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PSYCHOLOGICAL PERFORMANCE DURING RUNNING EXERCISE: EFFECT OF OLFACTORY IMAGERY ON DISTANCE

PSIHOLOŠKA ZMOGLJIVOST MED TEKAŠKO VADBO: UČINEK VOHALNIH POSNETKOV NA RAZDALJO

ABSTRACT

Psychological factors play an important role when it comes to sports performance. Various coaching and mental training programmes are applied to athletes in different types of sports. It has to be researched what particular effect mental training can have on running performance during training. To this purpose, 19 students from a German university took part in a controlled study assessing running performance with and without mental training intervention for eight weeks. There was a difference between meters completed per training session in the female intervention and control group (5119.70 ± 272.72 m vs. 4858.80 ± 551.70 m, $p \leq 0.02$, $\eta 2 = 0.14$) and a by trend difference between meters completed per training session in the male intervention and control group (5781.20 ± 437.27 m vs. 5963.40 ± 709.09 m, $p \leq 0.09$, $\eta 2 = 0.09$). Students in the intervention group displayed a higher increase in meters completed per training session (males $p \leq 0.00$, $r = 0.42$ vs. controls $p \leq 0.03$, $r = 0.40$; females $p \leq 0.00$, $r = 0.52$ vs. controls $p \leq 0.03$, $r = 0.24$). Findings suggest that mental training can effectively enhance running performance and that females respond better to the intervention.

Keywords: Motivation, performance, conditioning, gender, olfactory stimulus

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IZVLEČEK

Psihološki dejavniki igrajo pomembno vlogo pri športni uspešnosti. Za športnike v različnih vrstah športa se uporabljajo različni programi treniranja in psihološkega usposabljanja. Raziskati je potrebno vplive miselnega treninga na tekaško zmogljivost med treningom. V ta namen smo vključili 19 študentov ene nemške univerze razdeljenih v kontrolno in intervencijsko skupino. Opazili smo razlike med intervencijsko in kontrolno skupino žensk med opravljenimi števci na treningu (5119,70 ± 272,72 m proti 4858,80 ± 551,70 m, $p \leq 0,02$, $\eta 2 = 0,14$). Značilne razlike smo opazili tudi pri moških v intervencijski in kontrolni skupini (5781.20 ± 437.27 m proti 5963.40 ± 709.09 m, $p \leq 0.09$, $\eta 2 = 0.09$). Preizkušanci v intervencijski skupini so pokazali večji porast števcev, opravljenih na treningu (moški $p \leq 0,00$, $r = 0,42$ v primerjavi s kontrolami $p \leq 0,03$, $r = 0,40$; ženske $p \leq 0,00$, $r = 0,52$ v primerjavi s kontrolami $p \leq 0,03$, $r = 0,24$). Ugotovitve kažejo, da lahko miselni trening učinkovito izboljša tekaške sposobnosti in da se ženske značilno bolje odzovejo na intervencijo takšnega tipa.

Ključne besede: Motivacija, uspešnost, pogojenost, spol, vohalni dražljaj *Corresponding author*:* Johanna Weber

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INTRODUCTION

Sports-performance during both training and competition is limited by physical aspects and psychological factors such as motivation: performance-demands in regards to psychological factors have, for example, been found in handball (Weber & Wegner, 2016), netball (Grobbelaar & Eloff, 2011) and soccer (Hughes, Caudrelier, James, Redwood-Brown, Donnelly, Kirkbride et al., 2012). Brisson (2003) generally describes motivation as a relevant factor in female ice-hockey without having conducted a study. It is known that self-regulation practice enhances gymnastics-skill (Wolko, Hrycaiko & Martin, 1993). Hume, Hopkins, Robinson, Robinson & Hollings (1993) found that motivation correlates with attainment in gymnastics, while D'Arripe-Longueville, Hars, Debois & Calmels (2009) showed that achievement motivation is important in gymnastics. Munkácsi, Kalmár, Hamar, Katona & Dancs (2012) claim that a strong motivational driving force is essential to perform high level gymnastic exercises and maintain daily practice. Differences in motivational aspects have been found between male and female athletes competing at various types of sports, e. g. handball (Weber & Wegner, 2018 b).

One method of enhancing sports performance is mental training. Rongzhang (1987) states that track and field performance is influenced by mental attitude and should therefore be researched. One of the mental training practices constantly applied is imagery, which can play a crucial role in facilitating performance (Patrick & Hrycaiko, 1998). Imagery is defined as creation and recreation of an image in the mind (Weinberg & Gould, 2011) and can enhance performance (MacIntyre & Moran, 2007) as well as self-confidence (Hall, Rogers & Barr, 1990), and it can also regulate arousal (Weinberg, Butt, Knight, Burke & Jackson, 2003).

Patrick and Hrycaiko (1998, p. 5) state that "*Imagery involves internal representations (images) and/ or feelings of the performance […]. Imagery can also involve images and feelings of the situation in which the behaviour occurs*." Well-developed imagery includes not only seeing the situation in front of the inner eye, but also actually feeling it (Orlick, 1986). Lang (1977, 1979) states that imagery accesses information from memory that is similar to actual behaviour, while stimuli representing part of that memory may be used to create access to an event with emotional psychological and physiological responses. Presenting a suitable stimulus can favour access to beneficial memories, and access can be facilitated through imagery training.

A stimulus used in this manner can be of sensory nature, e. g. smell. Bensafi, Tillmann, Poncelet, Przybylski, Roubi, Bensafi et al. (2013) state that olfactory mental images are defined

as short-term memory representations of olfactory events that preserve some aspects of olfactory perceptions and therefore have an influence on mental imagery. E. g. infant rats learn to link olfactory stimuli to suckling and therefore to positive memories (Brake, 1981). Sports performance in darts is known to have been enhanced by imagery using music as a stimulus (Kuan, Morris, Kueh & Perry, 2018). These findings make it seem likely that sports performance can be enhanced via placing stimuli, e. g. an olfactory stimulus in successful sports situations and then retrieving the positive image/ emotion/ psychological or physiological state associated with the smell and thus the successful sports-situation.

Imagery training has been claimed to be beneficial to sports performance in several competitive sports such as basketball (Post, Wrisberg & Mullins, 2010), trampoline and other gymnastics disciplines (Isaac, 1992), field hockey (Smith, Wright, Allsopp & Westhead, 2007) and golf (Smith, Wright & Cantwell, 2008). Wolframm and Micklewright (2011) found that Dutch non-elite equestrian dressage riders improved their competitive results after an intervention using mental training techniques which they claim to be commonly used in sports (goal-setting, relaxation techniques, self-talk, concentration training and imagery) for eight weeks. Imagery has been shown to improve performance in ping pong. Children using imagery showed better improvement in accuracy and technical quality (Li-Wei, Qi-Wei, Orlick & Zitzelsberger, 1992). Elite soccer players employ more use of imagery than non-elite players (Salmon, Hall & Aslam, 1994), and the same holds true for synchronized swimmers (Ranucci, 2007) as well as synchronized skaters (Cumming & Ste-Marie, 2001). Danardani, Soegiyanto, Setijono & Sulaiman (2018) found that imagery improved performance in artistic swimming. Shambrook and Bull (1996) found that mental-imagery practice was able to improve free-throw consistency for a basketball player in a single-participant, multiple-baseline study.

Continuous tasks have also been shown to benefit from imagery training. Post et al. (2012) found that imagery training led to improved performance in swimmers after only 15 weeks of training. Patrick and Hrycaiko (1998) found that a mental training package including imagery improved running performance in male triathletes and runners. Bar-Eli and Blumenstein (2004) were able to show a positive effect of biofeedback training on running and swimming performance.

In the light of these findings, it has to be researched what effect, if any, mental training can have on running performance. Hypothesis: Mental training positively influences running performance. The following questions will be used to clarify matters:

1. Does running performance during training sessions increase similarly with or without mental training intervention when testing for correlation between training day number (1st to 16th training session) and distance completed per time with or without mental training for each participant individually?

2. Does running performance during training sessions increase similarly with or without mental training intervention when testing for distance completed per time during each separate training session with or without mental training for female and male participants separately?

3. Is there a difference in running performance during training sessions between participants with or without mental training intervention when testing for distance completed per each separate training session by participants in the intervention and control group (females and males separately)?

METHODS

Measurements included 19 participants, ten in the intervention group and nine in the control group. Recruitment took place via email in March and April 2020. All participants were sports students at a German university. Three participants dropped out due to injury during the experiment, two in the control group and one in the intervention group. The control group consisted of five female students and two male students (age 22.25 ± 2.05 years) and the intervention group consisted of two female student sand seven male students (age 22.50 ± 2.27 years).

Table 1. Participant data.

	N	Age
Intervention group		
m	7	22.67 ± 1.53
f	2	22.00 ± 2.45
Control group		
m	2	22.38 ± 2.00
f	5	23.00 ± 4.24

Participants were required to complete two training sessions per week on non-consecutive days over eight weeks, thus completing 16 training sessions. Each session consisted of 20 minutes of running (self-determined running track), while the distance completed had to be recorded. Participants were allowed to skip two of the 16 sessions. Missing more than two sessions (e. g.

due to appointments or injury) resulted in dropout. The intervention group had to include mental training in the form of imagery training into their training programme. Before running, every participant of the intervention group had to sniff a pleasant smell, e. g. deodorant, perfume, shower gel. Participants were only allowed to smell it again after training if they were feeling content with their training performance. The aim was to achieve a form of conditioning connecting good performance to a pleasant feeling and a pleasant smell, thus enhancing running performance by accessing previous positive emotions through the olfactory stimulus to which those emotions are linked. The smell is supposed to work as a reminder of previously experienced emotion. The control group was not allowed to use this technique. To rule out interfering effects resulting from other stimuli, running with music or peers was not permitted.

To answer research question 1, testing of Spearman`s rho was performed for a connection between distance in meters completed per time during each training session and number of the training session (training session after onset of training, e. g. first, second, …, sixteenth) within the intervention and control group for each participant individually.

To answer research question 2, participants were separated into males and females and Spearman`s rho for a correlation between training day number (1^{st} to 16^{th} training) and distance completed on that day was calculated for females and males separately within the intervention and control group, thus including 14 to 16 trainings sessions per participant.

To answer research question 3, Oneway ANOVA was performed for male and female participants separately, testing for differences between the intervention and control group regarding meters completed within the 232 analyzed training sessions.

The criterion level for significance was set at $p<0.05$ and the by trend significance at $p<0.10$. Effect size was evaluated with η^2 (Eta partial squared), where $0.01<\eta^2<0.06$ constitutes a small effect, $0.06<\eta^2<0.14$ constitutes a medium effect and $\eta^2>0.14$ constitutes a large effect (Cohen, 1988). Correlations were calculated via Pearson and Spearman`s Rho with correlation levels >0.1 (weak), >0.3 (moderate) and >0.5 (strong). The level of statistical power for detecting any effect at all is 0.65 for 16 participants and .89 for 232 analyzed training sessions (Cohen, 1988). Statistical analysis was performed in SPSS, version 25 (SPSS, Inc., Chicago, IL).

RESULTS

Students in the intervention group displayed a higher increase in meters completed per training session when seen individually per participant (table 1) and when seen within the intervention and control group as a whole (table 2), and there was a difference between meters completed per training session in the female intervention and control group and a by trend difference between meters completed per training session in the male intervention and control group (table 3).

Table 2. Correlation levels and p-values for each participant regarding meters per training session according to training day (1st to 16th training session).

Correlation between distance per training [m] and number of training day	**Intervention group**	**Control group**
Spearman`s rho	0,89**	0,80**
p	0,00	0,00
N	15	16
Spearman`s rho	0,11	0,80**
p	0,68	0,00
N	16	16
Spearman`s rho	0,98**	0,94**
p	0,00	0,00
N	16	16
Spearman`s rho	0,80**	-0,49*
p	0,00	0,05
N	15	16
Spearman`s rho	0,73**	0,81**
p	0,00	0,00
N	16	16
Spearman`s rho	0,44*	0,46*
p	0,09	0,09
N	16	15
Spearman`s rho	0,71*	-0,37
p	0,03	0,19
N	15	14
Spearman`s rho	0,32	
p	0,23	
N	16	
Spearman`s rho	0,90*	
p	0,00	
N	16	

*moderate correlation by trend

**strong correlation

Table 3. Correlation between increase in meters completed and training day (1st to 16th training session) for all analyzed training sessions.

	Intervention group (male)	**Intervention group (female)**	**Control group (male)**	**Control group (female)**
Spearman`s rho	0,42**	0,52***	0,40**	0,24*
p	0,00	0,00	0,03	0,03
N	109	32	32	77

***strong correlation
**moderate correlation
*low correlation

Table 4. Differences between intervention and control group in meters completed per training session for each of the 232 training sessions (14 to 16 sessions for each participant).

Differences in m completed in 20 min. per training session	**N**	$\bar{X} \pm SD$	p	η^2
Females Intervention group vs. control group	35 56	5119.70 ± 272.72 4858.80 ± 551.70	0.02	0.14
Males Intervention group vs. control group	109 32	5781.20 ± 437.27 5963.40 ± 709.09	0.09*	0.09

* by trend significance

DISCUSSION

When testing for meters completed in relation to the day after onset of training for each participant, participants in the intervention group displayed marginally higher correlations between meters completed and day after onset of training. In contrast to the control group, no participant of the intervention group showed a decrease in meters completed. This hints that running performance increased slightly more when including mental training into the training routine.

When assessing meters completed in relation to the day after onset of training for the intervention and control group separately for male and female participants, it is clear that the correlation was slightly higher in male runners with intervention than in controls. In female runners, the correlation was much stronger with mental training than in controls. This suggests a stronger increase in meters completed per time when conducting mental training.

While male runners showed a by trend difference between meters completed in the intervention and control group, females displayed a significant difference in meters completed between the intervention and the control group.

Results of the current study match those of Patrick and Hrycaiko (1998) as well as those of Bar-Eli and Blumenstein (2004), where it was possible to improve running performance via imagery training.

No unintended effects on participants were measurable during the study. One of the limitations of the study is the rather small sample size, which does not allow for generalizability of findings. The research should be viewed as preliminary until it can be repeated with a larger sample of both genders and in different kinds of sports as well as other age groups. Also the effect on untrained participants should also be clarified. Another limitation might arise from the fact that students were able to choose which group they wanted to be in. Despite increasing motivation for the task and decreasing dropouts, this led to a high number of males in the intervention group and a high number of females in the control group. This constellation might have an effect on findings due to individual receptiveness for the intervention. It might be advisable to repeat the study with randomized allocation to intervention and control group. It might further be necessary to test real imagery training against a placebo.

Nevertheless, findings suggest that an olfactory stimulus can be used in imagery training to create a positive state of arousal and other beneficial effects and that mental training thus has an effect on running performance during training. In the current study it seems that females respond to this kind of olfactory intervention better than males, probably due to them being more emotional than males. Laukka and Quick (2011) found that females more often than males use music for enhancing emotional aspects of sports performance, while Costarelli and Stamou found a higher emotional intelligence in female athletes. These previous studies could support current findings.

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Declaration of research-ethics

The research complied with the Helsinki-declaration of 1975, informed consent was obtained from all participants. Participants volunteered to take part in the study.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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