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The Role of Preparatory Heart Rate Deceleration on Balance Beam Performance

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Preparatory heart rate deceleration occurs in tasks with an external focus of attention and is often assumed to facilitate balance performance. However, its effects upon sport-related complex balance movements have not been studied. Heart rate patterns during the preparation period of an acrobatic element (flic-flac) on the balance beam were studied in 14 female gymnasts (*M* age 13.2 years). A significant heart rate deceleration was found in attempts with a fall in the consecutive acrobatic element, but not in attempts without a fall. These data suggest that preparatory heart rate deceleration may be detrimental to the performance of complex movements on the balance beam.

Keywords: gymnastics, focus of attention, mental readiness, anxiety, postural control

Many sport activities are preceded by a preparation period, wherein the competitors' psychological state is thought to be predictive of final performance (Guillot et al., 2005; Landers et al., 1994). Heart rate deceleration during this preparation period of a task that requires an external focus of attention is assumed to be a marker of optimal functioning of attentional processes, and may thus be used to predict sport performance (Landers et al., 1994; Tremayne & Barry, 2001). Most of the studies in this field investigated aiming tasks, such as archery (Landers et al., 1994; Robazza, Bortoli, & Nougier, 2000), rifle shooting (Konttinen, Lyytinen, & Viitasalo, 1998), pistol shooting (Tremayne & Barry, 2001), or golf putting (Boutcher & Zinsser, 1990; Hassmen & Koivula, 2001). In these tasks, adequate postural control is important because the athletes must rely on a stable frame of reference during the aiming phase of the task. Postural stability thus plays a major role in these sport activities. Although more complex balance skills abound in

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sports such as dance, ice skating, or gymnastics, research efforts on the heart rate deceleration effect appear to be limited to the aiming skills mentioned.

A focus of attention that is directed on the effects of the movement (external focus of attention) rather than on the movement itself (internal focus of attention) is associated with optimal performance (Wulf & Prinz, 2001) and is typically found in expert-level athletes (Hatfield, Landers, & Ray, 1987). Support for the positive effect of an external focus of attention has been found in sports such as golf (Perkins-Ceccato, Passmore, & Lee, 2003), volleyball (Wulf, Gärtner, McConnel, & Schwarz, 2002), and baseball (Castaneda & Gray, 2007). Radlo, Steinberg, Singer, Barba, and Melnikov (2002) manipulated the attentional strategy (internal vs. external) and found performance improvement in a dart-throwing task in the external focus group. This performance improvement was associated with heart rate deceleration. On the contrary, the internal focus group showed a performance decrement associated with heart rate acceleration.

Postural control is attentionally demanding, and these demands increase with the complexity of the postural task being performed (Woollacott & Shumway-Cook, 2002). An external focus of attention has been consistently associated with optimal balance performance (Huxhold, Li, Schmiedek, & Lindenberger, 2006; McNevin & Wulf, 2002; McNevin, Shea, & Wulf, 2003; Shea & Wulf, 1999; Wulf, McNevin, & Shea, 2001; Wulf, Mercer, McNevin, & Guadagnoli, 2004). By instructing the participants to focus their attention on markers on a stabilometer (external focus), performance was better than when the participants were instructed to focus on their feet (internal focus; Wulf et al., 2001). Wulf et al. (2001) proposed a constrained action hypothesis to explain this external focus benefit. When using an internal focus of attention, subjects tend to actively intervene in the control of their movements, which interferes with automatic motor control processes. In contrast, an external focus promotes the utilization of automatic control processes, resulting in enhanced performance and learning. Moreover, the benefits of an external focus appear to increase with task complexity (Landers, Wulf, Wallmann, & Guadagnoli, 2005).

However, these studies have used laboratory balance tasks, but sport-related complex balance movements (e.g., gymnastics) have not been studied in this context yet. Moreover, the balance beam in gymnastics is a static apparatus, which is by definition unable to give additional information on the movement effect. So it is unlikely that attention that is directed to the effects of the movements on the environment (external focus of attention) will be beneficial in this specific balance task. This hypothesis is confirmed by other studies on attention focus during gymnastic performance. Guillot, Collet, and Dittmar (2004) stated clearly that when action is organized, bodily, proprioceptive information becomes more important. This suggests that an internal focus of attention would be beneficial in gymnasts. This is confirmed by the finding that gymnasts and dancers shift their sensorimotor dominance from vision (external) to proprioception (internal; Golomer, Cremieux, Dupui, Isableu, & Ohlmann, 1999). Danion, Boyadjian, and Marin (2000) stated that although the gymnasts are dependent on vision, their ability to use the remaining sensory modalities is better than experts in other sports and sedentary individuals, and the authors further added that the role of vision in more dynamic, acrobatic elements such as somersaults is less understood. Finally, Vuillerme, Teasdale, and Nougier (2001) demonstrated that gymnasts can rapidly reorganize the hierarchy among the sensory inputs to ensure adequate postural control. Thus, the performance of the acrobatic element can be considered as a task in which the sensory input of the proprioceptive system is crucial, and consequently an internal focus of attention is beneficial. Therefore, the main purpose of the current study was to investigate the hypothesis that an external focus of attention and the associated heart rate deceleration are not beneficial in sport-related balance tasks on static devices. The preparatory heart rate patterns before the performance of a complex skill (acrobatic element) on the balance beam and its influence on performance outcome were investigated. This performance outcome was quantified in terms of successful and unsuccessful performance.

Recently, Poolton, Maxwell, Masters, and Raab (2006) compared the constrained action hypothesis with the conscious processing hypothesis (Masters, 1992). In the latter hypothesis, stress affects performance through a process in which anxiety induces a conscious reinvestment of explicit knowledge to control the execution of the skill and, paradoxically, disrupts the automaticity of performance. This performance decrement has been consistently reported with self-focused (internal) attention (Liao & Masters, 2002; Maxwell, Masters, & Poolton, 2006). These data suggest that the beneficial effects of an external focus of attention and the associated heart rate deceleration could be influenced by changes in anxiety level. Facchinetti, Imbiriba, Azevedo, Vargas, and Volchan (2006) found that, while watching aversive pictures, a freezing-like reaction occurred in postural stability and this was accompanied with heart rate deceleration. This heart rate deceleration must be understood in the initial attentional nature of defense. So it is plausible that this defensive immobility, caused by increasing levels of anxiety, could lead to changes in balance performance on the beam.

A second aim of the current study was to investigate the possible role of anxiety on the performance of the acrobatic element. Because anxiety is believed to have a detrimental influence on the possible effects on heart rate deceleration associated with an external focus of attention, the acrobatic element was executed on a balance beam at three different heights. It was hypothesized that anxiety would increase with increasing height, leading to significant changes in attention processes. These changes would then be reflected in different preparatory heart rate patterns with significant changes in balance performance as an eventual result.

Method

Participants

Fourteen Belgian female gymnasts volunteered for this study. They were national-level gymnasts with 3 to 14 years of experience (*M* = 7.5 years, *SD* = 2.9 years), and they reportedly trained 7 to 13 hr per week (*M* = 9.9 hr, *SD* = 2.3 hr). The gymnasts ranged in age from 11 to 19 years (*M* = 13.2 yr, *SD* = 2.3 yr), in height from 139 to 167 cm (*M* = 154.2 cm, *SD* = 9.9 cm), and in body mass from 32.0 to 55.5 kg (*M* = 44.2 kg, *SD* = 9.2 kg). Written informed consent was obtained from the participants and the parents. This study was approved by the Ethical Committee of Ghent University Hospital.

Task

Each participant performed three attempts of a compulsory routine on a balance beam of three different heights. The three heights were the normal competition height (1.25 m), a lower than competition height (0.20 m), and a higher than competition height (1.70 m). The order of the heights during the experiment was randomized between participants. The compulsory routine consisted of four elements in fixed order, namely, a hold (scale forward), a jump (wolf hop), a gymnastic turn (1/1 turn), and an acrobatic element (flic-flac). All gymnasts mastered these skills. These skills (or similar ones) were part of their individual competition balance beam routine. Routines with a fixed order of elements allow an analysis between participants. The duration of the routine was shorter than a normal competition routine, to minimize physiological fatigue because of the multiple attempts. By using a fixed routine instead of separate elements (e.g., the acrobatic element), the ecological validity was retained.

Measurements

Self-Report Scales. To assess competitive anxiety, the Dutch version of the Competitive State Anxiety Inventory 2 (CSAI-2; Bakker, Vanden Auweele, & Van Mele, 2003) was used, which consists of three subscales: cognitive anxiety (CA), somatic anxiety (SA), and self-confidence (SC). Each subscale has items to be scored using a 4-point scale (1: *not at all*, 4: *very much so*). Subscale scores may range from 9 to 36. The CSAI-2 has been shown to have good internal consistency and construct validity. We used instructions to minimize social desirability bias (Martens, Vealey, & Burton, 1990).

Performance. All routines were performed and videotaped against a neutral background. Performance analysis was restricted to the acrobatic element and the presence of a fall was used as measure of performance outcome. A fall leads to a 0.50-point penalty. This is critical because the interindividual differences between gymnasts are very small and the difference between a medal and an anonymous ranking is often defined by tenths of a point. Therefore, using the occurrence of a fall to discriminate between successful and unsuccessful performance is valid and relevant in balance beam performance in gymnasts.

Physiological Measurement. Heart rate was measured beat by beat during the balance beam routine with a telemetric heart rate monitor (Polar Vantage NV). To ensure that there was no inconvenience for the gymnasts, the watch was taped to the back. None of the gymnasts reported to be hindered by the heart rate monitor. After each session, the heart rate data were transmitted to a personal computer. Measurement errors were filtered with the Polar Precision Performance Software for Windows. The filter was set at a moderate filter power and a minimum protection zone of 6 beats per minute (Cottyn, De Clercq, Pannier, Crombez, & Lenoir, 2006). The heartbeats during the preparation period of the acrobatic element were extracted for further analysis. The preparation period is a self-paced event, so the duration and the number of beats differed among participants. Therefore, a repeated measures analysis of the heart rate pattern—with heartbeat or time as a separate factor as has been used previously in the literature (e.g., Verschuere, Crombez, De Clercq, & Koster, 2004)—was not possible. As an alternative, four time points were calculated from the heart rate data during the preparation period preceding each attempt. The preparation period was defined as the time period between the moment the gymnasts stood still after the previous element (1/1 turn) and the moment that the acrobatic element was initialized. This analysis was established by synchronizing the heart rate data with the video recordings of the balance beam routines. The four time points are as follows: the heart rate at the beginning of the preparation period (T1), the mean heart rate during the first half of the preparation period (T2), the mean heart rate during the second half of the preparation period (T3), and the heart rate at the end of the preparation period (T4)—for instance, a preparation period of 3 s and in which 7 heartbeats were counted, successively, 134 bpm, 134 bpm, 135 bpm, 134 bpm, 133 bpm, 133 bpm, and 130 bpm. Thus, T1 is the first heartbeat (134 bpm); T2 is the mean of the second, third, and fourth heartbeats (134 bpm); T3 is the mean of the fourth, fifth, and sixth heartbeats (133 bpm); and T4 is the seventh heart beat (130 bpm). This method allows comparison of the preparatory heart rate patterns of preparation periods with differing durations and numbers of heartbeats.

Procedure

Each participant performed all beam performance tests on the same day. Participants were informed about the tests, were instructed on how to use the questionnaire, and were given more information on heart rate measurement. After a standard warm-up of 15 min, the balance beam routine was demonstrated and one practice attempt was allowed. This attempt was performed on a floor mat and not on the balance beam. Then in random order, the participants performed the tests at the three different heights. At each height, the same sequence of measurements was carried out. First, while seated, the participants scored the CSAI-2. Then, participants performed three successive attempts of the compulsory balance beam routine on each of the three different heights. Heart rate was measured continuously during the routine.

Data Analysis

The data analysis was executed in four steps. First, to evaluate whether elevated height was successful in manipulating anxiety, a 3-factor (height) ANOVA for repeated measures was used to investigate differences in the subscales of the CSAI-2 (cognitive anxiety, somatic anxiety, and self-confidence). Post hoc analysis (least significant difference) was used to examine possible differential effects for height. Second, the preparation period before the acrobatic element is a self-paced event and the duration is predicted to fluctuate between attempts. Therefore, a 3 (height) × 3 (attempt) ANOVA for repeated measures was used to investigate differences in the duration of the preparation period. Post hoc analysis (least significant difference) was used to examine differential effects for height and attempt. Third, to investigate whether heart rate patterns (deceleration, acceleration, or no changes) were different between heights and attempts, a 3 (height) × 3 (attempt) × 4 (time) ANOVA for repeated measures was used. Post hoc analysis (least significant difference) was used to examine main effects for height, attempt, and time. Fourth, to investigate whether heart rate patterns differed between successful (no fall) and unsuccessful performance (fall) of the acrobatic element, a 2 (fall) × 4 (time) ANOVA for repeated measures was used. Significant higher order interactions were further explored with lower order ANOVA for repeated measures. Finally, differences of the duration between unsuccessful performance and successful performance were tested with a 2-factor (fall) ANOVA for repeated measures.

Owing to technical disturbances, some values were missing (3%). These were replaced by the series mean. Greenhouse–Geiser adjustment was used when the assumption of sphericity was violated. Partial eta squared (η^2) was reported as a measure of effect size. Statistical significance was set at $p < .05$.

Results

Self-Report Scales

The mean ± *SD* values for cognitive anxiety, somatic anxiety and self confidence on the three heights are presented in Table 1. A significant increase in cognitive anxiety, $F(2, 26) = 25.26$, $p < .001$, $\eta^2 = .66$, and somatic anxiety, $F(2, 26) = 29.65$, $p < .001$, $\eta^2 = .70$, was found, and a significant decrease in self-confidence, $F(2, 26) = 21.71$, $p < .001$, $\eta^2 = .63$, occurred with increasing height. Post hoc significant differences were found between all height conditions for the different components of CSAI-2 ($p < .001$), except for the difference between self-confidence on the NORMAL height and the HIGH height, although this difference approached significance ($p = .062$).

Duration of Preparation Period

The means and standard deviations of the duration of the preparation period are presented in Table 1. A significant main effect was found for height, $F(2, 26) = 4.52$, $p < .05$, $\eta^2 = .26$, but not for attempt, $F(2, 26) = .60$, *ns*, $\eta^2 = .04$. The interaction Height × Attempt was not significant either, $F(4, 52) = .12$, *ns*, $\eta^2 = .01$. Post hoc analysis of the significant main effect for height revealed significant shorter duration at the LOW height compared with the NORMAL, $p < .05$, height and the HIGH height, $p < .05$. No significant difference in duration was found between the NORMAL and the HIGH height.

Table 1 Means and Standard Deviations of the CSAI-2 Variables Cognitive Anxiety (CA), Somatic Anxiety (SA), and Self-Confidence (SC) on Three Different Heights (LOW, NORMAL, and HIGH)

N = 14	LOW	NORMAL	HIGH
CA	13.4 ± 3.7	18.8 ± 5.7	24.5 ± 7.1
SA	14.6 ± 3.8	20.7 ± 5.3	27.9 ± 7.8
SC	27 ± 5.3	21.1 ± 5.2	17.4 ± 6.7

Heart Rate Pattern

The means and standard deviations of heart rate at the four time points for each height and each attempt are presented in Table 2. There was a significant main effect for height, $F(2, 26) = 17.40$, $p < .001$, $\eta^2 = .57$, and for time, $F(3, 39) = 6.07$, $p = .002$, $\eta^2 = .32$, but no significant main effect was found for attempt, $F(2, 26) = 1.33$, *ns*, $\eta^2 = .09$. Post hoc analysis of the significant main effect for height revealed that the heart rate during the preparation period of the acrobatic element was significantly lower on the LOW height compared with the NORMAL height, $p < .001$, and the HIGH height, $p < .001$. Post hoc analysis of the significant main effect for time revealed a significant lower heart rate at the end of the preparation period (T4) compared with the beginning of the preparation period (T1), $p = .015$, during the first half of the preparation period (T2), $p < .01$, and during the second half of the preparation period (T3), $p < .01$. There were no significant interactions for Attempt × Time, $F(6, 78) = .53$, *ns*, $\eta^2 = .04$ or for Height × Time, $F(6, 78) = .95$, *ns*, $\eta^2 = .07$. There was a significant interaction for Height × Attempt, $F(4, 52) = 6.12$, $p < .001$, $\eta^2 = .32$. The significant interaction for Height × Attempt was investigated in more detail with a 3-factor (attempt) ANOVA for repeated measures and revealed a significant main effect for attempt at the LOW height, $F(2, 26) = 3.50$, $p < .05$, $\eta^2 = .21$, and at the NORMAL height, $F(2, 26) = 7.29$, $p < .01$, $\eta^2 = .36$, but not at the HIGH height, $F(2, 26) = 2.69$, *ns*, $\eta^2 = .09$. Post hoc analysis of the significant main effect for attempt at the LOW height revealed a significantly higher heart rate at the third attempt compared with the first attempt, $p < .05$, and post hoc analysis of the significant main effect for attempt at the NORMAL height revealed a significantly lower heart rate at the third attempt compared with the first attempt, $p < .01$. There was no significant interaction for Height × Attempt × Time, $F(12, 156) = .67$, *ns*, $\eta^2 = .05$.

Table 2 Mean and Standard Deviation of Duration of the Preparation Period and the Heart Rate on Four Time Points During the Preparation Period Before an Acrobatic Element on the Balance Beam, on Three Different Heights (LOW, NORMAL, and HIGH) for Three Attempts

N = 14	Attempt	Duration (s)	T1 (bpm)	T2 (bpm)	T3 (bpm)	T4 (bpm)
LOW	First	1.9 ± 1.2	132.1 ± 17.0	131.2 ± 16.7	129.2 ± 16.9	127.9 ± 16.4
	Second	1.8 ± 1.1	132.3 ± 16.4	131.1 ± 17.1	130.8 ± 16.8	128.9 ± 15.4
	Third	1.8 ± 0.9	137.4 ± 13.9	136.6 ± 14.8	136.6 ± 15.2	133.6 ± 15.6
NORMAL	First	2.8 ± 1.6	145.4 ± 17.9	144.6 ± 19.0	143.2 ± 19.6	142.6 ± 18.0
	Second	2.6 ± 1.2	144.2 ± 15.7	143.2 ± 15.4	139.7 ± 16.4	137.4 ± 17.1
	Third	2.7 ± 1.1	137.9 ± 17.4	136.4 ± 17.5	135.9 ± 18.1	135.4 ± 18.9
HIGH	First	2.9 ± 2.2	145.4 ± 17.8	145.8 ± 20.0	144.1 ± 21.8	143.0 ± 19.3
	Second	2.6 ± 1.5	142.8 ± 16.7	142.6 ± 17.3	142.3 ± 18.2	141.9 ± 17.8
	Third	3.1 ± 1.9	139.6 ± 16.6	139.9 ± 16.4	140.0 ± 16.2	137.4 ± 16.6

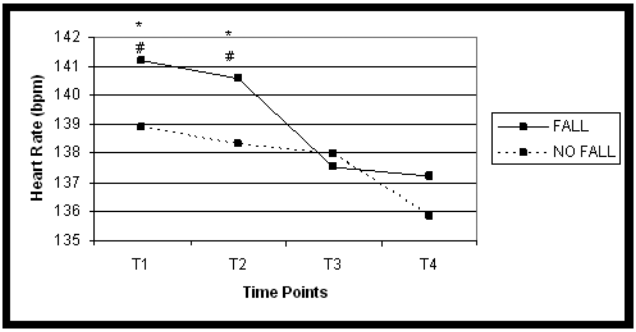

Figure 1 — Mean heart rate (beats per minute) at four time points (T1, T2, T3, and T4) for attempts with a fall and attempts without a fall. *Significantly different from T4 ($p <$ .01); #Significantly different from T3 ($p < .05$).

Performance

During the acrobatic element, 35 falls of 126 attempts (27.78%) occurred. Because no significant Time × Height × Attempt interaction was found for the heart rate patterns (see above), the nine attempts (three attempts at three heights) of each single participant were taken together. Next, for each participant, the attempts with and without a fall were categorized and the four time points were averaged for each category (fall vs. no fall). The $M \pm SD$ number of falls was 2.50 ± 1.61 out of 9 attempts. Two participants had no falls during the acrobatic element and were excluded from this analysis. ANOVA for repeated measures analysis automatically excludes participants with no observations in all conditions (here, fall and no fall). However, the heart rate (bpm) and *SD* of these two participants at the four time points of their successful trails were very similar to those of the other participants (141.5 ± 6.4 for T1, 140.5 ± 7.8 for T2, 140.0 ± 6.4 for T3, and 139.5 ± 7.8 for T4). The heart rate pattern of each group is described in Figure 1. A 2 (fall) × 4 (time) ANOVA revealed a significant interaction between fall and time, $F(3, 33) = 4.59$, $p < .01$, $\eta^2 = .29$, and a significant main effect for time, $F(3, 33) = 5.52$, $p = .003$, $\eta^2 = .33$. No significant main effect was found for fall, $F(1, 11) = 0.71$, *ns*, $\eta^2 = .06$. Further analysis of the significant interaction Fall × Time was investigated with a 4-factor (time) ANOVA for repeated measures and revealed that a significant time effect only was found for the attempts with a fall, $F(3, 33) = 8.16$, $p < .001$, $\eta^2 = 0.43$, and not for those without a fall, $F(3, 33) = 2.59$, *ns*, $\eta^2 = .19$. There were no significant difference in the duration of the preparation of the attempts with a fall and those without a fall, $F(1, 11) = 0.13$, *ns*, $\eta^2 = .01$.

Discussion

A significant heart rate deceleration was found during the preparation period of an acrobatic element on the balance beam in the attempts with a fall in the consecutive acrobatic element. A small, however nonsignificant, heart rate deceleration was found in the attempts without a fall. These data suggest that preparatory heart rate deceleration is associated with a detrimental effect upon balance beam performance.

Because the scores on the cognitive anxiety and somatic anxiety subscale of the CSAI-2 and heart rate were significantly higher with increasing height, it can be assumed that the height-induced anxiety manipulation was successful. But because no significant interaction was found between time and height, it can be concluded that heart rate deceleration pattern is not influenced by the height-induced anxiety changes. This is in line with Hassmen and Koivula (2001), who demonstrated that differences in state anxiety induced by noise do not influence the possible effect of preparatory heart rate deceleration. They found higher heart rate levels in the noise condition but this was not associated with a different heart rate pattern during the preparation period of the golf put. It was expected that the higher anxiety level would lead to more self-focused attention, which in turn should lead to a conscious reinvestment of explicit knowledge, and eventually a performance decrement (Liao & Masters, 2002). However, it is possible that self-focused (internal focus) attention does not have a detrimental effect on balance beam performance.

In the literature, preparatory heart rate deceleration has often been found in tasks with external attentional focus and is beneficial to the performance of such self-paced sport activities as rifle shooting, pistol shooting, archery, and golf. In addition, several studies found a facilitative effect of an external focus of attention on balance performance. The findings of the current study conflict with these results: A significant heart rate deceleration is associated with deteriorated balance performance. Wulf and Prinz (2001) defined an external focus of attention as attention that is directed to the effects of their movements on the environment (e.g., the implement or apparatus). This implies that the apparatus or the implement must be able to move. In most of the balance studies, a dynamic balance test on a stabilometer was used. In these studies, there was a clear movement effect because the stabilometer is a moving apparatus. In the current study, the gymnasts performed on a static balance beam, which is by definition unable to give additional information on the movement effect. So it is unlikely that an external focus of attention was beneficial in this specific balance task. Several authors suggested that the performance of the acrobatic element can be considered as a task for which the sensory input of the proprioceptive system is crucial and consequently an internal focus of attention is beneficial (Golomer et al., 1999; Danion, Boyadjian, & Marin, 2000; Vuillerme, Teasdale, & Nougier, 2001; Guillot, Collet, & Dittmar, 2004). This is further confirmed by the fact that in the few studies that investigated the influence of attentional focus on static balance (center-of-pressure measurement on a force platform), no beneficial effect of an external focus of attention was found (Landers et al., 2005; McNevin & Wulf, 2002). This was explained by the fact that static balance is controlled more or less automatically and that an external focus would be especially pronounced in relatively complex skills, for which automatic control processes still need to be acquired (Landers et al., 2005). Our findings suggest that it is not the complexity of the balance task that is the main factor in the beneficial effects of an external focus of attention, but is instead the availability of information on the movement effect. In other words, when the implement is static and thus unable to provide information about the movement effect, an external focus of attention is not beneficial. To test this hypothesis, a direct manipulation of the focus of attention, while performing an acrobatic element on a static balance beam, is necessary.

Facchinetti et al. (2006) found that anxiety-induced heart rate deceleration was associated with freezing. This defensive immobility led to changes in postural stability. So it is possible that the heart rate deceleration–related impairment of the balance performance gymnasts in the current study was caused by such a freezing effect. In the cardiac-coupling hypothesis, Obrist et al. (1974) suggests that heart rate deceleration is concomitant with motor quieting. This reduction in somatic activity could also be reflected in the freezing effect. The phenomenon of freezing can be studied by kinematic analysis, but because force plate measurements were not possible during balance beam performance in this study, another method should be used to investigate the kinematic properties of postural stability. Pijpers, Oudejans, Holsheimer, and Bakker (2003) used a geometric index of entropy to measure the fluency of the movements during climbing. It would be a fruitful suggestion to measure entropy during performance on the beam to investigate this freezing phenomenon.

Singer (2002) states that an ideal preperformance state for self-paced events involves the self-regulation of thoughts and emotions so that they are compatible with what needs to be done. Radlo et al. (2002) refer to an optimal state of mental readiness and Robazza, Bortoli, and Nougier (1999) mention an optimal arousal level specific to the task. This is in line with the concept of the readiness potential. Voluntary movement is preceded by increased cortical activity, beginning up to 2 s before movement initiation (Cunnington, Windischberger, & Moser, 2005). The function of this phenomenon is that the supplementary motor area generates and encodes motor presentations that are then maintained in readiness for action. It is possible that in the current study, an inappropriate level of readiness occurred during the preparation period of the attempts with a fall.

In summary, a significant heart rate deceleration was found during the preparation period of an acrobatic element on the balance beam, but this was only found in the attempts where a fall during the acrobatic element followed. This can be explained in terms of focus of attention or within the concept of optimal state of mental readiness. The findings also question the generalization of the beneficial effect of an external focus of attention on balance.

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