 2) at the back of the 4 foot.
b) hit stones No. 3 and No. 4 for a possible double.
c) hit and stay on stone No. 2.
d) freeze to stone No. 1.
e) hit stone No. 1 and roll.



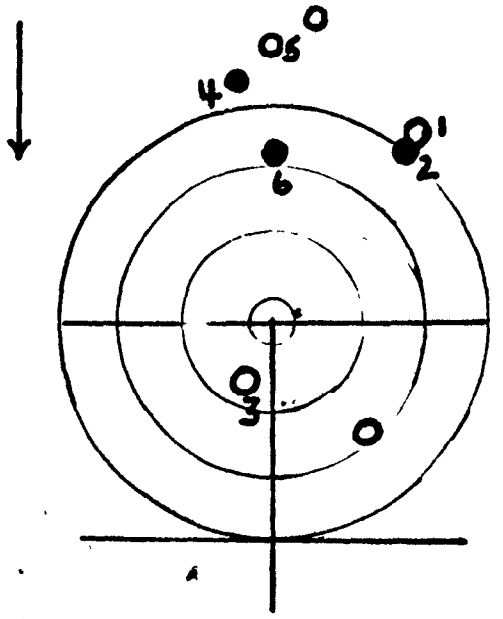
11. You are playing the fifth end of a ten-end game. The score is tied. You have last rock. Your third is throwing his last rock. You would ask him to:

a) place a corner guard on the side rock.
b) run the front guard off.
c) draw behind the front rock.
d) draw to the open side.
e) draw to the back of the 12 foot.



12. You are ahead by two points. You are playing the ninth end of a ten-end game. You do not have last rock. You are playing your last rock. You would:

a) try to tap the shot rock to the back of the house.
b) freeze to the shot rock.
c) hit the shot rock.
d) play a guard.
e) draw to the 8 foot for fifth shot rock.




13. You are playing the tenth end of a ten-end game. You are down by two and have last rock. You are throwing your last rock. You would:

a) hit stone No. 1 to drive No. 2 onto No. 3.
b) tap No. 3 stone to the back of the house.
c) draw to the 4 foot.
d) play the raise of No. 4 rock onto No. 3 rock.
e) hit stone No. 5 onto No. 6.

14. You have lost the toss. Where would you ask your lead to place his first stone?

a) in front of the rings - short guard.
b) in the house - to the T-line.
c) biting front ring.
d) long guard.
e) through the house.

15. You are playing the eighth end of a ten-end game. You have last rock. You are down three or more points. You would:

a) play each rock to hit and stay.
b) clutter the front of the house with short guards.
c) play to hit every rock and roll out.
d) draw or freeze to anything in the house.
e) remove any of the opposition's rocks from the front of the house.

16. This is the tenth end of a ten-end game. You are ahead by one point and have the last rock. You would:

a) play all rocks behind the "T" line.
b) call your team's rocks through the house or run off front guards.
c) put up corner guards.
d) draw to every rock.
e) clutter up the front of the house.

17. This is the tenth end of a ten-end game. You are down by one point and have last rock. You would:

a) place all your rocks in front of the "T" line.
b) keep the front of the house cluttered and hope to bury a rock.
c) keep the house clean and play for one point and the tie.
d) place a corner guard, draw behind it.
e) draw or freeze to every opposition's rock.

18. You are playing the eighth end of a ten-end game. You are ahead by three points. You would:

a) get one rock in the house and guard it.
b) play a straight draw game.
c) play the game wide open.
d) clutter up the front of the house.
e) draw in front of the "T" line.

19. This is the tenth end of a ten-end game. You are ahead by one point, but you do not have last rock. You would:

a) clutter up the front of the house.
b) keep the front of the house clear.
c) hit everything and hope to roll out.
d) put up corner guards and draw behind.
e) play wide open, give them the tie, and have an extra end.

20. This is the tenth end of a ten-end game. You are down by one point and you do not have last rock. You would:

a) concede the game.
b) clutter up the front of the house, attempt to draw behind.
c) hit all the opposition's rocks.
d) call all your players' rocks through the house.
e) draw or freeze to all the opposition's rocks.

SCORING SYSTEM FOR KNOWLEDGE OF CURLING STRATEGY TEST

| Question No. | Points Awarded | | | | |
|---|---|---|---|---|---|
| | 5 | 4 | 3 | 2 | 1 |
| 1 | d | a | e | b | c |
| 2 | c | d | e | b | a |
| 3 | e | c | a | d | b |
| 4 | b | e | d | a | c |
| 5 | e | d | b | c | a |
| 6 | b | a | d | e | c |
| 7 | c | b | d | a | e |
| 8 | a | d | b | c | e |
| 9 | e | b | a | d | c |
| 10 | b | e | d | a | c |
| 11 | d | c | e | b | a |
| 12 | a | c | b | d | e |
| 13 | a | b | d | e | c |
| 14 | b | c | a | e | d |
| 15 | b | d | a | e | c |
| 16 | b | a | c | d | e |
| 17 | d | e | a | c | b |
| 18 | c | e | a | b | d |
| 19 | e | c | a | b | d |
| 20 | b | e | c | d | a |

# APPENDIX D

## PERSONAL DATA SHEET

NAME: _____ AGE: _____ SEX: _____

1. How many times a week do you curl? 1 2 3 4 5 6 7

2. How many years have you curled? _____

3. Do you curl for a) pleasure only, b) competition?

4. What position do you most often play in your club? _____

5. Are you familiar with your club's method of rating curlers? _____

6. If yes, please describe it.

7. Are you happy with the rating system? _____

8. Please rate yourself on each of the following curling skills on the scale provided to the right.

| | Expert | Above Average | Average | Below Average | Beginner |
|---|---|---|---|---|---|
| A. Sweeping ability | | | | | |
| B. Shot-making ability | | | | | |
| i. take-out | | | | | |
| ii. draw | | | | | |
| C. Delivery | | | | | |
| i. style | | | | | |
| ii. hitting the broom | | | | | |
| D. Reading ice | | | | | |
| E. Strategy | | | | | |
| F. Ability to withstand anxiety | | | | | |

# APPENDIX E

## SUMMARY TABLES OF MEANS AND STANDARD DEVIATIONS

# I SUMMARY TABLES OF MEANS AND STANDARD DEVIATIONS FOR THE CSAT

## A. In-turns and Out-turns

| | 1st CSAT Administration (N = 32) | | 2nd CSAT Administration (N = 23) | |
|---|---|---|---|---|
| | In-turn | Out-turn | In-turn | Out-turn |
| $\bar{X}$ | 33.34 | 34.22 | 29.35 | 30.22 |
| S.D. | ~~11.13~~ | 10.73 | 10.05. | 13.05 |

## B. Sub-tests

| | THE HIT | | THE DRAW | | THE GUARD | | THE RAISE | | THE CHAP AND LIE | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1st CSAT | 2nd CSAT | 1st CSAT | 2nd CSAT | 1st CSAT | 2nd CSAT | 1st CSAT | 2nd CSAT | 1st CSAT | 2nd CSAT |
| $\bar{X}$ | 14.81 | 13.65 | 13.75 | 11.48 | 15.06 | 10.09 | 8.66 | 9.09 | 15.22 | 15.13 |
| S.D. | 5.33 | 6.96 | 5.41 | 4.52 | 4.96 | 5.56 | 4.55 | 4.57 | 6.51 | 7.23 |

## C. In-turns and Out-turns on Sub-tests (1st CSAT Administration only)

| | THE HIT | | THE DRAW | | THE GUARD | | THE RAISE | | THE CHAP AND LIE | |
|---|---|---|---|---|---|---|---|---|---|---|
| | IN | OUT | IN | OUT | IN | OUT | IN | OUT | IN | OUT |
| $\bar{X}$ | 7.06 | 7.75 | 6.53 | 7.22 | 7.44 | 7.63 | 4.25 | 4.41 | 8.06 | 7.16 |
| S.D. | 3.46 | 3.74 | 3.57 | 3.31 | 2.79 | 3.31 | 3.02 | 3.06 | 4.10 | 3.89 |

II SUMMARY TABLE OF THE DIFFERENCES IN MEANS BETWEEN MALES AND FEMALES

| Variable | Females | S.D. | Males | S.D. | $t^2 = F$ |
|---|---|---|---|---|---|
| Age | 29.38 | 8.50 | 27.00 | 9.49 | .56 |
| Total KCS Score | 80.19 | 6.95 | 85.88 | 5.48 | 6.61* |
| Years of Experience | 4.56 | 2.63 | 8.13 | 6.43 | 4.21* |
| Frequency of Practise | 2.44 | 1.21 | 3.25 | .93 | 4.54* |
| Team Position | 2.44 | 1.26 | 2.13 | 1.09 | .56 |
| Self-Rated Sweeping Ability | 3.25 | 1.06 | 3.81 | .75 | 2.99 |
| Self-Rated Take-out Ability | 2.88 | .96 | 3.25 | .45 | 2.02 |
| Self-Rated Draw Ability | 2.69 | 1.20 | 3.50 | .73 | 5.38* |
| Self-Rated Style Ability | 3.19 | .98 | 3.38 | .62 | .42 |
| Self-Rated Hitting the Broom | 2.94 | 1.00 | 3.31 | .60 | 1.66 |
| Self-Rated Ice Reading | 2.50 | 1.37 | 3.31 | .70 | 4.47* |
| Self-Rated Understanding Strategy | 2.38 | 1.20 | 3.38 | .72 | 8.14* |
| Self-Rated Ability to Withstand Anxiety | 3.94 | .93 | 3.56 | .81 | 1.48 |
| Judges' Average Rating | 44.94 | 18.37 | 57.38 | 9.60 | 5.76* |

*$p < .05$

II SUMMARY TABLE OF THE DIFFERENCES IN MEANS BETWEEN MALES AND FEMALES (continued)

| Variable | Females | S.D. | Males | S.D. | $t^2 = F$ |
|---|---|---|---|---|---|
| CSAT and KCS Test | 138.13 | 26.61 | 163.19 | 16.01 | 10.42* |
| Average CSAT Scores | 56.06 | 19.62 | 74.94 | 13.88 | 9.87* |
| Total Self-Concept Factor | 23.88 | 6.71 | 27.38 | 3.84 | 3.28 |
| Rating of Judge 1 | 47.63 | 26.09 | 61.25 | 12.30 | 3.57 |
| Rating of Judge 2 | 43.50 | 20.70 | 55.36 | 10.83 | 4.13 |
| Rating of Judge 3 | 32.75 | 18.84 | 53.50 | 8.71 | 15.99* |
| Total of 1st CSAT Admin. | 54.31 | 25.33 | 76.50 | 14.15 | 9.37* |
| Total of 2nd CSAT Admin. | 47.73 | 26.99 | 69.83 | 31.74 | 7.13* |
| In-turn 1st CSAT Admin. | 26.63 | 12.71 | 37.88 | 9.42 | 8.09* |
| In-turn 2nd CSAT Admin. | 15.13 | 14.58 | 27.06 | 15.20 | 5.14* |
| Out-turn 1st CSAT Admin. | 27.94 | 14.10 | 38.38 | 7.54 | 6.82* |
| Out-turn 2nd CSAT Admin. | 13.56 | 13.81 | 30.00 | 17.41 | 8.75* |
| The Hit 1st CSAT Admin. | 11.31 | 5.71 | 17.13 | 4.56 | 10.12* |
| The Hit 2nd CSAT Admin. | 5.63 | 6.66 | 14.00 | 8.35 | 9.83* |
| The Draw 1st CSAT Admin. | 10.94 | 5.45 | 15.75 | 5.54 | 6.14* |
| The Draw 2nd CSAT Admin. | 6.69 | 6.04 | 9.81 | 6.72 | 1.92 |

*$p < .05$

II SUMMARY TABLE OF THE DIFFERENCES IN MEANS BETWEEN MALES AND FEMALES (continued)

| Variable | Females | S.D. | Males | S.D. | $t^2 = F$ |
|---|---|---|---|---|---|
| The Guard 1st CSAT Admin. | 13.25 | 6.05 | 15.94 | 4.58 | 2.01 |
| The Guard 2nd CSAT Admin. | 5.06 | 5.95 | 9.44 | 6.60 | 3.88 |
| The Raise 1st CSAT Admin. | 7.06 | 4.75 | 9.94 | 4.45 | 3.12 |
| The Raise 2nd CSAT Admin. | 4.13 | 4.83 | 8.94 | 5.53 | 6.87* |
| The Chap and Lie 1st CSAT Admin. | 11.88 | 7.92 | 17.50 | 4.77 | 5.93* |
| The Chap and Lie 2nd CSAT Admin. | 7.19 | 7.66 | 14.56 | 9.34 | 5.95* |

*$p < .05$