CHAPTER 29

Movement Kinematics of the Golfer's "Yips"

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ABSTRACT

The golfer's cramp also known as the "Yips" is a breakdown of motor skills during execution of a putting stroke. The Yips has long been seen as a psychological problem and is nowadays discussed in terms of a focal dystonia but without sufficient understanding of its etiology. In this study kinematic analysis is used to investigate the disturbed movements involved in the Yips. Using the SAM PuttLab technology the systematic differences between the putting of amateur golfers and Yips afflicted golfers have been evaluated. Results show that Yips afflicted golfers show a widely disturbed putter face rotation. Mild forms of the Yips are more affected by irregular backswing path and timing. It is suggested that Yips evolves from exaggerated movement control strategies which has also been found in research of other task specific movement problems such as writer's cramp.

Keywords: putting, yips, analysis, movement

INTRODUCTION

The term "Yips" was introduced by a Scottish golf professional in the early 1900's to describe uncontrollable movement jerks occurring in golfer's putting strokes. Ever since that time many unexplainable problems in putting were summarized under the term "Yips". These maladies include "freezing", which is the inability to initiate the movement and "choking", which has been characterized as anxiety related (McKay et al., 1997). Surprisingly the Yips more often appears on very short putts which are limited in the complexity of movement demands. Specific tricks like the claw grip are partially successful. Many players mention a sporadic occurrence after a long history of playing golf. The Yips is in particular resistant to interventions. Once being affected many players are accompanied by the Yips for the rest of their career. Bernhard Langer, Sam Snead or Ben Hogan are famous players who suffered from severe Yips as their career progressed. Similar breakdowns of motor performance in highly skilled athletes are also known from other sports such as darts, bowling or cricket (Bawden and Maynard, 2001).
According to the research conducted by the Mayo Clinic the Yips adds in average 4.7 strokes to a round of golf (Smith et al., 2000). They estimate the prevalence of Yips in the population of golfers to be between 32.5% and 47.7% and assume

that the Yips represents a continuum between choking and dystonia (Smith et al., 2003). They categorized golfers who experienced Yips within mainly movement-related symptoms (jerking, Type I) or anxiety-related symptoms (choking, Type II). It is suggested that a clear definition for the Yips can not be raised due to the variety of symptoms and underlying mechanisms.

Other studies suggest neuro-structural deficits as cause for the muscular spasms (Sachdev, 1992; McDaniel, 2000). Yips is classified as a type of focal dystonia where movement execution is massively impaired by co-contraction and is primarily observed in persons who execute a specific movement for a long period of time such as musicians.

While most studies of the Yips focus on psychological or neuro-structural aspects, a substantial examination of the disturbed movement itself yet to be put forth. Up to this point, the characteristics of the disturbed movements have been only vaguely described. Mai & Marquardt (1994) showed that kinematic analysis could provide deep insight into the mechanisms of task specific movement disorders such as writer's cramp. This study herein adopts a similar approach for evaluating the movement characteristics of Yips affected golfers. The study explicitly focuses on putting Yips as a movement problem as described by the Mayo clinic classification Type I.

METHOD

Participants

The data sample contains 264 amateur golfers who were measured during an amateur tournament series in Germany. All players were invited to participate in the study but received no remuneration for evaluation of their data. Table 1 shows the biometrical data for the participants.

Table 1 Participants in the study

	N	Age	Sex ratio m:f	HC	Years golfing
Mean	264	44.7	208:56	16.6	8.7
SD		14.0		6.5	5.3

Apparatus

The putter movements were captured with the SAM PuttLab technology. A triplet containing three miniature ultrasound transmitters is mounted to the shaft. The system is calibrated for ball position and target direction with a laser. The weight of the triplet amounts to 48 grams. The overall sampling frequency is 210 Hz. During measurement the registered data is continuously transferred from the receiver to a PC via USB. The software scans the data stream and automatically detects valid putting strokes. A graphic report was printed for each player to validate the reliability of the data before statistical analysis with the software package SPSS 13.0.

Group selection

To identify Yips affected golfers, the kinematic characteristics of 6 self confessing Yips golfers were used as a template. The kinematic data showed a clear indication of the Yips in the rotation signal corresponding to the twitches of the hand or the lower arms. Around the time of impact, Yips affected golfers show large oscillations of face rotation which additionally are inconsistent throughout the movement repetitions. An oscillation was defined as at least one excessive opening and closing action of the putter face during a putting stroke.

Fig. 1 shows examples of the face angle and face rotation for a PGA Tour player, an unaffected amateur, a golfer mildly affected by Yips and a golfer heavily affected by Yips. For PGA Tour players face rotation is generally found to be limited, smooth and highly repeatable (Marquardt, 2007). Amateur golfers often show excessive and inconsistent face rotation (see Fig 1B). In contrast, a Yips golfer might not necessarily show excessive rotation but instead will present inconsistent oscillations around impact. In heavily affected Yips (Fig. 1D) the oscillations are getting out of control and face angle at impact is more and more affected.

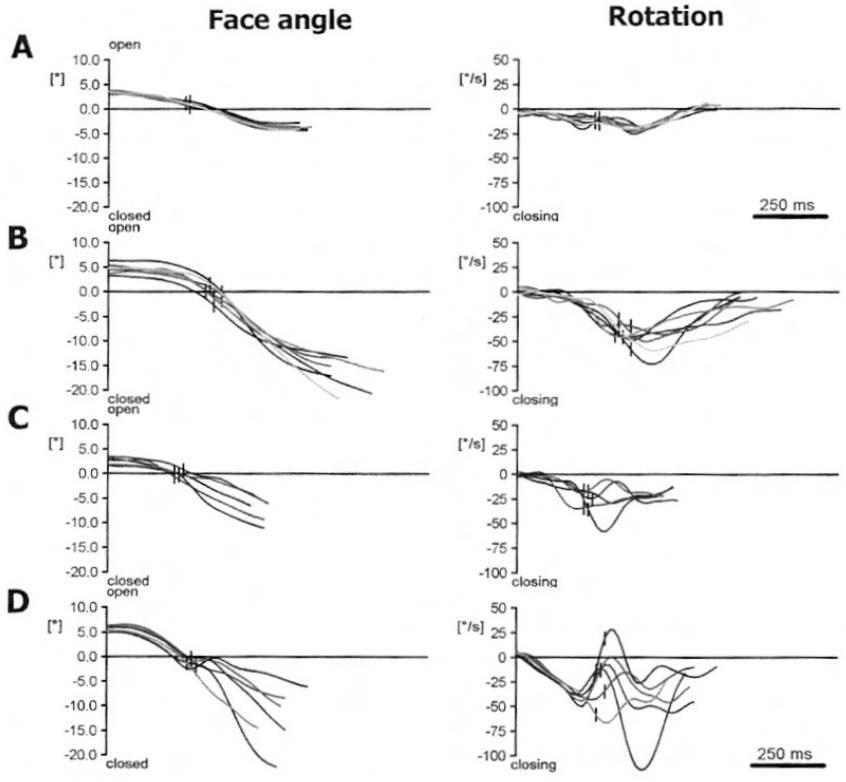

Fig. 1 Examples of face angle and face rotation (change of face angle per time) for (A) PGA Tour player, (B) amateur, (C) mildly affected Yips and (D) Yips. The vertical stripes indicate impact. Yips is defined as inconsistent oscillations of rotation (reopening and closing) around impact (C,D). Inconsistent rotation only as seen in (B) is not categorized as Yips.

Two movement experts then inspected the graphical result reports of all amateurs and rated the time course of rotation in comparison to the Yips affected golfer's rotation template. Strong oscillations with high inconsistencies were rated as "Yips", mild oscillations but still with high inconsistencies were rated with "mild Yips". Irregular rotation (i.e. high amount of closing or opening the face only) was not rated as a Yips problem irrespective of the level of consistency. The data for the resulting Yips groups are shown in Table 2.

Table 2 Data of the subdivided Yips groups

Group	N (total=264)	Percent	Age	HC	Sex ratio
unaffected	224	84.8%	44.0	16.9	177:47
mild Yips	21	8.0%	48.7	14.1	16:5
heavy Yips	19	7.2%	47.6	15.7	15:4

RESULTS

Mean Values (Technique)

A set of variables was analyzed to identify differences in the movement characteristics within the test groups in regards to mean values describing the putting technique and standard deviations representing the consistency of performance. The mean values for the test groups for 7 putts are shown in Table 3.

Table 3 Mean values for 7 putts for unaffected golfers, mild Yips and heavy Yips. ANOVA tests and post hoc t-tests (Bonferroni) were calculated to reveal significance levels: * $p<0.05$; ** $p < 0.01$; *** $p<0.001$.

Variable	Description	unaffected	mild Yips	heavy Yips	F	Sig.
BSTime	Backswing time	715 ms	**795** *	710	3.36	*
FSTime	Forward swing time	819 ms	816	807	0.05	n.s.
ImpTime	Impact time	322 ms	352	317	2.78	n.s.
BSPath	Backswing path	265 mm	**307** *	267	3.54	*
FSPath	Fwd swing path	798) mm	831	808	0.31	n.s.
Direct	Path direction	-0.47 °	-0.37	0.04	0.41	n.s.
FaceAim	Face angle at aim	0.26 °	-0.02	-0.73	1.96	n.s.
FaceImp	Face at impact	-0.03 °	0.08	-0.25	1.18	n.s.
Rot-10	Rotation 10mm to —impact	2.33 °	2.16	1.86	2.51	n.s.
Rot+10	Rotation 10mm after —impact	2.61 °	2.15	**1.77** **	5.3	**
RotSym	Rotation symmetry	0.28	-0.01	**-0.09** *	4.92	**
RotTotal	Total rotation	19.9 °	19.2	18.9	0.19	n.s.
RotRate	Rotation at impact	42 °/s	38	**31** *	3.4	*
ImpSpeed	Impact speed	1688 mm/s	1741	1674	0.70	n.s.

The analysis showed significant main effects for BSTime and BSPath. Post hoc t-tests (Bonferroni corrected) showed significant differences between unaffected golfers and mild Yips (BSTime $p<.05$, BSPath $p<.05$), whereas differences between unaffected golfers and heavy Yips were not significant. Significant main effects were also found for Rot+10, RotSym and RotRate. Post hoc t-tests (Bonferroni) showed significant differences between unaffected golfers and heavy Yips for Rot+10 ($p<.01$), RotSym ($p<.05$) and RotRate ($p<.05$), whereas differences between unaffected golfers and mild Yips were not significant.[1] Fig. 2 shows the club head rotation in the impact zone for the groups. Surprisingly, the rotation for heavy Yips is smaller than for unaffected golfers. Additionally the rotation changes into opposite directions through impact. For unaffected golfers the rotation increases after impact whereas for heavy Yips the rotation after impact is reduced.

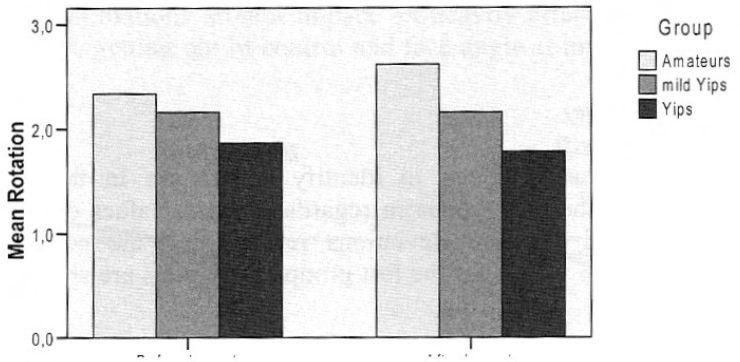

Fig. 2 Mean rotation Rot-10 (10mm before impact) and Rot+10 (10 mm after impact).

SD Values (Consistencies)

The standard deviations *SD* for the test groups representing the consistency of the performance in 7 putts are shown in Table 4. Values for *SD* of FSTime, FSPath, Direction, FaceAim and ImpSpeed did not show significant differences between groups. Significant differences were found for *SD* of BSTime, ImpTime, BSPath, FaceImp, Rot-10, Rot+10, RotSym, RotTotal and RotRate. Post hoc t-tests (Bonferroni corrected) showed significant differences between mild Yips and unaffected golfers for *SD* of ImpTime ($p<.001$) and BSPath ($p<.001$) but no significant differences for BSTime. Significant differences were found between unaffected golfers and heavy Yips for *SD* of all rotation parameters Rot-10 ($p<.001$), Rot+10 ($p<.001$), RotSym ($p<.001$), RotTotal ($p<.001$), RotRate ($p<.001$) and for *SD* of FaceImp ($p<.05$). No significant differences were found between unaffected golfers and mild Yips in the rotation parameters.

Table 4 *SD* values for 7 putts for unaffected golfers, mild Yips and heavy Yips for the parameters

[1] A discriminant function analysis of the mean values revealed highest pooled within groups correlations between unaffected golfers and mild Yips for BSPath (0.515), BSTime (0.488), ImpTime (0.436) and RotSym (0.419). The discriminate functions classified 71.8% of the originally grouped mild Yips cases correctly. The highest pooled within groups correlations between unaffected golfers and heavy Yips were Rot+10 (0.599), RotSym (-0.519), RotRate (-0.508) and Rot-10 (0.441). The discriminate functions classified 76.1% of the originally grouped heavy Yips cases correctly.

analyzed. ANAOVA tests and post hoc t-tests (Bonferroni) were calculated to reveal significance levels.

Variable	Description	unaffected	mild Yips	heavy Yips	F	Sig.
BSTime	Backswing time	40	49.1	38.2	3.33	*
FSTime	Forward swing time	67.2	56.1	62.7	0.49	n.s.
ImpTime	Impact time	17.7	**24.5** ***	17.3	8.33	***
BSPath	Backswing path	19.8	**33.1** ***	24.7	15.1	***
FSPath	Fwd swing path	61.5	63.1	78.2	2.25	n.s.
Direction	Path direction	1.41	1.54	1.68	1.95	n.s.
FaceAim	Face angle at aim	1.14	1.24	1.50	2.74	n.s.
FaceImp	Face at impact	1.29	1.19	**1.61** *	3.36	*
Rot-10	Rotation 10mm to impact	0.53	0.60	**0.86** ***	12.35	***
Rot+10	Rotation 10mm after impact	0.67	0.91	**1.99** ***	50.3	***
RotSym	Rotation symmetry	0.74	0.88	**1.84** ***	30.9	***
RotTotal	Total rotation	3.2	4.4	**6.6** ***	23.6	***
RotRate	Rotation at impact	9.0	12.2	**22.9** ***	46.9	***
ImpSpeed	Impact speed	100	114	105	0.75	n.s.

Fig. 3 shows SD of face rotation before and after impact. Generally differences are smaller before impact. There is a significant difference between unaffected golfers and heavy Yips. The inconsistency increases dramatically for Yips after impact. [2]

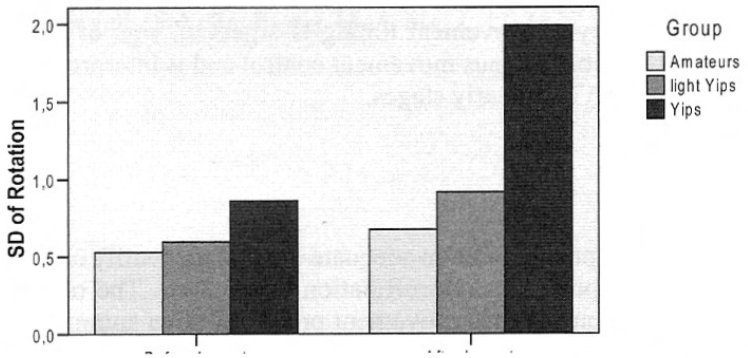

Fig. 3 Standard deviation *SD* of rotation Rot-10 (10mm to impact) and Rot+10 (10 mm after impact).

[2] A discriminant function analysis of the SD values revealed highest pooled within groups correlations between unaffected golfers and mild Yips for SD BSPath (0.740), SD ImpTime (0.549), SD RotRate (0.440) and SD Rot+10 (0.420). The discriminate functions classified 83.3% of the originally grouped cases correctly. The highest pooled within groups correlations between unaffected golfers and heavy Yips were SD Rot+10 (0.858), SD RotRate (0.831), SD RotSym (0.682) and SD RotTotal (0.602). The discriminate functions classified 91.8% of the originally grouped cases correctly. The analysis of the SD values revealed quite higher correlations as the analysis of the mean values.

DISCUSSION

This study directly investigated the characteristics of the disturbed movements involved in the golfer's Yips. We identified about 15% of golfers having mild or heavy Yips. This number is lower than found in other studies, but this study explicitly focused on problems of jerking only.

The kinematic analysis revealed systematic differences in both general technical aspects and in movement consistency. Heavy Yips golfers showed significant differences on the level of rotation only. Unaffected golfers increase rotation through impact whereas heavy Yips golfers in particular reduce rotation through impact, which is also reflected by negative rotation symmetry. Yips golfers seem to act against closing the putter through impact which could be one critical factor involved in the development of Yips. Many golfers interpret rotation as a negative effect without understanding that natural face rotation is a consequence of rotating the putter in a tilted swing plane (Marquardt, 2007).

Heavy Yips golfers also showed impaired consistency of all rotation parameters resulting in a significantly inconsistent face angle at impact. These results suggest that Yips is primarily a direction problem and not necessarily a distance problem. Yippers who grip the putter softly could still be able to control distance of their putts whereas Yippers who grip extremely firm experience severe distance problems. Other parameters did not show significant differences for heavy Yips leading to the assumption that in Yips not the complete movement necessarily does break down rather than movement jerks are added to regular putting movements.

Surprisingly no significant differences were found between unaffected golfers and mild Yips in the rotation parameters. Instead the mild Yips group showed significant differences in backswing time, backswing path and reduced consistency of backswing path and impact time. Slowing down of movement time and reduced consistency of movement timing is a general sign of an increased level of conscious or subconscious movement control and is interpreted as one of the triggers to develop Yips at early stages.

APPLICATION

The kinematic analysis proved to be an adequate method to identify critical factors involved in the development and manifestation of the Yips. The objective data allows the differentiation between movement problems often summarized under the term Yips. In addition, the data can be used in identifying Yips problems at very early stages. This presents an opportunity to help tailor individual treatment strategies to cure the Yips. A vicious circle of initial movement problems, subsequent exaggerated movement control, resulting interference of open-loop and closed loop feedback processing and further decrease of performance is suggested. Information derived from kinematic analysis might contribute to develop a systematic treatment concept for Yips which has been previously proposed for the treatment of writer's cramp (Mai & Marquardt, 1994).

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