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ORIGINAL ARTICLE

The role of positive and negative reinforcement by coaches in the acquisition of new motor skills depending on the present sport motive

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ABSTRACT

The results of this pilot study should allow conclusions to be drawn about the influence of the trainer's approach and the motor learning behaviour depending on the existing motive structure. To this end, two groups were randomly formed, each of which watched a learning video in which six steps for learning to juggle were shown. The two groups were randomly given either a positively or negatively reinforced speech in sound and text. The 27 participants (8 girls, 19 boys, mean age: 17.74, SD = 0.86) are sports students supported by the Olympic training centre. The results showed a dependence of motor learning performance on trainer response ($mean_{pos}$ = 4.93, $mean_{neg}$ = 4.27, *p* = .030 (one-sided), d = -0.74). In the present study, the mean differences between the hope- and fear-motivated groups show large differences in this respect, but these are not significant, certainly due to the small sample size ($mean_{fear}$ = 4.2, $mean_{hope}$ = 5.0, *p* = .103). It was interesting to note that the fear-motivated athletes in particular benefited from receiving positive coaching instructions. The calculation of the effect size confirms this assumption (d = .366). The covariance analysis also indicate that the motor learning performance depends on the positive or negative trainer instruction when these are adjusted for the respective co-variables skin conductivity, blood volume pulse and present motive structure (partial η^2 = 0.128-0.139). The results show that the positive influence of the coach's approach in the context of motor learning is of great importance.

Keywords: Physical activity psychology, Coaching applications, Achievement motivation, Elite athletes, Sports career.

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INTRODUCTION

The influence of the coach-athlete relationship and thus also the coach's approach on the athletic performance of athletes is a decisive factor in the management of training processes (Rottensteiner, Laakso, & Konttinen, 2015; Gearity, 2012; Schmid et al., 2023). To achieve this, existing motivational structures in the athletes must be taken into account so that the coach's approach can be applied as precisely as possible in order to guarantee sporting success (Thompson et al., 2022).

In the present study, the three need for achievement, power and affiliation are taken into account, as it is assumed that learning performance is influenced by the different characteristics of the motives. The study was designed to capture the influence of a negative coach's approach and anticipates that this will have different effects on athletes motivated by hope or fear. The results of the motive classes were therefore summarised and the items assigned to the motive characteristics (hope and fear) (Table 2).

Based on the self-determination theory, Wekesser et al. (2021) point out that social environmental factors, such as the coach-athlete relationship, play a key role in the context of intrinsic motivation processes. The authors refer to the three major psychological need categories of experiencing competence, autonomy support and relatedness. In a study with 53 coaches and 250 female athletes, Rocchi and Pelletier (2018) were able to record the extent to which the coaches' behaviour was perceived as positive or negative (self-perception and perception by others), with 30% of the coaches seeing their own behaviour as more positive than the athletes perceived it. It was shown that a match between the two perceptions positively influences six dimensions of the athletes' basic psychological needs (BPN). In line with the present study, it is interesting to note that a large deviation between the two perceptions has a competence-thwarting effect. In a study of 42 student team athletes (football, basketball, volleyball, handball, mean age: 25.1), Wegner and Teubel (2014) found that the assessment of implicit motives with the OMG has a good predictive probability for subsequent sporting performance (ß = .30, b = .23, $t(41) = 2.03$, $p = .05$), whereas the assessment of explicit motives showed no correlation (ß = .23, b = .02, $t(41) = 1.55$, $p = .13$). For this study, the participants had to fulfil a motor task in which they had to hit shots at a defined distance. After each attempt (success, failure), the participants were allowed to decide anew which distance they wanted to choose in order to score as many points as possible. Each athlete was allowed to compete in their own sport.

Visek et al. (2015) found that positive coaching was very important for young athletes' sense of fun. Wekesser et al. (2021) were able to prove that the interpersonal behaviours of coaches correlate significantly with the extent of the coach-athlete relationship (positive or negative).

Jowett, Yang and Lorimer (2012) investigated relationships between empathy and satisfaction with coaches' instructions in the context of the coach-athlete relationship. Empathy was found to be a significant dimension of communication (β = .84), resulting in a correlation with positive and negative reinforcement of the coach-athlete relationship. The results show that satisfaction with the coach-athlete relationship has a positive influence on the athletes because they feel that their coaches are attuned to their needs, are empathetic and therefore know them better. The athletes presumably derive increased confidence for individual training planning from this.

These results, along with other findings related to coach-athlete relationships, have been corroborated by other researchers in the field (e.g. Lorimer & Jowett, 2009; Correia & Rosado, 2019; Jowett, Yang, & Lorimer, 2012; van Aart et al., 2017). Davis et al. (2018) showed that a good coach-athlete relationship is associated with good cognitive performance (β = -.228, p = .033), although this could not be shown for motor tasks (β = .019, p = .861).

In their study design, 82 athletes were examined who completed a multiple 5m shuttle test and were then tested cognitively using a Stroop test. Cortisol levels were measured as a biomarker for the acute stress response. Similar to the measurement of skin impedance in the present study, the measurement of the cortisol level shows a strong correlation with the physiological stress response. The cortisol response (baseline cortisol concentration) showed increased values compared to the initial value measured just 20 minutes after the exercise (p = .029, $mean_{Pretest}$ = 7.93, $mean_{Posttest}$ = 10.32).

In addition, physiological and psychological developments in young competitive athletes influence learning performance, so that it can be assumed that the developmentally differentiated approach of the trainer is of great importance in this context. The aim of the present study was therefore to identify relationships between existing performance motive structures and motor learning performance as a function of positive or negative reinforcement of the coach's instructions. Pfeffer, Würth and Alfermann (2015) point out that there are correlations between the coach's instructions and the sports performance of the athletes, whereby differences between the sports must be taken into account.

Smith et al. (2018) showed that in a study of 20 rugby players, the coach's language had a positive influence on performance, with 6 dimensions of the coach's approach being identified following an interview evaluation procedure. The dimensions 'expressing the challenge' and 'rewards of success; (...) creating and enhancing belief and empowering the athlete to take personal responsibility' are of particular interest for the present study. (Smith et al., 2018; p. 216 & 217) The dimensions mentioned indicate that a positive coach approach can increase athletic performance, which also corresponds to the hypotheses of the current study.

The biofeedback method employed in the present study enables the athletes' physical reactions to be monitored and the impact of coach instructions to be evaluated (Moon, 2022). Specifically, this means that skin conductance (SC), for example, is closely related to the athletic performance of the respective athlete, as it can be assumed that arousal of the body increases skin conductance (Güllich, 2013).

Electrodermal activity indicates an emotional-affective response through a short-term reduction in electrical skin resistance due to increased sweat production (Winters, 2012, Haus et al., 2020; Beckmann & Ehrlenspiel, 2017).

From the problems and correlations presented, questions can be derived that relate to the significance of a positive or negative trainer response for motor learning performance using juggling as an example, taking into account co-factors such as the existing motive structure, skin conductivity and blood volume pulse.

MATERIALS AND METHODS

Study design and participants

The study included 27 participants aged between 16 and 19 who were involved in competitive sport (girls = 8, mean age: 17.5, SD = 0.93; boys = 19, mean age: 17.84, SD = 0.83). It was assumed that no one had any experience in juggling, so there was no specific entry level. In addition, it was checked whether the random assignment of the two groups (positive and negative trainer instructions) were comparable due to the initial motivational situation (Table 1). A boxplot of this distribution visualises the results of the Mann-Whitney U-test (Figure 1).

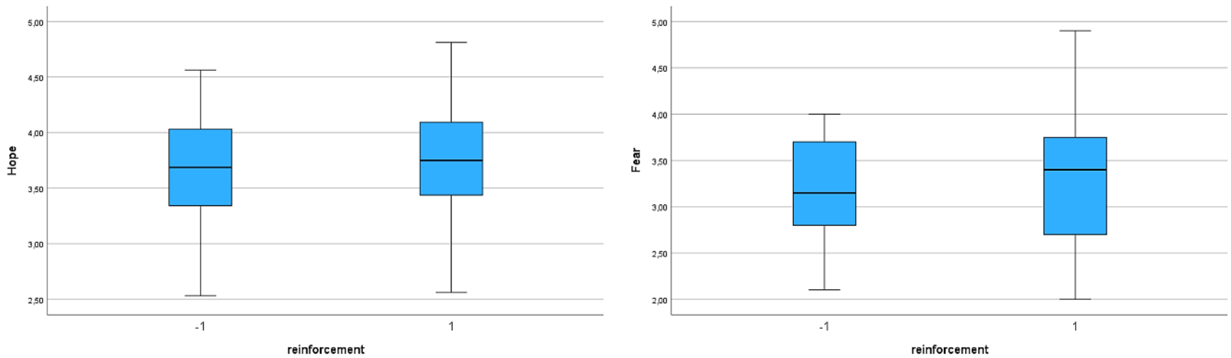

Figure 1. Box plot for the fear and hope associated motive structure of the two groups, which were negative (-1) or positive (+1) reinforced by the coaches.

Table 1. Comparison of the groups with regard to their fear and hope motive expression, which were randomly given positive or negative reinforcement by the trainer (Mann-Whitney U-test).

Motive	Group	N	Mean	SD	Mean rank	Exact Sig. (two-sided test)	Asymp. Sig. (two-sided test)
Hope	Neg. reinforced	12	3.68	.56	13.46	.755	.751
	Pos. reinforced	15	3.72	.598	14.43		
Fear	Neg. reinforced	12	3.17	.61	12.83	.516	.494
	Pos. reinforced	15	3.35	.77	14.93		

Measures

The groups were surveyed using the UMS-10 (German, Schönbrodt & Gerstenberg, 2012) with regard to their level of achievement motivation (Cronbach's α, mostly .87, Table 3). This questionnaire comprises 36 items, which were taken from the PRF, AMS, MAFF, PVQ and GOALS and can be analysed using a six-point Likert scale. (rated on a 6-point Likert scale ranging from 5 = strongly agree to 0 = strongly disagree).

The items were categorised according to the three motive classes so that they could be assigned to the two categories 'Hope' and 'Fear' (Table 2). In addition, skin conductance and blood volume pulse were measured using biofeedback to determine dependencies on possible physical reactions that could have an influence on motor learning performance (Biograph InfinitiTM software, ProComp Infiniti system). Motor performance was assessed using the 6 learning steps, which were categorised into learning performance levels 1-6 (Figure 2).

Table 2. Items and Variables of the UMS-10.

Items		Positive	Negative
Fear		9;11;13;16;18;23;26;28;33;35	
Hope		7;12;15;17;20;22;25;27;29;30;34;36; 8;3;14;32	
	Power	3;14;19;32	1;4;11;21;23
Need for…	Affiliation	2;7;10;12;15;17;20;22;24;25;27;30;34;36	5;6;9;13;16;18;28;31
	Achievement	8;29	26;33;35

The descriptive results of the scales are shown in Table 3. The correlations were calculated for all variables, although it should be noted that the variables of the need for Affiliation, Achievement and Power scales are subcategories of the variables of the Hope and Fear scales. This is of course taken into account in the analysis and in this case only serves the purpose of completeness.

Table 3. Descriptive statistics, standard deviations, alpha reliability and correlations for main variables in the study.

Variable	M	SD	∝	1	2	3	4	5	6
Motor learning	4.65	.89	-	1					
Achievement	3.63	.47		-.14	1				
Power	3.64	.6	.805	-.22	.10	1			
Affiliation	3.63	.45	.722	.28	-.123	-.218	1		
Fear	3.39	.39	.75[1]	.124	.488** (p = .01)	.049	.38 (p = .05)	1	
Hope	3.82	.44	.74[1]	.07	-.16	.228	.685** (p = <.001)	-.181	1

*Note. **. Correlation is significant at the .01 level (2-tailed), *. Correlation is significant at the .05 level (2-tailed), [1]cf. Table 2: Items and factors.*

Procedures

The participants were randomly divided into two groups who watched a 6-step juggling instruction video while actively following the methodical steps with standardised balls (ball = 100 g) (Figure 3). Both videos were visualised identically and lasted 3 minutes, with one video containing six positively reinforced instructions and the other negatively reinforced by six trainer instructions. The respective learning step was presented for 30 seconds and simultaneously imitated by the participant. The successfully completed learning step resulted in the performance score (1-6). A cancellation of the motor learning process within a learning step was scored as 0.5 if necessary, so that performance was recorded in a very differentiated manner.

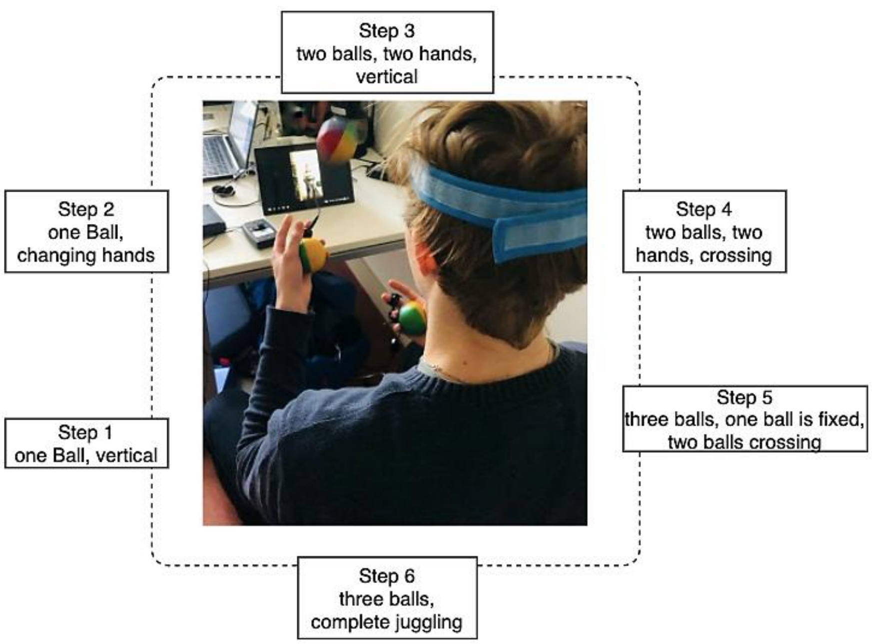

Figure 2. Standardised sequence of the 6-step video instruction for learning to juggle with three balls.

Ethics

This study was preceded by an authorisation procedure by the local administrative authority (Berlin Senate Administration). Each participant signed a document outlining all data protection issues as well as the procedure for conducting the study. All instruments that had to be completed by the participants were numbered using a code and will be destroyed within two years. The coding was based on the initials of the mother and her date of birth generating a ten-digit code.

The data collection of the individual practice performance (juggling) was also coded and followed the same pattern so that the values could be assigned later.

Analysis

The factors of the German UMS-Sport show good internal consistency in general which are proofed by other authors as well (Schönbrodt & Gerstenberg, 2012, Table 3). A small number of items did not fit to the demand of the study why these items were deleted (Table 2).

Descriptive statistics of the variables were calculated, Kolmogorov-Smirnov test was used to assess the normality of the data. As the data was normally distributed, the t-test was used to find significances between the groups, if the data was not normally distributed the non-parametric Mann-Whitney U-Test was applied to determine the differences between the groups. The effect size was calculated with Cohen's d and interpreted as d = .20 small effect; d = .50 medium effect; d = .80 strong effect (Cohen, 1988). The significance level was set up at p <. 05. The statistical data treatment was carried out with SPSS 29.0. The Pearson-correlation was used for the main variables of the study to finally analyse the relationship between all the variables. The results show the effect-size (Cohens`d), which was proofed by the hedges correction because of the small sample size (Table 4 and 5). The ANCOVA shows that there might be a difference in the motor learning-process comparing the two groups which were positive or negative reinforced by the coach`s instruction depending on the impact of any variable (Table 7).

RESULTS

The diagrams in Figure 3 illustrate that an increased hope motive 'defies' negative coaching instructions and can still achieve good results, whereas a weaker hope motive leads to poorer results with negative coaching instructions. Both presentations confirm that positive coach instructions can lead to better learning outcomes, especially for athletes with a higher fear motive and a lower hope motive. These hypotheses will be analysed in the course of the presentation of results.

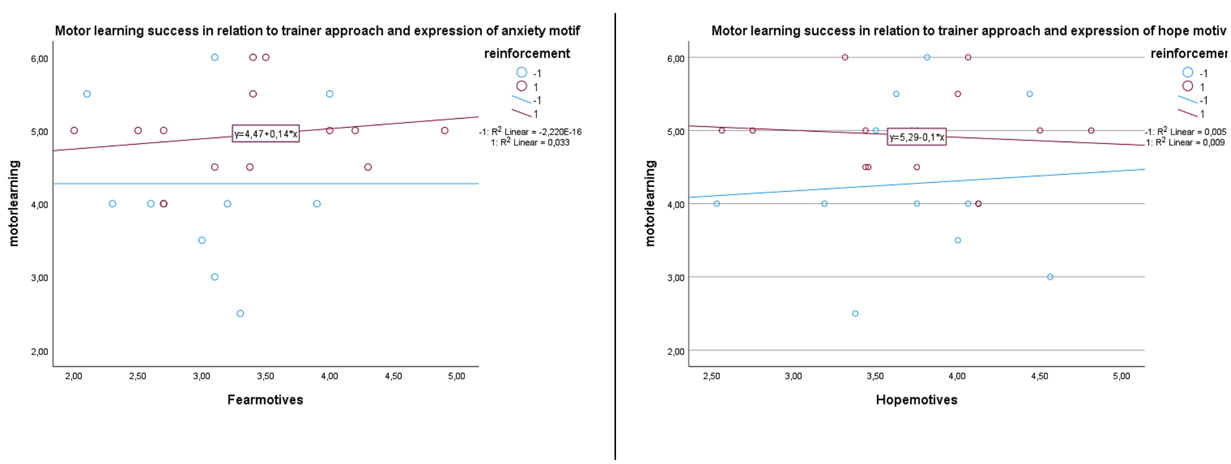

Figure 3. Motor learning success depending on the trainer's approach and the existing fear and hope motive expression.

In order to analyse the presumed correlations shown in Figure 3 in detail, the extent to which the trainer's instructions influence the motor learning process will be shown below. Table 4 shows that there are differences between the two groups in a one-sided significance test.

Table 4. Differences of the two groups which were positively or negatively instructed by the coach (Kolmogorov-Smirnov-*p*-value > .5).

Variable	Group	n	Mean	SD	df	T	*p*	d	Hedges Corr.
Motor learning	Negative	11	4.27	1.1	24	1.971	.060	-.74	.758
	Positive	15	4.93	0.59					
SC	Negative	11	5.22	4.47	24	0.966	.344	-.384	.371
	Positive	15	6.93	4.45					
BVP	Negative	11	46.29	16.14	24	1.955	.062	-.736	.751
	Positive	15	58.63	15.72					

*Note. * p = < .05 two-tailed, d = Cohen`s d.*

The hypothesis that the pre-motive-structure of hope for success and the fear of failure in the three main Sport specific Motives (Achievement, Power, Affiliation) are related to learning performance was checked and the results are presented in Table 5.

Table 5. Differences of the two groups which were organized by the pre-motive-structure positively or negatively instructed by the coach (Kolmogorov-Smirnov-*p*-value > .5).

Variable	Group	n	Mean	SD	df	T	*p*	d	Hedges Corr.
Motor learning	Negative	12	4.67	0.89	24	-0.66	.948	-.025	-.026
	Positive	14	4.64	0.93					
SC	Negative	12	7.32	4.87	24	-1.19	.245	-.469	-.454
	Positive	14	5.25	3.99					
BVP	Negative	12	51.7	16.63	24	0.473	.640	.186	.180
	Positive	14	54.9	17.37					

*Note. * p = < .05 two-tailed, d = Cohen`s d.*

An analysis of the different motor learning abilities based on the existing motive structure showed that, regardless of the coach's approach, the fear-motivated athletes achieved the same results as the hope-motivated athletes. The groups are categorised according to whether they are above or below the overall mean value ($Mean_{Fear}$: 3.38, $Mean_{Hope}$: 3.82).

A closer look at the group results shows that the coach's instruction has an impact on learning performance, especially for fear-motivated athletes (Table 6). For a closer look, four groups were categorised: 1: Hope-motivated with negative coaching instruction, 2: Hope-motivated with positive coaching instruction, 3: Fear-motivated with negative coaching instruction, 4: Fear-motivated with positive coaching instruction.

A boxplot (median test) is created to visualise the results (Figure 4). The median comparisons indicate differences without any evidence of significance (Table 6).

The boxplot illustrates the motor learning process of the four groups in relation to the coaches' instructions.

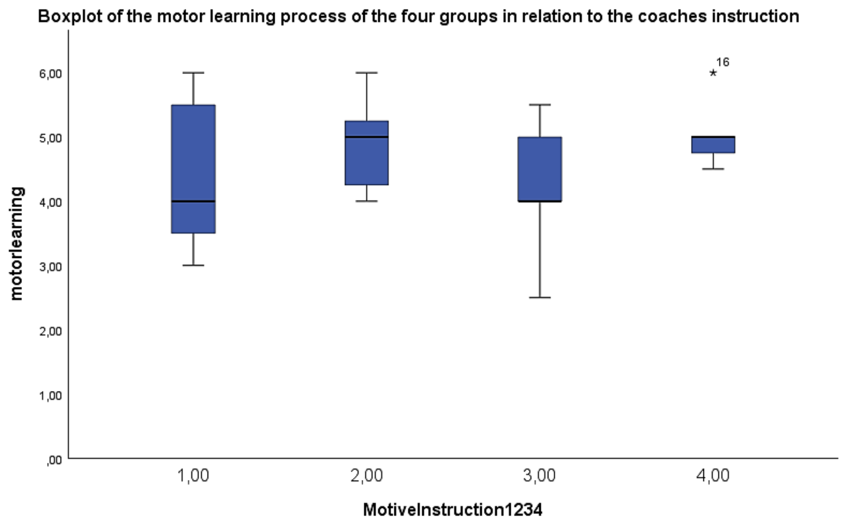

Figure 4. Presentation of the learning success of four groups: 1: Hope-motivated with negative trainer instructions, 2: Hope-motivated with positive trainer instructions, 3: Fear-motivated with negative trainer instructions, 4: Fear-motivated with positive trainer instructions.

Table 6. Differences in motor learning of the four groups: 1: Hope-motivated with negative trainer instruction, 2: Hope-motivated with positive trainer instruction, 3: Fear-motivated with negative trainer instruction, 4: Fear-motivated with positive trainer instruction.

Group	N	Mean	SD	Mean rank	Z	*p*	d	Kolmogorov- Smirnov *p*-value
1	6	4.33	1.17	6.17	-1,051	.293	0.28	.42
2	8	4.88	0.69	8.50				.52
1	6	4.33	1.17	6,08	-0.094	.925	0.028	.69
3	5	4.20	1.15	5,90				**.03**
2	8	4.88	0.69	7,69	-.307	.759	0.079	.42
4	7	5.0	0.50	8,36				.69
3	5	4.2	1.15	5,00	-1.268	.205	0.366	.52
4	7	5.0	0.5	7,57				**.03**

*Note. * p = < .05 two-tailed, d = Cohen`s d.*

The results must be recorded differently due to the small samples, so that in this case the effect size is also indicated at low significance and later compared with a co-analysis of variance (ANCOVA).

Interestingly, the results between the groups with positive trainer instruction do not differ significantly and without effect size (Table 6) and the comparable groups with negative reinforcement show a fairly large effect, but without being significant.

We assume that the factors influencing learning performance are confounding variables and therefore calculate an ANCOVA for the variables Skin Conduction (SC), Hope, Fear, and the overall motive structure (Table 7).

It is assumed that the dependent variable motor learning can be predicted by the independent variables (covariates) SC, Hope, Fear and the present motive structure, taking reinforcement into account.

Alternatively: It is assumed that the learning outcomes in the motor learning process using the example of juggling differ significantly for the different trainer approaches (positive or negative) after adjusting for the covariates skin conduction (SC), hope, fear and present motive structure. The results in this regard are shown by the single-factor ANCOVA (Table 7).

Table 7. Test of between subject effects: ANCOVA, dependent variable: motor learning result.

Variable	Source	Sum Squares	df	Mean Square	F	Sig.	Partial η^2
SC	Reinforcement	2.606	1	2.605	3.503	.074	.132
	Error	17.106	23	.744			
Hope	Reinforcement	2.770	1	2.770	3.722	.066	.139
	Error	17.115	23	.744			
Fear	Reinforcement	2.494	1	2.494	3.373	.079	.128
	Error	17.003	23	.739			
Motive Structure	Reinforcement	2.485	1	2.485	3.216	.087	.128
	Error	17.00	22	.773			

After adjusting for motive structure, no statistically significant difference in motor learning results (juggling) was found for the different positive or negative reinforced groups, $F(1, 22) = 3.216$, $p = .087$, partial $\eta^2 = .128$. In detail similar results of no statistical differences were found for Fear: $F(1,23) = 3.373$, $p = .079$, partial $\eta^2 = .128$, Hope: $F(1,23) = 3.722$, $p = .066$, partial $\eta^2 = .139$ and SC: $F(1,23) = 3.503$, $p = .074$, partial $\eta^2 = .132$.

The results show that, despite the lack of significance, medium-size effects are detectable after adjustment for the influencing variables (Richardson, 1996).

DISCUSSION

The present study is to be understood as a pilot project that is to be followed by a significantly larger sample. This will ensure that generalised statements can be made about the dependencies of learning performance on the sports performance motive structure of the athletes and on the instructions of the coaches. Larger samples also allow subgroups to be analysed precisely so that, for example, the same number of genders can be compared with each other. A different consideration of the genders in particular provides information about an optimised coach approach, as there are differences here during development that primarily relate to the coach-athlete relationship (van Aart et al., 2017; Pullen et al., 2022; Correira & Rosado, 2019).

In addition, differentiated analyses would be possible that also take into account the different types of sport, so that, for example, a distinction could be made between individual and team sports in order to be able to meet the different demands in these two groups in order to improve athletic performance (Schröder, 2024; Correira & Rosado, 2019). Furthermore, it would be beneficial to examine physical reactions to coaching instructions in more detail in order to optimise learning processes. Unfortunately, it is difficult to measure physical parameters such as blood volume pulse and skin conductivity during simultaneous movement because the movements cause sensors to shift. This results in large measurement inaccuracies, which must be corrected on the one hand by a larger sample and on the other hand by optimised technology.

Nevertheless, Figure 5 illustrates the extent to which learning performance is dependent on skin conductance (SC) and the trainer's instructions. It can be seen here that an increased skin conductance could lead to a lower learning performance with negative trainer instructions. This can be explained by the fact that negative stress inhibits performance and thus increases the probability of errors. At this point, however, it must be pointed out that fluctuations or highs and lows in skin impedance are likely to produce meaningful results.

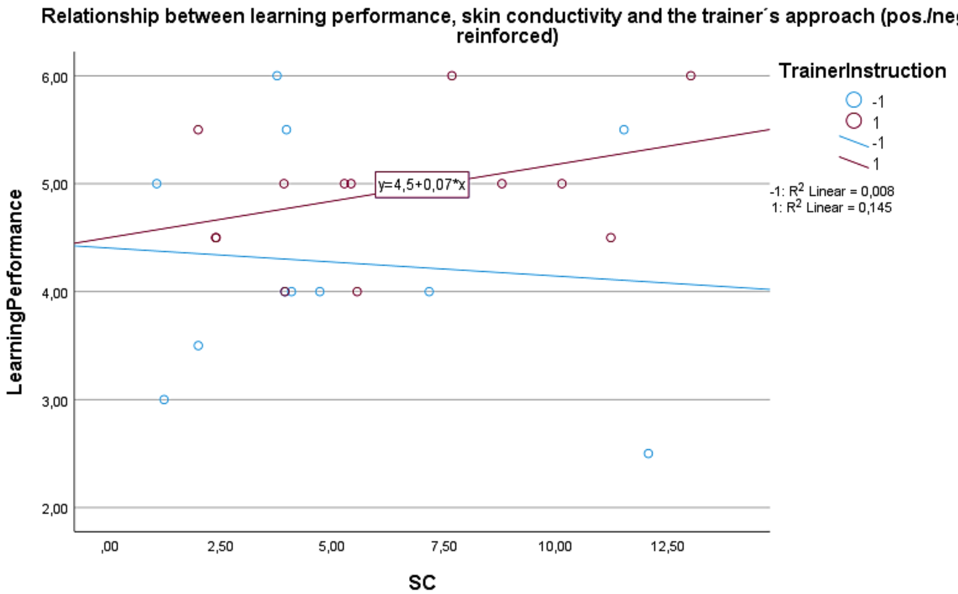

Figure 5: Motor learning success depending on the trainer's approach and skin conductivity.

After adjusting for SC, no statistically significant difference in motor learning results (juggling) was found for the different positive or negative reinforced groups ($F(1,23) = 3.503$, $p = .074$, partial $\eta^2 = .132$). However, the significance value of .074 is promising, which makes it desirable to continue the study with a larger sample.

The present study therefore shows that skin impedance could be suitable as biofeedback to show correlations between motor learning and trainer instructions.

CONCLUSIONS AND IMPLICATIONS

The high dropout rate in competitive sport must be addressed with targeted measures. As the reasons for premature career termination also lie in the coach-athlete relationship, this must be optimised and therefore individualised. It is therefore imperative to harmonise the coach's approach with the existing motivational structures of the athletes. Sagar & Jowett (2012) state in their study of 324 athletes (mean age: 20.11) that the majority perceive negative feedback from the coach as unmotivating and only a very small proportion (N = 3) stated that something could be learnt from this negative coach feedback. For communication after a mistake in training, the athletes in the study stated that verbal aggression leads to the athletes feeling demoralised and demotivated. Here too, only a fraction stated that this negative speech from coaches in the event of a mistake led to an improvement in learning (N = 2).

Viewing athletes as individualised promotes their confidence and therefore also reduces the risk of dropouts. Schmid et. Al (2023) state in their study of 257 cross-country skiers from Norwegian sports schools that 84% of athletes stopped competitive sport between 2015 and 2019. One of the aims of the study was to determine the factors influencing a possible dropout, whereby the ‘strong coach-athlete working alliance’ was identified as a predictor of long-term cooperation between athletes and coaches [$\chi^2 = 17.05$, df = 5 and $p = .004$ (<.05).

Although the present study could not show any significant results, the effects indicate that there are differences in learning performance between the groups due to the coach's approach.

Even if a high level of fear motives can represent a high drive for performance, as failures should be strategically avoided, it can be assumed that the increase in fear at developmental age leads to athletes ending their career prematurely. This can be explained by the fact that performance-anxious athletes try to avoid performance-related borderline situations, which becomes increasingly unlikely as their career progresses, resulting in emotional exhaustion, which has already been identified by numerous authors (González-Hernández et al., 2021; Gustafsson et al., 2017, Fischer & Brückner, 2023). It can also be assumed that dropout athletes distance themselves completely from sport due to their fear of failure and also no longer act as coaches, which has a negative impact on competitive sport in the long term, as their skills are no longer available as a resource. It is therefore very important that coaches take into account the individual needs of athletes and offer helpful support. Gearity (2012) was able to show that athletes perceive poor coaching as strongly negative because individualisation was not sufficiently taken into account.

Rottensteiner et al. (2015) show in their study with 2235 athletes (female: 756, boys: 1479) that a positive coach-athlete relationship with the involvement of athletes in movement tasks makes a positive contribution to the well-being of athletes. These results are also confirmed by other authors. Olympiou et al. (2008), for example, were able to prove from their study of 591 athletes that there is a strong correlation between the motivational climate and the coach-athlete relationship ($r = 0.5$). In a study of 391 soccer players, Alvarez et al. (2012) showed that there were positive correlations between perceptions of task climate and satisfaction of the needs for competence, autonomy, and relatedness.

Based on the findings of numerous authors and the results of the present study, consideration of the existing motivational structures in the context of the coach-athlete relationship and the resulting alignment with individual needs represents a decisive factor in performance optimisation, which can ultimately also prevent dropouts.

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No potential conflict of interest was reported by the author.

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