The Vicious Circle Involved in the Development of the Yips

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ABSTRACT
Data was collected using the SAM PuttLab from 264 amateur golfers who were measured during an amateur tournament series in Germany. Each golfer had to hit seven straight putts on a regular putting green at a distance of four meters using their own putter. Findings include that Heavy-Yips golfers showed an impaired control of face rotation and face angle at impact. It is proposed that the Yips is a Contextual Movement Disorder and a number of specific factors seem to be involved in its development: anxiety, overcontrol, interference, and awareness of the problem. These factors operate in a vicious circle and any of the factors could trigger the start of the Yips. A behavioural treatment approach can be used to interrupt this vicious circle, based on the premise that the putting movements can normally be executed without breakdown in a different context.

Key words: Golf Putting, Kinematic Analysis, Motor Control

INTRODUCTION

The term "Yips" generally describes the inability to execute a regular putting stroke, in particular the occurrence of involuntary and uncontrollable jerking of the hand or the wrist. The problem has been described as being organic (focal dystonia) or psychological (choking), or as a continuum between both aetiologies. According to research of the Mayo Clinic more than 30% of golfers are affected by this problem which adds on average 4.7 strokes to a round of golf [1]. The Yips can affect professional golfers as well as amateurs and often leads to a high level of frustration and desperation about their golf game. Similar breakdowns of motor performance in highly skilled athletes are also known in other sports like darts, bowling or cricket [2].

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It is typically not the difficult putts that are affected, but rather the simple ones. The Yips often only appears on short putts, which are limited in the complexity of movement demands. It becomes impossible for the affected golfer to access their normal movement pattern even if they try to force it consciously. On the contrary, the more the player tries to avoid the problem, the harder it tends to break out. Many prominent golfers have been affected by the Yips, including Bernhard Langer, Sam Snead, Ben Hogan and Tom Watson.

YIPS SYMPTOMS

According to various case reports, many players mention a sporadic beginning after a long personal history of golf. In particular, the resistant nature of the problem is significant. Once affected, many players suffer from the Yips for the rest of their career. Some players report that once in a while they are able to putt normal again after quitting golf for some time, but that the problem soon returns (especially in pressure situations).

Typically, the Yips is assigned to involuntary movement jerks during the putting stroke [1, 3]. The substantial cocking and twisting of the wrist or the forearms result in an unpredictable ball action. *Choking* is a general symptom of decreased motor performance in sports due to increased performance anxiety, resulting in a disconnection from the movement. *Freezing* describes increased grip pressure and stiffness of a player, the inability to initiate the movement, and cramping during movement execution. Some players also report tremors of wrists or arms throughout the stroke, inhibiting control of the putter at impact.

RESEARCH ON THE YIPS

The discussion of the Yips being either a psychological disorder or an organic disorder has a long history. Various articles and studies have been published, but with yet insufficient understanding of the aetiology of the problem. Consequently, there is not yet any accepted treatment approach available. Although anxiety seems to play an important role in the development of the Yips, the exact mechanisms underlying an increased level of anxiety and the fundamental breakdown of movement performance are still unclear. McDaniel et al. [4] defined the Yips as a focal dystonia, where anxiety is exacerbating the problem, but is not the cause of the problem. Although 77% of the affected golfers reported the severity of the Yips being proportional to their anxiety level, no differences were found between affected and normal golfers with regard to the general level of performance anxiety. Sachdev [5] confirmed these results and found that more severely affected golfers tended to rate themselves more anxious, but the severity of the Yips did indicate more severe ratings of psychopathology. Anxiety was seen as a modulating effect which has also been found in other movement disorders.

The diagnosis of the Yips as a focal dystonia is based on the motor impairment involved in Yips which seems similar to the problems of cramping, tremors and clumsiness reported in other focal dystonias [6, 7]. Adler et al. [7] found abnormal co-contractions in Yips-affected golfers and also assumed evidence of the Yips being a focal dystonia. Focal dystonia is generally described as focal cramping of a muscle or group of muscles and is mainly observed in persons who professionally need to

execute a specific movement for a long period of time (hence 'writer's cramp', 'musician's cramp'). The pathology of focal dystonia is assigned to structural changes of the basal ganglia and its corresponding transmitters. However, the aetiology of focal dystonia is not yet completely understood. Focal dystonia could also comprise mechanical, psychological and other task-specific problems and can be modulated by anxiety. Recent studies show that the disturbed movements can be retrained in a very short amount of time, thus contradicting the pure neurological definition of focal dystonia being an overuse syndrome [8]. Additionally it has been shown that in writer's cramp it is not the basic movement competences that are disturbed, but rather the execution of a movement in a specific context [9]. It is conjectured that writer's cramp develops as a consequence of exaggerated movement control strategies where increased level of movement control interferes with the execution of automated, open-loop movements.

Comprehensive studies of the Yips conducted by the Mayo Clinic [1, 3] suggest that the Yips should be defined as a motor phenomenon with multiple possible aetiologies, ranging from focal dystonia to choking. For golfers with handicaps of less than 12, it was found that the prevalence of the Yips is between 32.5% and 47.7%. They suggest that a clear definition cannot be made due to the variety of symptoms and underlying mechanisms. Besides an evaluation of personal habits, and the nature and onset of symptoms, the researchers measured vital parameters and discovered an elevated level of blood pressure, heart rate and elevated grip pressure in Yips-affected golfers. They concluded that the increased sympathetic activation is a consequence of the increased level of anxiety. However, it seems questionable whether the definition of a continuum from an organic neurological disease (focal dystonia) to a common psychological phenomenon in sports (performance anxiety) truly describes one and the same putting problem.

Most previous studies on the Yips focused on either psychological abnormalities or neuro-structural deficits involved in Yips. Adler [7] used EMG to measure muscle activity in the arms during putting and found increased level of co-contraction in Yips-affected golfers. In this study, we used kinematic movement analysis to investigate the putting movements in Yips-affected and normal golfers. Part of the study has already been published in another article [10]. In this article, we want to more precisely describe the disturbed functional aspects of the putting movements in Yips-affected golfers. Based on the results, we will discuss the aetiology of the problem and propose a theoretical model for development of the Yips which could also be used to tailor systematic treatment of the problem.

METHOD

PARTICIPANTS

The data sample contains 264 amateur golfers who were measured during an amateur tournament series in Germany. Each golfer had to strike seven straight putts on a regular putting green at a distance of four meters and using their own putter. For each golfer, two practice putts were allowed before the measurement began. The players were not informed about the purpose of the study. 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 Males:Females	Handicap	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 in high resolution using the SAM PuttLab technology. The system consists of a sender unit mounted to the shaft which contains three miniature ultrasound transmitters. The weight of the triplet amounts to about 50 grams. A receiver unit is standing in front of the golfer. The system is calibrated with a laser for ball position and target direction. The overall sampling frequency is 210 Hz. During measurement, the registered data is continuously transferred from the receiver unit to a PC via USB. The recording software scans the data stream and automatically detects valid putting strokes to be stored to file. The analysis software can calculate more than 30 characteristic parameters for each putting stroke. Only a set of parameters was analysed in this study. A graphic report was printed for each player to validate the reliability of the data before statistical analysis with the software package SPSS 15.0.

GROUP SELECTION

To identify Yips-affected golfers, the kinematic characteristics of six self-confessing Yips-affected golfers were used as a template. The kinematic data of the Yips golfers clearly showed a severe disturbance of the rotation signal corresponding to the twitches of the hand or the lower arms. Around the moment of impact, the Yips golfers showed irregular large oscillations of face rotation which additionally were 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.

Strong oscillations with high inconsistencies were rated as “heavy Yips”, mild oscillations but still with high inconsistencies were rated with “mild Yips”. Irregular rotation (i.e., high amount of either closing or opening the face only) was not rated as a Yips problem irrespective of the level of consistency. The selection of the test groups is described in more detail in Marquardt and Fischer [10]. The data for the resulting Yips groups are shown in Table 2. Yips golfers tended to be slightly older, but no differences in handicap were found.

Table 2. Data of the Subdivided Yips Groups

Group	N	Percent	Age	Handicap	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

A set of variables was statistically analyzed to reveal differences in the putting movements of the test groups. The mean values describe the general putting technique. The standard deviations (SD) represent the variability of performance. The data was

sorted according to functional groups for setup, direction control and distance control. Parameters representing Setup are only direction of face angle at address position. Parameters determining the direction of the ball are face angle and path direction at impact. Additionally, we looked at putter face rotation, putter path arc and face rotation relative to the arc which are critical for face angle and path direction at impact; these are consistent and smooth for a natural and unaffected putting stroke. Parameters representing distance control are impact speed, and duration of backswing and time back to impact. Consistent timing is a typical characteristic of skilled movement execution and is critical for good distance control in putting. The mean values and the corresponding standard deviations for the test groups for the seven putts are shown in Table 3.

Table 3. Mean Values and Standard Deviations (SD) 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	Unaffected	Mild Yips	Heavy Yips	F	p
SETUP						
Face angle at aim	FaceAim [°]	0.26	-0.02	-0.73	1.96	n.s.
	SD	1.14	1.24	1.50	2.74	n.s.
DIRECTION						
Path direction at impact	Direct [°]	-0.47	-0.37	0.04	0.41	n.s.
	SD	1.41	1.54	1.68	1.95	n.s.
Face angle at impact	FaceImp [°]	-0.03	0.08	-0.25	1.18	n.s.
	SD	1.29	1.19	1.61 *	3.36	*
Rate of face rotation	RotRate [°/s]	42	38	31 *	3.4	*
at impact	SD	9.0	12.2	22.9 ***	46.9	***
Arc of path at impact	Path Arc [°]	7.3	4.4	2.7	2.4	n.s.
	SD	5.0	5.4	7.7 ***	8.5	***
Rotation relative to arc	RelRot [°]	-3.1	-3.1	-3.1	0.02	n.s.
inside of +-10 mm	SD	1.5	1.5	2.1	2.9	n.s.
DISTANCE						
Impact speed	ImpSpeed [mm/s]	1688	1741	1674	0.70	n.s.
	SD	100	114	105	0.75	n.s.
Duration of backswing	BSTime [ms]	715	795 *	710	3.36	*
	SD	40	49.1	38.2	3.33	*
Time to impact in	ImpTime [ms]	322	352	317	2.78	n.s.
Downswing	SD	17.7	24.5 ***	17.3	8.33	***

SETUP PARAMETERS

Heavy Yips golfers tend to aim more left and tend to aim more inconsistently, but the statistical analysis did not reveal significant effects for mean aim angle or for consistency of aim between unaffected golfers, mild Yips and heavy Yips golfers.

DIRECTION PARAMETERS

The ANOVA group comparison showed significant main effects for *RotRate*, *SD*

FaceImp, *SD RotRate* and *SD PathArc*. Values for *Direct*, *FaceImp*, *PathArc*, *RelRot, SD Direct* and *SD RelRot* did not show significant differences between groups. Post-hoc t-tests (Bonferroni) showed significant differences between heavy Yips and unaffected golfers for *RotRate* ($p < .05$), *SD FaceImp* ($p < .05$), *SD RotRate* ($p < .001$) and *SD PathArc* ($p< .001$). Heavy Yips golfers rotate less through impact and have a more inconsistent face angle at impact, inconsistent face rotation and inconsistent path arc compared to unaffected golfers. If the face rotation is calculated relative to the amount of path arc (*RelRot*), no differences were found. No significant differences at all were found between mild Yips golfers and unaffected golfers for direction control parameters.

DISTANCE PARAMETERS

The ANOVA group comparison showed significant main effects for *BSTime*, *SD BSTime* and *SD ImpTime*. Values for *ImpSpeed*, *ImpTime* and *SD ImpSpeed* did not show significant differences between groups. Post-hoc t-tests (Bonferroni corrected) showed significant differences between mild Yips and unaffected golfers for *BSTime* ($p < .05$) and *SD ImpSpeed* ($p < .001$). Mild Yips golfers show an increased duration of the backswing. The time from top-of-backswing through to impact is also more inconsistent. No significant differences at all were found between heavy Yips golfers and unaffected golfers for distance control parameters.

DISCUSSION

Kinematic analysis of a putting stroke proved to be an adequate method to systematically investigate the characteristics of Yips affected putting movements. Although the studies of the Mayo Clinic used analysis technology to measure heart rate, EEG or EMG in Yips-affected golfers [1, 7], they were not able to draw conclusions on the disturbed functional aspects of the movement. It seems unclear if the measured abnormal brain activity and the co-contraction of the forearms represent basic motor control problems (i.e., dystonia) or rather represent consequences of a more complex movement problem. Consequently, this research was not able to provide relevant information to develop a conclusive treatment approach for curing the Yips. In contrast, the kinematic analysis in the current study revealed that in the Yips it is not the complete movement that breaks down but rather specific, functional aspects. Heavy Yips golfers show an impaired control of face rotation and face angle at impact. Other functional aspects such as movement timing or length of the backswing could play an important role in the early development of the Yips.

DIRECTION CONTROL PROBLEM

Part of the data already published [10] revealed that in heavy Yips golfers the amount of face rotation through impact is reduced and the consistency of all rotation parameters is drastically impaired. In this article, we sorted the parameters into the different functional groups for Setup, Direction control and Distance control. Significant differences for heavy Yips golfers were found in the level of Direction control, but not in the level of Setup or Distance control. Consequently we interpret the manifestation of the Yips as a problem connected to direction control, but not directly connected to distance control. This result corresponds to the fact that the Yips mostly occurs in short

putts, where control of ball direction is critical. Longer putts, which are generally more associated with distance control, are not normally affected by Yips.

In this study, we analysed the arc of the putter path and the face rotation relative to the putter path. The results show a tendency of Yips-affected golfers to reduce the arc of the putter path at impact. The variability of path arc is significantly increased in heavy Yips. We previously found that, in heavy Yips golfers, face rotation through impact is reduced and variability of rotation is increased. Yips-affected golfers seem to interrupt both natural face rotation closing the putter face and movement of the putter to the inside on a natural arc. Surprisingly, if face rotation is seen relative to the putter path arc, no more differences between the groups could be found. The simultaneous impairment of face rotation and putter path suggests that in the Yips face angle and putter path are still somehow coupled and that both the hands and the forearms are simultaneously involved. This could also be a consequence of a generalization of dystonic movement problems from distal joints to proximal joints which has also been described for other task-specific movement disturbances such as writer's cramp, where the problem starts in the hands and develops into the arms and shoulders [9].

YIPS IN THE EARLY STAGES

The kinematic analysis could also help to identify the Yips problems at an early stage. Most of the golfers who show mild Yips symptoms are not yet aware of a specific putting problem. They may only recognize some inconsistency in their putting. Golfers who showed mild but inconsistent oscillations of face rotation were classified as mild Yips golfers in this study. Surprisingly, for this group of golfers no direction parameter showed significant differences. In contrast, significant differences were found for distance control parameters. Mild Yips golfers showed a significantly longer backswing time and an increased variability of time to impact.

Consistent movement rhythm and timing are typical characteristics of automated movement execution [11]. Automated movements are always executed in an open-loop mode of motor control where no feedback information is processed during the execution of the movement [12]. The processing of feedback information is always associated with considerable time demands, thus slowing down the movement and increasing the variability of movement timing. Increased movement time is a general sign of an increased level of conscious or subconscious movement control. The tendency for increased movement control in mild yips golfers could be interpreted as one of the triggers to develop the Yips at early stages.

FOCAL DYSTONIA

The cramping and jerking involved in the Yips is often assigned to focal dystonia. Our data does not support the contention that the movement problems involved in the Yips are a consequence of a neurological disease. Only specific functional aspects of the putting movements are disturbed in the Yips, whereas other aspects are not affected. From this result, we conclude that in the Yips the original movement program is still active but is superimposed by a second and conflicting movement program which is connected to the functional aspect of direction control.

Although cramps or co-contraction are typically involved in the Yips, a convincing explanation is still lacking as to why the movements can still be executed perfectly well

if the context of the task is only slightly changed. The Yips often disappears if the ball is hidden under a cover and the golfer does not know if there is always a ball to be hit or not. The Yips can also disappear if the ball is fixed to the ground, the hole is removed, or is replaced by a symbolic target like a tee. Other golfers appear to experience the Yips for a specific distance on short putts, but if the putt is slightly longer or shorter the movement is all of a sudden perfect. If the movement program is disorganized by overuse (repetitive strain injury), which is assumed as an origin of focal dystonia, or if any other neurological sensory-motor deficit is the cause of the problem, it would be impossible to switch back and forth between normal and disturbed execution if exactly the same movement is executed but in a different context.

It is also unclear how people who never played golf before could be affected by the Yips. These golfers are explicitly excluded from most Yips studies, because they do not conform to the definition of the Yips being a disorder acquired over a long period of time. We have seen many novices or high-handicap golfers being measured on the PuttLab who show severe Yips, but without being aware of any problem of their movement. These golfers might have brought in the problem from other sports such as tennis. Our future research will focus on these groups of golfers to better understand the development of the Yips.

These phenomena seem to contradict the clinical diagnosis of the Yips as being a focal dystonia. Furthermore, the prevalence of the Yips seems much too high for focal dystonia. The prevalence of focal dystonia in the population is 3 in 10,000 [13]. The Mayo Clinic suggests that up to 47.7% of golfers are affected by Yips [1]. Is it plausible that a very high percentage of golfers are affected by focal dystonia when it has such a low prevalence in population as a whole? Rather, the high percentage of golfers affected with the Yips suggests that it is a *normal* phenomenon in golfers.

THE VICIOUS CIRCLE

If the putting stroke is only disturbed in a specific context, but can be executed perfectly well in other contexts, then it is not the basic movement itself that is disturbed but rather the execution of the movement in a specific context. Therefore, we propose to describe the Yips as Contextual Movement Disorder (CMD). A number of specific factors seem to be involved in the development of contextual movement disorders. Typically, task-specific movement disturbances only occur under high-precision demands, which *per se* focus attention on a successful movement outcome. This would appear true for hitting short putts where a miss will be interpreted as failure. Our data analysis showed that critical factors for the development and manifestation of the Yips are impaired movement timing associated with increased level of movement control in early Yips and impaired face rotation and path arc associated with jerking of the hands and forearms in heavy Yips. The jerking could then be interpreted as an interference in the execution of an open-loop movement and the activation of a feedback-controlled, closed loop. Smith et al. [1] described the Yips as a problem with multiple possible aetiologies, but, in their model, initial performance anxiety results in a continuum of problems ranging from focal dystonia to choking. In our model, the different factors can occur and influence each other at the same time and are connected by a vicious circle which accelerates once it is closed (see Figure 1).

Anxiety. Several studies showed that anxiety is modulating the problem, but it is not the cause of the problem. The severity of the Yips symptoms also increases with the level of anxiety. Other critical factors modulating the problem are avoidance of failure or estimated consequences of missing an important putt.

Overcontrol. The Yips is connected to conscious or sub-conscious control of impact. Without a ball or without impact, there is no Yips. We found increased movement time representing increased level of movement control in mild Yips golfers. McDaniel et al. [4] found increased level of obsessional thinking in Yips golfers. Processing of visual feedback information also tends to interrupt ongoing, open-loop movements [14].

Interference. In the Yips, it is not the complete movement that breaks down. The existing open-loop movement is superimposed by a second conflicting movement connected to direction control which results in jerking on short putts. By interrupting face rotation and path arc, the conflicting movement is working against a ball direction to the left. The results from Smith et al. [1] confirm that the Yips more often occurs on short putts and on left-to-right breaks.

Perception. Jerking only without awareness of the problem is different from the Yips. Jerking only does not seem to directly result in a pathologic putting problem. But the perception of the problem will trigger anxiety, which again triggers interference and thus will accelerate the process. In Yips-affected golfers, increased self-perception and subsequent self-rating play an important role.

Due to a vicious circle, the starting point of developing Yips could be any of the factors involved. The assumed interdependency between the different factors throws a very different light on the continuum of problems. Some golfers experience their first Yips-affected putt under increased performance anxiety, while in other golfers the Yips may develop as a consequence of a generally increased level of movement control or increased focus of attention to details of the putting stroke. High-handicap golfers can show jerking where anticipation of impact seems to play an important

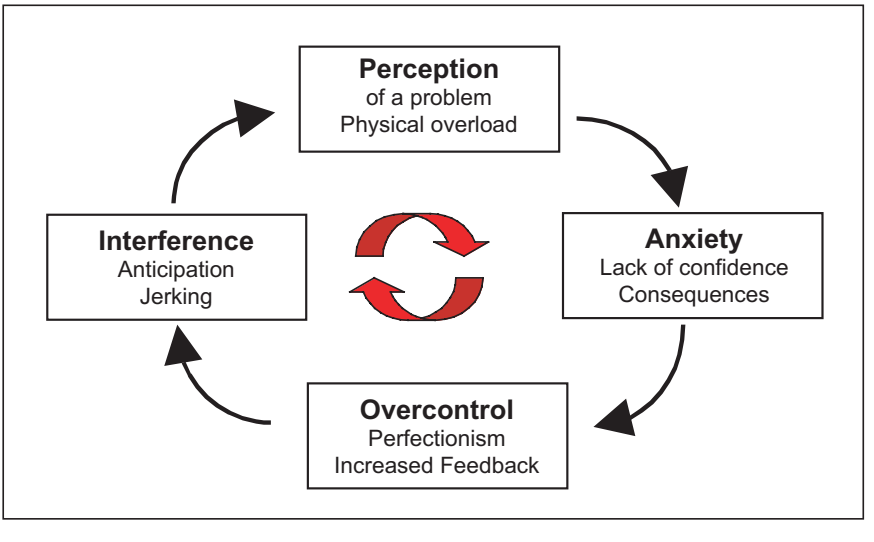

Figure 1. The Vicious Circle Involved in the Development of Yips.

role. Other golfers may first perceive a problem in their putting, then try to correct the problem, but the more they focus attention to their putting the worse it becomes. Once the vicious circle starts accelerating, the problems develop in a downwards spiral and the devastating movement strategies and compensations become established as an automated movement pattern.

THERAPY

The understanding of theYips as a vicious circle could facilitate a better understanding of the inter-dependency of the factors involved in the development of the Yips. The variety of factors involved in development of the Yips seems to correspond to the variety of treatment approaches suggested to cure the Yips. Depending on the individual severity of the factors involved, different treatment approaches might in fact be adequate. In some golfers, the anxiety problems might dominate whereas others apply inadequate control strategies. In some golfers, the jerking itself is out of control whereas in others exaggerated self-perception is a problem. However, we use a treatment approach where we first search for preserved movement capabilities on a lower level of movement complexity that may be selected as reference movements and as a starting point for re-training of the intended movements [9]. The level of complexity of movement where undisturbed movements can be found can vary considerably between golfers. For some golfers, it is enough to put more focus on a consistent stroke rhythm, whereas others need to swing the putter freely without a ball. Once an undisturbed movement is found, the task complexity is reintroduced step by step. When a condition is reached where the movement is becoming impaired again, we work back and forth until we are able to shift the problem to the next level. The result of such a training session is shown in Figure 2.

The problem facing this golfer is indicated by large oscillations of the wrist and of the putter rotation around impact (Figure 2, Left). The speed and acceleration signals of the putter are less affected. A portion of movement beginning in the forward swing also seems unaffected. After 4 hours of training (Figure 2, Right), the problem almost disappeared. The wrist movements are now smooth and follow the movement of the putter. Rotation signals are now also in a normal range. It needs to be noted that the putter movements before and after the training look very similar apart from a slightly smoother finish of the forward stroke after training.

CONCLUSION

Kinematic analysis of putting is an adequate method to distinguish between the different putting problems summarized under the notion of the Yips. The vicious circle proposed in this article may promote a better understanding of the inter-dependency of the different factors involved in the Yips. Choking and freezing need to be clearly distinguished from the manifestation of the pathologic phenomena in the Yips. A more precise diagnosis for the Yips will be needed in the future to no longer summarize all uncontrollable putting problems under the same notion. A more precise definition of Yips will also enable more specific treatment approaches to be developed. Using kinematic analysis to identify the Yips at early stages or even before outbreak could be another emphasis of future research.

The Yips does not involve a complete breakdown of movement, but rather a

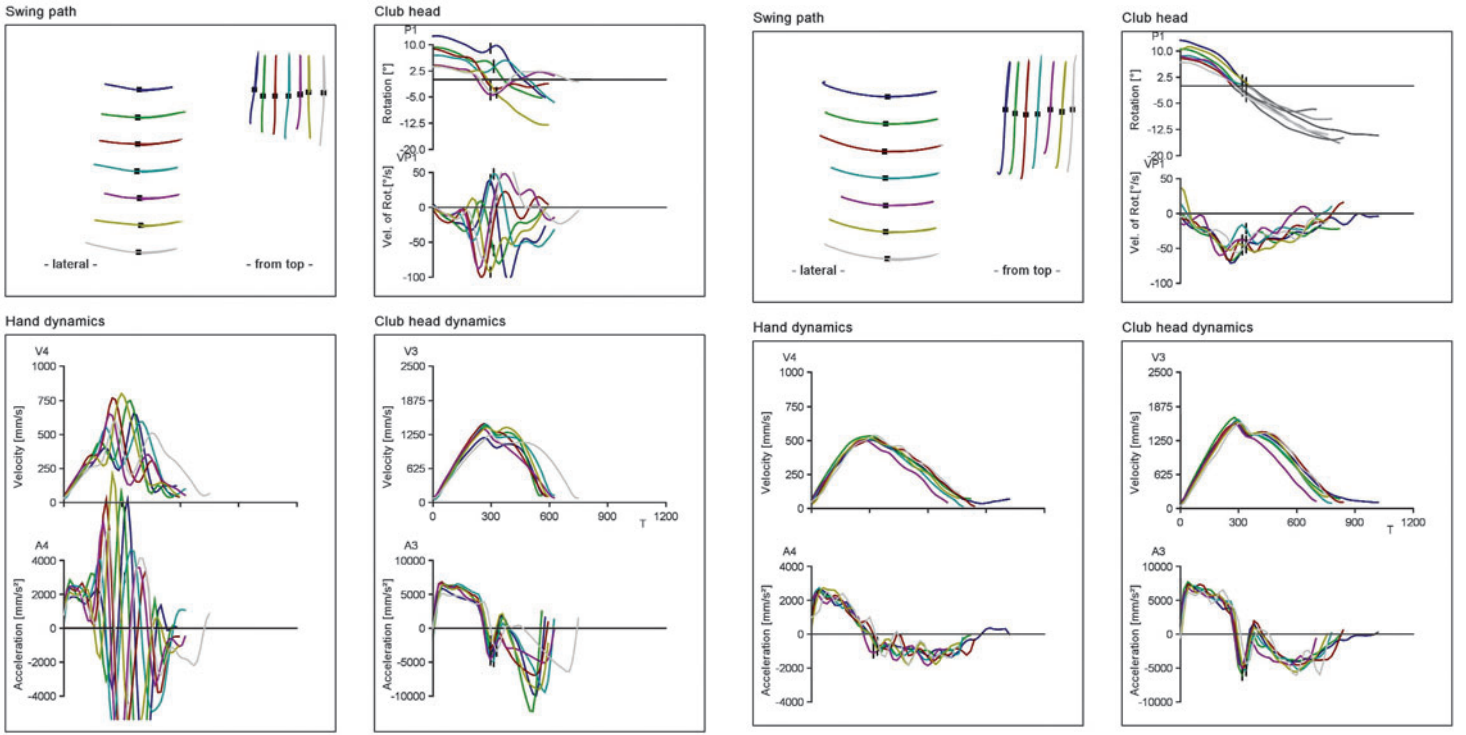

Figure 2. PuttLab Analysis of a Yips-Affected Golfer Before (Left) and After (Right) 4 Hours of Training
The data of 7 putts is superimposed. All graphs show only the forward swing. In each graph, the following is displayed: Upper left: Path in lateral and top view. Upper right: Club face rotation and velocity of rotation. Lower left: Velocity and acceleration of the right wrist. Lower right: Velocity and acceleration of the putter.
Impact is the downpeak in the acceleration signals.

disturbance of direction control in a specific movement context. These findings contradict the clinical definition of focal dystonia. The Yips seems to be a "learned" disorder based on fatal movement strategies introducing an increased level of movement control in automated movements which results in jerking and is amplified by anxiety.

We propose a behavioural treatment approach to interrupt this vicious circle. As the movements can normally be executed perfectly well in a different context, it seems promising to exploit these preserved movement competences to tailor individual treatment and to retrain the originally intended movements. Yips-affected golfers trained with this method showed very promising results after short treatment time. A continuation study also needs to more precisely investigate the psychometric variables of the golfers.

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