The influence of internally focus of attention during vigorous-intensity aerobic exercise for improving health status.

WAKATABE, Shun / HAYASHI, Yoichi

(出版者 / Publisher)
法政大学スポーツ研究センター
(雑誌名 / Journal or Publication Title)
BULLETIN OF Sports Research Center, HOSEI UNIVERSITY / 法政大学スポーツ研究センター紀要
(巻 / Volume)
41
(開始ページ / Start Page)
37
(終了ページ / End Page)
43
(発行年 / Year)
2023-03-31
(URL)
https://doi.org/10.15002/00026649

The influence of internally focus of attention during vigorous-intensity aerobic exercise for improving health status.

Shun Wakatabe (Graduate school of Sports and Health studies, Hosei University, Japan.)
Yoichi Hayashi (Graduate school of Sports and Health studies,
Faculty of Letters, Hosei University, Tokyo, Japan.)

Abstract

The purpose of this study was to examine the influence of internal focus on the ratings of perceived exertion and affect during acute high-intensity cycling exercise. Fourteen healthy male participants were recruited (22.1 ± 1.8 years). The participants performed an incremental maximal test to assess the participants' aerobic capacity and three experimental trials. In the experimental trials, the participants pedaled on a stationary cycle ergometer at 70% $\dot{V}O_{2max}$ for 20-min in three conditions: control, internal sensory monitoring, and active self-regulation. During the 20-min cycling in each condition, the participants rated their overall and peripheral perceived exertion (RPEover, RPEperi) in 5-min intervals. Before and after 20-min cycling, participants assessed their positive engagement, negative affect, and tranquility. No significant differences in both RPEs were observed among the three conditions. In all conditions, positive engagement was higher after cycling. In addition, there were no significant differences in negative affect and tranquility. Our study suggests that internal focus does not influence perceived exertion and affects when participants conduct ACSM recommended vigorous intensity exercise. Further research needs to examine the reason that no influence of internal focus has emerged in our study.

Key words : Internal sensory monitoring, Active self-regulation, ACSM recommendation, Borg's RPE 6-20 scale, Waseda Affect Scale of Exercise and Durable Activity.

Introduction

Exercise adherence is important to promote health. Perceived effort is one of the factors that impair exercise participation (Trost et al., 2002). Therefore, excessive perceived exertion should be decreased. Focusing on bodily sensations during aerobic exercise is suggested to increase perceived exertion. However, there is no study about the influence of internal focus that sufficient exercise volume was adopted. Therefore, research that adopts sufficient exercise volume for promoting health is needed.

Excessive perceived exertion might provoke negative feelings, and people could not adhere exercise participation. Excessive perceived exertion should be prevented to promote health and exercise adherence. Franklin (1988) reported dropout rates of structed exercise programs had been from 9% to 87% (mean = 45%). Moreover, Gjestvang et al. (2020) reported that about 20% of new exercisers drop out within half a year. Also, Trost et al. (2002) indicated that perceived effort inhibits exercise participation.

Focusing on bodily information is one of the factors that increase perceived exertion. Masters and Ogles (1998) suggested that association (focusing on bodily sensation) may increase perceived exertion. For example, focusing on bodily sensations during 10-min cycling at 60% $\dot{V}O_{2max}$ increased RPE (Johnson and Siegel, 1992). Also, Schucker and Parrington (2019) reported that perceived exertion was significantly higher focusing on breathing than focusing on video (external focus) during 6-min treadmill running. In addition, Stanley et al. (2007) reported that RPE in internal focus was significantly higher than in external focus during 15-min cycling at 75% $\dot{V}O_{2max}$. These studies suggested that internal focus may lead to increase perceived exertion. Therefore, focusing on bodily sensation during exercise might induce excessive perceived exertion. Therefore, internal focus during aerobic exercise might not be good from the perspective of exercise adherence.

To indicate the influence of internal focus during exercise programs, researchers must adopt adequate exercise volume to promote health. Unfortunately, no study on the influence of internal focus in sufficient exercise volume was examined in the past. In previous studies, researchers examined the influence of internal focus on perceived exertion in 15-min cycling at 60% $\dot{V}O_{2max}$ (Johnson and Seigel, 1992), 10-min cycling at 75% $\dot{V}O_{2max}$ (Stanley et al., 2007), 6-min running (Schucker and Parrington, 2019; Neumann and Piercy, 2013), and 10-min running at 60% HRR (Ziv et al., 2012). However, these exercise volumes were not sufficient to promote health. The American College of Sports Medicine (ACSM) recommends aerobic exercise for a minimum of 30 min at 46-63% $\dot{V}O_2max$ or for a minimum of 20 min at 64-90% $\dot{V}O_2max$ to promote and maintain health (ACSM, 2018). Mitchell et al. (2018) reported that moderate to vigorous exercise (46–90% $\dot{V}O_2max$) improved cardiorespiratory fitness for cardiac rehabilitation. In addition, 20 or 40 min moderate (60% HRR) and vigorous (80% HRR) exercise increased brain-derived neurotrophic factor that is associated with mood regulation and cognitive function (Schmolesky et al., 2013).

To confirm the influence of internal focus, our study aimed to examine the influence of internal focus on perceived exertion in the case that sufficient exercise volume is adopted. As a sufficient exercise volume, 20-min cycling at 70% $\dot{V}O_2max$ is adopted. This exercise volume meets ACSM recommendations for healthy adults (ASCM, 2018). Additionally, our study aimed to examine the influence of internal focus on one' s affect. The impact of internal focus was examined in detail by examining the influence on perceived exertion and one' s affects.

Methods

Participants

We recruited fourteen healthy male participants (age: 22.1 ± 1.8 years, height: 169.6 ± 5.0 cm, weight: 68.2 ± 11.0 kg, % fat: 17.3 ± 6.1 %, $\dot{V}O_2max$: 42.0 ± 6.1 ml/min/kg) in this study. The university's ethics committee (Graduate school of Sports and Health Science, Hosei University) approved the study protocol (approval number: 2019_22).

Instrumentation

Japanese Version of the Ratings of Perceived Exertion (Onodera and Miyashita, 1976)

In our study, perceived exertion during exercise was assessed by the RPE scale. This RPE scale comprised a 15-grade scale with scores ranging from 6 to 20. Onodera and Miyashita (1976) demonstrated that this scale correlates strongly with % HRmax and the percentage of maximal oxygen uptake (% $\dot{V}O_2max$).

Waseda Affect Scale of Exercise and Durable Activity (Arai et al., 2003)

The 12-item scale capture negative affect, positive engagement, and tranquility. This scale was designed to assess the affects during acute exercise. The internal consistency, content validity, and factorial validity of this scale have been examined and ensured appropriateness with Arai et al. (2004).

Procedure

The participants visited the laboratory on four occasions. They performed an incremental cycling test and three experimental trials to assess their aerobic capacity. During the first visit, the participants signed an informed consent form, and their body composition and height were measured. Afterward, all participants were informed of the procedure and the required measurements, and each provided informed consent. Moreover, the participants were asked to answer a questionnaire in Japanese about their current stage of exercise behavior (Marcus and Forsyth, 2003).

Incremental cycling test protocol

Aerobic capacity was assessed by incremental cycling test using an upright cycling ergometer with an electromagnetic brake (AEROBIKE Ⅱ, COMBI Corporation). The load of the ergometer could only be manually changed by 2 W; therefore, the load control was also calibrated in 2 W. The participants cycled at 30 W for 1 min, after which the load was increased by 14 W or 16 W every minute (30 W every 2 min) until volitional exhaustion. The incremental test measured gas exchange and heart rates using a respiratory gas analyzer (POWERMETS, AT-1100A, ANIMA Corporation) and a chest heart rate monitor (T31C, Polar Electro).

An individual's $\dot{V}O_2max$ was determined using two out of the following three criteria: 1) leveling off observed (the plateau in $\dot{V}O_2$ (< 150ml/min) despite exercise intensity increased), 2) respiratory exchange ratio more than 1.10, and 3) heart rate reaching 90% of HRmax (206.9 – (0.67 × age)). The $\dot{V}O_2max$ value was determined according to the criteria set by Tanaka et al. (1990). However, the maximum heart rate, one of the variables used in the formula, was given by Gellish et al. (2007). If no criterion was met during the test, $\dot{V}O_2peak$ was used as $\dot{V}O_2max$.

Experimental trials protocol

The participants performed three experimental cycling tasks. During the cycling task, the participants were asked to focus on one of the three manipulation instructions. They rode an electromagnetically braked upright cycling ergometer for 30 minutes. They performed a 5-min warm-up at 35% $\dot{V}O_2max$, a 20-min cycling at 70% $\dot{V}O_2max$, and a 5-min cool down. During the 20-min cycling in internal sensory monitoring and control conditions, the participants freely determined the pedaling rate in the range of 55–65 rpm. Throughout the experimental trials, gas exchange and heart rate were measured using the same apparatus in the incremental cycling test. Two types of RPE (overall RPE: RPRover, peripheral RPE: RPEperi) were measured every 5 min during the 20-min cycling task. Before and after the experimental trial, participant' s affects were measured using the WASEDA. Three experimental trials were separated by at least 24 h, and the manipulation order was randomized.

Exercise intensity

In previous studies that examined the influence of internal focus during cycling exercise, 15-min at 60% $\dot{V}O_{2}max$ (Johnson and Siegel, 1992) and 10-min at 75% $\dot{V}O_{2}max$ (Stanley et al., 2007) were used as exercise duration and intensity. ACSM and the American Heart Association (AHA) position stand (Haskell et al., 2007) recommended moderate- and high-intensity aerobic exercise. ACSM (2018) recommends aerobic exercise at 46-63% $\dot{V}O_{2}max$ for a minimum of 30 min or at 64-90% $\dot{V}O_{2}max$ for a minimum of 20 min to promote and maintain health. In addition, exercising at higher intensities is expected to improve performance and prevent blood circulation and type 2 diabetes (Garber et al., 2011). In previous studies (Johnson and Seigel, 1992; Stanley et al., 2007), exercise volume was insufficient compared with ACSM recommendation (ACSM, 2018). Considering exercise intensity and duration, 20-min at 70% $\dot{V}O_{2}max$ was adopted in this study as the aerobic exercise volume because it is expected to produce the higher benefit of exercise.

Manipulation

In our study, the internal focus was based on that proposed by Brick et al. (2014). Brick et al. (2014) introduced a new categorization of attentional focus: internal sensory monitoring, outward monitoring, active self-regulation, active distraction, and involuntary distraction. In our study, we paid attention to the effects of internal focus. Therefore, two types of internal focus were used.

Internal sensory monitoring (*ISM*): In ISM condition, the participants pay attention to their leg muscle sensations. The participants were asked to focus on their leg muscle sensation during cycling. In order to sustain attention to muscle sensation, a bulletin board was placed in front of the bicycle ergometer, and a form was posted with instructions to pay attention to muscle sensation in the pedaling leg. In addition, the experimenter verbally instructed the participant to pay attention to the muscle sensation every 2 minutes and 30 seconds. After completing the 20-min cycling, the participants subjectively assessed the degree of compliance with the instruction on a 5-point scale. Before the experimental trial, the participants were told that they would be asked on a 5-point scale how well they had complied with the instructions after completing the cycling, and they were asked to maintain their attention on muscular senses during the cycling.

Active self-regulation (AS): In AS condition, the participants were asked to change pedaling rate every five minutes to one of three different pedaling rates (55, 60, or 65 rpm). The order and combination of changes were set randomly for each participant. The pedaling rate was indicated using an electronic metronome, and the participant was instructed to pedal in time with the metronome. In addition, a form with instructions to maintain the pedaling rate by the metronome was posted on a bulletin board in front of the bicycle ergometer. If a difference occurred between the metronome rhythm and the pedaling rate during the cycling, the experimenter instructed the participant to adjust the pedaling rate, and the participant was asked to try to maintain the indicated pedaling rate. Unlike ISM conditions, they were not given specific instructions regarding their bodily sensation.

Statistical analysis

A two-way repeated-measures analysis of variance (time × condition) was conducted to compare changes in the independent variables (RPEover, RPEperi, and affect). Moreover, we calculated the area under the curve (AUC) for both RPE in each condition. The AUC represents a total fluctuation of perceived exertion in each condition exercise. A one-way repeated-measures ANOVA was conducted to compare the AUC in each condition. A *p*-value less than 0.05 was considered statistical significance. All statistical analyses were performed using SPSS software version 25. If significant main effects and interactions were observed, a *post hoc* analysis was conducted using Bonferroni adjustment. Cohen's *d* effect size (ES) was computed for each condition. Data are presented as mean and standard deviation.

Result

RPE

RPEover, RPEperi, AUC, and statistical values are presented in Tables 1 and 2. For RPEover and RPEperi, no significant main effects on condition (RPEover: F [2, 26] = 0.35, P = 0.71, *Partial* η^2 = 0.03; RPEperi: F [2, 26] = 0.67, P = 0.52, Partial η^2 = 0.05) or interactions (RPEover: F [6,78] = 0.29, P = 0.94, *Partial* η^2 = 0.02; RPEperi: F [6, 78] = 0.75, P = 0.61, *Partial* η^2 = 0.06) were observed. A significant main effect on time was observed for RPEover and RPEperi (RPEover: F [3, 39] = 39.99, $P < .01$, *Partial* η^2 = 0.76; RPEperi: F [3,39] = 52.29, $P < .01$, Partial η^2 = 0.80). Both RPEs increased during the cycling task in all conditions. For the AUC of RPEover and RPEperi, there were no significant main effects on the condition (RPEover: F [2, 26] = 0.16, P = 0.85, *Partial* η^2 = 0.01; RPEperi: F [2,26] = 0.13, P =

Table 1. The results of mean RPE and AUC in each condition, and statistical analysis.

	Condition			ANOVA			
	Control	Active SR	Internal SM	Effect	*F*	*P*	*Partial* η^2
RPE overall							
5min	13.07 (0.92)	13.14 (0.95)	13.43 (1.22)	C	0.35	0.71	0.03
10min	14.43 (0.94)	14.29 (1.27)	14.50 (1.09)				
15min	15.29 (1.38)	15.29 (1.49)	15.36 (1.45)	T	39.99	< 0.01	0.76
20min	15.64 (1.60)	15.79 (1.81)	16.07 (1.94)				
Total	14.61 (1.57)	14.63 (1.71)	14.84 (1.73)	C×T	0.29	0.94	0.02
RPE peripheral							
5min	13.93 (1.44)	14.07 (1.59)	14.07 (1.90)	C	0.67	0.52	0.05
10min	15.43 (1.28)	15.43 (1.45)	15.64 (1.60)				
15min	16.21 (1.63)	16.64 (1.86)	16.43 (1.50)	T	52.29	< 0.01	0.80
20min	16.64 (1.82)	17.21 (1.93)	17.36 (1.69)				
Total	15.55 (1.84)	15.84 (2.07)	15.88 (2.04)	C×T	0.75	0.61	0.06
AUC							
RPE overall	4.86 (3.69)	4.61 (2.65)	4.32 (3.65)	C	0.16	0.85	0.01
RPE peripheral	5.14 (3.84)	5.50 (2.26)	5.57 (3.83)	C	0.13	0.88	0.01

Note. Standard deviations are presented in parentheses. Internal SM represents the Internal sensory monitoring condition, and Active SR represents the Active self-regulation condition. In ANOVA columns, C represents condition factor, T represents the time factor, and C × T represents condition and time interaction.

0.88, *Partial* η^2 = 0.01). Fluctuations of RPEover and RPEperi were not different with conditions.

Affect

The results of WASEDA in this study are presented in Tables 3 and 4. In positive engagement, no significant main effects on conditions (F [2,26] = 0.85, P = 0.44, *Partial* η^2 = 0.06) and interaction effects (F [2,26] = 2.61, P = 0.09, *Partial* η^2 = 0.17) were observed. A significant main effect on time was observed (F [1,13] = 28.31, P <. 01, *Partial* η^2 = 0.69). Positive engagement was increased after the cycling task compared to that before the task. No significant main effects or interactions were observed regarding negative affect (condition: F [2,26] = 1.02, P = 0.37, *Partial* η^2 = 0.07; times: F [1,13] = 0.19, P = 0.67, *Partial* η^2 = 0.02; interaction: F [2,26] = 0.95, P = 0.40, *Partial* η^2 = 0.07) and tranquility (condition: F [2,26] = 0.30, P = 0.75, *Partial* η^2 = 0.02; times: F [1,13] = 0.06, P = 0.81, *Partial* η^2 < 0.01; interaction: F [2,26] = 2.05, P = 0.15, *Partial* η^2 = 0.14).

Discussion

We examined the influence of internal focus on perceived exertion and its affects during adequate exercise for promoting health. The results of our study suggest that internal focus did not influence perceived exertion during 20-min cycling at 70% $\dot{V}O_{2}max$. The participant' s RPE reaches a "hard" level on Borg' s RPE scale. This result suggests that when exercise intensity has reached a "hard" level, the internal focus might not exacerbate perceived exertion. In addition, our result of WASEDA suggests that internal focus during high-intensity cycling did not influence the exerciser' s feelings. From the results of our study, the internal focus might not have a negative influence when people conducted ACSM recommended exercises.

Internal focus may not exacerbate perceived exertion during 20-min cycling at 70% $\dot{V}O_{2}max$. Theoretically, perceived exertion during exercise was emphasized when internal sensory monitoring was used (Lind et al., 2009). Therefore, we hypothesized that RPE was higher in the internal sensory monitoring condition than in the control condition. In a previous study, RPE was higher when participants paid attention to bodily sensation than when no specific instruction (Johnson and Siegel, 1992). Also, Schucker et al. (2014) reported higher RPE during running when runners focused on their movement compared with no specific instruction. Based on this report, we predicted

Table 2. Mean differences, 95% CI, and Cohen' s *d* about each RPE

	Control – Internal SM		Control – Active SR		Internal SM – Active SR	
	Mean difference [95% CI]	*d*	Mean difference [95% CI]	*d*	Mean difference [95% CI]	*d*
RPEoverall						
5min	-0.1 [-0.61, 0.46]	0.10	-0.4 [-1.04, 0.32]	0.40	-0.3 [-1.02, 0.44]	0.29
10min	0.1 [-0.85, 1.13]	0.11	-0.1 [-1.00, 0.86]	0.06	-0.2 [-0.87, 0.44]	0.24
15min	0.0 [-1.38, 1.38]	0.00	-0.1 [-1.41, 1.26]	0.04	-0.1 [-1.05, 0.90]	0.05
20min	-0.1 [-1.58, 1.29]	0.07	-0.4 [-1.89, 1.03]	0.22	-0.3 [-1.30, 0.73]	0.21
Total	0.0 [-0.97, 0.94]	0.01	-0.2 [-1.18, 0.72]	0.15	-0.2 [-0.82, 0.39]	0.19
RPEperipheral						
5min	-0.1 [-0.84, 0.55]	0.15	-0.1 [-0.90, 0.61]	0.15	0.0 [-1.04, 1.04]	0.00
10min	0.0 [-0.76, 0.76]	0.00	-0.2 [-1.04, 0.61]	0.20	-0.2 [-0.87, 0.44]	0.24
15min	-0.4 [-1.71, 0.85]	0.25	-0.2 [-1.30, 0.87]	0.15	0.2 [-0.91, 1.34]	0.14
20min	-0.6 [-2.11, 0.97]	0.27	-0.7 [-2.11, 0.68]	0.38	-0.1 [-1.33, 1.04]	0.09
Total	-0.3 [-1.20, 0.63[	0.19	-0.3 [-1.11, 0.47]	0.23	0.0 [-0.83, 0.76]	0.03

Note. Mean differences were calculated by subtracting the value measured in each condition. Internal SM represents the Internal sensory monitoring condition, and Active SR represents the Active self-regulation condition. 95% CI = 95% Confidence Interval. *d*: Cohen's *d*, small = 0.20, medium = 0.50, large = 0.80 (Cohen, 1992).

Table 3. Descriptive statistics for Positive engagement, Negative affect, and Tranquility.

	Time		ANOVA			
	Pre	Post	Effect	*F*	*P*	*Partial* η^2
Positive engagement						
Control	9.07 (3.65)	12.57 (3.61)	C	0.85	0.44	0.06
Internal SM	9.14 (4.72)	11.93 (4.41)	T	28.31	< 0.01	0.69
Active SR	8.14 (2.74)	13.21 (2.99)	C × T	2.61	0.09	0.17
Negative affect						
Control	7.07 (3.99)	7.50 (3.39)	C	1.02	0.37	0.07
Internal SM	6.64 (4.36)	6.21 (3.83)	T	0.19	0.67	0.02
Active SR	5.93 (3.54)	6.79 (3.64)	C × T	0.95	0.40	0.07
Tranquility						
Control	11.71 (5.03)	12.07 (3.67)	C	0.30	0.75	0.02
Internal SM	10.57 (4.99)	10.79 (5.45)	T	0.06	0.81	< 0.01
Active SR	13.29 (3.89)	11.43 (4.38)	C ×T	2.05	0.15	0.14

Note. Standard deviations are presented in parentheses. Internal SM represents the Internal sensory monitoring condition, and Active SR represents the Active self-regulation condition. In ANOVA columns, C represents the condition factor, T represents the time factor, and C × T represents condition and time interaction.

Table 4. Mean differences, 95% CI, and Cohen's *d* about each affect.

	Control		Internal Sensory Monitoring		Active self-regulation	
	Mean difference [95% CI]	*d*	Mean difference [95% CI]	*d*	Mean difference [95% CI]	*d*
Positive engagement	3.50 [1.02, 5.98]	0.82	3.07 [1.30, 4.85]	1.04	5.07 [3.61, 6.53]	2.01
Negative affect	0.43 [-1.87, 2.72]	0.11	-0.50 [-2.29, 1.29]	0.16	0.86 [-0.28, 1.99]	0.44
Tranquility	0.36 [-2.82, 3.53]	0.07	-0.57 [-2.66, 3.80]	0.10	-1.86 [-5.15, 1.44]	0.33

Note. Mean difference values were calculated by subtracting the value measured after the cycling task from the value measured before the cycling task. 95% CI = 95% Confidence Interval. *d*: Cohen's *d*, small = 0.20, medium = 0.50, large = 0.80 (Cohen, 1992).

that RPE when the participants used active self-regulation, which focuses on their cadence, was higher than when they were not instructed specific attention. However, our research indicated no significant differences in both RPEs.

One possible reason that internal focus did not influence RPE is too high a participant' s RPE level. 70% $\dot{V}O_{2max}$ corresponds to the intensity at which fatigue information related to respiration and metabolism is accentuated and perceived as subjective bodily fatigue (Robertson et al., 1979). Furthermore, Hutchinson and Tennenbaum (2007) reported associative thoughts predominated in cycling at 70% $\dot{V}O_{2max}$. Based on these researches, participant' s focus during control conditions in our study may be more internal. Therefore, the degree of internal focus in the control condition might be equivalent to it in ISM and AS conditions. This equivalent degree of internal focus might induce no difference in RPEs.

Our study suggests that internal focus did not influence the exerciser's affects: positive engagement, negative affect, and tranquility. Regarding positive engagement, the effect size shows 2.04 in AS condition, 0.82 in the control condition, and 1.04 in the ISM condition. The effect size in the AS condition was larger than in the other conditions. Since exercise intensity and duration were similar in each condition, it can be concluded that the factor that affected the magnitude of the effect size was not due to the exercise intensity or effort sensation. The difference between the AS and the other conditions is that the cadence rate varied during the cycling. Takaishi et al. (1994) reported that effort sensation during cycling at 70% $\dot{V}O_{2peak}$ was lower when participants cycled at 60rpm and 70rpm than when they cycled at 40 and 50 rpm. Therefore, the change of effort sensation due to the change of cadence might have influenced positive engagement. However, what mechanism by which the change of rpm influences the positive engagement is unclear. Future study needs to examine the mechanism of how the change of cadence influences exerciser's positive engagement.

From the perspective of health promotion and exercise adherence, our results suggest that internal focus during vigorous-intensity cycling exercise might not negatively influence exercise behavior. Masters and Ogles (1998) suggested that internal focus may increase perceived exertion, and Brick et al. (2014) suggested that internal sensory monitoring might exacerbate perceived exertion. Therefore, we hypothesized that internal sensory monitoring may exacerbate perceived exertion. However, our results suggested that internal sensory monitoring does not influence perceived exertion (Table 1). The reason that no influence of internal focus was shown is unknown. An exercise program that prevents dropout could be customized if the reason is proven. Future study needs to examine how internal focus influence exercises adherence in detail.

References

American College of Sports Medicine (2018). ACSM's guidelines for exercise testing and prescription (10th ed). Wolters Kluwer, Chapter 6: 143-179.

Arai, H., Takenaka, K., and Oka, K. (2003). Ikkasei unndou ni motiiru kannjou syakudo -syakudo Kaihatsu to unndouji ni okeru kannjou no kenntou [Affect scale for acute exercise: Scale development and examination of the exercise-induced affects]. The Jpn. J. Health Psychol., 16: 1-10.

Arai, H., and Matsumoto, H. (2004). Waseda Affect Scale of Exercise and Durable Activity (WASEDA) niokeru kouseigainenndatousei oyobi insidatousei no kenntou [Examination of the construct and factorial validity of the Waseda Affect Scale of Exercise and Durable Activity (WASEDA)]. Jpn. J. Test Meas. Health Phys. Educ., 4: 7-11.

Brick, N., MacIntyre, T., and Campbell M. (2014) Attentional focus in endurance activity: New paradigms and future directions. Int. Rev. Sport Exerc. Psychol., 7: 106-134.

Franklin, B. A. (1988) Program factors that influence exercise adherence: practical adherence skill for clinical staff. In Dishman RK (ed), Exercise Adherence: Its Impact on Public Health (pp. 237-258). Champain: Human Kinetics.

Garber, C. E., Blissmer, B., Deschenes, M. R., Franklin, B. A., Lamonte, M. J., Lee, I., Nieman, D. C., and Swain, D. P. (2011) American College of Sports Medicine. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. Med. Sci. Sports Exerc., 43: 1334-1359.

Gellish, R. L., Goslin, B. R., Olson, R. E., McDonald, A., Russi, G. D., and Moudgil, V. K. (2007) Longitudinal modeling of the relationship between age and maximal heart rate. Med. Sci. Sports Exerc., 39: 822-829.

Gjestvang, C., Abrahamsen, F., Stensrud, T., and Haakstad, L. A. H. (2020). Motives and barriers to initiation and sustained exercise adherence in a fitness club setting-A one-year follow-up study. Scandinavian Journal of Medicine and Science in Sports, 30(9), 1796-1805.

Haskell W. L., Lee I. M., Pate R. R., Powell K. E., Blair S. N., Franklin B. A., Macera C. A., Heath G. W., Thompson P. D., and Bauman A. (2007) Physical activity and public health updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Circulation, 116: 1081-1093.

Hutchinson, J. C., and Tenenbaum, G. (2007) Attention focus during physical effort: The mediating role of task intensity. Psychol. Sport Exerc., 8: 233-245.

Johnson, J. H., and Siegel, D. S. (1992) Effects of association and dissociation on effort perception J. Sport Behav., 15: 119-129.

Lind, E., Welch, S. A., and Ekkekakis, P. (2009) Do 'mind over muscle' strategies work? Sports Med., 39: 743-764.

Marcus, B. H., and Forsyth, L. H. (2003) Motivating People to Be Physically Active 2nd edition. Human Kinetics.

Masters, K. S., and Ogles, B. M. (1998) Associative and dissociative cognitive strategies in exercise and running: 20 years later, what do we know? Sport Psychol., 13: 253-270.

Mitchell, L. B., Lock, J. M., Davison, K., Parfitt, G., Buckley, P. J., and Eston, G. R. (2019) What is the effect of aerobic exercise intensity on cardiorespiratory fitness in those undergoing cardiac rehabilitation? A systematic review with meta-analysis. Br. J. Sports Med., 53: 1341-1351.

Neumann, D. L., and Piercy, A. (2013) The effect of different attentional strategies on physiological and psychological states during running. Australian Psychol., 48: 329-337.

Onodera, K., and Miyashita, M. (1976) Zennsinn jikyuusei unndou ni okeru syukannteki kyoudo to kyakkannteki kyoudo no taiousei -Rating of perceived exertion no kanntenn kara- [A study on Japanese scale for rating of perceived exertion in endurance exercise]. Jpn. J. Phys. Educ. Health Sport Sci., 21: 191-203.

Robertson, R. J., Gillespie, R. L., McCarthy, J., and Rose, K. D. (1979) Differentiated perceptions of exertion: Part II. Relationship to local and central physiological responses. Percept. Mot. Skills, 49: 691-697.

Schmolesky, T. M., Webb, L. D., and Hansen, A. R. (2013) The effects of aerobic exercise intensity and duration on levels of brain-derived neurotrophic factor in healthy men. J. Sports Sci. Med., 12: 502-511.

Schücker L., Knopf C., Strauss B., and Hagemann N. (2014) An internal focus of attention is not always as bad as its reputation: how specific aspects of internally focused attention do not hinder running efficiency. J. Sport Exer. Psychol., 36: 233-243.

Schücker, L., and Parrington, L. (2019) Thinking about your running movement makes you less efficient: attentional focus effects on running economy and kinematics. J. Sports Sci., 37: 638-646.

Stanley, C. T., Pargman, D., and Tenenbaum, G. (2007) The effect of attentional coping strategies on perceived exertion in a cycling task. J. Appl. Sport Psychol., 19: 352-363.

Takaishi, T., Yasuda, Y., and Moritani, T. (1994) Neuromuscular fatigue during prolonged pedaling exercise at different pedaling rate. Eur. J. Appl. Physiol. 69:154-158.

Tanaka, K., Takeshima, N., Kato, T., Niihata, S., and Ueda, K. (1990) Critical determinants of endurance performance in middle-aged and elderly endurance runners with heterogeneous training habits. Eur. J. Appl. Physiol. Occup. Physiol., 59: 443-439.

Trost, S. G., Owen, N., Bauman, A. E., Sallis, J. F., and Brown, W. (2002) Correlates of adults' participation in physical activity: review and update. Med. Sci. Sports Exerc., 34: 1996-2001.

Ziv, G., Meckel, Y., Lidor, R., and Rotstein, A. (2012) The effects of external and internal focus of attention on physiological responses during running. J. Hum. Sport Exerc., 7: 608-616.