Cuadernos de Psicología del Deporte, vol. 16, 2, 77-86
Recibido: 29/12/2014
Aceptado: 20/04/2016

ISSN edición impresa: 1578-8423
ISSN edición web (*http://revistas.um.es/cpd*): 1989-5879

¿Afecta la focalización interna realmente en el rendimiento de carrera? Aproximación experimental hacia el efecto de la focalización atencional

Does an internal focus really affect running performance? An experimental approach to the effect of attentional focus

Isso afeta o foco interno realmente no desempenho de corrida? A abordagem experimental para o efeito de foco de atenção

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Resumen: Hasta ahora, los estudios sobre los efectos del foco atencional sobre el rendimiento en carreras de fondo han mostrado resultados controvertidos, especialmente derivados de las metodológicas de estudio. Se ha sugerido que un foco atencional interno, centrado en la respiración, aumenta el consumo de oxígeno del corredor, disminuyendo así la economía de carrera. Sin embargo, en los estudios realizados hasta la fecha no se ha controlado en tiempo real a nivel experimental el uso de un foco atencional concreto. Nuestra hipótesis establece que el uso controlado de un foco atencional interno o externo no tiene un efecto sobre la economía de carrera (consumo de oxígeno a una velocidad establecida) si se corre a una intensidad moderada. Un total de 30 corredores de larga distancia (ocho mujeres), con edades de 18 a 50 años (M = 32,87, DT = 8,15) participaron como voluntarios. El protocolo experimental consistió un diseño intrasujeto realizado en tres sesiones: (1) prueba de esfuerzo para detectar el umbral aeróbico, (2) uso de un foco atencional interno, y (3) uso de un foco atencional externo. Durante las sesiones 2 y 3, los participantes realizaron 55 min carrera a intensidad moderada. Mediante el uso de una aplicación móvil y un mando inalámbrico patentados fue posible controlar, a nivel experimental, si los participantes mantenían eficazmente el foco atencional solicitado durante las sesiones. Los resultados muestran que no hubo efecto del uso del foco atencional interno o externo en la economía de carrera. Se concluye que, a una intensidad moderada, los corredores son libres de elegir se estrategia atencional sin que se afecte su rendimiento.
Palabras clave: estrategias cognitivas, consumo de oxígeno, la evaluación del foco atencional, percepción de esfuerzo, carrera de fondo.
Abstract: Up to now, the effects of attentional focus on performance in long distance running have showed controversial results, especially derived from methodological issues. It has been considered that an internal attentional focus on breathing increase the runner's oxygen consumption, decreasing running economy. Nevertheless, none of these conclusion have controlled in real time if participants maintained the instructed attentional focus. We hypothesized that the controlled use of and internal vs. external attentional focus will not have an effect on running economy (oxygen consumption at a set speed) at a moderate intensity. A total of 30 (eight females) long distance runners, aged range from 18 to 50 years (*M* = 32,87, *SD* = 8,15) volunteered for the study. The experimental protocol consisted on three sessions (scheduled in three different days): (1) maximal incremental treadmill test, (2) internal attentional focus, and (3) external attentional focus. During sessions 2 and 3, participants performed a 55 min treadmill run at moderate intensity (70% VO_2max. Though a mobile application and a wireless controller it was possible to control for the first time if participants effectively maintained the requested attentional focus during the sessions. Results showed that there was not effect of attentional focus (internal vs. external) on running economy. We conclude that when the workload is controlled at a moderate intensity, runners are free to choose were to focus their attention without affecting their running economy.
Keywords: cognitive strategies, oxygen consumption, attentional focus assessment perceived exertion, long distance running
Resumo: Até agora, os efeitos de foco de atenção sobre o desempenho na corrida de longa distância têm mostrado resultados controversos, especialmente derivados de questões metodológicas. Considerou-se que um foco de atenção interna na respiração aumentar o consumo de oxigênio do corredor, diminuindo economia de corrida. No entanto, nenhum destes conclusão têm controlado em tempo real, se os participantes mantiveram o foco de atenção as instruções. Nossa hipótese é que o uso controlado do e interna vs. foco atencional externo não vai ter um efeito sobre a economia de corrida (consumo de oxigênio a uma velocidade set) em uma intensidade moderada. Um total de 30 (oito mulheres) corredores de longa distância, faixa de idade entre 18 a 50 anos (M = 32,87; DP = 8,15) se voluntariou para o estudo. O protocolo experimental consistiu em três sessões: (1) teste máximo incremental em esteira, (2) foco de atenção interna, e (3) foco atencional externo. Durante as sessões de 2 e 3, os participantes realizaram uma corrida (55 min) em intensidade moderada. Os resultados mostraram que não houve efeito do foco atencional (interno vs. externo) sobre a economia de corrida. Conclui-se que, quando a carga de trabalho é controlado em uma intensidade moderada, os corredores são livres para escolher se a centrar a sua atenção, sem afetar a economia de corrida.
Palavras-chave: estratégias cognitivas, através do consumo de oxigênio, avaliação foco atencional esforço percebido, corrida de longa distância

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Introduction

Heretofore, there have not been clear conclusions about the effect of attentional focus on performance in the context of endurance sports. Attention has been widely studied regarding to motor learning and motor control, researchers had concluded that attentional focus plays a key role on motor performance (Wulf, 2013). Nevertheless, on endurance sports, one of the big issues regarding to sport psychology remains unclear, where to focus attention to perform at one's best? Particularly, long distance running, which is considered as one of the most stressful situations in which a person participates voluntary (Eich & Metcalfe, 2009; Aitchison, Turner, Thompson, Micklewright & St Clair, 2013),,has been the dominant sports where the manipulation of the attentional focus have been studied.

Different recommendations have yielded so far, and researchers have shown contrary results about where to focus attention to enhance performance. Attentional focus in endurance sports have been formally studied for more than 36 years, in 1977 Morgan and Pollock highlighted a distinction between two broad categories of attentional focus, developing the term of cognitive strategies of association and dissociation, which has become a dominant construct linking attention and physical effort. Association was regarded as an internal attentional style, turning focus inward and toward bodily sensations. Dissociation is an external attentional style, referred to any thought that serves to distract attention away from internal sensations (Brick, MacIntyre & Campbell, 2014; Conolly & Tenenbaum, 2010; Masters & Ogles, 1998; Salmon, Hanneman, & Harwood, 2010)..The majority of research concerning attentional focus has used this dichotomous model. Throughout non experimental studies, it has been suggested, that associative thoughts or internal focus were related to a better sport performance (for review see Brick et al., 2014). Nevertheless, the criteria of what is considered a running performance was not unified, a wide range of variables have been considering performance parameters (i.e. perceived exertion, running speed, time to exhaustion, distance). Contrary, using an experimental approach, Morgan, Horstman, Cymerman, & Stokes (1983) conducted a laboratory research in which they set the exercise intensity as a control variable and concluded that during a treadmill run performed at 80% of maximum aerobic capacity, physiological parameters are similar regardless of the cognitive strategy used, these findings has been supported by Connolly and Janelle (2013).

Nonetheless, those conclusions were obtained from correlation methodologies and do not offer an overwhelming explanation, without an objective performance parameter, results must be considered with caution. None of the studies before 2009 have assessed the effect of cognitive strategies on physiological performance parameters throughout experimental approaches. In order to avoid the controversies and the lack of overwhelming explanations of the non-experimental studies, the approach proposed by Schücker, Hagemann, Strauss, & Völker (2009), using the objective performance parameter of running economy (whereas time to exhaustion and speed can be affected by the person's motivation, running economy cannot be influenced by motivation), had set the standard to follow in order to assess the effect of attentional focus on running performance.

Defined as the steady-state oxygen consumption (VO_2) at a set speed, running economy has been presented as a valid performance criterion (Sawyer, et al., 2010). Since Schücker et al., (2009) five studies have been conducting manipulating attentional focus and using running economy as the dependent variable. Experimental studies have shown different results (see Table 1). Studies that have showed effects of attentional focus on running economy (Schücker et al., 2009; Schücker, Anheier, Strauss, Hagemann, & Völker, 20133; Schücker, Knopf, Strauss, Hagemann, 2014) have concluded that external attentional focus increases running economy. Contrary internal attentional focus increased oxygen consumption and consequently decrease running economy. Since exercise workload was equal for all conditions (internal breathing, internal movement and external) Schücker et al., (2009) argued that changes in oxygen consumption, was due to the attentional focus. Their results showed that during the focus on breathing condition the respiratory rate decrease, and simultaneously the respiratory volume increase. This data showed that during those conditions participants breathed more slowly and deeper; this data itself could explain why internal conditions were less economical and supports that for practical purposes, the common recommendation to focus on breathing while running is not effective. Schücker et al., (2009) discussed that those results was due to attentional focus manipulation to breathing process. Breathing is a highly automatic process, and it works more effectively while running if is not subjected to conscious control.

Table 1. Studies of the effect of cognitive strategies and running economy.

Study	Participants (N)	Experimental sessions	Exercise Duration (minutes)	Attentional focus manipulation	Exercise Intensity	Physiological Measures	Attentional focus manipulation control	Results
Schücker et al. 2009	Trained long distance runners (24) 6 woman, 18 men Age (M = 30,8, SD = 8,9)	2: one for setting the workload, one experimental	30 10-min for each task (90-s break)	a)internal focus: running movement condition b)internal focus: breathing condition c)external focus: focus on a video	75% VO_2 Max	-VO_2 -Respiratory Rate -Respiratory minute volume -RQ -HR -Blood lactate	Retrospective Questionnaire % of time using the required attentional focus	External focus generated the lowest oxygen consumption. $p < .01$
Ziv et al. 2012	Basketball players (17) all male Age (M = 15,1 SD = ,6)	1	30 10-min warm up 10 min for each task	a)internal focus: leg movement b)external focus: focus on a video	60% HRR	- VO_2 -Ventilation - Respiratory Rate -Respiratory exchange ratio -RPE (1-10 scale)	None	No significant differences in any of the physiological variables between conditions $p > .05$ No differences in RPE between conditions
Schücker et al. 2013	Trained long distance runners (20)	2: one for setting the workload, one experimental	30 10-min for each task (90-s break)	a)internal focus: breathing condition b)external focus: focus on a video c)control: no instructed focus	85%VO_2 Max	- VO_2 -HR -Blood lactate -RPE (6-20 scale)	Retrospective Questionnaire % of time using the required attentional focus	External focus generated the lowest oxygen consumption. $p < .01$
Ziv et al. 2013	Physical education Students (20) all male Age (M = 26,5 SD = 4,04)	1	20 10-min for each task +8-min warmup	a)internal focus: leg movement b)external focus: focus on a video	9,6 $km{\cdot}hr^{-1}$	- VO_2 -Ventilation -Respiratory Rate -RPE (1-10 scale)	Retrospective Open-ended strategy check Questionnaire	No significant differences in any of the physiological variables between conditions $p > .05$ No differences in RPE between conditions
Schücker et al. 2014	Active long distance runners (32) 14 woman, 18 men Age (M = 30,7, SD = 10)	1	24 6-min for each condition (2-min break)	a) internal breathing b) internal movement c) internal feeling of the body d) control: no instructed focus	Speed at 60% of the personal's 1000 m time	- VO_2 - Respiratory Rate - Respiratory minute volume -Ventilation -RQ -HR -Energy expenditure -RPE (6-20 scale)	Retrospective Questionnaire % of time using the required attentional focus	Internal breathing and internal movements conditions required higher VO_2 than internal feeling of the body and control conditions $p < .01$ No differences in RPE between conditions

For Schücker et al., (2009) this results can be explained within the movement control theories (Wulf, 2013), where is established that conscious control breaks movement down and decreases performance. Schücker et al., (2009) conclude that the internal focusing of attention on breathing disrupt the natural, and automatic cycle. These results were confirmed in subsequent studies (Schücker et al., 2013; Schücker et al., 2014), and until now it should be considered focus on breathing could decrease running performance. In order to analyse if this effect was also observable during high intensity exercise, Schücker et al., (2013) set a workload speed related to the 85% of the maximum oxygen consumption (VO_2max), the results showed that an external focus improved running economy.

It is interesting that they use a high intensity exercise workload, until Schücker et al., (2013) researches had set exercise workload at moderate intensities (Schücker et al., 2009; Ziv, Meckel, Lidor, & Rotstein, 2012; Ziv, Rotstein, Lidor & Meckel, 2013). Nevertheless, the use moderate intensity was not an arbitrary decision; it is based on Tenenbaum's (2001) model. Tenenbaum (2001) proposed that when people are working hard in terms of perceived effort, their thoughts naturally become more narrow and internal and could be not possible to distract the attention of internal stimuli. This proposal was demonstrated by several studies (Baden, Warnick-Evans and Lakomy, 2004; Hutchinson, 2011; Hutchinson & Tenenbaum, 2007; Tenenbaum & Connolly, 2008).

Nonetheless, the proposed model has not been studying using fully experimental protocols, in Tenenbaum's model attention is workload dependant, but those results do not have practical implications, since attention is not considered voluntary dependant, so is not possible to answer the question of where to focus attention to perform at one's best? Once confirmed that focusing on breathing alters the natural cycle, thus increased oxygen consumption Schücker et al., (2014) analysed the effect of attentional focus on three different internal attention conditions. In addition to the two common used conditions, focus on breathing and focus on movement, they included a third condition: focus on the feeling of the body. Results showed that even between internal conditions oxygen consumption varied, so it was discussed that focusing on the feeling of the body generated the lower oxygen consumption compared to the other conditions. Thus, it was concluded that not all the internal conditions decrease running economy as it was considered, they highlight that is not the internal or external condition by itself, but if the attention is directed to an internal automatic process, like breathing and movement. Nevertheless, they not included an external condition.

Through a similar methodology, regarding to the attentional focus instructions Ziv et al., (2012; 2013) obtained that attentional focus did not had an effect on oxygen consumption. In their studies, these authors did not use the internal condition of focus on breathing, only was considered the attentional condition of focus on movement, since is the same condition used by Schücker et al., (2009, 2013) and different results were found it is interesting to highlight that it is possible that the attentional focus condition of focus on breathing has a decisive role on the oxygen consumption. Ziv et al., (2012; 2013) discuss that Schücker et al., (2009, 2013) results could be partially attributed to the external condition, particularly these authors suggest that the video using for the external condition allowed runners to adjust their pace accordingly, throughout a visual speed feedback, and consequently this leaded to the improved running economy (Ziv et al., 2013).

In order to avoid this biased effect, they used the video during all conditions, the internal included. The results, different from the ones obtained by Schücker et al., (2009, 2013) can be discussed in terms of the methodology applied. Ziv et al., (2012, 2013) studies did not use maximum oxygen consumption to set the sessions workload. In addition, participants are different in almost all the studies (see Table 1) but Schücker et al., (2009, 2013, 2014) used mainly trained runners, which can be considered more ecological than using basketball players (see Ziv et al., 2012). Regardless on the giant steps reached with the use of objective parameters to assess the effect of attentional focus on running performance, it is still unclear which strategy is more beneficial for endurance sport performance.

Since 1977, controversies about the effect of attentional focus on running performance have been present in the scientific literature. Despite the advances on the experimentation, some issues are still unclear. Specially, the attentional focus assessment. As Ziv et al., (2013) discussed, since the attentional focus was not measured directly it is possible that during all the studies, participants followed differently the attentional focus instructions, furthermore, there is not objective measure that confirms how many of the participants of such studies actually used the required attentional focus. We consider that using an objective performance variable, as running economy, is the path to follow for future researches. Nevertheless, and since controversial results have been presented, it would be necessary to use an objective attentional focus measure, or use a more precise attentional manipulation control. While oxygen consumption (dependent variable) is measured breath by breath, through precise tools, attentional focus (independent variable) has been measured by retrospective questionnaires. Such tools imply a retrospective approach. It would difficult for the athletes to remember their cognitions during a long distance run. As Hutchinson and Tenenbaum (2007) reported, the assessment of the attentional process is inherently difficult because cognitions are internal and not directly observable. Research using experimental designs, with dynamic manipulation checks for the use of cognitive strategies is needed (Blanchard, Rodgers, & Gauvin, 2004; LaCaille, Masters, & Heath, 2004).

As Quintana, Rivera, De la Vega, & Ruiz (2012) reported, cognitions stream while running is wide and dynamic, and therefore conclusions derived from uncontrolled attentional conditions may be treated with caution. We consider that controversies derived from contrary results obtained so far, could be due to the lack of control of the attentional focus in real time. Moreover, the instruction to focus on "breathing in and out" may cause the oxygen consumption impairment. Studies directed to analyse the effect of breathing instructions for stress management have shown that attention to breathing significantly reduced respiratory rate and alters the tidal volume (Conrad et al., 2007; Sasaki & Maruyama, 2014). Therefore, different internal attentional instructions are needed.

According to this, we hypothesized that an internal attentional instruction that requires participants to focus on breathing without paying attention to breathing in an out will not decrease running economy. In addition, the controlled use of and internal vs. external attentional focus will not have an effect on running performance at a moderate speed.

Though a mobile application and a wireless controller it was possible to control if participants maintained the requested attentional focus during the experimental sessions. In order to not disturb the attentional process we conducted 2 sessions, one internal and one external. Following the studies of Schücker et al., (2009, 2013) we set the workload at a moderate intensity.

Method

Participants

The sample for this study included thirty (eight females) long distance runners members of a local running club, aged range from 18 to 50 years (M = 32,87, SD = 8,15). Participants maximum oxygen consumption (M = 53,90, SD = 7,51 ml/kg/min).

Long distance runners were defined as those who regularly run more than 10 km (Benyo & Herderson, 2002). The inclusion criteria required that participants trained regularly at least two times per week and compete in 10 km, half marathon and marathon distances, being free of any disease, and not taking any medication. Participants were excluded from the study if they did not complete the three experimental sessions over a time period of ten days. Permission of the institutional ethics committee was obtained and all participants provide informed consents according to the standards set by the Declaration of Helsinki. Sample size was calculated using the study of Schücker et al., (2009) as reference, we use the same variable of oxygen consumption (VO_2) during both conditions their results were: internal focus (M = 39,19, SD = 4, 38 ml/kg/min) and external focus (M = 42,80, SD = 5, 16 ml/kg/min) using the equation $n = 2(Z\alpha+Z\beta)2\cdot(S12+ S22)/d2$. Result was n = 29,48.

Experimental design

Assessment took place in three sessions: (1) incremental test to record the maximum oxygen consumption, (2) internal focus, and (3) external focus. Sessions two and three were counterbalanced. All sessions were performed on different days at approximately the same time of the day. If participants had competed or performed high intensity training during the 48 hours before the session, they were rescheduled for another day, within de 10 days period. The target speed for session 2 and 3 was set at the ventilatory threshold (VT1). This threshold represents the point where acid lactate starts to increase above the rest level but does not exceed 2 millimoles per liter at a certain exercise workload (Orr, Greenn, Hughson& Bennett, 1982).. VT1 can be considered as a moderate workload (Jones & Carter, 2000; Tjelta & Enoksen, 2001). In addition, during this session participants familiarized with the Rating of Perceived Exertion scale (RPE; Borg, 1998) and the physiological measure devices. During Sessions 2 and 3, participants performed a 55 min treadmill run at a speed corresponding to their ventilatory threshold (plus a 3 min warming up at 3km•h-1 lower than the target workload speed and a 3 min active cool down). RPE values (central and peripheral) were obtained every 5 min. Participants were informed of the exact exercise duration and the workload speed before each session.

Measures

Background and demographic questionnaire. Which included information related to their running background (preferred distance, coming races, injuries, and personal records).

Perceived exertion. The Rating of Perceived Exertion (RPE; Borg, 1998) was used as a measure of central (cardiorespiratory) and peripheral (local-muscular) exertion during the exercise (Bolgar, Baker, Goss, Nagle, & Robertson (2010). The RPE is a 15 point category-ratio scale; the odd numbered categories have verbal anchors. Beginning at 6, "no exertion at all," and goes up to 20, "maximal exertion."

Oxygen consumption: The steady-state oxygen consumption (VO_2) was measured continuously using a breath by breath procedure with a Vmax29c bxb metabolic & pulmonary analysis system (Sensormedics Corporation, California, US).

Attentional focus instructions. For the internal focus task, participants were instructed to focus on the breathing process by counting sets of seven exhalations. When one set was completed they had to make a double click using the controller. Throughout the gas analyser monitor, researchers were able to monitor each exhalation and check in real time if the task was been performed effectively.External focus task required that participants maintained an external focus style, in order to control if participants were effectively focusing on an external input, they were asked to focus on a color-word interference presentation. We use four words (yellow, green, blue, red) written in four colors (yellow, green, blue, red). All athletes were given the target word yellow written in red color letters. A total of 165 targets appeared three times per minute in no specific order. During the 55 min session 825 Words (4-s interval) were presented. Participants were instructed to make a double click with the controller every time the target appears during the presentation. This task was based on the Stoop Test (MacLeod, 1991); however, we did not request to verbalize the color of the word as the test does.

Both, internal and external focus tasks responses were monitoring and recording in real time through dynamic measure tools: the mobile phone application (MindFocus®, O3Well-Being Solutions, Spain) and the wireless controller (Zeemote JS1®, Zeemote Technology Inc., United Kingdom) which served as a response device. Both are effective and tools for real time measuring of cognitions while running (Quintana et al., 2012).

Procedure

Before Session 2, participants completed the background questionnaire. To verify the inclusion criteria, they reported their last training sessions. Participants were instructed about the attentional task they were going to perform. Immediately prior to each session, they were trained to operate the controller, which was used as a response device. All athletes were briefed in the use of the RPE scale, and all indicated that they felt confident with its use prior to the run. While all the runners were standing on the treadmill, the following instructions were given: "every 5 min you will be asked to provide a measure of the perceived exertion, you only have to point to the number which represents how you are feeling, the first number is for central exertion and the second number is for peripheral." "If at any point of the session you feel that you cannot run any longer let us know by saying the word, stop." For sessions 2 and 3, during the warm-up a general practice of both tasks was carried out. Oxygen consumption (VO_2) was measured during both sessions as an indicator of running economy (Sawyer et al., 2010). Heart rate was measured with ECG recordings at 5-min interval. Participants were informed of the fact that the task will be monitored. In addition, they did not receive any feedback about the task effectiveness or running outputs (e.g. speed, VO_2 or time).

Data Analysis

In order to control if participants were using the requested attentional focus, a percentage of task effectiveness was calculated. For the internal focus task, we compare participants' responses (total clicks) recorded with the mobile application, with the objective sets of seven exhalations recorded with the gas analyser (synchronizing with the first double click). External focus task effectiveness was obtained comparing the number of target recorded (total clicks per minute) with the total number of targets (per minute) during the presentation. Average oxygen consumption (VO_2) values from minutes 6-55 were calculated. Shapiro and Wilk's W test for normality was calculated for oxygen consumption (VO_2) for both associative and dissociative sessions, as well as in three different intervals (T1: minutes 6-20, T2 minutes 21-40, T3 minutes 41-55).

Wilcoxon Rank-Sum Test was used for statistical comparison of oxygen consumption (VO_2) during the associative and dissociative sessions, as well as intra session along three different moments (T1,T2, T3). Alpha level was established at p = ,05.

Results

Descriptive means and standard deviations are presented for all variables. During the internal focus session a mean of 225,50 (*SD* = 47,33) sets of seven exhalations were registered. Participants focused on an average of 1578,50 (*SD* = 332) exhalations. A total of 825 words (165 targets) were displayed during the dissociative session. The results showed that a mean of 158,70 (*SD* = 5,97) targets were registered. Task effectiveness percentages are presented in Table 2.

Table 2. Average task effectiveness, perceived exertion related to cognitive strategies.

Variables	Attentional Focus *M (SD)*	
	Internal	External
Task Effectiveness (%)	94,47 (5,00)	96,18 (3.53)
RPE Central	10,54 (2,24)	10,44 (2,30)
RPE Peripheral	10,74 (2,58)	10.57 (2,29)

Note. N = 30; RPE = rating of perceived exertion.

Oxygen consumption

Average oxygen consumption during the sessions (total and for three time intervals) are presented in Table 3. Shapiro and Wilk's W test for normality showed that oxygen consumption during associative session was not normal distributed (p = ,04), same result was found on that session during T1 (p = ,04). Dissociative values of oxygen consumption and intra session associative T2 and T3 were normally distributed (p > ,05).

Wilcoxon Rank-Sum Test for two samples (associative and dissociative conditions) showed no differences in oxygen consumption between the two sessions (see Table) During the sessions participants' oxygen consumption was stable. This result confirms that the exercise workload was effectively controlled at moderate intensity.Moreover these results showed that an internal focus did not increased oxygen consumption and consequently decreased running economy. Figure 1 illustrated the course of oxygen consumption during both sessions.

Table 3. Average oxygen consumption during the experimental sessions and Wilcoxon Rank-Sum Test results.

	Oxygen consumption[a] *M (SD)*			
Time Intervals	Associative	Dissociative	Z	*p*
T1 (minutes 6 to 20)	37.49 (4.65)	38.06 (4.41)	.00	1.00
T2 (minutes 21 to 40)	38.04 (4.70)	38.84 (3.48)	-.61	.53
T3 (minutes 41 to 55)	38.46 (5.08)	39.05 (3.82)	-.09	.92
Total (minutes 6 to 55)	38.00 (4.69)	38.65 (3.63)	-.52	.60

Note. N = 29; [a] = ml/kg/min.

Perceived Exertion

Perceived exertion values (central & peripheral) for minutes 5 to 55 are presented in Table 2. The paired samples t-test reveal that there were no differences in RPE values between internal and external sessions (central, t = -,18, p = ,85; peripheral, t = -,40, p = ,69).

Discussion

The purpose of the present study was to analyse the effect of the controlled use of an internal vs. external attentional focus on running economy. We hypothesized that if the attentional instructions on the internal condition were not directed to focus on breathing in and out there will be not effects on oxygen consumption when the workload is set at a moderate intensity. We further assume that some of the controversies about the effects of attentional focus can be explained by the used methodology so far, which could be the cause of the effects and not the method to analyse the causes. There is no doubt that breathing is an automatic process and asking participants to consciously focus on breathing can alter the natural cycle as Schücker et al.,(2009, 2013, 2014) have discussed. Nevertheless, we proposed a new internal attentional instruction that did not alter the breathing cycle when the workload is controlled at a moderate intensity. Our results showed no differences on oxygen consumption between an internal and external attentional focus. We demonstrate with an experimental trial that an internal attentional focus was not prejudicial for running performance, considering running economy as a reliable performance indicator (Sawyer, et al., 2010). These results are in consonance with the ones obtained by Ziv et al., (2012, 2013). Using a different internal attentional focus condition (focus on movement), these authors found that there were no effects on running economy between internal vs. external attentional focus. Despite similarities, Ziv et al., (2012, 2013) have not studied the focus on breathing condition, which is the instruction that we used. Moreover, it is not clear if focus on movement can be considered as a purely internal focus instruction (Brick et al., 2014).

On contrary our results are opposed to those obtained by Schücker et al., (2009, 2013, 2014). Our results showed that focus on breathing, counting sets of 7 exhalations, do not interfered with the automatic control of breathing. One explanation for these differences might be the methodological issues. In Schücker's studies participants performed both conditions on the same day, one before the other; this may not be the cleanest condition if oxygen consumption was the dependent variable. In our study we performed two sessions, one for each attentional instruction. Moreover, exercise duration was higher during our study, in order to assess a possible fatigue effect on oxygen consumption and avoid biased results.

Following Ziv et al., (2013) discussion, these authors also highlighted that some of the cited effects of an internal attention focus could be due to the methodological issues. Is worth to mention that during past studies attentional focus was not measured directly and there is not objective measure that confirms how many of the participants really used the attentional focus. With a task effectiveness % of 94,47 for internal condition and 96,18 for external, we were able to assess if participants were really using an internal or external conditions. These results are higher than the retrospective attention manipulation checks performed so far. Schücker et al., (2009) manipulation checks were 85% for the internal focus: breathing and 90% for external focus. Schücker et al., (2014) internal focus: breathing 79%. Ziv et al., (2013) reported that during their study participants followed the attentional instructions 78% of the time.

Our attentional tasks required that participants focus on stimuli that appeared within few seconds (internal conditions one exhalation almost every 2 seconds and external condition one visual stimuli every 4 seconds) during the 55 minutes of the session, that is 20 minutes more than all the studies so far (see Table 1). Responses for every minute were analysed to obtain task effectiveness. In addition, oxygen consumption was stable during session, showing that there were not alterations of the natural cycle, even at the end stage of the session.

Contrary to oxygen consumption, RPE values increased along the session. Since during the sessions participants ran at the same speed and HR and VO_2 values were stable, our results suggest that RPE is not attentional focus dependent.

This result seem opposed to the proposal that attentional focus has a mediating effect over how the perception of effort is integrated, operating as a filter of the physiological inputs derived from physical activity (Baden et al., 2004; Masters and Ogles, 1998; Morgan et al., 1983; Schomer, 1986; Tammen, 1996). Nevertheless, perceived exertion is a complex construct, with physiological and psychological components, and is the wide interaction of these components the responsible of the exertion response (Razon, Hutchinson, & Tenenbaum, 2012). Thus, our results showed not effects on running economy and perceived exertion, which was considered as the principal dependent variable in the attentional focus before the experimental studies using oxygen consumption.

Some limitations may be considering, the size of the sample was modest, however due to the experimental design and the complex of the procedure a total of 30 participants was useful for our purposes. In addition, despite the attentional tasks we used can be considered as easy tasks (counting seven exhalations and recognizing the word yellow written in red letters), those task are not 100% ecological, normally runners do not have to focus on those conditions while training or competing. The range of attentional instructions is wide. Nevertheless, we have considered that those tasks were the best ones in order to control if participants were really using the instructed attentional focus. Specially, we focus on two tasks that require a constant attentional focus, like breathing and an active distraction task, like focus on a visual stimulus.

It is worth to mention that originally, internal (association) and external (dissociation) attentional focus were conceived as coping strategies. Morgan and Pollock (1977) developed the concepts of cognitive strategies with a precisely differentiated attentional focus, but also as coping mechanisms against stressors (Masters & Ogles, 1998). In our study, participants were trained runners, who regularly trained at higher speeds than the aerobic threshold. Moreover, the workload used during the experimental sessions can be considered as a non-stressful situation. Up to now, any study has focus on assess the effect of the attentional focus as a coping strategies. It would be interesting to analyse what would be the effect if the exercise bout is perceived as a stressful situation. Further studies using a higher workload speed are needed, even higher than the one used by Schücker et al., (2013).

Our results showed that when workload is controlled at a moderate intensity the attentional focus manipulation has not effect on running performance.

Practical implications

From a practical view, assuming that using an internal or an external attentional focus at moderate intensity runners are free to choose the attentional focus which is considerate the most comfortable based on their personal experience without compromising running economy. Coaches and personal trainers who aim to help runners to improve through given attentional focus instructions must considered that asking runners to focus on breathing in and our may lead to a disturbance of the natural automated breathing cycle, reducing the respiratory rate and increasing oxygen consumption, and consequently running economy is compromised.

Acknowledgements.- We thank volunteers for their participation, the companies that have facilitated the technology for this study and the professionalism and expert advices of the medical staff of the Exercise Physiology Laboratory at the Complutense University of Madrid, where this research was conducted.

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