

THE SCIENCE OF TIDDLYWINKS

An investigation by

THE CAMBRIDGE UNIVERSITY TIDDLYWINKS CLUB

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Acknowledgements.

The club is indebted to Messrs. E. Lehman & Co., Ltd., H. P. Gibson & Sons Ltd., W. B. Tattersall Ltd. and The Marchant Games Co. Ltd., manufacturers of tiddlywinks, for directing and helping us in our search concerning the history of the game of Tiddlywinks.

To Messrs. Eaden Lillie of Cambridge for their controlled aggression to the club's experimenting on their numerous and varied carpet textures.

The club is especially grateful to Peter Shepherd & Co. Ltd., of Reading, who gave the club three samples of different types of needleloom carpeting which formed the foundation for chapter I "The Effect of Carpets". This firm also very generously gave the club four standard size tiddlywinks mats, made from their best needleloom carpeting for use in our matches.

In the club's search for knowledge we came across a very erudite work called "The Phoenix Dictionary of Games". This book we would like to claim as a reference because we would like to quote it here:-

"To scorn Tiddlywinks because it is played by children is to refuse milk because it is the food of babies!"

Introduction.

This thesis has been compiled as the official document of the C:U.Tw.C. In view of the lack of previous research in this field we do not claim that the subject has been exhausted by this thesis; but it is hoped that it will stimulate interest in the subject and lead to helpful criticism and suggestions.

This work is based largely on the club members' own experience and is an attempt to determine the mechanics of this sport. Thereby it is hoped to gain a knowledge of the factors which affect the play of the game, and thus to eradicate, if possible, random factors for which the player is not capable of allowing, and so to prove that the game is essentially one of dexterity and skill.

The results shown were collected at normal and specially arranged extraordinary meetings of the club in the Lent and Easter terms of 1955.

Historical Survey.

After scouring the British Museum, Cambridge University Libraries, and writing to many manufacturers of the game we discovered that Tiddlywinks is an old English game. It has been manufactured for over a hundred years but little is known of the game's origin. However, owing to the simplicity of the materials required it is quite possible that Stone Age Man had the occasional squidge while chipping flints. At this early period man was not able to comprehend rules and also the counters used would not jump well except upon moss--a possible explanation of the number of bodies found in bogs. The game would not have started seriously until the advent of carpets or blankets; skins would not have made a good foundation and interest in the game would have waned upon a surface of this nature.

Carpets and blankets became plentiful during the Industrial Revolution; it is therefore suggested that it was about the beginning of the 19th century that the game started in earnest.

The rules have remained similar throughout this period. However, around 1870 the game was confused with dominoes, because dominoes was then played with counters. The game Tiddlywink (singular) was different from Tiddlywinks but similar to dominoes.

It is the belief of the C.U.Tw.C. that no other official body of tiddlywinks players is in existence or has existed for any reasonable length of time. The club would, however, welcome news of the formation of any such body.

## Chapter 1.

## "The Effect of Carpets"

### The method of research.

The game is played with five variable factors

- (1) The type of mat upon which the game is played.
- (2) The tiddlywink (the counter being flicked).
- (3) The squidger (the instrument used to flick with; this is usually another round counter in normal games).
- (4) The player himself, and the type of stroke he makes.
- (5) The atmosphere:-
  - (a) physical.
  - (b) mental: noise and other gamesmanship factors.

These above divisions are a complete analysis of the game and as such formed a convenient division for research purposes. It is essential to have only one variable, or as few as possible, changing throughout an experiment, otherwise the result is obscured.

This thesis is divided into chapters which deal with each of these divisions individually; since the experiments bear on more than one chapter. The results are attached as an appendix at the end, the averages are summarised in each chapter. The method of performing the experiments, all of which are of a statistical nature, is given with the experiment in the appendix.

The club members were particularly impressed by the method employed in the deduction of the theory of gravitation which followed the pattern facts, law, theory, test of theory, conclusion. Thus the individual chapters follow this pattern.

### "The Carpet"

#### The facts.

The experimental research done in this field can be divided into two parts (a) qualitative.  
(b) quantitative.

The qualitative experiments were performed by a select committee of the C.U.Tw.C. who flicked through the many varieties of carpet material in Baden Lillies Carpet shop. The results of these experiments were obvious and hence needed no further research to be proven.

- They were:-
- (1) The deeper the pile the greater the vertical components of the tiddlywink's trajectory.
  - (2) The shallower the pile the better directional control the player had.
  - (3) Pileless carpets e.g. felts and needlelooms gave the player best control (provided they were not too soft).

The quantitative experiments were performed on various types of carpets: 3 types of needleloom, a 5/16" new pile carpet, a 1/10" worn carpet, 1/8" moderately new pile carpet, 3/16" worn pile carpet.

The tests are divided into three types, based on the three fundamental shots in the game, i.e. long, medium and short.

The long shots (4 ft) test for directional control on the carpet for hard shots.

The medium shots (6") test for directional and longitudinal control for soft shots.

The short shots (2") test for vertical control on the carpet.

The results of the 4 ft shots. (Test 1).

Tiddlywink size (see Appendix A for actual sizes and weights).

Carpet.	Large.	Medium.	Small.
<u>Average distance from the pot. in inches.</u>			
1/10" pile (worn)	2.58	3.08	3.59
1/8" pile (mod. new)	3.17	2.75	5.33 *
3/16" pile (worn)	1.91	2.33	3.91
5/16" pile (new)	2.67	3.50	4.75
Berkshire needleloom	1.42	2.13	2.22
Downshire "	1.99	2.13	2.84
Winchester "	1.93	1.82	2.81 +

\* results of only one player.

+ Two players found medium more difficult than large.

and " " " " less " " "

The results of the 6" shots. (Test 2).

Worn carpets having an uneven surface make an unreliable research medium. The 5/16" pile type carpet was used, together with the three types of needleloom, and one worn carpet, which is seen to behave like needleloom.

Carpet.	<u>Average No. sunk from 6" using a medium counter.</u>
Berkshire	34.6
Winchester	25
Downshire	34.3
5/16" pile	7.3
1/10" " (worn)	27.6

The results of the 2" shots. (Test 3).

Carpet.	<u>Average No. sunk from 2" using a medium sized counter.</u>
Berkshire	24.6
Winchester	30.0
Downshire	22.3
5/16"	17.6
1/10" worn	45.3

It was observed that the 5/16" carpet gave ample lift but the wrong direction, the direction was found to depend on the way in which the tiddlywink was pressed into the carpet.

Laws.

From these results certain facts are seen to be highly probable.

- (1) The pile of a carpet has a detrimental effect on the control the player has with all three types of shot. It is to be noticed, however, that when the pile is worn, and thus hardly exists, the carpet possesses the same good qualities as needleloom.
- (2) If the tiddlywink is squidged on the floor it will not rise more than an inch or two, the rise being probably due to the aerodynamics of the wink more than anything else. This fact indicates that the mat is the factor which makes the tiddlywink jump. This point is verified by observing in the qualitative experiments that a deep pile gives more lift than a shallow one.

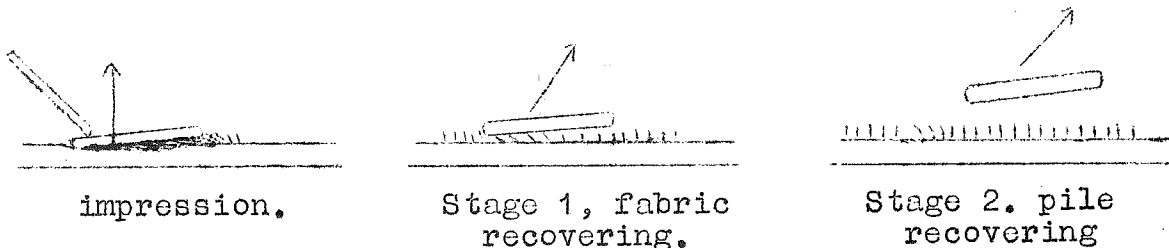
Theory.

From (2) above the only property of the carpet which will make a tiddlywink jump is its elasticity or spring.

When a tiddlywink is squidged the carpet beneath is squashed this has two effects, (a) the pile of a pile carpet will be flattened.  
(b) the flattened pile and carpet backing will be squashed together.

The division is due to these two factors having different effects.

On a new pile carpet the pile stands vertically; thus when the wink is pressed into the carpet, there is a great chance of all the pile being flattened to point in the same direction. Thus when the squidger leaves the surface of the wink the carpet will rise very quickly (depending on the length of time that the wink is pressed down, it being found by very simple qualitative tests that carpets suffer from fatigue). The carpet will rise in two stages, first the fabric and fibres will rise vertically from their compressed state; second the pile fibres will rise with a circular motion.





The arrow represents the resultant force of the carpet on the tiddlywink. The resulting effect should be a directional leap. (N.B. the forward drive on the wink is given chiefly by the squidger leaving the tiddlywink, as is shown by flicking a tiddlywink on the floor with no carpet).

Check.

To check whether the pile of a carpet has a directing influence on squidding as is suggested by this theory. (i.e. the pile all being flattened in the same direction) a further experiment was performed. (see Test 4 in the appendix).

This test was conducted with the pile lying under the counter in a direction at right angles to the proposed flight path of the tiddlywink. The tiddlywink was then carefully aimed straight at the cup by means of a ruler as squidger and two research workers aligning the shots.

Results for the four foot shots were:-

Player	Average dist. from the cup.
L.C.M.H.	4.8" Right
R.H.P.	5.17" "
W.M.S.	.8" Left
B.J.T.	2.8" Right
F.N.H.	1.17" "

mean 2.7" Right.

The average distance off the cup left or right with four foot tests was  $\frac{1}{2}$ " if the pile was not at right angles to the direction of aim. The significance is therefore seen.

However, as has already been stated, pile carpets suffer from marked fatigue; for these hard four foot shots the pile does not rise sufficiently fast compared with the fabric of the carpet, and therefore does not have such a marked effect on these shots as on the softer shots due to the tiddlywink leaving the carpet before the pile rises. The average distance off for the 6" shots was of the order of 0.80" which is equivalent to 5" off at a distance of 4 ft. The two inch shots were impossible to measure the distances involved being too small to measure with the required accuracy. However several 2" shots were known to miss the pot altogether due to the angular deflection.

The conclusions from this test are:-

- (a) The pile does have an effect on the flight of the tiddlywink due to the circular manner in which it rises.
- (b) The pile rises slower than the carpet fabric (this point seems so likely that no further tests were made to prove it). The fabric requires greater forces to compress it hence it will have a greater coeff. of elasticity.
- (c) The softer shots, merely flatten the pile and are thus most effected by the pile.

Also the pile will rise unevenly depending upon the elasticity of the individual fibre and the amount of pressure it has sustained. If this is true, which seems highly probable, we should expect the smaller tiddlywinks to be more erratic in play than the large tiddlywinks, due to the former being more effected by small irregularities. This is an observed fact, but the effect is most certainly not only due to this cause as is shown in chapters 2 and 3.

#### Summary.

The conclusions may be listed as follows:-

- (a) The compression of the carpet is the cause of the tiddlywink jumping.
- (b) The carpet supplies this lift in two ways. The rising of the pile and the rising of the squashed fabric and fibres. The fabric rises faster than the pile fibres. Thus hard shots are directionally the most accurate.
- (c) The pile rises with a circular motion, which gives a small directional effect on hard shots, but is more marked on soft shots which only get their lift from the pile rising.
- (d) The pile rises unevenly, making small counters more erratic than large counters.
- (e) When a tiddlywink is squidged, the motion of squidging makes the wink slide into the pile so that the pile will lie under the wink in a fore-aft direction when rising it will help to give a very slight horizontal velocity to the wink in the direction of the squidge. However this is a small effect, but is worth bearing in mind when playing tiddlywinks on pile carpets; for by making the wink slide into the carpet the direction will be more accurate.

#### Conclusion;

A carpet which is suitably resilient and yet has no pile is best for tiddlywinks; i.e. a medium felt or certain types of needleloom carpets (the club has found that Berkshire needleloom as supplied by the Peter Shepherd Carpet Co.Ltd., is ideal for tiddlywinks).

Playing on a carpet of this sort, the player has full directional and vertical control of the wink, provided he has sufficient dexterity to be able to take advantage of it.

(The club also found that Christ College carpets were better than Trinity's).

## Chapter 11.

### The Best Shape & Size for a TIDDLYWINK

In our search for tiddlywinks, which took us clambering up into cold attics to hunt in cobwebbed tea chests full of childhood pleasures, and, in the other extreme, trotting down the stairs to the basement of Gray's of Cambridge, to retrieve a sack full of apparently useless counters, we found a remarkably large number of different winks; they differed in diameter, in thickness and in the shape of their faces.

We could not, of course, carry out appropriate tests on every different tiddlywink; instead we divided the counters into groups, took a typical specimen from each group and subjected it to tests aimed at deciding which is the best counter under a given set of conditions.

The tests were of two kinds:

- a. To find which is the best diameter for a counter.
- b. To find which is the best thickness; whether it is a uniformly thick counter with flat faces, or a uniformly thin counter with flat faces or a counter with convex faces.

#### TESTS:

Three different counters, typical of three of the groups into which the tiddly winks fell, were taken, i.e., large, medium and small (see appendix for diameter and weights). Each in turn was flicked a number of times towards the cup from different ranges. This was repeated on different carpets.

Test 1. For the first part of the test, the range was four feet, and the measurement taken was the perpendicular distance between the zero position (i.e. the cup) and the direction of propagation of the tiddlywink. The average of twelve shots was calculated without regard to whether the deviation was to the left or to the right of zero. The following results were obtained with different carpets which for the sake of brevity will be called carpet A, B, C, etc.

#### Carpet A.

Large	Medium	Small
1.8"	1.8"	2.8"
1.8"	1.8"	3.1"
1.17"	2.25.	2.1"

#### Carpet B.

Large	Medium	Small
2.1"	1.8"	2.8"
2.17"	2.4"	2.5"
1.67"	2.0"	2.3"

#### Carpet C.

Large	Medium	Small
2.75"	3.2"	5.3"

#### Carpet D.

Large	Medium	Small
2.37"	3."	3.6"

#### Carpet E.

Large	Medium	Small
2.9"	3.4"	3.67"

#### Carpet F.

Large	Medium	Small
1.8"	2.4"	4.0"

Provided the carpet is similar to needleloom, that is, it does not exert a force in any particular direction, except vertical, then the deciding factor concerning the direction of flight of the wink, will be the direction in which the squidger is withdrawn. Slight variations in this factor will have a larger effect on the smaller wink than on the larger ones. This is explained in greater detail in chapter 111.

The counters did not appear to curve in the air so the effect of wind resistance is probably small.

Analysis of the results of Test 11 provide considerable interest. At a range of four feet the convex counter is the most accurate, then comes the thick counter with the thin wink as an "also-ran".

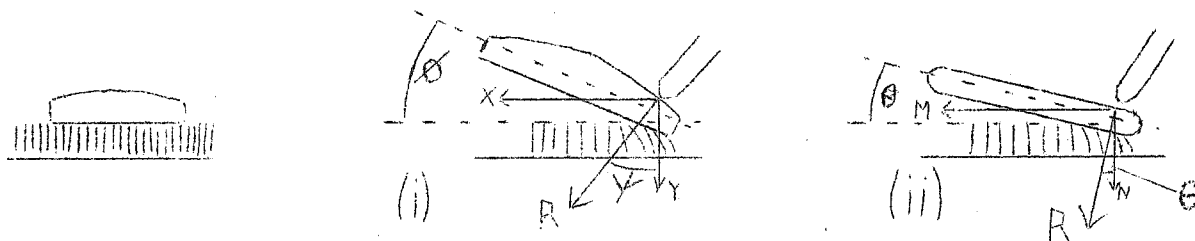
At a range of six inches the greatest amount of control can be exercised over the thick counter with the convex counter second and the thin one last. The thick wink is also the "best" at 2 inches with the thin one next and this time the convex counter as an also-ran.

One point, which cannot necessarily be deduced from these figures, but is quite obvious while carrying out the experiment, is the reluctance of the convex counter to rise. The results at four feet demonstrate the good directional control that can be exercised, but the results at six inches and two inches do not in themselves tell the whole story.

The reason for the low number of successes at six inches and more especially at two inches, was not, in the main, due to faulty directional control, but rather to an incapacity to control elevation.

Now let us try to explain the trends in test 11. It was first noticed that the thin counter had the greatest deviation. As all three counters were the same size the main reason for this large deviation is that it is the lightest of the three, and hence more susceptible to small changes in the applied forces; the thickness probably contributes to these errors as well.

The next problem is to try to explain the reluctance of the convex counter to rise. Various theories can be put forward and they are now given.



If the same pressure is exerted by the squidger in both cases expressed diagrammatically above, then the resultant  $R$  will be the same for the convex and the flat counters. For a given pressure the convex wink will sit at a greater angle of elevation than the flat wink, as in the former case the squidger in forcing the counter forward and into the carpet more than in the latter instance. Therefore  $\theta$  will be greater  $\Theta$ .

The resultant force is perpendicular to the surface of the wink at the point of contact with the squidger; for the flat one, therefore, the angle between the resultant and the vertical will be  $\theta$ ; in the case of the convex counter the angle that the

resultant force makes with the vertical will be  $\psi$ , which from the geometry of the figure will be greater than  $\theta$ .

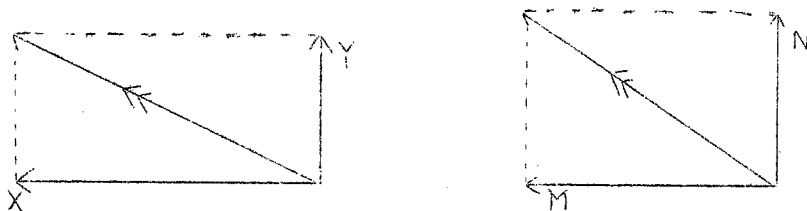
Now consider the forces acting. The vertical component of  $R$  causes the pile and fabric of the carpet to be depressed and the greater this component, the greater the depression and in turn the greater the upward force exerted by the carpet.

The vertical forces in (i) and (ii) are  $R \cos \psi$  and  $R \cos \theta$  respectively. From the argument above  $\psi$  is greater than  $\theta$ , therefore  $R \cos \psi < R \cos \theta$  and there will be less vertical lift on the oval than on the flat wink.

By similar reasoning the horizontal force in (i) is greater than in (ii).

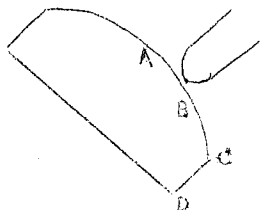
$$R \sin \psi > R \sin \theta$$

If a vector diagram of forces is drawn for both cases the resultant of the parallelogram will give the angle of elevation of the trajectories.



In drawing these figures the forces were moved to the centre of gravity and as the spin is not to be considered in this chapter (see chapter 6) the resulting couples are ignored.

This is one way of explaining why the convex counter does not rise much in flight. Another method of approach is drafted below:



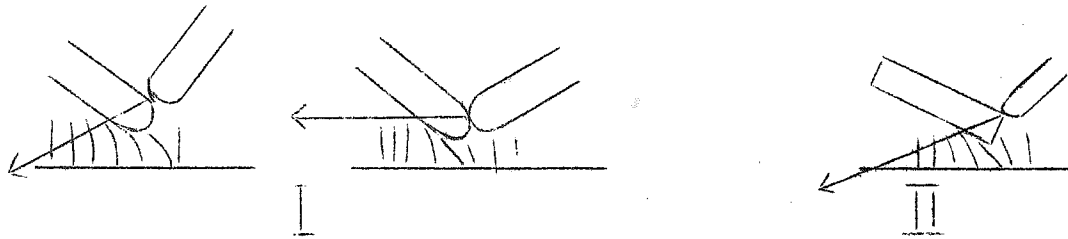
When the squidger is moving from A to B the wink is pressed down in such a way that it rotates about D with the centre of gravity continually rising. Due to the curvature of the wink however, as the squidger moves from B to C the centre of gravity no longer rises but begins to fall as S gets nearer to C. When the wink is flicked the upward force of the carpet is used, first, in stopping the downward motion of the Centre of Gravity and then in giving the wink lift. The angle of elevation will then be less than if the whole of the force exerted by the carpet were used in accelerating the centre of gravity upwards.

In the case of a flat wink, if the squidger is withdrawn at a reasonable speed, the centre of gravity continues to rise during the time that it is in contact with the squidger, and then all the force of the carpet can be used in accelerating the centre of gravity upwards, thereby giving it greater elevation than the convex wink. D, B, and C are not necessarily in the positions given in the diagram but serve to explain the method qualitatively.

This theory can be tested to some degree by taking a film of a shot using a convex wink with a scale behind it. It would, of course, have to be a good camera which photographs at a large number of frames per second.

### The Edge of the Tiddlywink.

The two types of edges considered were the bevelled edge (Fig. I) and the straight edge (Fig. II). When they were both squidged with approximately the same pressure, it was found that the former had a greater horizontal range than the latter. For an explanation let us consider the diagram:-



As the squidger is drawn along the flat surface of the wink, it pushes it further into the carpet, but when it reaches the edge (Fig. I) the resultant force becomes more horizontal, and at the instant of the squidger leaving the wink the force is horizontal. In Fig. II, however, the limiting direction of the resultant force is approximately as shown and consequently the horizontal component will not be as great as with the bevelled wink, thereby resulting in a shorter range.

To emphasize the importance of the edge in giving horizontal range an experiment was carried out in which the squidger was pressed onto the flat surface of the wink and then withdrawn quickly and horizontally; in this way the squidger hardly touched the edge and the wink sprung vertically into the air with scarcely any horizontal range.

### The Nature of the Surface of the Tiddlywink.

It was found that a rough surface was not desirable owing to the jerky withdrawal of the squidger resulting in lack of control. The plastic tiddlywinks were found to be quite suitable as their surfaces are reasonably smooth, thereby facilitating a uniform withdrawal of the squidger. It was found that a thin layer of olive oil on the squidger decreased the frictional force and gave greater control (the effect was not very marked in the case of the smooth plastic winks).

### Summary.

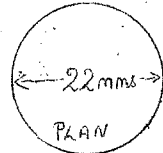
In investigating the best shape and size for a tiddlywink the following conclusions can be drawn:-

1. There is very little to choose between the large and medium counters as regards the optimum diameter; the larger is the better of the two. The small counter is comparatively inaccurate.
2. The greatest directional control can be exercised with the convex counter, but it is difficult to make it rise more than an inch or two when making a soft shot e.g. 6 inches range. The thick flat counter, on the other hand, lends itself to good elevation control and is more suitable for 6 and 2 inch shots.
3. The bevelled edge is better than the straight edge.
4. The smoother the surface the better the control.

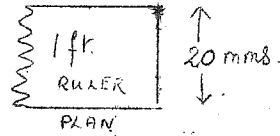
THE SQUIDGER - CHAPTER III

EXPERIMENT

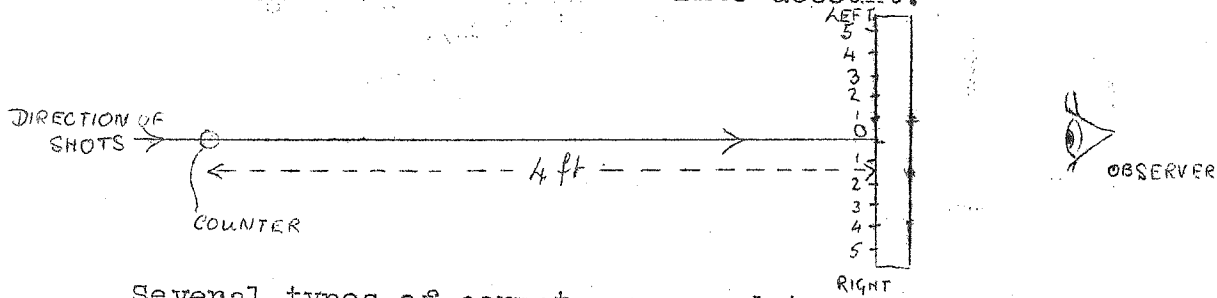
Two types of squidger were used - (i) Round



(ii) Square



in an attempt to determine the effect of the shape (in horizontal section) of the squidger on the accuracy of the shot, Medium sized counters were used throughout, with a shooting distance of 4ft, and only those shots arriving at about 4 feet were taken into account.



Several types of carpet were used to eliminate errors involved in a change of pile affecting the action of the squidgers.

Results (condensed from "Results of Test 5 in the Appendix) (distances shown are the algebraic mean of all shots taken by certain players)

Player	Carpet	Round Squidger	Square Squidger
L.C.M.H.	3/16" pile	2	2
R.C.M.	3/16" pile	9	3"
J.R.	3/16" pile	4"	5"
W.M.S.	3/16" pile	5 "	3 "
D.A.	" pile	4 "	1 3/4 "
M.R.H.	" pile	3 1/2 "	3 "
F.N.H.	" pile	4 "	3 "
B.J.T.	1/8" pile	3 1/2 "	3 "

This shows an average deviation as follows: Round Squidger - 4 3/4"  
Square Squidger - 3"

Conclusion to be drawn from Results

The above results can be taken to show that a squidger with a square shape in horizontal section has an increased accuracy of aim of 36% over that with a circular horizontal section.

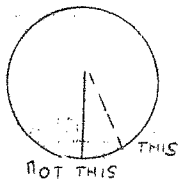
Explanation and Theory

On trying to play the game on a plane hard surface (such as a wooden floor), in which the movement of the squidger against the counter is the only controlling force, it is found that the counter is propelled horizontally and suffers no vertical displacement. Thus it can be concluded that the effect of squidger alone is to propel the counter horizontally.



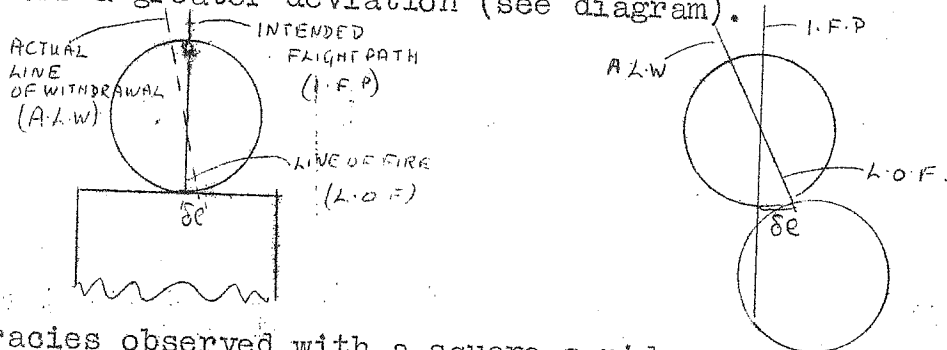
The counter is round and therefore the squidger must be just touching it at one point at the time of displacement. Therefore the counter must move off in a direction through its centre of gravity and this point.

The errors due to lack of skill of the player will cause a slight sideways shift of the squidger, i.e. and also a slight singular twist, which is



very small with a ruler. The ruler is long enough to be held by the palm and fingers, but with a circular squidger this does not matter. Therefore this angular twist may be ignored.

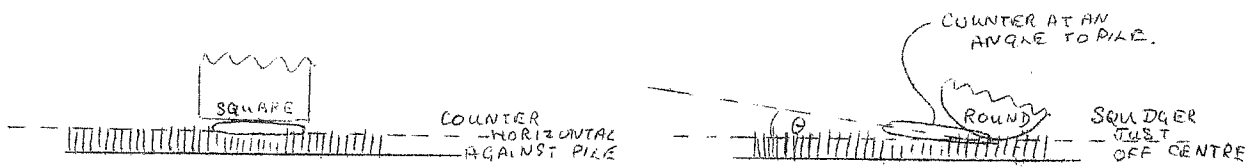
For the same sideways displacement  $d_1$  of the squidger the round squidger gives a greater deviation (see diagram).



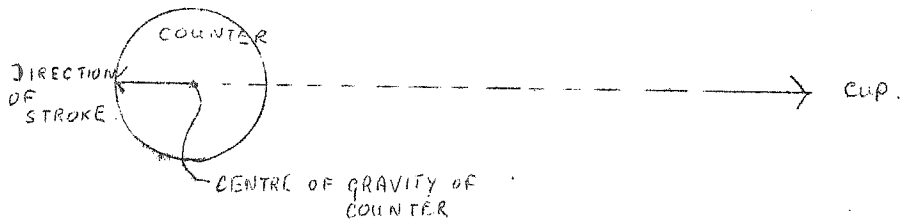
The inaccuracies observed with a square squidger are due to bad aiming, i.e. the I.F.P. was wrongly directed. Also the smaller counters, having greater curvature, will be more inaccurate.

Another effect may be due to the fact that when a square squidger is drawn across the counter through the centre of gravity, it presses the counter down uniformly against the pile of the carpet and this gives greater accuracy than the round squidger which has a tendency to press the counter down at an angle to the pile, because of a greater tendency to let the squidger suffer a sideways displacement.





It must be pointed out, however, that with practice a player can achieve accuracy with a round squidger (which is in normal use in the game of Tiddleywinks), and that he can, without errors in either direction, stroke the counter exactly through its centre of gravity and in a line with the cup.



However, small carpet irregularities may have to be allowed for if the surface is not a homogeneous, level surface.

## CHAPTER IV

### P L A Y

A player of tiddlywinks of C.U.Tw.C. standard is required to master four basic strokes. These are (1) Long Drive, (2) Approach Shot, (3) Short Putt, and (4) Cover-up Shot. Each one has a definite technique in its performance, although there is, of course, a continuous graduation between these shots.

These four shots will now be described in detail:-

- (1) Long Drive. This varies in distance, the greater distance being four feet. This is the first shot from teeing up, and should be brought to the point of perfection where any wink may be landed within six inches of the pot. The requirements are horizontal distance, and directional control. The direction is controllable since the wink will move in the line of direction of withdrawal of the squidger (from an isotropic carpet). The horizontal distance is obtained by holding the squidger at a small angle from the horizontal and withdrawing from the centre of the wink with a steady pressure at a constant moderate speed. As in all cases, the amount of pressure needed can only be determined by experience.
- (2) The Approach Shot. This covers distance from about 4 - 12". Here it is required to land the wink within two inches of the pot, though preferably inside it. Here approximately equal horizontal - vertical velocities are required. The direction is controlled as described before, the squidger is held at about 45°, and the withdrawal is more rapid. The pressure is kept as even as possible, although it probably increases when nearer the edge.
- (3) Short Putt. This is done from a distance of 0 - 3" from the pot, and requires large vertical velocity in comparison with horizontal velocity. This is obtained by holding the squidger in a near vertical position, making a rapid withdrawal from the wink with an increase of pressure on approaching the edge.
- (4) Cover-up Shot. This entails placing your wink on top of an opponent's from a distance of 0 - 2". The method is to hold the squidger in a near horizontal position. A very slow withdrawal is made. As the edge of the wink is approached, it tilts up, then on further withdrawal begins to drop again, and when it actually leaves the wink the resulting force is such that it just moves forward a short distance, thus covering the opponent's wink. The necessary force and speed of withdrawal must be learnt by repeated practice.

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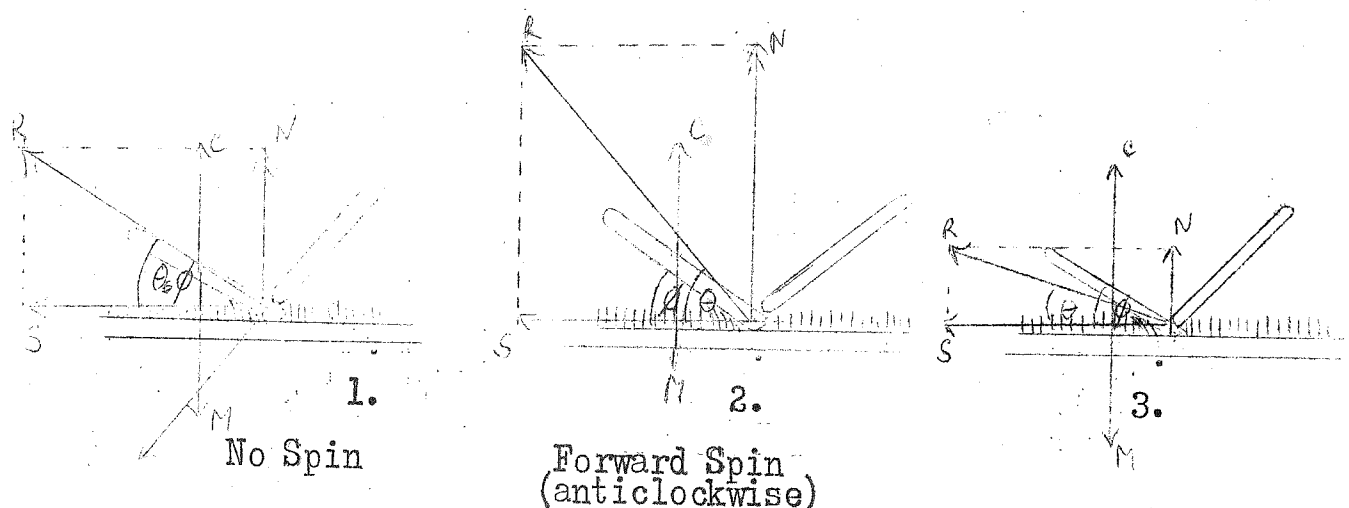
There are two main methods of holding the squidger, depending whether it is to be held nearly vertical or horizontal. In the first case, the second finger is held on top of the squidger, with the thumb underneath. In the second case the positions are reversed, the thumb being on top.

Conclusion. It is not possible to describe completely the shots of tiddlywinks, since they depend to such a large extent on experience, and it is necessary for each player to develop the individual style which produces, for him, the best results.

## CHAPTER V.

### S P I N

Consider a tiddlywink on the point of being squidged. The static picture showing the forces involved in three possible positions is given below. (See diags. 1, 2 & 3.)



Where S is the horizontal force given by the squidger, N is the vertical force, M is the weight of the wink, C is the normal reaction of the carpet since  $C = M$  (by definition of C).

The wink will move only under the influence of the forces N & S whose resultant is R.

Now it is a law of mechanics that if a force acts on a rigid body it accelerates the centre of gravity as if all the mass were centred there, and the body rotates about C-G due to the couple formed in transferring the force to the C-G. Thus transfer "R" to the C-G and the resultant spin is obvious. It is seen from this treatment that the direction of spin depends upon the relative sizes of  $\theta$  and  $\phi$ .

$\phi$  the angle the tiddlywink sits in the carpet is determined by the depth and softness of the carpet. Given a carpet  $\theta$  can be varied a small amount by the type of stroke employed.

By carefully watching tiddlywinks being flicked on a 1/10" pile carpet, the spin was considered to be always in the same direction (forward). By repeating this experiment on a wooden floor the wink was observed to spin either forward or not at all. The same experiment was conducted on four layers of silk, the wink leapt but did not spin. To check the veracity of these results, a very fast cine-film should be taken (the Club here regrets its lack of funds), for the speed at which the counter flies is quite sufficient to deceive the eye.

The Club members spent many weary hours lying on the floor watching the spin on tiddlywinks which had been flicked from various materials in various ways. Never was one wink observed to spin backwards ("Backwards" is produced in case 3). This fact needs establishing conclusively because the eye is not sharp enough to judge accurately the spin of a fast-moving wink, however, if established, which seems probable, it suggests that there is a connection between the angle the wink may sit in a carpet and the vertical reaction on the wink, or that the wink is unable to rotate backwards due to this motion necessitating the trailing edge of the wink rubbing on the carpet. This point has not been solved, due to lack of experimental evidence.

One of the most frustrating shots in playing tiddlywinks is that which lands near the cup and then rolls several feet away. Why should the wink roll?

### Facts on Rolling

Conditions:- (Nos. are out of a total of 50 shots)

1. Flicking a distance of 4ft. the wink falls vertically on to the mat (shooting down a staircase - vertical drop 3ft.)

No. of winks which roll - 3

2. Flicking on wood a distance of 4ft. winks rise little more than 2 - 3".

No. of winks which roll - 19

3. Flicking on a carpet 1/10" pile distance of 4ft.

No. of winks which roll - 7

4. Flicking on a carpet 1/10" pile distance of 4ft. drawing the squidger sideways, i.e. rotate the squidger while flicking, so that the wink leaves the carpet set at an angle in the rolling plane (as opposed to pitching and yawing planes)

No. of winks which roll - 24

### Laws concerning Rolling.

1. The horizontal velocity of a landing tiddlywink is proportional to its chance of rolling.
2. The method of squidging can have an effect on rolling potentialities.

### Theories

All spinning bodies tend to rotate about their axis of greatest moment of inertia.

Thus if a tiddlywink is spinning and hits the floor, bounces, hits again and bounces, etc., it stands a very good chance of being shaken into its most stable spinning position, that of rotation about an axis perpendicular to the plane of the wink. It will then roll, provided the tiddlywink is not horizontal.

It is an observed fact from our childhood days of playing ducks and drakes that a body when travelling nearly horizontally bounces many more times than one falling vertically. Thus a tiddlywink of relatively large horizontal velocity stands a greater chance of bouncing into a rolling attitude than one travelling with little horizontal velocity, due to the different number of bounces.

The method of squidging employed in the experiment No. 4 given above meant that the tiddlywink flew not with its axis of spin horizontal, as is usual, but with it slightly tilted. On bouncing in this attitude, the following probably occurs:-

Friction retards the point A; the spin carries the tiddlywink forward in its original direction, eventually making it curve away.

This swerve due to the friction at A, and the rotation of the spin, makes the C-G rise due to its forward motion, which in turn creates a precessional force, the issue becoming quite complex. However, it is seen that the tiddlywink has virtually started to roll merely by being retarded at one edge.

### Conclusion

To prevent rolling:-

- (a) Make all long shots high shots as well.
- (b) Take care to keep the tiddlywink horizontal in the rolling plane while squidging.

A suggestion arising from the law that bodies tend to rotate about their axis of greatest moment of inertia, is that while a tiddlywink is spinning in the air the transition is taking place from one axis to another.

To check this several tiddlywinks were squidged out of an upstairs window, the drop being of the order of 20ft. The spin was carefully observed on the way down. The only result which was noticed was that the rate of spin increased with increased speed of the wink, but the axis appeared to remain constant. The conclusion to this has not been worked out yet.

## Chapter 6. THE ATMOSPHERE (Physical)

### Aerodynamical Effect

If a ruler is spun along its longitudinal, horizontal axis the ruler flies. Similarly the tiddlywink when squidged is spinning about a horizontal axis and it is therefore suspected that there is a slight aerodynamical effect on the trajectory of the wink. The wink is spinning forward (see Chapter 5); hence its trajectory will be shorter than its trajectory if it were not spinning. This point can only be surmised, the effect will only be of the order of a few centimetres for a long shot, as is found by intelligent observation of shots; no experimental technique has been discovered whereby two identical squidges can be made where one is spinning the other not.

### Draughts

Owing to the wink loading (ratio of surface area to weight) a tiddlywink is very vulnerable to the effect of draughts. However, the time of flight is so small that only large draughts (of the order of five knots) would have any appreciable effect.

### Density of Atmosphere

The critical velocity of the tiddlywink is far less than its actual velocity; assuming Reynolds number (R) to be approximately ten for air.

$$v < R \frac{\eta}{\rho r}$$

$$v < 10 \frac{0.1}{0.8} < 1.25 \text{ cms/sec}$$

where  $v$  = critical vel.

$\frac{\eta}{\rho}$  = kinematic viscosity

$r$  = radius of tiddlywink.

The tiddlywink obviously exceeds this, it is also spinning which would lower Reynold's number, therefore the wink flies in a stalled condition.

In the stalled state the resisting force is due to the inertia of the air. Thus the wink will be slowed up in its flight due to a factor which chiefly depends on the radius of the wink. The tiddlywink is in flight for such a short time that this effect is quite negligible, but it is interesting to appreciate the factors involved while the tiddlywink is flying. The larger tiddlywinks will be slowed up more than the smaller ones, but owing to the greater inertia of these larger counters the effect is partially cancelled.

### Humidity

During a match the humidity of the air may change appreciably; the importance of knowing how this will affect play is thus seen.

The humidity has a marked psychological effect as is well known.

The physics of it are less easily seen, for one does not get vapour trails due to the rarefaction behind a spinning wink and rarely does a room become moist enough to reach its dew point, thus affecting the tiddlywink-squidger interface.

It is therefore suggested that the humidity is only a psychological factor.

## Temperature

This would affect the friction of tiddlywink-squidger interface which, as was shewn in Chapter 3, affects the accuracy of play, by increasing the chance of a faulty slip of the squidger.

However, the temperature of a room varies only in a zone of 10' C. which is insufficient to cause considerable changes in the coefficient of friction of either the tiddlywink or the squidger surfaces.

Chapter 7. THE ATMOSPHERE (Mental)

The mental atmosphere is half the game. More games than one would suspect are lost through gamesmanship factors. The C.U.Tw.C. is very aware that there are psychological factors which affect what is commonly called "form".

Such gamesmanship ploys as those given by Stephen Potter in his book on the subject are skilful, varied, and if discovered, best kept secret. The C.U.Tw.C. does not intend, even for the noble cause of furthering knowledge, to disclose its methods of gamesmanship. However there is another type of psychological factor known usually as "atmosphere"; this the club has divided into three types: wine, women, and song. They are treated separately.

Wine (see appendix Test 7)

The results recorded shew that for this individual, beer has little effect on play. Further experiments are needed for it is felt that this factor depends on the temperament of the player. The particular member upon whom this test was conducted is known to be a dazzling billiard player only when tight. The same may happen with tiddlywinks. All that was noticed was a marked lack of interest after his 600th squidge - it is suggested that this is only natural.

Women

The club as a whole performed qualitative tests in this respect while playing a team of show girls organised by the "Daily Mirror". Nobody's play deteriorated or improved markedly even though the concentration of the individual player was destroyed to a certain extent. The club won 9-3, a certain chivalrous nature appeared towards the end of the evening.

Quantitative tests have been performed, see Test 10 below: -

Test 10

	Players			
	1.	2.	3.	4.
Lady in room and antagonistic 6" shots sunk.....				
Lady in room and interested 6" shots sunk.....				
Lady expected but not present 6" shots sunk.....				
Lady breathing down neck of player 6" shots sunk.....				
Normal standard for the day 6" shots sunk.....				

Conclusion: - No comment.



Song

The "song" was created by one wireless on full blast, two observers shouting at the top of their voices while banging two cake-tin lids together. This racket fluctuated in power while the player was performing the 6" and 2" shots. See Test 8.

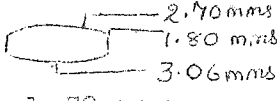
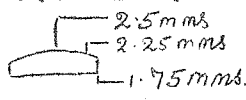
The conclusion is that the racket takes one by surprise, but only the first round. The players' thoughts being divided between playing the shot, and a desire to get it over with quickly, before he goes deaf. The second round however he has adjusted himself and resumes his normal standard.

This tests external rows but when a match is conducted in a cocktail party the player may be required to keep up an intelligent or at least intelligible conversation while playing. This necessarily divides the player's concentration, destroying his form to a considerable extent. Test 11 was conducted by a few members. The players gave a lecture on the origin of the earth or "plastics in industry" while trying to sink 6" shots; the results shew the worth of this form of gamesmanship.

<u>Test 11</u>	No. of successes in 100 shots from 6".	
	Player 1	Player 2
Normal play....	25	19
Play during lecture...	18	16

WEIGHTS AND SIZES OF TIDDLYWINKS

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<u>Size</u>	<u>Colour</u>	<u>Thickness</u>	<u>Width</u>	<u>Weight</u>
Large	Light blue	1.90. mms.	22.15 mm.	0.94 grms.
Large	Red	1.86 mms.	22.0 mm.	0.88 grms.
V. Large	Buff	 2.70 mms 1.80 mms 3.06 mms	26.1 mm.	1.78 grms.
V. Large	Green	1.70 mms.	29.6 mm.	1.54 grms.
V. Large	Dark blue	2.70. - edge 2.66. - middle	32.9 mm.	3.01 grms.
Thick medium	Light blue	1.87 mms.	17.15 mm.	0.55 grms.
Thin medium	Red	0.90 mms.	16.25 mm.	0.23 grms.
" "	Yellow	0.95 mms.	16.13 mm.	0.24 grms.
Thick medium	Orange	 2.5 mms 2.25 mms 1.75 mms	15.68 mm.	0.62 grms.
Small	Red	1.57 mms.	12.73 mm.	0.24 grms.
"	Yellow	1.42 mms.	12.70 mm.	0.22 grms.

## APPENDIX A

### Test 1 (Directional control of hard shots)

#### Object of the test

The directional control of three sizes of tiddlywink on various carpet surfaces for long shots, no account being taken of longitudinal displacements.

#### Method

A number of players flipped counters from various types of carpeting a distance of 4 feet. Only those shots which landed within 6 inches of the 4 ft. line were counted, the sideways displacement from a central cup being measured with a ruler by a sharp-sighted assistant.

Three types of counters were used - large, medium, small. (See sizes and weights of tiddlywinks at the beginning of this appendix). A square squidger was used.

#### Summary of results

Each result represents the average of the number of players shown by each carpet, each of whom played 12 shots. (By this method the personal factor was reduced).

#### DISTANCES OFF IN INCHES

Type of Carpet	No of Players Tested	Size of Tiddlywink Squidged		
		Large	Medium	Small
1/10" worn pile carpet	2	2.38	3.08	3.59
1/8" fairly worn pile	1	2.75	3.17	5.33
3/16" pile worn	4	1.91	2.33	3.91
5/16" pile new	4	2.67	3.50	4.75
Berkshire needleloom	4	1.42	2.13	2.22
Downshire needleloom	4	1.99	2.13	2.84
Winchester needleloom	4	1.93	1.82	2.81

The averages were taken as the algebraic mean (i.e. without regard to whether a shot was left or right of the cup).

### Test 11 (Directional control of soft shots)

#### Object of the test

To compare the directional and longitudinal control of the medium size of tiddlywinks when squidged from various carpet surfaces for a soft shot.

#### Method

Three players flicked the medium sized tiddlywink from a point 6 inches from the centre of a cup. (Each player had his own cup with which he underwent both test 2 and test 3). One hundred shots were taken per player and the number of shots sunk recorded. A square squidger was used.

RESULTS:- No of shots sunk in 100 squidges.

Carpet	Player =			Mean
	1	2	3	
	Ht.of cup 4.25 cms	4.0 cms	4.25 cms	-
	Diam.of cup 4.6 cms	4.1 cms	3.8 cms	-
Berkshire needleloom	47	25	32	34.6
Winchester "	29	21	25	25.0
Downshire "	42	33	28	34.3
5/16" pile	11	0	11	9.3
1/10" pile	42	26	15	27.6

Appendix A (cont.)

Test 111 (Vertical control over short distances)

Object of the test

To compare the capabilities of various types of carpeting for short vertical shots.

Method

Three players took 100 shots from a point 2 inches away from the centre of a cup of approximate height  $1\frac{1}{2}$ " and diameter 1.75". A square squidger was used on a medium sized tiddlywink. The number of shots sunk in 100 tries was recorded against the type of carpet used.

RESULTS:-

Carpet	Player =	1	2	3	Mean
	Ht.of cup	4.25 cms	4.0 cms	4.25 cms	
	Diam.of cup	4.6 cms	4.1 cms	3.8 cms	-
Berkshire needleloom		18	31	25	24.6
Winchester "		25	24	40	29.6
Downshire "		23	19	25	22.3
5/16" pile (new)		16	12	25	17.6
1/10" pile (worn)		42	51	43	45.3

Test 1V

Object of the test

The pile of a normal carpet has directing influence on the flight of a tiddlywink. The object of this test is to estimate the magnitude of this effect.

Method

Five players took 6 shots from a point 4 ft 6 ins. away from a zero mark as in Test 1 and 2.

The difference between this test and test 1 and 2 is that the shots were taken at right angles to the pile of a 5/16" pile carpet, each shot being alligned by an assistant. The players carefully withdrew the squidges in the straight line away from the cup. The tiddlywink to be flicked was put on the carpet and pressed down into it by moving it along the direction of the pile (i.e. at right angles to the line of fire).

The small tiddlywink was more affected by pile than the other two, therefore the small tiddlywink was used.

RESULTS:- Pile was sloping left a depth of 5/16". (new carpet)  
R = right; L = left.

Average distance of shot off centre.

Player	4 ft. shots	6" shots
L.C.M.H.	4.5/6" R	.79" R
R.H.P.	5.1/6" R	-
W.K.S.	5/6" L	.71" R
B.J.T.	2.5/6" R	.79" R
F.N.H.	1.1/6" R	.71" R

The distance was too short to measure fluctuations accurately.

Appendix A (Cont.)

Test V (Effect of shape of squidger)

Object of the test

To compare the control of tiddlywinks for hard shots using a round or a square squidger.

Method

The method used in this test is the same as that for test 1, except that there were two types of squidgers used: a round squidger which was a large counter (diam. 22 mms. approx.) and a square squidger which was a ruler.

Summary of results.

The distances quoted are averaged as in test 1 and are measured in inches.

Carpet	3/16" pile	3/16" pile	3/16" pile	3/16" pile	1/10" pile	1/10" pile	5/16" pile	1/8" pile
Player	1	2	3	4	5	6	7	8
No of shots taken	6	6	6	6	12	12	12	12
Average round	2.6"	9.3"	4"	5.6"	4.3"	3.5"	4.7"	3.5"
Average square	2.3"	3"	5"+	3.3"	1.7"	3.0"	3.1"	3.1"

'No of shots taken' is the number of shots taken with each squidger. +This player had a break between his trials during which time it is believed that he received a 'phone call; the club, therefore, suspects personal factors.

Test V1 (Number of shots required during the average game).

Object of test

To compare the relative frequencies of shots of the type tested in tests 1, 2 and 3.

Method

The game has been divided into three classes of shot. This division is based on the club's experience of the game.

- The shots are:-
- i) 1 ft or over (e.g. test 1 type)
  - ii) 1 ft - 3 ins. (e.g. test 2 type)
  - iii) less than 3". (e.g. test 3 type)

Several players played the game, unhindered by other players, and recorded the numbers of each shot required to sink their wink.


RESULTS:- Summary.

Player	1	2	3	4	5	6	7	8	
Shot type	1	2	3	1	2	3	1	2	3
Counters									
Large	1.5	0.5	1.75	1	0.75	1.25	1.25	0.75	1.25
Medium	1.20	2.0	3.60	1	2.25	2.25	1	1.33	1.83
Small	1.5	1.5	0.50	1	2.5	1.5	1.25	2.0	3.0

All results are the average of 4 tries.

## THE RULES OF TIDDLYWINKS

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1. The normal tournament pitch size is 2 yds. X 1 yd. the surface being a felt, needleloom, dunlipillo or other compressible material which rises from the compressed state in a vertical direction (as opposed to a circular upward motion e.g. pile carpets)
2. The cup (a standard egg-cup  $1\frac{1}{2}$ " high X  $1\frac{3}{4}$ " diam) is placed in the middle of the pitch.  

3. Each player plays with 6 counters which are:-  
Two large: approx-22mms. diam. weight approx 0.9 gms  
Four medium: " 16.5" " " " 0.2. "  
or 0.5. "  
These counters, called "tiddlywinks" are placed 3 ft. from the cup in the corners of the pitch.
4. Play proceeds by each player playing in turn in a clockwise direction. The players play for start by squidging a counter to the cup; the one nearest starts.
5. The aim of the game is to sink all one's winks first using a large counter as squidger (precise size of the squidger is optional)  

The first person	scores	5	pts.
" 2nd	"	3	"
" 3rd	"	1	"
" 4th	"	0	"
6. Players play in pairs situated opposite one another.
7. If one tiddlywink lands on top of another tiddlywink the tiddlywink underneath cannot be played until the covering tiddlywink is moved. This can be done by either the owner of the covering wink squidging it off or the other player or owner of the covered wink putting another wink upon the top of the heap and squidging the lot. (Follow through shots are quite permissible.)
8. A tiddlywink is deemed as played if it is observed by a majority of persons who observed the shot to have left the pitch.
9. If a tiddlywink leaves the required boundary of the pitch the player whose wink it is replaces it at the boundary point from which it left and loses a turn.
10. If a player has only a covered wink left he cannot play until the covering wink is removed.