

1 **TITLE PAGE**

2 **Title:** Psychodiagnostics: Classification of the yips phenomenon based on musician's
3 dystonia

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26 **ABSTRACT**

27 **Purpose:** Similar to musician's focal dystonia a task-specific phenomenon, known as yips
28 has also been reported in professional athletes. Yips is usually described as focal dystonia, or
29 choking under pressure, or as lying on a continuum between both. Based on the common
30 occupational conditions across musicians and athletes, the present exploratory study aimed to
31 investigate whether musicians diagnosed with focal dystonia and golfers affected with yips,
32 can be similarly sub-classified based on their psychological profiles.

33 **Methods:** Twenty healthy musicians, 20 musicians with focal dystonia, 20 healthy golfers
34 and 20 yips-affected golfers went through a test battery including three psycho-diagnostic
35 standardized questionnaires (the *Competitive Trait Anxiety Inventory*, the *Frost's*
36 *Multidimensional Perfectionism Scale*, and the *Stress Coping Questionnaire*), measuring trait
37 cognitive and somatic anxiety, perfectionistic tendencies and different stress coping
38 strategies.

39 **Results:** Findings based on a clustering procedure suggest that similar to musician's
40 dystonia, yips-affected golfers can be classified into those with and those without specific
41 elevated perfectionistic, stress and anxiety traits. The roles of these different psychological
42 profiles as possible triggering factors of the yips are discussed and compared to those of
43 musician's dystonia.

44 **Conclusion:** The current study suggests that the yips phenomenon might cover a broader
45 range of different subtypes of movement disturbances than those already suggested in the
46 literature. Finally a theoretical model, which explains the role of the different triggering
47 factors in the discrimination of the different subtypes, is suggested. A better classification and
48 understanding of the different subtypes of yips could lead to a more accurate diagnosis and to
49 the design of more individualized treatment intervention.

50

51 **Keywords:** yips-affected golfers; musician’s dystonia; psycho-diagnostics; cluster analysis;
52 classification; triggering factors

53

54 **INTRODUCTION**

55 Task-specific focal dystonias often affect individuals in professions where highly trained fine
56 motor skills are required (1, for a review). Insights concerning the aetiology of task-specific
57 focal dystonias have previously been obtained by comparing focal dystonia patients from
58 different professions, for instance musicians and writers (2). Similarly, the current study
59 attempts to examine and compare the psychological backgrounds of musicians diagnosed
60 with focal dystonia and golfers affected with yips. Focal dystonia in musicians or musician’s
61 dystonia is characterized by muscular incoordination and loss of voluntary motor control
62 while playing a musical instrument. It usually affects one, two or more fingers of the more
63 heavily used hand (3). As a result, irregularities in timing, unevenness in movements and
64 slowing down of fast musical passages lead to a deterioration in the overall performance
65 quality (3). Yips is a similar movement disorder and is defined as: “a psycho-neuromuscular
66 impediment affecting the execution of fine motor skills during sporting performance” (4). In
67 golfers it is mainly characterized by twisting or jerking of the lower arm (and wrist) either
68 before or during ball contact. It mainly occurs in relatively short-distance putting and usually
69 leads to missing the putt (4-6). Dystonic musicians (DM) and yips-affected golfers (YG) have
70 involuntary movement and task-specificity in common. Task-specificity indicates that
71 symptoms occur primarily while playing the musical instrument or while putting with the
72 golf club. Furthermore, both occupations require an extensive amount of practicing and the
73 execution of repetitive fine-motor temporospatially coordinated movements under high-
74 pressure conditions (7).

75

76 Although there are commonalities between the two types of movement disorders, differences
77 also exist. For instance, musician's dystonia is characterized by a prolonged flexion or
78 extension of the affected body part (finger[s]). In contrast, golfer's yips is described more as
79 a twisting or dystonic tremor-like movement. Furthermore, the prevalence of musician's
80 dystonia is estimated to be approximately 1% (3) and is much lower than the reported
81 prevalence rates of yips, which range from 17 to 48 % (5,6,8). Finally, focal dystonia in
82 musicians affects professional or experienced players (3). While yips-affected golfers also
83 usually operate at a higher skill-level (9), a few recent studies have suggested the existence of
84 yips symptoms in beginners (8,10,11,12).

85

86 The aetiology of both task-specific movement disorders is multifactorial and still not fully
87 understood. Pathophysiological findings on focal dystonia have indicated abnormal inhibitory
88 mechanisms, dysfunction of the sensorimotor system, abnormalities within the basal ganglia,
89 and abnormal brain plasticity (1,3). Concerning the aetiology of golfer's yips, different
90 studies have classified this phenomenon either as focal dystonia (an organic problem), or
91 'choking under pressure' (a psychological problem), or on a continuum between both (6,9,13-
92 15,16). Choking under pressure describes the occurrence of a significant drop in performance
93 due to a perceived mismatch between situational demands and the athlete's resources (e.g.
94 due to increased performance anxiety) (17). Where on this continuum the yips phenomenon
95 sits remains a matter of debate.

96

97 With respect to psychological investigations, findings in various forms of focal dystonia have
98 clearly revealed that the condition in a considerable proportion of patients is related to
99 psychological comorbidities. Review studies have concluded that those comorbidities were
100 not a psychoreactive effect but pre-existed the dystonia onset (18). Concerning DM, studies

101 have found associations with higher levels of anxiety, perfectionism, neuroticism, social
102 and/or other specific phobias (3,19). Recently, a more detailed investigation by Ioannou and
103 Altenmüller (20) revealed that DM can be sub-classified into those with and those without
104 psychological vulnerabilities, based mainly on contrasting levels of chronic perfectionism,
105 anxiety and stress-coping styles. Further studies comparing the different subtypes have
106 indicated that in addition to sensorimotor triggering factors (e.g. workload, handedness,
107 instrument, controllability of actions etc.), psychological comorbidity should be considered as
108 an additional triggering factor, which could significantly contribute to the manifestation of
109 focal dystonia (21,22). However, increased levels of stress and anxieties related to music
110 performance have been also reported in many healthy musicians, a condition known as music
111 performance anxiety. Several studies have shown that musicians with performance anxiety
112 often experience motor deterioration (23-25) or muscular stiffness, which could in turn
113 disrupt fine motor coordination (26).

114

115 Studies focusing on yips' psychological profiles remain highly contradictory (4). Some
116 studies have found psychological features distinguishing between affected and unaffected
117 athletes. For instance, yips-affected athletes would experience higher levels of perfectionism
118 (27) and tend to consciously control their movements or to think obsessively about the
119 problem (5). Furthermore Philippen and Lobinger (12) reported that about two thirds of YG
120 primarily focus internally or on potential mistakes while stroking and Stinear et al. (16)
121 reported alteration of the state anxiety between relaxed and stressed conditions, which was
122 associated with changes in putting accuracy. In contrast, other studies could not confirm the
123 existence of distinguishing psychological profiles (9,28) or any association with reinvestment
124 (29) between yips-affected athletes and controls. The ambiguity may be due to different
125 methodological approaches, such as the usage of different golfer's yips criteria (28), or

126 because of a heterogeneity (e.g. different subtypes grouped together) among the yips-affected
127 athletes (13). Only a few studies have suggested the existence of different subtypes of YG, for
128 instance into those who primarily report movement-related symptoms versus those with
129 anxiety-related symptoms (6,9,16) or those who may experiencing both symptom subtypes
130 (4). There is therefore a necessity for further investigation of the psychological triggering
131 factors to the manifestation of yips, and a clarification of the different possible subtypes.

132

133 The current open-design exploratory study aimed to investigate and compare the
134 psychological profiles of DM and YG. Based on the nature of both occupations, which
135 include high level of performance under stressful and demanding endo- and exogenous
136 conditions, sub-characteristics related to trait anxiety, perfectionism and stress coping
137 strategies were examined (20,28). The yips phenomenon, which remains under-investigated
138 in comparison to focal dystonia, seems to cover a range of still-unidentified subtypes, as well
139 as some already suggested in the literature. We expected that similar to DM (20,22), YG
140 would be sub-classified into different psychological profiles. As a final goal we attempted to
141 explain the role of those different psychological profiles by suggesting a broader
142 classification of yips in comparison to previous evidence and reports. We hope that the
143 comparison between the two similar movement disorders will provide further understanding
144 of the yips phenomenon and its possible subtypes.

145

146 **METHODS**

147 *Participants*

148 Eighty participants, (20 healthy musicians [HM], 20 DM, 20 healthy golfers [HG] and 20
149 YG) filled out a psycho-diagnostic test battery. HM were randomly recruited via published
150 announcements and were either freelancers or members of orchestras, music schools or

151 universities. DM were all diagnosed with focal hand dystonia by the last author (EA) and
152 were selected from the outpatient clinic of Music Physiology and Musicians' Medicine after
153 setting exclusion criteria (i.e. participants with any neurological [e.g. secondary dystonia,
154 tremor] or psychiatric [e.g. depression] disturbances). Patients selected in this way were
155 contacted in random order and asked for their willingness to participate. Likewise, HG and
156 YG were both randomly recruited from local golf clubs (also via published announcements)
157 and from the database of the Institute of Psychology (same procedure as above). All golfers
158 were re-tested and assigned as yips-affected and non-affected by the second author (MK). YG
159 were mainly characterized by involuntary movements such as twisting or jerking of the lower
160 arm during the one-handed putting test (28). Further characteristics can be seen in [Table 1](#).
161 All participants were informed of the requirements of the investigation and all provided
162 informed consent before testing commenced. The protocol was conducted in accordance with
163 the declaration of Helsinki and was approved by ethics committee of the board of the German
164 Association of Psychology.

165

166 ***Instruments***

167 The *Competitive Trait Anxiety Inventory* (CTAI) (GER: Wettkampf-Angst-Inventar Trait
168 (30)), which is widely used in sport science, was used to assess trait anxiety before
169 performance/competition. This psycho-diagnostic instrument has also been used in the past to
170 assess competitive trait anxiety in musicians (20,22). CTAI assesses trait anxiety in three
171 different components: "somatic anxiety" (e.g. "*Before competition I feel nervous*"), "self-
172 doubt concern" (e.g. "*Before competition I worry about failing under pressure*"), and
173 "concentration problems" (e.g. "*Before competition I am prone to distractions*"). All
174 subscales consist of four items each and are answered on a 4-point scale ranging from 1 "*not*
175 *at all*" to 4 "*very much*". As suggested by the authors of the CTAI, the third subscale was

176 excluded from the analysis due to its low reliability (30). The reported Cronbach's alpha
177 value for the "somatic anxiety" subscale is .81 and for the "self-doubt concern" .83 (30).

178

179 Perfectionism was assessed with the German version of the *Frost's Multidimensional*
180 *Perfectionism Scale* (FMPS) (GER: Mehrdimensionale Perfektionismus Skala von Frost),
181 (31). FMPS consists of 35 different items that form six different subscales: "concern over
182 mistakes", "personal standards", "parental expectations", "parental criticism", "doubts about
183 actions" and "organisation". Cronbach's alpha values for the six subscales range from .70 to
184 .90. The participants had to rate each item on a 6-point scale from 1 "*does not apply at all*"
185 to 6 "*applies very well*".

186

187 Stress coping strategies were obtained via the short form of the German *Stress Coping*
188 *Questionnaire* (SCQ) (GER: Stressverarbeitungsfragebogen), (32), which mainly examines
189 positive and negative coping stress strategies. Positive coping strategies include the subscales
190 "play down", "guilt denial", "distraction", "substitutional satisfaction", "situation control",
191 "reaction control" and "positive self-instruction". Negative coping strategies include the
192 subscales "flight tendency", "mental perseveration", "resignation" and "self-incrimination".
193 Finally two more neither positive nor negative strategies, "need for social support" and
194 "active avoidance" are also included. The internal consistency (α) of the all the subscales
195 ranges between .77 and .94. The participants had to imagine being in a stressful situation and
196 estimate on a 5-point scale from 0 "*not at all*" to 4 "*most likely*" to which degree a statement
197 applied to their own behaviour (total number of items 78). Finally, demographic,
198 occupational and movement disorder information were also collected.

199

200 ***Statistical analysis***

201 I. Group differences: A multivariate analysis (MANOVA) was used to examine possible
202 group differences (HM vs. DM vs. HG vs. YG) on the 21 different subscales which derive
203 from the three psycho-diagnostic questionnaires. An additional two-way MANOVA with
204 fixed factors of “occupation” (golfers vs. musicians) and “disorder” (affected vs. non-
205 affected) was also conducted in order to examine a possible interaction effect between the
206 two factors. Due to the fact that no group differences were found between the four groups
207 (apart from on two subscales) and no interaction effect was found between “occupation” and
208 “disorder” a more detailed data exploration was conducted.

209

210 II. Cluster analysis: Assuming that no group differences existed, all participants were grouped
211 together and all 19 subscales were used as dependent variables. A hierarchical procedure was
212 then applied in order to estimate the x number of clusters (33). Subsequently a K -means
213 analysis was performed in order to classify all participants into those x clusters. In order to
214 estimate which dependent variables (subscales) contributed the most to the classification of
215 participants into clusters, Mann-Whitney U tests were used. Finally the proportions, firstly
216 between all musicians (patients and controls) vs. all golfers (patients and controls) and
217 secondly between HM vs. DM vs. HG vs. YG, were calculated within each cluster, and tested
218 by a chi-square test for significant frequency differences.

219

220 Point-biserial correlations were used to estimate effects of age, years of experience and
221 cumulative hours of practicing, between clusters for musicians and golfers respectively. A
222 significance level of $p < .05$ was used and Bonferroni corrections were applied in order to
223 prevent inflated type I error. Data analyses were performed in IBM SPSS Statistics software
224 package (version 24) and R (version 3.4.2).

225

226 **RESULTS**

227 Using Pillai's trace on all 21 subscales indicated a marginally significant psychological group
228 difference, $V = .993$, $F(63, 174) = 1.37$, $p = .058$, $\eta_p^2 = .331$. Follow-up univariate ANOVAs
229 (p accepted at $< .05/21_{\text{subscales}} = .00238$) were significant only for the subscales, "play down":
230 $F(3, 76) = 5.67$, $p = .001$, $\eta_p^2 = .183$, and "resignation": $F(3, 76) = 5.45$, $p = .002$, $\eta_p^2 = .177$.
231 Bonferroni post-hoc tests revealed significant differences between DM vs. HG ($p = .001$) for
232 the "play down" subscale, and between DM vs. HG ($p = .002$) and DM vs. YG ($p = .021$) for
233 the "resignation" subscale (Table 2).

234
235 A two-way MANOVA with fixed factors "occupation" (golfers vs. musicians) and "disorder"
236 (affected vs. non-affected) indicated only an effect for occupation, $V = .433$, $F(21, 56) = 2.04$,
237 $p = .018$, $\eta_p^2 = .433$. Neither a disorder effect ($V = .323$, $F(21, 56) = 1.27$, $p > .05$, $\eta_p^2 = .233$)
238 nor an interaction effect between the two factors ($V = .286$, $F(21, 56) = 1.07$, $p > .05$, $\eta_p^2 =$
239 $.286$) were observed. Follow-up univariate ANOVAs (p accepted at $< .05/21_{\text{subscales}} = .00238$)
240 on the occupation effect were significant only for the "play down" subscale: $F(1, 76) = 10.97$,
241 $p = .001$, $\eta_p^2 = .126$ with golfers showing a slightly higher score (1.9 ± 0.1 [M \pm SE]) than
242 musicians (1.4 ± 0.1 [M \pm SE]).

243
244 Assuming that all four groups share similar psychological profiles due to a general lack of
245 group differences, the 19 subscales without significant differences (excluding "play down"
246 and "resignation" subscales) were used as single variables in the following clustering
247 procedure. It was first established that none of the 19 variables (subscales) showed any
248 substantial collinearity with any of the others: all correlations: $-.31 \leq r \leq .71$ (Pearson).
249 Therefore all values were standardized into z-scores, since subscale evaluations were
250 performed on different Likert scales. A hierarchical clustering analysis (Ward's method -

251 Squared Euclidean distance) indicated the classification of all 80 participants into two distinct
252 clusters (see Dendrogram, Supplemental Digital Content 1). Different clustering procedures,
253 algorithms and distance measures revealed similar clustering patterns, indicating the stability
254 of the results. Finally a *K*-means analysis, based on two clusters, classified all participants.
255 Reliability, which was tested by a cross-tabulation percentage agreement between two
256 randomly divided subsamples (split-half) of the original data, indicated a Rand index of .49,
257 and an Adjusted Rand Index of .02 (34).

258

259 Due to unequal group sizes of the resulting clusters and the non-normally distributed data in
260 some variables (Shapiro-Wilk < .05), a follow-up Mann-Whitney U tests between the two
261 clusters indicated that 13 out of 20 variables (subscales) functioned as primary contributors to
262 the classification of the participants into two clusters (*p* values were accepted after a
263 Bonferroni correction at < .05/19_{subscales} = .0026). These characteristics were: “doubts about
264 actions”, “concern over mistakes”, “flight tendency”, “parental criticism”, “parental
265 expectations”, “active avoidance”, “mental perseveration”, “substitutional satisfaction”, “self-
266 incrimination”, “personal standards”, “somatic anxiety”, “need for social support” and “self-
267 doubt concern” (Figure 1). According to the classification of all participants into those two
268 profiles, cluster 1 (representing participants with elevated scores of the above characteristics,
269 *n* = 46) was labelled as “High tendency to Perfectionism, Anxiety and - inability to cope with
270 - Stress” (HPAS) profile, and cluster 2 (representing participants with contrasting scores, *n* =
271 34) was labelled as “No tendency to Perfectionism, Anxiety and - inability to cope with -
272 Stress” (NPAS) profile.

273

274 The association between the two clusters and the two occupations (musicians and golfers)
275 revealed a significant difference: $\chi^2(1) = 7.37, p = .007$ (also Fischer’s exact: *p* = .012).

276 Cluster 1 (HPAS) was mostly represented by musicians whereas cluster 2 (NPAS) was
277 mostly represented by golfers. Finally, no significant association (2 x 4) was found between
278 the two clusters and the proportion of HM, DM, HG and YG, $\chi^2 (3) = 7.57 p > .05$ (Table 3).
279 No differences between HPAS and NPAS clusters for DM and YG respectively were found
280 concerning age, age when started playing, years and cumulative hours of experience, onset
281 age, years of experience until onset, or level of expertise.

282

283 Due to differences in age, years of experience and cumulative hours of practicing between
284 musicians and golfers, a point-biserial correlation was conducted in order to detect whether
285 these three variables had any effect on the classification of musicians and golfers respectively
286 to the two clusters (HPAS and NPAS). Results revealed that the classification of musicians
287 into HPAS and NPAS was not significantly related to age, $r_{pb} = .049, p > .05$, years of
288 experience, $r_{pb} = .023, p > .05$ or cumulative hours of practicing, $r_{pb} = .088, p > .05$. Hence, of
289 the variability in the classification of musicians into two clusters, age accounted for ($R^2 =$
290 $(.049)^2 = .0024$) 0.2%, years of experience for 0.1% and cumulative hours of practicing for
291 1%. Likewise, the classification of golfers in HPAS and NPAS was not significantly related
292 to age, $r_{pb} = .269, p > .05$, years of experience, $r_{pb} = .142, p > .05$ or cumulative hours of
293 practicing, $r_{pb} = -.080, p > .05$. Age accounted for 7%, years of experience for 2%, and
294 cumulative hours of practicing for 1% of the variability in the classification of golfers into
295 clusters. Finally, in order to examine (indirect) whether any psychological trait (subscale) was
296 a psycho-reactive effect (i.e. due to the onset of the motor disturbances) all subscales were
297 correlated with the number of years after onset. Results indicated no significant correlations
298 for DM whereas for the YG only one perfectionistic feature (“parental criticism”: $r_s = .573, p$
299 $= < .01$), one neutral (“active avoidance”: $r_s = .638, p = < .01$) and two negative coping

300 styles, (“flight tendency”: $r_s = .568, p = < .01$; “resignation”: $r_s = .584, p = < .01$) indicated
301 significant correlations.

302

303 **DISCUSSION**

304 The current study revealed that all musicians and golfers (patients and healthy ones
305 respectively) could be sub-classified into two different subgroups characterized by
306 contrasting psychological profiles. The role of these different subtypes, as they relate to
307 previously suggested triggering factors, are discussed and compared across yips and
308 musician’s dystonia. Finally a more refined classification of the yips is suggested, which
309 remains to be confirmed by further electrophysiological examinations.

310

311 Multiple comparisons between groups (HM vs. DM vs. HG vs. YG) revealed no
312 psychological differences (20,28). Following studies suggesting that focal dystonia patients
313 (18,20) and yips-affected athletes are characterized by psychological heterogeneity (4,6,16), a
314 clustering analysis was conducted. Findings indeed indicated the existence of two contrasting
315 psychological profiles. Classification of participants into those two profiles was based on
316 either high levels (HPAS) or low levels (NPAS) of specific perfectionistic traits, negative
317 coping stress strategies and somatic and cognitive trait anxieties (for specific characteristics
318 see Figure 1). Distributions of the two occupations within the two clusters indicated that the
319 HPAS profile was mostly represented by musicians (63%) whereas the NPAS profile was
320 mostly represented by golfers (68%) (see Table 3). The higher representation of the HPAS
321 profile by musicians compared to golfers can probably be explained by the fact that the
322 majority of the former group were professionals. For professional musicians, performing is a
323 livelihood activity, whereas for golfers of such a high handicap this is not the case (mean
324 handicap < 27 ; handicap is a numerical representation of golfers’ playing ability with lower

325 numbers indicating better performance). However concerning the classification of each
326 occupation individually into HPAS or NPAS, results indicated that proficiency (measured
327 indirectly by “years of experience” and “cumulative hours or practicing”) did not play a role
328 at all. Finally, the greater representation of musicians and golfers in the HPAS and NPAS
329 profiles, respectively, did not differ across patients and controls. That is, whether a
330 participant was a patient or control did not affect the probability of their having an HPAS or
331 NPAS profile, and this was the case for musicians and golfers (see [Table 3](#)). This emphasizes
332 the existence of two different psychological subtypes for both occupations.

333

334 Different subtypes in YG and DM have been also reported in the past. For instance, Ioannou
335 and Altenmüller (20) found that one in two DM was characterized by psychological
336 comorbidities. Likewise, different subtypes of YG have also been described by Smith et al.
337 (6), who distinguished a group of YG with more dystonia-related symptoms (Type I) and a
338 group with symptoms related to performance anxiety or choking (Type II). Both subtypes
339 were further evaluated by Stinear et al. (16) while performing under low- and high-pressure
340 conditions. Besides the fact that the cognitive anxiety of those classed as Type I was
341 increased during the stress condition, putting performance remained unaffected. On the other
342 hand, Type II golfers (with anxiety-related symptoms) demonstrated reduced putting
343 accuracy under stress. The authors suggested that Type I could be more related to impaired
344 initiation during motor execution, a characteristic related to patients suffering from focal
345 hand dystonia. In contrast, Type II (anxiety-related symptoms) was suggested to be
346 associated with performance anxiety rather than with motor impairments of the central
347 nervous system (9,16). The authors further indicated that there are also YG who experience
348 both physical (dystonic) and psychological (choking) symptoms, with these golfers being
349 labelled as Type III (4). However this subtype remains under-investigated.

350

351 The study by Stinear et al. (16) which seems to be the only experimental investigation
352 comparing these different subtypes may be partially problematic. No objective assessments
353 were used for participants' stress levels; instead the Competitive State Anxiety Inventory
354 (CSAI-2) was used to evaluate state anxiety between low- and high-pressure conditions. This
355 specific questionnaire has also been reported to have questionable validity and reliability
356 (4,35). According to our knowledge there are no other experimental studies which
357 investigated differences between the above suggested subtypes. An investigation similar to
358 Stinear et al. (16) which compared the performance accuracy in DM under relax and stress
359 conditions revealed no differences either for patients with or without psychological
360 comorbidities (22). Moreover, and in contrast to Stinear et al. (16), the induced stress-level in
361 DM was evaluated mainly by objective measurement (i.e. cortisol level and
362 electrocardiography).

363

364 Apart from the limited evidence suggesting the classification of yips into Types I and II, the
365 high prevalence of yips (17 to 48 %) seems to be at odds with that of musician's dystonia
366 (1%) and that of other forms of primary focal dystonia (< .05%) (36). Specifically, Smith et
367 al., (34) suggested that of 72 YG (2 were excluded), 40 were assigned as Type I (dystonia
368 symptoms), 16 as Type II (psychological symptoms) and 14 as Types I and II (or according
369 to Clarke et al. (4) as Type III). Likewise, Stinear et al. (16), who used only 9 non-affected
370 golfers and 15 yips-affected golfers, concluded that 8 yips-affected golfers could be classified
371 as Type I, and 7 as Type II. Given that the prevalence of yips has been reported to range
372 between 17 and 48% (hypothetical mean = 32.5%) (5,6,8), the proportions of YG classified
373 as Type I (dystonia symptoms) in the two studies described above (57% in Smith et al., (6),
374 53% in Stinear et al., (16)) would suggest a hypothetical prevalence of Type I yips-affected

375 golfers of 17-18%. This remains high with respect to the prevalence of focal dystonia more
376 generally, and we believe that yips may cover a broader range of different subtypes mostly
377 unrelated to focal dystonia.

378

379 We argue that Type II YG (with anxiety-related symptoms), who showed motor instabilities
380 under stress situations may not be related to those DM with psychological comorbidities.
381 Instead, Type III golfers who experience both physical (dystonic) and psychological
382 (choking) symptoms (4,6) maybe closer to those DM with additional psychological
383 comorbidities (22). However, Type II YG seem to be linked to those “healthy” (non-
384 dystonic) musicians who experience motor disturbances due to elevated performance anxiety
385 (23-26,37). Up to 60 % of active musicians have reported a negative impact of music
386 performance anxiety on their performance (24). Wesner et al. (25) reported that 21% of
387 healthy musicians were characterized by increased levels of music performance anxiety;
388 16.5% of them reported that music performance anxiety also impairs their musical
389 performance. Other studies have further indicated that the level of anxiety increases when
390 musicians are performing with a higher public status (37), or when solo compared to
391 ensemble performance is required (23). A parallel can be drawn between findings indicating
392 performance deterioration in musicians who suffer from music performance anxiety with
393 studies revealing yips-symptoms exacerbation under stressful situations (5,6,16). However
394 more experimental studies investigating yips symptoms under stress and relax conditions are
395 needed in order to clarify the effect of stress and anxiety on the motor performance of yips.

396

397 The extent of these psychological traits as aggravating risk factors for the triggering of task-
398 specific symptoms in musician’s dystonia and yips remains poorly understood. A recent
399 study which investigated a homogenous group of DM (only pianists) revealed that those

400 patients with elevated levels of anxiety, stress, and perfectionism had developed focal
401 dystonia about 10 to 15 years earlier than those patients without any psychological
402 comorbidity. It was suggested that those psychological behaviours (i.e. stress, anxiety and
403 perfectionism) in combination with other well-known sensorimotor triggering factors (see
404 next paragraph) could contribute as aggravating and accelerating risk factors to the
405 manifestation of focal dystonia (22). The pre-dystonic phase when minor and temporarily-
406 limited motor disturbances occur not only under stressful performance conditions but also,
407 for instance, while practicing, is known as *Dynamic Stereotype*, and is primarily linked to
408 musicians with elevated psychological traits, such as stress and perfectionism (14). A
409 prolongation of this situation which could lead to persistent dystonic movement patterns and
410 task-related loss of control, and therefore to focal dystonia (21). Therefore we suggest that
411 similar to DM, the HPAS-YG (yips-affected golfers with specific psychological tendencies)
412 may be described and further distinguished primarily into either (a) YG with performance
413 anxiety / choking (unrelated to dystonia), or to a lesser degree (b) YG with Dynamic
414 Stereotype (especially in cases where motor deterioration seems to also be present in non
415 stressful conditions), or to an even lesser degree (c) YG with focal dystonia accompanied by
416 psychological comorbidity.

417

418 The current study also detected a proportion of musicians and golfers who seem to have
419 developed their motor deficits in the absence of any stress, anxiety and perfectionism (i.e.
420 NPAS profile). Studies have already indicated that the deterioration of the fine motor control
421 of DM and YG, either with or without any psychological comorbidity, is mainly generated by
422 various common sensorimotor triggering factors. For instance, overuse (muscular fatigue),
423 demanding and intensive motor coordination, intensive repetitive patterns, gender (more
424 males are affected), handedness (right-handed players are mostly affected on the right hand

425 and left-handed players on the left), and specific biomechanics are among the most common
426 triggering factors (3,6,9,10,13,16,21). Finally at least in musician's dystonia a genetic
427 predisposition has also been reported. About 35% of DM have family members affected by
428 other forms of dystonia (38). Therefore, NPAS-YG (yips-affected golfers with no
429 psychological tendencies), or those classified as Type I (dystonia symptoms) according to
430 Stinear et al. (16), could form another subtype of yips. However the prevalence of this
431 subtype (17-18%) remains highly at odds with the prevalence of those DM with no additional
432 psychological comorbidities (0.5%) (17).

433

434 The prevalence inconsistency between the two movement disorders may be further explained
435 by a few recent studies which identified yips symptoms in novices, especially during putting
436 with one hand (8,10-12). These findings emphasize the postulation that not all subtypes of the
437 yips should be linked either to task-specific focal dystonia or to psychological comorbidities
438 (e.g. choking) or to a combination of both. Marquardt (10) suggested that yips in novices
439 derives not from a general movement disturbance, but instead from disruption to the
440 executive movement mechanism in a specific context. Finally, more recently Marquardt et al.
441 (11), also studying yips symptoms in novices, suggested that the only motor abnormal
442 behavior was jerking while putting. The authors therefore classified yips-affected athletes as
443 falling under either "yips in golfers" or "jerking in novices". Further studies are of course
444 needed to clarify this classification but yips symptoms in amateurs highlight that further
445 factors such as the level of expertise (e.g. handicap) and years of experience could also form
446 crucial criteria for classifying yips-affected athletes (4,6). For instance, the high level of
447 expertise (professional musicians) and the number of years of experience before onset (20-25
448 years) has been found to be associated with the manifestation of focal dystonia in musicians.
449 Likewise, several studies drawing parallels between a subtype of YG and focal dystonia

450 included YG with a mean handicap below 7 and a mean of more than 25 years of experience
451 (6,13).

452

453 Summarizing the above discussion we suggest that golfers with movement disturbances can
454 be sub-classified to the following subgroups: a) to those with only “jerking symptoms in
455 novices”, b) to those YG with “performance anxiety” (with psychological comorbidity mostly
456 related to “choking under pressure”), c) to those YG with “dynamic stereotype” (with
457 psychological comorbidity and more persistent motor disturbances), d) to those YG with
458 “focal dystonia accompanied by psychological comorbidity”, and e) to those YG with “focal
459 dystonia in the absence of any psychological comorbidity”. Although the suggested subtypes,
460 and the extent to which they overlap or lie on a continuum, remain to be further investigated
461 we suggest a schematic representation whereby the different subtypes can be diagnosed (or
462 further explored) based on the different triggering factors (psychological and sensorimotor)
463 which could initiate symptoms (Figure 2). The suggested subgroups, which aim to
464 complement the initial classification suggested by Smith et al. (6), could be used for further
465 exploration and explanation of the yips phenomenon in affected athletes.

466

467 The diagnostic parameters which could contribute significantly to a better distinction between
468 the above suggested subtypes of yips are: i) psychological comorbidity, ii) level of expertise,
469 dividing golfers into those with high (handicap < 5) and low (handicap > 20; (6), iii) years of
470 experience before onset (<1 vs. 20-30), iv) family-related history, v) exploration of the sports
471 biography / motor failure (e.g. whether motor symptoms occur under stressful, non-stressful,
472 or both conditions (10)), and vi) evaluation based not only on subjective but also on objective
473 measurements (e.g. kinematic screening test (8), physical / neurological phenomenological
474 examination, test of sensory trick, muscular co-contractions etc.). The inclusion of all the

475 different subtypes under the label of yips could also explain the high yips-prevalence in
476 contrast to musician's dystonia (5,6,8). Our future plans focus on the evaluation and the (re)-
477 adjustment of the above-suggested subtypes of yips (and musician's dystonia), using
478 psychological, electrophysiological, and behavioral assessments. Investment in the
479 classification of yips could enhance the diagnostic repertoire and promote studies focusing on
480 more specific and tolerated treatments.

481

482 Finally we would like to underline a few limitations of the current investigation. First, the
483 psycho-diagnostic evaluation was based on self-reports. A more reliable analysis should be
484 preferably based on both subjective and objective measurements (9). Furthermore, musicians
485 of the current study were mainly professional players (about two thirds) whereas the
486 performance level of the recruited golfers was varied around the middle handicap range.
487 Therefore, musicians and athletes of more similar professional levels should be examined.
488 Additional characteristics such as cognitive patterns and the focus of attention, which have
489 previously been suggested to be partly responsible for generating choking in at least a portion
490 of yips-affected athletes, should also be examined (12,17,39). In addition, obsessive-
491 compulsive behaviors, which have been highly detected in various forms of focal dystonia
492 (18), remain to be comprehensively examined in both DM and YG. Finally, some
493 investigations have suggested that psychological traits related to obsessional thinking and
494 self-reported anxiety could be a psychoreactive phenomenon in YG (5,6,9). In contrast,
495 perfectionism and trait anxiety investigated in the current study did not support any strong
496 evidence of psycho-reaction, however more studies investigating a wider range of
497 psychological aspects are needed to clarify this (18,20). Besides the challenges that motor
498 and psychological behaviours may share common neurobiological networks (40), task-
499 specific movement disorders remain rather unknown. Comparisons between similar

500 movement disorders may provide further insights, advancing understanding of the
501 aetiological mechanisms behind them.

502

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510

511 **CONFLICT OF INTEREST**

512 The authors declare that they have no relationships with companies or manufactures who will
513 benefit from the results of the present study. The results of the present study do not constitute
514 endorsement by ACSM and are presented clearly, honestly and without fabrication,
515 falsification, or inappropriate data manipulation.

516

517 **REFERENCES**

- 518 1. Torres-Russotto D, Perlmutter JS. Task-specific dystonias. A review. *Ann N Y Acad*
519 *Sci* 2008;1142:179-199.
- 520 2. Rosenkranz K, Williamon A, Butler K, Cordivari C, Lees AJ, Rothwell JC.
521 Pathophysiological differences between musician's dystonia and writer's cramp. *Brain*
522 2005;128(Pt 4):918-31.
- 523 3. Altenmüller E, Jabusch H-C. Focal hand dystonia in musicians: Phenomenology,
524 aetiology, and psychological trigger factors. *J Hand Ther* 2009;22:144-155.

- 525 4. Clarke P, Sheffield D, Akehurst S. The yips in sport: A systematic review. *Int Rev*
526 *Sport Exerc Psychol* 2015;8(1):156-184.
- 527 5. McDaniel KD, Cummings JL, Shain S. The yips: A focal dystonia of golfers.
528 *Neurology* 1989;39:192-195.
- 529 6. Smith AM, Adler CH, Crews D, et al. The “yips” in golf: A continuum between a
530 focal dystonia and choking. *Sports Med* 2003;33(1):13-31.
- 531 7. Ericsson KA, Krampe RT, Tesch-Römer C, The role of deliberate practice in the
532 acquisition of expert performance. *Psychol Rev* 1993;100:363-406.
- 533 8. Klämpfl, MK, Philippen PB, Lobinger BH. Self-report vs. kinematic screening test:
534 Prevalence, demographics, and sports biography of yips-affected golfers. *J Sports Sci*
535 2015;33(7):655-664.
- 536 9. Adler CH, Crews D, Kahol K, et al. Are the yips a task-specific dystonia or “golfer’s
537 cramp”? *Mov Disord* 2011;26:1993-1996.
- 538 10. Marquardt C, Strauss M, Hermsdörfer J. Putting “yips” and Jerking in golf novices.
539 In: *International Journal of Golf Science*, 2016, 5(Suppl.), S1-S77. In: *Proceedings of*
540 *the World Scientific Congress of Golf VII*; 2016 Jul 18-22: (Scotland). 2016, p S50-
541 S51.
- 542 11. Marquardt C. The vicious circle involved in the development of the yips. *Int J Sports*
543 *Sci Coach* 2009;4:67-78.
- 544 12. Philippen PB, Lobinger BH. Understanding yips in golf: Thoughts, feelings, and
545 focus of attention in yips-affected golfers. *Sport Psychol* 2012;26:325-340.
- 546 13. Adler CH, Crews D, Hentz JG, Smith AM, Caviness JN. Abnormal co-contraction in
547 yips-affected but not unaffected golfers: Evidence for focal dystonia. *Neurology*
548 2005;64:1813-1814.
- 549 14. Lobinger BH, Klämpfl MK, Altenmüller E. We are able, we intend, we act - but we

- 550 do not succeed: A theoretical framework for a better understanding of paradoxical
551 performance in sports. *J Clin Sport Psychol* 2014;8(4):357-377.
- 552 15. Masters R, Maxwell J. The theory of reinvestment. *Int Rev Sport Exerc Psychol*
553 2008;1:160-183.
- 554 16. Stinear CM, Coxon JP, Fleming MK, Lim VK, Prapavessis H, Byblow WD. The yips
555 in golf: Multimodal evidence for two subtypes. *Med Sci Sports Exerc* 2006;38:1980-
556 1989.
- 557 17. Hill DM, Hanton S, Matthews N, Fleming S. Choking in sport: A review. *Int Rev*
558 *Sport Exerc Psychol* 2010;3:24-39.
- 559 18. Zurowski M, McDonald WM, Fox S, Marsh L. Psychiatric comorbidities in dystonia:
560 Emerging concepts. *Mov Disord* 2013;28(7):914-920.
- 561 19. Enders L, Spector JT, Altenmüller E, Schmidt A, Klein C, Jabusch H-C. Musician's
562 dystonia and comorbid anxiety: Two sides of one coin? *Mov Disord* 2011;26(3):539-
563 542.
- 564 20. Ioannou CI, Altenmüller E. Psychological characteristics in musician's
565 dystonia: a new diagnostic classification. *Neuropsychologia* 2014;61:80-88.
- 566 21. Altenmüller E, Ioannou CI, Raab M, Lobinger B. Apollo's curse: Causes and cures of
567 motor failures in musicians: A proposal for a new classification. *Adv Exp Med Biol*
568 2014;826:161-178.
- 569 22. Ioannou CI, Furuya S, Altenmüller E. The impact of stress on motor performance in
570 skilled musicians suffering from focal dystonia: physiological and psychological
571 characteristics. *Neuropsychologia* 2016;85:226-236.
- 572 23. Brugués AO. Music performance anxiety--part 1. A review of its epidemiology. *Med*
573 *Probl Perform Art* 2011;26(2):102-105.

- 574 24. Fishbein M, Middlestadt SE, Ottati V, Straus S, Ellis A. Medical problems among
575 ICSOM musicians: overview of a national survey. *Med Probl Perform Art* 1988;3:1-
576 8.
- 577 25. Wesner RB, Noyes R, Davis TL. The occurrence of performance anxiety among
578 musicians. *J Affect Disord* 1990;18:177-185.
- 579 26. Yoshie M, Kudo K, Murakoshi T, Ohtsuki T. Music performance anxiety in skilled
580 pianists: effects of social-evaluative performance situation on subjective, autonomic,
581 and electromyographic reactions. *Exp Brain Res* 2009;199(2):117-126.
- 582 27. Roberts R, Rotheram M, Maynard I, Thomas O, Woodman, T. Perfectionism and the
583 “Yips”: An initial investigation. *Sport Psychol* 2013;27:53-61.
- 584 28. Klämpfl MK, Lobinger BH, Raab M. How to detect the yips in golf. *Hum Mov Sci*
585 2013a;32(6):1270-1287.
- 586 29. Klämpfl MK, Lobinger BH, Raab M. Reinvestment - The Cause of the Yips? *PLoS*
587 *One* [Internet]. 2013b;8(12):e82470. doi:10.1371/journal.pone.0082470
- 588 30. Brand R, Ehrlenspiel F, Graf K. *Das Wettkampfangst-Inventar (WAI). Manual zur*
589 *komprehensiven Eingangsdagnostik von Wettkampfangst, Wettkampfangstlichkeit*
590 *und Angstbewältigungsmodus im Sport. [The Competitive Anxiety Inventory (CAI).*
591 *Manual for comprehensive diagnostics of competition anxiety and anxiety*
592 *management in sports]*. Bonn (Germany): Bundesinstitut für Sportwissenschaft; 2009.
- 593 31. Altstötter-Gleich C, Bergemann N. Testgüte einer deutschsprachigen Version der
594 Mehrdimensionalen Perfektionismus-Skala von Frost, Marten, Lahart und Rosenblate
595 (MPS-F). [Test score of a German-language version of the multidimensional
596 perfectionism scale by Frost, Marten, Lahart and Rosenblate (FMPS)]. *Diagnostica*
597 2006;52:105-118.
- 598 32. Erdmann G, Janke W. *Stressverarbeitungsfragebogen (SVF). Stress, Stress-*

- 599 *verarbeitung und ihre Erfassung durch ein mehrdimensionales Testsystem [Stress*
600 *coping questionnaire (SCQ). Stress, stress processing and their detection by means of*
601 *a multi-dimensional test system]*. Göttingen: Hogrefe; 2008.
- 602 33. Punji G, Stewart DM. Cluster analysis in marketing research: review and suggestions
603 for applications. *J Mark Res* 1983;20(2):134-148.
- 604 34. Hubert L, Arabie P. Comparing partitions. *J classification* 1985;2:193-218.
- 605 35. Cox RH, Martens MP, Russell WD. Measuring anxiety in athletics: The revised
606 competitive state anxiety inventory-2. *J Sport Exerc Psychol* 2003;25:519-533.
- 607 36. Steeves TD, Day L, Dykeman J, Jette N, Pringsheim T. The prevalence of primary
608 dystonia: a systematic review and meta-analysis. *Mov Disord* 2012;27(14):1789-1796.
- 609 37. Fehm L, Schmidt K. Performance anxiety in gifted adolescent musicians. *J Anxiety*
610 *Disord* 2006;20(1):98-109.
- 611 38. Schmidt A, Jabusch HC, Altenmüller E, et al. Etiology of musician's dystonia:
612 Familial or environmental? *Neurology* 2009;72(14):1248-1254.
- 613 39. Land WM, Franka C, Schacka T. The influence of attentional focus on the
614 development of skill representation in a complex action. *Psychol Sport Exerc*
615 2014;15(1):30-38.
- 616 40. Ron MA. Primary focal dystonia--a disease of brain and mind: motor and psychiatric
617 manifestations have a common neurobiological basis. *J Neurol Neurosurg Psychiatry*
618 2009;80(10):1059-1059.

619

620 **Supplemental digital content 1:** Dendrogram revised.tiff

621

622 **Captions:**

623 **Figure 1.** Final cluster centers of the principal (left to right) subscales which contributed to the classification of participants
624 into HPAS (n = 46) and NPAS (n = 34) profiles (clusters). Abbreviations: HPAS = *High tendency to Perfectionism, Anxiety*

625 *and - inability to cope with - Stress profile; NPAS = No tendency to Perfectionism, Anxiety and - inability to cope with -*
626 *Stress profile. Error bars: $\pm 1SE$.*

627

628 **Figure 2.** The above schematic representation suggests the classification of the yips phenomenon inspired by the comparison
629 between dystonic musicians and yips-affected golfers. The different boxes (subtypes) are located according to severity (y-
630 axis) and experience (x-axis). Finally, the contribution of the psychological and/or sensorimotor triggering factors to the
631 different subtypes is also indicated. Subtype (A) indicates mainly jerking symptoms in novice golf players. Subtype (B)
632 indicates motor disturbances due to stressful and demanding conditions. Subtype (C) indicates subjects with subtle but more
633 persistent motor disturbances. Those subjects are also characterized by more persistent psychological traits (e.g. elevated
634 stress, anxiety, perfectionism etc.). Subtype (D) indicates an accelerated (earlier in years) manifestation of dystonic cramps.
635 Usually these patients come from the Dynamic Stereotype phase. Finally, subtype (E) indicates those individuals with an
636 already manifested focal dystonia. This subtype represents subjects who develop dystonia either exclusively due to
637 sensorimotor triggering factors, or due to psychological and sensorimotor triggering factors (i.e. Dynamic Stereotype).
638 Subtypes (A) and (B) have so far been seen to be unrelated to focal dystonia. However, it remains unknown whether there is
639 a continuum between these two subtypes and the absolute manifestation of dystonia.

640

Table 1. Participant characteristics

Parameter	HM	DM	HG	YG
Age: years (<i>M</i> ± <i>SD</i>)	39.7 ± 8.5	41.3 ± 8.5	51.3 ± 14.1	53.9 ± 13.9
Gender: (female / male) (<i>n</i>)	3 / 17	3 / 17	2 / 18	2 / 18
Handicap: (<i>M</i> ± <i>SD</i>)	-	-	33.5 ± 18.7	27.4 ± 17.5
Occupation: Professional / semi-professional or music student / amateur: (<i>n</i>)	20 / 0 / 0	10 / 8 / 2	-	-
Handedness: (right / left / both) (<i>n</i>)	19 / 1 / 0	15 / 2 / 3	18 / 0 / 2	19 / 0 / 1
Affected hand: (right / left / both) (<i>n</i>)	-	14 / 4 / 2	-	16 / 2 / 2
Started playing at the age of: (<i>M</i> ± <i>SD</i>) ^a	8.6 ± 3.4	8.7 ± 3.1	39.2 ± 16.6	46.3 ± 11.7
Years of experience: (<i>M</i> ± <i>SD</i>)	31.2 ± 8.0	32.6 ± 8.6	12.0 ± 13.0	7.6 ± 5.2
Cumulative hs of experience: (<i>M</i> ± <i>SD</i>)	42095 ± 19294	29032 ± 16598	4036 ± 9114	2494 ± 2613
Onset age of symptoms: (<i>M</i> ± <i>SD</i>)	-	33.7 ± 8.2	-	50.3 ± 12.7
Years after onset: (<i>M</i> ± <i>SD</i>)	-	7.7 ± 6.2	-	3.6 ± 4.1
Years of experience until the onset (<i>M</i> ± <i>SD</i>) ^b	-	24.9 ± 7.6	-	4.3 ± 4.2

Abbreviations: *M* ± *SD* = mean ± standard deviation; HM = healthy musicians; DM = dystonic musicians; HG = healthy golfers; YG = yips-affected golfers. Instrument distribution for HM: piano 50%, violin 15%, violoncello 15%, flute 10%, clarinet 5% and horn 5%, (100% classical musicians) and for DM: piano 65%, guitar 20%, violin 5%, e-bass 5% and percussions 5%, (75% classical musicians, 20% jazz / rock / pop and 5% other). DM vs. YG: ^a*W* = 210, *z* = -5.415, *p* < .001, ^b*W* = 190, *z* = -5.346, *p* < .001.

641

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Occupation: Professional / semi-professional or music student / amateur: (<i>n</i>)	20 / 0 / 0	10 / 8 / 2	-	-
Handedness: (right / left / both) (<i>n</i>)	19 / 1 / 0	15 / 2 / 3	18 / 0 / 2	19 / 0 / 1
Affected hand: (right / left / both) (<i>n</i>)	-	14 / 4 / 2	-	16 / 2 / 2
Started playing at the age of: (<i>M</i> ± <i>SD</i>) ^a	8.6 ± 3.4	8.7 ± 3.1	39.2 ± 16.6	46.3 ± 11.7
Years of experience: (<i>M</i> ± <i>SD</i>)	31.2 ± 8.0	32.6 ± 8.6	12.0 ± 13.0	7.6 ± 5.2
Cumulative hs of experience: (<i>M</i> ± <i>SD</i>)	42095 ± 19294	29032 ± 16598	4036 ± 9114	2494 ± 2613
Onset age of symptoms: (<i>M</i> ± <i>SD</i>)	-	33.7 ± 8.2	-	50.3 ± 12.7
Years after onset: (<i>M</i> ± <i>SD</i>)	-	7.7 ± 6.2	-	3.6 ± 4.1
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Abbreviations: *M* ± *SD* = mean ± standard deviation; HM = healthy musicians; DM = dystonic musicians; HG = healthy golfers; YG = yips-affected golfers. Instrument distribution for HM: piano 50%, violin 15%, violoncello 15%, flute 10%, clarinet 5% and horn 5%, (100% classical musicians) and for DM: piano 65%, guitar 20%, violin 5%, e-bass 5% and percussions 5%, (75% classical musicians, 20% jazz / rock / pop and 5% other). DM vs. YG: ^a*W* = 210, *z* = -5.415, *p* < .001, ^b*W* = 190, *z* = -5.346, *p* < .001.

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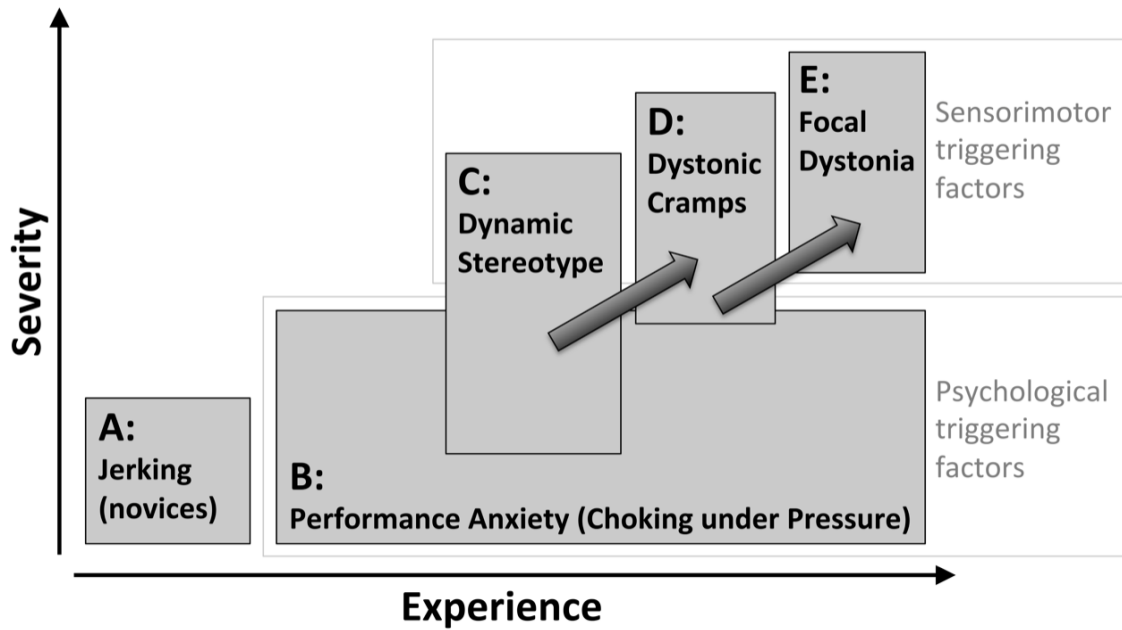
Table 3. Clusters (HPAS vs. NPAS) * Groups (Musicians vs. Golfers or HM vs. DM vs. HG vs. YG). Crosstabulations: 2x2 and 2x4

Clusters	Cluster 1 (HPAS) (<i>n</i> = 46) 57.5%				Cluster 2 (NPAS) (<i>n</i> = 34) 42.5%			
	Musicians (29)		Golfers (17)		Musicians (11)		Golfers (23)	
Occupations within clusters (%)	63.04	36.95	32.35	67.64	32.35	67.64	32.35	67.64
Clusters within occupations (%)	72.50	42.50	27.50	57.50	27.50	57.50	57.50	57.50
Groups (<i>n</i>)	HM (15)	DM (14)	HG (8)	YG (9)	HM (5)	DM (6)	HG (12)	YG (11)
Groups within clusters (%)	32.60	30.43	17.39	19.56	14.70	17.64	35.29	32.35
Clusters within groups (%)	75.00	70.00	40.00	45.00	25.00	30.00	60.00	55.00

Abbreviations: HM = healthy musicians; DM = dystonic musicians; HG = healthy golfers; YG = yips-affected golfers; HPAS = *High tendency to Perfectionism, Anxiety and -inability to cope with - Stress* profile; NPAS = *No tendency to Perfectionism, Anxiety and -inability to cope with Stress* profile; (*) = significant; *ns* = non-significant.

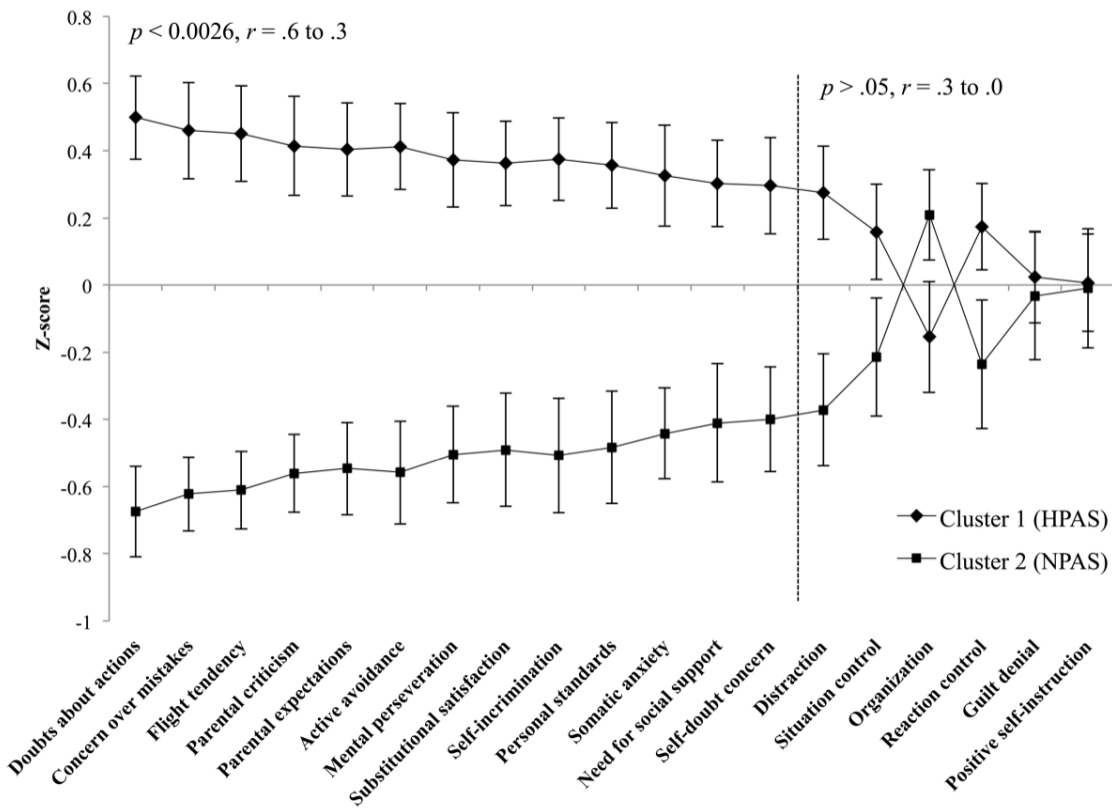
643

Classification of yips-affected golfers



644

Final Cluster Centers



645