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# Instructional approaches in youth volleyball training settings: the influence of player's age and gender

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> The purpose of this study was to examine the instructional approaches used by youth volleyball coaches by considering the influence of age and gender of players. The particular focus is on the coach's behaviours, the type of practice, and the directness profile (assessed by the level of players' dependence-autonomy on decision-making and task control). Twenty-eight youth volleyball coaches of a wide range of sport performance levels, evenly divided by the characteristics of their players' gender and age (under 14s and under 18s, from developmental level) were selected for observation of their practice. Results of the survey showed the predominance of a coach-centred pedagogical approach. Prescriptive feedback was thoroughly prevalent, whereas strategies to promote active learning were seldom used. Instructions were focused on technical skills and the typical practice was based on a molecular approach, consisting of acquisition tasks with a low level of contextual interference. The analysis of the coaching directness profile demonstrated reduced autonomy in players' decision-making and task control. This study showed a prevalence of coach-centered approach to coaching independently of the player's gender and age in youth volleyball training settings

> KEY WORDS: Instructional approach; Coaching; Youth volleyball; Players' gender; Players'age.

### Introduction

The traditional teacher-centred approaches, even though supported by the process-product research, do not avoid the criticism of those who advocate more indirect approaches, which places learners at the centre of the learning process (Allison & Barrett, 2000; Chandler & Mitchell, 1990; Turner & Martinek, 1995). The debate between the defenders of direct

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teaching approaches (explicit teaching, step by step learning progression, well structured and closely monitored tasks) (Rosenshine, 1979; Rink, 2001, 2005), and of indirect teaching approaches (based on constructivist and social theories of learning) (Hastie & Siedentop, 1999; Putnam, Lampert, & Peterson, 1990) has attracted little attention in sport games coaching until recently (Reid et al., 2007). In fact, the bottom-up, molecular approach isolating movement skills from the actual performance contexts (Rovegno, 1995) has been an important criteria for good practice in coaching team sports. In adopting this type of approach coaches take full responsibility for setting game problems, diagnosing players' weaknesses, and prescribing adequate solutions (Souza & Oslin, 2008). This approach has been accused of strengthening coach dependency rather than providing support for the development of players' decision-making capacity (Handford, et al., 1997).

In recent years, several alternative models to teaching games such as the *Teaching Games for Understanding* (TGfU) (Bunker & Thorpe, 1982), the *Tactical Games approach* (Mitchell, Oslin, & Griffin, 2006), the *Play Practice model* (Launder, 2001), the *Ball School model* (Kroger & Roth, 1999) have been introduced. These models support a holistic view in which "learning is the active construction of meaning by persons, the understanding of a whole, a process that is in some essential way different from learning a series of parts or elements" (Rovegno, 1995, p. 286).

All these approaches have attracted significant attention from theoreticians and practitioners, as they sought ways to redefine and deepen the learning process of technical and tactical aspects of the game into a more intertwined relationship, by focusing on the development of game performance through a tactic-to-skill approach involving modified games (Hopper, 2002; Chow et al., 2007). The rationale of these game-based models is based on the assumption that game tasks are not only moments for skill application, but also spaces to solve problems (Nevett et al., 2001; Hopper, 2002; Griffin et al., 2003). Game-based training situations are seen to offer many opportunities for using cognitively demanding instructional strategies suited to enhance players' tactical awareness, decision-making, as well as skill execution within game-like contexts (Light, 2004; Souza & Oslin, 2008). While looking for research evidence beyond the customary school environment, Gabbett, Jenkins, and Abernethy (2009) were recently able to confirm the value of game-based training for improving skill and also physical fitness in team-sport athletes.

Taking it one step further, a new approach called Nonlinear Pedagogy (Chow et al., 2007) intends to provide theoretical grounds to alternative

models of teaching games from a motor learning perspective. Informed by Dynamical Systems Theory and Newell's (1985) constraints model, Nonlinear Pedagogy involves manipulating key task constraints on learners to facilitate the emergence of functional movement patterns and decision-making behaviours. Thus the essential role of the teacher or coach is to identify the major constraints of each individual and to manipulate relevant task and performer constraints at the appropriate learning stage (Davids et al., 2005). This new approach, requires critical changes in the key variables of the instructional process, namely in the goals and content of instructional tasks (i.e. type of practice); in the coaches' behaviours during practice; and in the role played by coaches and players in the regulation of instructional tasks (i.e. directness profile), which jointly configures the particular features of the training environment (Cohen, Raudenbush, & Ball, 2003; Metzler, 2000).

Framed upon didactical ideas derived from the Teaching Games for Understanding Model (Bunker & Thorpe, 1982), and the Skill Development Approach (Rink, 1993), Mesquita et al., (2005) have introduced an instructional approach in volleyball setting, called *step-by-step game*. It emphasizes the adaptation of learning tasks to the games' demands and considers three types of instructional tasks, namely acquisition tasks, structuring tasks, and adaptation tasks. From the first tasks to the last ones the variability of practice is gradually increased resembling more the actual game conditions (Williams & Hodges, 2005). Moreover, the time to spend in acquisition tasks needs to be reduced to the minimum necessary to prevent game disruption (Mesquita et al., 2005). Indeed, in the case of volleyball the focus on technique can hinder the use of tactical focus in the teaching of games. In fact, volleyball is a kind of sport in which technical faults have immediate detrimental consequences on game flow, resulting in either rule violation or return failure. The logical priority ascribed to technique in volleyball teaching has supported the argument for perpetuating the technical approach, even if this approach has made volleyball an unfriendly sport for many children (Rovegno 1995). Moreover the reliance on isolated skills is further constrained by a coach-centred instruction, with few, if any, opportunities for players to take on their own initiative.

To what extent volleyball coaches are staying with this kind of instructional approach or moving toward a more player-centred, game-based approach is a matter badly in need of descriptive empirical work (Potrac, Jones, & Cushion, 2007). Examining the manner in which coaches use the acquisition, structuring and application tasks will provide a useful starting point to expose their instructional approaches to games teaching. Further extending the analysis to include the directness profile promoted by coaches during practice, and the kind of information they deliver in their coaching will give information about the degree of autonomy players might experience in the learning process. Moreover, inspecting the nature (e.g. more descriptive or more questioning) and content (e.g. more technical or more tactical oriented) of the coaches' feedback will reveal the explicit-implicit balance of instructional profile, and the molecular-holistic affinity of the teaching approach. Since these instructional variables are not independent and the configuration of the instructional approach adopted by coaches is a result of their interaction, it will be useful to characterize not only each variable *per se* but also the relationship established between them.

The study of coaches' instructional approaches should also consider the major contextual variables related to coaches' and players' characteristics (Coté et al. 1995). There is empirical research comparing preferences of female and male players, and players at different skill levels for coaches' behaviours and leadership styles (Beam, Serwatka, & Wilson, 2004; Riemer & Toon, 2001; Sherman, Fuller, & Speed, 2000; Smoll & Smith, 1989) and behaviours adopted by coaches during practice according to their gender (Lacy & Goldston, 1990). However, variables such as players' gender and age which are also likely to influence on coaching behaviour, practice type and coaching directness profile have not yet been studied in youth training settings.

The interest on coaches' instructional approaches in games teaching is a recent research topic, which justifies the usefulness of descriptive studies that portray how coaches teach the game, and provide baseline data for more advanced research. In this scope it will be useful to examine the key variables of the instructional approaches in coaching considering also the players' characteristics to formulate a more comprehensive description of coaches' instructional approaches in games teaching, using volleyball as a task vehicle.

The aim of this study was to examine the instructional approaches of youth volleyball coaches by considering the influences of players' age and gender. The particular focus was set on coach's behaviours, type of practice, and coaching directness profile (assessed by the level of players' dependenceautonomy on decision-making and task control about what to do, when to do, how to do, and with what results). Furthermore, probing questions were set to examine whether the nature and content of feedback; the type of practice and the nature and content of feedback; and the type of practice and players' autonomy in problem solving were somehow related.

Although this research was carried out in volleyball, the findings can be inferred to other sports thus providing generic assistance to developing coaching practice.

## Methods

#### PARTICIPANTS

The participants of this study were twenty-eight Portuguese volleyball coaches, eight females (n= 8) and twenty males (n=20), certified by the Portuguese Volleyball Federation, and fourteen of the coaches also have a Physical Education degree. The coaches were aged  $29.14 \pm 8.16$  years and had  $7.89 \pm 6.28$  years of experience in coaching volleyball comprising all levels of practice (recreational, developmental and elite levels). Although not being probabilistic, the sample adds up to 60% of the teams that were participating in the age leagues of under 14s and under 18s of the Oporto Volleyball Association for the year 2007. Oporto Association is the most representative of Portugal since it comprises 65% of the total of Volleyball players of the country Coaches were divided in function of two splitting criteria: age group and gender of the teams they were coaching at the moment.

#### VARIABLES

Players - Gender and age (under 14s and under 18s).

*Coach's behaviours* – 1. Feedback: 1.a. Nature: prescriptive, descriptive, positive evaluation/encouragement and negative evaluation/punishment, attentional focus statements, questioning; 1.b. Content: technique, individual tactics, team tactics, physical/rules and general instruction

2. Practice type: Acquisition tasks, structuring tasks and adaptation tasks.

3. *Coaching directness profile*: 3.a. Pacing (control and task regulation): regulated by coach or by players; 3.b. Players autonomy in problem solving: with no autonomy, partial autonomy and total autonomy.

#### **OBSERVATION TOOL**

As no single instrument suited the range of questions of the study completely, observational categories were selected from different instruments that met the criteria of content and construct validity. The categories deemed to apply on the coach's feedback were adapted from Fishman and Tobey (1978), Piéron and Delmelle (1982), Mesquita et al., (2008) and Hastie (1999). The categories for the type of practice structures were adopted from Mesquita and Graça (2004), while the categories for Directness profile adopted from Metzler (2000). Before pilot testing the observation tool, three experts evaluated whether the categories exhausted the respective instructional dimensions, and could be accurately classified. Each expert was given the list of categories to apply to a segment of a youth volleyball training session. The experts reported that the categories were exhaustive, and the percentage of agreement between their records reached the strong consistency score of 95.3%. The instrument is presented in Table I.

#### DATA COLLECTION

Data collection procedures strictly observed the requirements of the University of Porto Ethics Committee for human and social research. All participants were previously informed TABLE I

Categories And Definitions Of The Observation System

1.	COACH'S BEHAVIOURS
1 ^	NATURE
1.A.	Prescriptive (Pr) – The coach gives an indication/imposes a solution that the player should respect. Descriptive (D) – The coach describes the way the player accomplished any previous action. Positive Evaluation/encouragement (Pos) – The coach evaluates the players' performance in a positive way or praising or encouraging the player. Negative Evaluation/punishment (Neg) – The coach evaluates the player's performance in a negative way reflecting disapproval or punishment. Attentional focus statements (AF) – The coach gives an indication to reface the attention of the player. Questioning (Q) – Coaches place a question to the players about its previous performance.
	Technical $(T)$ – The coach gives information related to biomechanically efficient body position with and without the ball
	Individual tactics (IT) – The coach gives information about decision-making related to the individual
	Team tactics (TT) – The coach gives information about team systems, according to principles and rules of playing, and about decision-making related to the collective performance. Physical and rules (PHR) – The coach gives information about physical performance or rules. General information (GI) – The coach gives information without specific volleyball content.
2.	PRACTICE TYPE Acquisition tasks (AT) – practice of one or more skill outside the game exigencies, under low con- textual interference conditions. Structured tasks (ST) – drills that integrate two or more actions according the game flow and coop- erative game to apply the skills under facilitate conditions. Adaptation tasks (AdT) – opposition game under conditioned conditions (modification of represen- tation and exaggeration) or game with normal flow and official rules.
3. 3.A.	COACHING DIRECTNESS PROFILE PACING
3.в.	Coach $(\bigcirc)$ – The coaches control the rhythm of the task and delivery its end. Players (P) – The rhythm and the ending of the task is controlled by the players. AUTONOMY IN PROBLEM SOLVING Without autonomy (WA) – The coaches prescribe the action and the solution in tasks

Without autonomy (WA) – The coaches prescribe the action and the solution in tasks. Partial autonomy (PA) – The coaches prescribe the action but not the solution in tasks. Total autonomy (TA) – The players decides the action and the solution in tasks.

about the goals of the study, the conditions of participation, and were assured of confidentiality and anonymity of personal information. All participants volunteered and gave informed consent to taking part in the study. One coaching session per coach was video recorded during typical practice session in the competitive phase of the season, making a total of 28 analyzed training sessions. Following recommendations of Lacy and Darst (1985) Lacy and Goldston (1990) and Potrac et al. (2007), eligible sessions were only from the middle of the week, more precisely Tuesday, Wednesday or Thursday, since they are likely to be less affected by the immediacies of the "next/past match", and could provide a more representative portrait of the typical practice structure and pedagogical strategies employed by coaches.

The observational material for this study constituted the fundamental part of the training session. The conditioning segments of the training sessions as well as the initial and the final parts of each session were not included in to systematic observation. The total amount of time coded in 28 training sessions was 2430 minutes, with each coach being observed on average for  $87\pm1,12$  minutes.

Data were compiled using event recording procedures, which has been shown to be a valid method for the analysis of coaches' behaviour (Potrac et al., 2007), and type of practice (Graham 1987; Mesquita et al., 2008), allowing a cumulative record of the number of discrete events within a specified time.

Coaching behavioural data were coded into observational categories by two trained observers. In the training phase all observers discussed the rules and solved possible differences regarding each category. This phase was ended with an independent observation test. After two weeks the same test was given with no feedback provided in the interim. No difference was found between the observers or test-retest observations, which proved the reliability of the coding protocol. The Wilcoxon text was used since the requirements to apply parametric statistics were not verified.

#### DATA ANALYSIS

Total number of observed behaviours and percentages from each behavioural category were submitted to descriptive and inferential statistics. Since the requirements of normality and homogeneity of the variations were not verified through the Kolmogorov-Smirnov test and the Levene test, respectively, non-parametric statistics (U de Mann-Whitney) were applied. Additionally the Effect size (ES), the index that measures the magnitude of a treatment effect, was calculated. Cohen (1988) and Winer et al. (1991) proposed ES values of 0.2 which represent small differences, 0.5 moderate differences, 0.8+ large differences. Spearman's rank correlation tests were also used to verify the degree of association of the variables. For all the tests the level of significance was set at p£0.05.

#### RELIABILITY

The reliability of the observations was assured by the inter-observer and intra-observers' agreement, within a 30-day interval, using Bellack's agreement rate (Van der Mars, 1989). Twenty-seven tasks (12.2%) of the total practice task were analyzed, for each variable, a higher value than the minimum (10%) described in literature (Tabachnick and Fidell, 2000). The minimum value found was 93% from the inter-observer's agreement. Cohen's Kappa was also calculated to eliminate the agreement by chance. Coefficient K values ranged from 0.85 to 0.90 in the inter-observer's agreement, and from 0.84 to 0.89 in the intra-observer's agreement. Fleiss (1981) argues that scores greater than 0.75 indicate strong agreement.

## Results

#### COACH BEHAVIOUR

As illustrated in Table II, from a total of 7460 units of information, the highest single category observed for the coaches was the *prescriptive feedback* (Pr) (46.4%), followed by the category *positive feedback* (Pos) (25.2%). Low values were verified for the categories *questioning* (Q) and *attentional focus statements* (AF) with 4.9% and 2.1%, respectively.

The Nat	ure Of Feedl	back In Relatio	on To Players' Gen	der And Age		
			(	Gender	A	lge
	Freq	%	Male M±SD	Female M±SD	Under 14 M±SD	Under 18 M±SD
Pr D Pos Neg Q AF	3462 815 1880 782 365 156	46.4% 10.9% 25.2% 10.5% 4.9% 2.1%	$\begin{array}{c} 135.07 \pm 57.53 \\ 29.07 \pm 19.51 \\ 15.79^{*} \\ 16.79^{*} \\ 13.07 \pm 6.64 \\ 16.46^{*} \end{array}$	112.21±46.83 29.21±12.26 13.21* 12.21* 13.00±6.36 12.54*	137.43±53.36 34.79±13.23 13.25* 15.36* 15.21±5.73 <b>18.79</b> *	$\begin{array}{c} 109.86 \pm 50.26\\ 23.50 \pm 16.95\\ 15.75^{*}\\ 13.64^{*}\\ 10.86 \pm 6.44\\ \textbf{10.21}^{*} \end{array}$

TABLE II

\* Mean rank (Mann-Whitney test)

From the analyses of the gender influence, no values reached statistical significance. The analyses of team age group influence revealed differences uniquely in the category *attentional focus statements*, with coaches in teams under 14s providing more of this kind of feedback (Mann-Whitney U= 38.000; p=0.005, ES=.32).

Considering the content of instruction *technical* instruction (T) was mostly used (43%), and the *general instruction* (GI) also presented a high value (34.3%) (Table III). Tactical instruction was directed more often to individual players (IT) than to the whole team (TT) (15.2% and 6.3% respectively). Comparative analysis between different age groups or gender did not reveal any statistical differences.

Some significant correlations were found between content and nature of feedback. Technical instruction was highly correlated with *prescriptive* and *descriptive* information (r=.833; p=0.001 and r=.712; p<0.001). Also, individual tactics correlated significantly with *prescriptive* feedback (r =.723;

The Con	tent Of Feed	dback In Relati	ion To Players' Gen	eder And Age		
			(	Gender	А	ge
	Freq	%	Male M±SD	Female M±SD	Under 14 M±SD	Under 18 M±SD
T IT TT PHR GI	3207 1137 468 86 2562	43.0% 15.2% 6.3% 1.2% 34.3%	121.79±55.89 44.14±23.10 12.71* 16.18* 16.32*	107.29±41.03 37.07±19.51 16.29* 12.82* 12.68*	138.14±43.72 39.86±24.22 15.43* 14.04* 13.82*	90.93±42.53 41.36±18.80 13.57* 14.96* 15.18*

TABLE III

\* Mean rank (Mann-Whitney test)

p<0.001) and *general* information was highly correlated with *positive* feedback (r =.909; p<0.001).

## TYPE OF PRACTICE

Table IV presents the type of practices observed in training sessions. There was a clear dominance of *acquisition tasks*, which constituted 67.9% of the tasks. *Structuring tasks* came second with 21.3%, and finally *adaptation task*, with only 10.8%. Comparative analysis between different age groups or gender failed to reveal any differences in the distribution of practice types.

No significant correlations were found between the different type of practice tasks and nature and content of coach's feedback (*nature* and *content* of instruction).

			(	Gender	A	Age
	Freq	%	Male M±SD	Female M±SD	Under 14 M±SD	Under 18 M±SD
AT ST AdT	150 47 24	67.9% 21.3% 10.8%	5.29±2.73 12.89* 14.86*	5.29±2.73 16.11* 14.14*	5.57±2.93 12.36* 13.71*	5.00±2.48 16.64* 15.29*

				Table IV	
Different Pr	actice Types	s In Relation	ı To Players'	Gender And	Age

\* Mean rank (Mann-Whitney test)

#### DIRECTNESS PROFILE

Table V reveals that practice sessions were in a large part directly controlled and regulated by coaches (pacing) (76%). Only 24% of the tasks were regulated by players themselves. No apparent differences in pacing profiles of practices were found between age groups or gender.

Regarding the degree of *autonomy in problem solving*, we found relatively few opportunities for players to exercise autonomy, as only in 27.6% of the practice tasks players were able to own some or all decisions to be made (*partial autonomy* and *total autonomy*). Indeed *total autonomy* for players was allowed only in 9% of the practice tasks and coaches decided what the players had or needed to do in 72.4% of the practice. No differ-

			(	Gender	A	lge
	Freq	%	Male M±SD	Female M±SD	Under 14 M±SD	Under 18 M±SD
C P WA PA TA	168 53 160 41 20	76.0% 24.0% 72.4% 18.6% 9.0%	6.36±1.69 11.61* 5.29±2.13 13.68* 15.14*	5.29±2.34 17.39* 5.50±3.08 15.32* 13.86*	5.79±2.29 12.93* 5.50±2.79 13.00* 15.43*	5.86±1.92 16.07* 5.29±2.49 16.00* 13.57*

 TABLE V

 Pacing And Autonomy In Problem Solving In Relation To Players' Gender And Age

\* Mean rank (Mann-Whitney test)

ences between age groups or gender were detected in *autonomy in problem solving* profiles.

Concerning the relationship between *autonomy in problem solving* and *type of practice*, only one significant correlation was found between the category *without autonomy* (WA) to solve problems and the *acquisition tasks* (AT) (r = .764; p < 0.001).

## Discussion

This study examined the coach's behaviours, the type of practice, and the directness profile adopted by youth volleyball coaches during practice sessions. Irrespective of players' age group or gender, coaches predominantly used a coach-centred approach. The nature of instruction was most often prescriptive focusing on technical content, and practice, mainly controlled by coaches, consisted of acquisition tasks, which gave players few opportunities to attain autonomy in problem solving and understanding.

One of the variables used to characterize the instructional approach was the nature of the information delivered by coaches throughout their practice. The prevalence of an explicit instructional profile was clearly demonstrated by the fact that coaches' feedback was mainly transmitted in the prescriptive mode (46.4%), as commonly found also in other studies (Lacy and Goldston, 1990; Potrac et al. 2002). Conversely, the use of *questioning* was low (4.9%), which implies that coaches are failing to take full advantage of an important instructional strategy that has been proven effective in eliciting cognitive efforts, problem solving, creativity, and critical thinking in other domains (Fenwick & Parsons, 2000; Hammerman et al., 1994; Knight et al., 1997; Otero & Graesser, 2001; Sachdeva, 1996; Thomas, 2000). The high emphasis of technical aspects in volleyball, like biomechanically efficient body position (Rovegno, 1995) can partly explain the nature of coaches' feedback. However, as Vickers et al. (2004) have claimed, instead of dwelling over skill execution information, coaches should direct their efforts also to other aspects of performance, such as tactical knowledge and critical decision-making factors. The player-centred approach involves the use of questions to develop player's tactical awareness and understanding (Souza & Oslin, 2008). Even in sports like swimming, where technical demands are prevalent, the combination of delayed feedback and questioning has been shown to improve swimmers technique (Chambers & Vickers, 2006).

Moreover, this study showed that affective interactions between coaches and players were predominantly positive. Some studies demonstrated that positive interactions contribute to enhance coach-players relationship and to create a positive learning atmosphere (Lacy & Darst, 1985; Potrac et al, 2007). Moreover Black and Weiss (1992) verified that players' perception of coaches' positive interaction was associated with perception of higher levels of success, competence, enjoyment, and preference for optimally challenging activities. Thus, positive interaction, if wisely used, has potential to enhance players' self-efficacy and confidence levels and is valuable in reinforcing players' behaviours desired by their coaches (Potrac, et al., 2002). Furthermore, this study showed a significant and positive correlation between positive feedback and general information suggesting the concern of coaches in creating a good coaching atmosphere to enhance learning. Recent research on professional top-level soccer coaches (Cushion & Jones, 2001; Potrac et al., 2002; 2007) considered positive interaction to be related to coach expertise. In this study, the wide range of coaching experience did not allow the analysis of its influence on coaches' instructional approaches. For a better understanding further research should consider how coaching experience influence the instructional approaches adopted by coaches, namely by recurring to in-depth qualitative analysis.

Therefore, the overall pattern emergent in this study is probably a consequence of the prevalence of acquisition tasks (67.9%) (e.g. practice of one or more skills under low contextual interference conditions). These findings can probably be explained by the reliance in a molecular approach to teaching team sports, especially in Volleyball where technique is traditionally highly favoured (Rovegno, 1995), and the coach is typically assumed to be responsible for setting game problems and formulating solutions (Souza & Oslin, 2008). Findings may also reflect the widespread belief that skill development must be firstly addressed in an out-of-game context, under the rule of a prescriptive approach (Blomqvist et al., 2001; Jones, 1982; Williams and Hodges, 2005). Both schema theory (Schmidt, 1975; Schmidt & Lee, 1999) and dynamical systems approaches (Davids et al., 2001) acknowledge that variability of practice "encourages learners to develop movement patterns that are more adaptable and better equipped to negotiate the largely unpredictable coordinative demands of competition" (Reid et al. 2007, p.6). Yet these theoretical tenets seem to remain neglected by coaches of this study, as application tasks amounted only to 10.8%.

As different authors argue, the *modus operandi* of traditional approach to teaching games consists of breaking the game down to its "fundamental skills". Critics would claim that the scarcity of game-like practice results in players with poor capacity to solve problems during games, becoming bad decision-makers with low autonomy to appreciate, understand, and implement opportune decisions (Souza & Oslin, 2008). Indeed the higher preference of coaches this study for acquisition tasks, in which players are deprived of autonomy, clearly shows the coaches' preference to retain and control the prerogative of determining solutions. Only 24% of the pacing of the tasks was controlled by players and no more than 27.6% of the tasks provide players with the opportunity to make autonomous decisions about the actions or solutions for instructional tasks. As Kidman (2001) argued team sport demands the necessity to understand and appreciate the game context, which means that players need to make informed decisions, take ownership for their learning, and exercise choice in a way to promote play autonomy.

Considering the players' age, coaches from this study did not differentiate their instructional approach in any of the considered variables (coach behaviour, type of practice and directness profile). However, instructional approaches are likely to have different impact on the learning according to the players' age. In the earlier stages of learning, players may benefit more from prescriptive feedback to improve performance when the technical demands are quite simple (i.e. basic patterns to execute the forearm pass) and the learning tasks do not require problem-solving (Williams & Hodges, 2005). On the contrary, when the complexity increases (i.e. applying the forearm pass in the game context) the absence of prescriptive feedback may encourage learners in their problem-solving process (Wulf & Shea, 2004).

Researchers in the fields of Motor Learning and Pedagogy (Boyce et al., 2006; Gentile, 2000; Rose & Christina, 2006) uphold that variability of practice should be introduced as soon as players were able to figure out and replicate the basic motor pattern. This means that acquisition tasks (low variability) should be reduced to the minimum time required for acquiring the basic motor patterns (Rink, 1993). Even in Volleyball, where technical proficiency is important to sustain the ball in the game, the focus on game-based tasks (i.e. adaptation tasks) showed to be effective in several technical and tactical measures of play performance with 12-15 year old physical education students (Mesquita et al., 2005). So it is necessary to give space for personal interpretation; for players to decide what skill to apply or how to apply it in unpredictable situations, just as it happens in the game. Discovery learning could work more positively, compared with tightly controlled learning, by encouraging learners to more effectively explore constraints for decisionmaking and skill execution variability (Vereijken, 1991; Chow et al., 2007). In spite of this evidence, more empirical research is needed to examine the impact of different instructional approaches on the learning considering the players' age and the specificity of the subjects 'contents.

Along the same line, coaches from this study showed a similar instructional profile irrespective of players' gender. Comparisons between boys' and girls' preference for coaches' behaviours have produced inconsistent findings. Smoll and Smith (1989) reported that female players perceived and preferred positive behaviours (e.g. reinforcement, encouragement) more than boys. Beam, Serwatka, and Wilson (2004) indicated that male athletes showed greater preferences for autocratic and social support behaviours, while female athletes had greater preferences for situational consideration and training and instruction behaviours. However, Sherman, Fuller, and Speed (2000) found no gender-based differences for players' preferences. The absence of differences in instructional approaches for male and female teams may be a hint that the increasing participation of females in organized sports, either as coaches or players, in the last two decades is attenuating the differences on the behaviours profile among gender. As this is just a supposition, more research is needed to clarify this issue bringing to coaching setting new insights about the appropriateness of the instructional approaches to players' gender.

To go beyond the description of the instructional approaches used by coaches it will be important that further research could examine the impact of different instructional approaches on the player's perception about their usefulness and on the learning achievements. Moreover, research needs to analyse deeply the instructional approaches used by coaches in a more extensive way accompanying the coaching daily practice of the same coaches throughout the sportive season. This query will require a qualitative analysis which attends to the ecological nature of the coaching process and underlying beliefs, knowledge, and reasons for coaches' behaviours in particular coaching settings. This could render a deeper analysis of instructional approach and a thorough understanding of the coaching process. Notwithstanding, this new research avenue needs to work closely with coach education in order to design and implement more effective and adaptive programs, considering the ecological features of the teaching and learning process, which may legitimate the targeted instructional approach.

However the call for qualitative research should not undermine the value of the findings from this study. This is because the sample here is somewhat representative of youth sport coaches in volleyball within Portugal since the reality of the sportive and cultural setting of the coaches under analyse constitutes a substantial proportion of the youth coaches of the most representative volleyball association of the country.

## Conclusion

Instruction is not a simple linear and easily quantifiable process; on the contrary, it is problematic to determine which instructional approach is the most effective in producing long-term improvement in player's performance. The analysis of the youth volleyball coaches' behaviours revealed the over-whelming dominance of a coach-centred approach, featured by the preference for prescriptive feedback with a main focus on technical elements.

The type of practice was definitely molecular, with a predominance of acquisition tasks involving situations of low contextual interference bearing in mind skill efficiency, without much concern to the constraints of the context of application. The coach-centred approach was also reflected in the reduced autonomy conceded to players for problem solving and self-pacing task. Coach's behaviours profile did not vary substantially according to players' age or gender.

Based on the findings a considerable gap exists between the instructional profile observed in this study and the recommendations extracted from the recent research evidence on sport pedagogy, coaching, and motor learning. In order to narrow this gap, efforts have to be made in producing and delivering ecologically validated knowledge; enhancing coach education programs; and in multiplying opportunities and support to help coaches to improve their practice and instruction.

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## Physical activity, sedentary time and subjective well-being in Taiwanese older adults

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The purpose of the study was to investigate whether physical activity and time spent sedentary are associated with subjective well-being in older people. A nationally representative telephone survey was used (n=1,450; mean age 62.1±9.1 years). The results demonstrated that total physical activity (kcal/week) was positively related to several dimensions of subjective well-being, including physical, psychological, independence, learning and growth, and social well-being. These associations, especially in physical and independence well-being, were stronger in the older group (70+ years). Time spent in sedentary mode produced negative and low-to-moderate correlations with subjective well-being, particularly physical, independence, learning and growth, and environmental well-being. These relationships were stronger in females. Older people, especially females and those 70 years and older who are more physically active and spent less sedentary time, experience higher levels of well-being. These findings draw attention to the role of an active lifestyle for enhancing well-being in the older population.

KEY WORDS: Aging, Sedentary Behavior, Quality of Life, Life Satisfaction

## Introduction

Improvement in the well-being of older people has become a priority for policy across the international community (World Health Organization, 2002). Regular physical activity has consistently been identified as a vital part of healthy living and the achievement of quality of life in older age (Biddle & Mutrie, 2007; Fox & Mutrie, in press). For example, the National Blueprint: Increasing Physical Activity among Adults Aged 50 and Older in the US

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(Robert Wood Johnson Foundation, 2001), the Chief Medical Officer's Report: At least five a week in England (UK Department of Health, 2004), and the Physical Activity Guidelines for Americans (US Department of Health and Human Services, 2008), each provide a convincingly strong evidence base for both preventive and therapeutic benefits of physical activity for physical and mental aspects of older people's health.

Subjective well-being (SWB), as an underlying indicator of a good life, has been receiving increasing research interest (Fox, Stathi, McKenna, & Davis, 2007; Hamer, Stamatakis, & Mishra, 2010; Nguven, et al., 2007). Studies featuring a range of research designs have shown that physical activity can improve older people's subjective well-being (Biddle & Faulkner, 2002). Physical activity in these studies has usually denoted leisure-time physical activity in the form of center-based group exercise programs. Less attention has been paid to energy expenditure of overall physical activity. including active transport, domestic, occupational as well as leisure-time physical activity, even though it has been recognized that activity in these contexts can contribute to health (Abu-Omar & Rutten, 2008; Gordon-Larsen, Nelson, & Beam, 2005; Hamilton, Hamilton, & Zderic, 2007; Weller & Corey, 1998). In some countries such as the UK, daily lifestyle activity as opposed to programmed exercise has been shown to make up the bulk of activity and energy expenditure for older people. Fox, Stathi, McKenna and Davis (2007) using accelerometry to indicate degree of daily movement in older people from three different European countries found associations between total daily physical activity and moderate to vigorous physical activity and aspects of mental well-being.

Physical inactivity and sedentary behaviors have long been regarded as interchangeable terms. However, recent literature suggests that time spent sedentary or sitting is independent of time in total physical activity (Biddle, Gorely, & Stensel, 2004). It is therefore important to estimate the impact of levels of sedentary behavior separately to physical activity. Yet little is known about the relationships of sedentary behaviors with subjective well-being in adults of late middle age and older, especially when controlling the influence of physical activity.

Further studies are required to explore these relationships particularly among cultures different to Europe and North America. For example, the rapidly industrializing countries in the East are also witnessing growth in the elderly sector, and these changes are at a faster rate than in the West (Bengtson & Putney, 2000), but few studies regarding physical activity and subjective well-being in older adults have been conducted in Eastern societies. Indeed, existing studies have been dominated by instruments of well-being developed in Western societies (Lee & Russell, 2003; McAuley et al., 2000), meaning that less of Eastern-based devices are available for use. The adoption of culture-specific instruments is highlighted by evidence showing that subjective well-being has distinct meanings across different cultures (Deiner & Seligman, 2004; Keith et al., 1994; Torres, 1999). The recent development of the Chinese Aging Well Profile has provided new opportunities to test relationships of physical activity with subjective well-being in Eastern cultures (Ku, Fox, & McKenna, 2008).

The main purpose of this study, therefore, was through the administration of a culturally specific instrument, to investigate the relationships between subjective well-being, participation in total daily physical activity, and sedentary time in a nationally representative sample of middle aged and older people from Taiwan. Specifically, we examined whether a) physical activity including active transport, work, household chores, and leisure-time physical activity; b) time spent sedentary, are associated with dimensions of subjective well-being in middle aged and older people. We also examined the consistency of these relationships across different genders and age groups.

## Methods

## SAMPLE

All the data in the study were taken from the National Physical Activity and Successful Aging Survey that was conducted through telephone interview by the Taiwan Sports Affairs Council in 2004. Five thousand participants aged 15 years and older were drawn nationally using random-digit dialing with stratified random sampling, controlling for gender, age and region. Among them, the data of 1,450 participants (males = 774) aged 50 and over (mean age 62.1  $\pm$ 9.1 years) were analyzed.

#### Measures and variables

#### Dependent variables

During the national telephone survey, participants aged 50 and over were further asked to complete the 31-item Chinese Aging Well Profile. The instrument construction and development were grounded on qualitative interview and five sequential psychometric testing phases (Ku, Fox, & McKenna, 2008). Alpha coefficients (0.67–0.93) were acceptable to very good. Exploratory and confirmatory factory analyses were both performed, suggesting satisfactory factorial validity. Two-week test-retest reliability was assessed using Person's correlation and Intraclass correlation coefficients (ICC). The results all exceeded or closed the acceptable level of 0.70.

The Chinese Aging Well Profile comprises seven subscales: (i) 'physical' well-being (5 items): the extent to which a strong, healthy body and an energetic lifestyle, free from pains and illnesses has been maintained; (ii) 'psychological' well-being (5 items): the extent to which cognitive function has been maintained and feelings towards daily life are positive rather than negative; (iii) 'independent' well-being (5 items): the extent to which there are feelings of independence and ability to take care of self; (iv) 'learning & growth' well-being' (4 items): the opportunity to learn new knowledge and skills, and pursue self-growth; (v) 'material' well-being (4 items): the extent to which there are no worries about financial situations; (vi) 'environmental' well-being (4 items): the extent to which there is satisfaction with the government's social welfare services and living environment; and (vii) 'social' well-being (4 items): the extent to which there is a feeling of close relationships with your family and friends and capacity to support to others in the community. Responses are indicated on a five-point Likert scale anchored by strongly disagree (1) and strongly agree (5) (Ku, et al., 2008).

## Predictor variables

#### (i) Physical activity

The short telephone version of the International Physical Activity Questionnaire (IPAQ) (IPAO Research Committee, 2004) was administered. Its reliability and validity has been demonstrated in many countries, providing good test-retest reliability (Spearman's rho clustered around 0.8) and criterion validity median  $\rho$  of about 0.30, which is comparable to most other self-report validation studies (Craig, et al., 2003; Rutten, et al., 2003). The English version of the IPAQ short form was translated into a Chinese version by the Taiwan National Sports Affairs Council. This involved comparison, by an expert panel composed of professionals specializing in physical activity measurement, of the Taiwan and English versions with regard to clarity, common language, and conceptual equivalence. Modifications to wording of items were made as appropriate. The raw data were subjected to the data processing protocol recommended by the IPAQ Research Committee (2004). This included procedures for eliminating outliers and truncated extremes of data. Total physical activity consists of leisure-time, occupational, domestic and commuting physical activities, which were then estimated by weighting the reported minutes per week within each category of physical activity intensity as follows. Vigorous activity was recorded as 8 METs; moderate activity: 4 METs; and walking: 3.3 METs. Energy expenditure (kcal/week) of each activity per week was calculated by: activity intensity (METs)×frequency (days)×duration for each day (minutes), all based on the assumption of an individual with 60 kg of weight (Irwin, et al., 2002; Taylor, et al., 1978). The total weekly energy expenditure (kcal/week) was obtained by adding up the energy expenditure of the three categories (Craig, et al., 2003).

#### *(ii)* Sedentary time

As part of the IPAQ, respondents were asked 'during the last 7 days, how much time did you spend sitting on a week day?' Responses were recorded in hours ranging between 0 and 14.

#### (iii) Covariates

Socio-demographic variables including age (50-59, 60-69, 70+), gender, education level (primary or below, junior/senior, college+), monthly income (none, 1-29,999, 30000+New

Taiwan Dollars), religious beliefs (0: no; 1: yes), employment status (working, retired, unemployment, housekeepers), marital status (unmarried, married, widowed/separate/divorced) and living condition (alone, with spouse only, with families) were available in this national survey. These variables are commonly regarded as correlates of subjective well-being (Diener, Suh, Lucas, & Smith, 1999; Kim & Moen, 2002; Smith, Borchelt, Maier, & Jopp, 2002).

#### Data treatment and analysis

The sample of 1,450 subjects provided a large enough data set for multivariate analyses. In the raw dataset, only six CAWP items were identified that had missing data for more than 10% of the sample (10%-14%), which exceeds the recommended level requiring critical action (Cohen & Cohen, 1983). Listwise and pairwise estimations are the most popular treatments in statistical analyses. However, these two estimations are based on the assumption that the pattern of missing values is missing completely at random (MCAR). Little's chi square test in SPSS Missing Value Analysis showed the missing pattern not to be MCAR (chi-square=7,137.2, df= 6,185, p< 0.001). However it has been argued that it is justified in these circumstances to estimate based on missing at random (MAR) as a starting point for analyzing survey data when encountering incomplete cases (Allison, 2003; Rubin, Stern, & Vehovar, 1995; Schafer & Graham, 2002; Sinharay, Stern, & Russell, 2001). All the variables with missing values were estimated and replaced using expectation maximization (EM) estimation of SPSS Missing Data Analysis.

Characteristics of the sample were presented first. Then, two Multivariate Analysis of Variance (MANOVA) models were conducted, which allows comparison of group means across various dimensions of subjective well-being without inducing the multiple testing problems related with repeated ANOVA. The first model was with subjective well-being dimensions as dependent variables and age groups, and gender as the predictor variables. Interactions between gender and age groups were examined. The second model including physical activity and sedentary time as dependent variables was conducted in the same procedure. One interaction (gender and age group) emerged in the second model and so remaining analyses (e.g. correlation and linear regression) were conducted separately by gender and age group. For additional purposes of exploring covariates, several MANOVA models were performed to assess whether socio-demographic variables significantly differed in mean values across dimensions of subjective well-being.

To assess the extent to which physical activity and sedentary time was associated with each of the dimensions of well-being ('physical', 'psychological', 'independence', 'learning & growth', 'material', 'environmental' and 'social'), Pearson correlation coefficients between physical activity, sedentary time and seven dimensions of subjective well-being were calculated. Then, seven models of multiple linear regression analyses were employed. For each model, physical activity, sedentary time and covariate variables (age, gender, education level, income and employment), showing significant results in previous MANOVA tests, were entered for adjustment. To explore whether there is any meaningful differences in relationships by age or gender groups, the interaction terms, such as physical activity and gender, physical activity and age, sedentary time and gender as well as sedentary time and age were included in the seven models. These models were then conducted separately by gender and age groups. Multi-collinearity checks confirmed that this was not a problem for these analyses (Belsley, Kuh, & Welsch, 1980; de Vaus, 2002). All the analyses were carried out using SPSS version 16.0.

## Results

Table I shows the distributions of the total sample and its stratification by gender. Participants were primarily older adults aged 60+, having no schooling or primary education only, having monthly income from 1-29,999 New Taiwan dollars, working, married, and living with families.

The patterns of each subscale of the Chinese Aging Well Profile by different genders and age groups were shown in Table 2. MANOVA demonstrated that dimensions of subjective well-being differed by gender and age groups. Significant main effects were both observed for gender (F=7.04,  $\eta^2$ =0.03, p<0.001) and for age (F=7.87,  $\eta^2$ =0.04, p<0.001), but no interaction (F=0.89,  $\eta^2$ =0.004, p=0.57). Gender differences were significant for only three dimensions, including 'physical' (F=8.46,  $\eta^2$ =0.01, p=0.004), 'independence'

	Charac	teristics of the	e sample			
Variable	n	All %	<b>N</b> n	len %	Wo n	omen %
Total	1450	100.0	774	53.4	676	46.6
AGE GROUP 50-59 60-69 70+	650 442 358	44.8 30.5 24.7	321 208 245	41.5 26.8 31.6	329 234 113	48.6 34.7 16.7
EDUCATION LEVEL Primary or no schooling Secondary College+	738 477 235	50.9 32.8 16.2	331 289 154	42.8 37.3 19.9	407 188 81	60.2 27.8 12.0
Monthly income (NT dollars) 0 1-29,999 30,000+	345 698 406	23.8 48.2 28.0	124 364 286	16.0 47.0 37.0	222 334 120	32.8 49.5 17.7
RELIGIOUS BELIEF Yes No	1069 381	73.7 26.3	206 568	26.6 73.4	175 501	25.9 74.1
EMPLOYMENT Working Retired Unemployment Housekeeper	605 391 32 421	41.8 27.0 2.2 29.1	411 287 24 51	53.2 37.1 3.2 6.6	194 104 7 370	28.7 15.3 1.1 54.8
MARITAL STATUS Unmarried Married Widowed/separate/divorced	30 1365 55	2.0 94.2 3.8	19 731 23	2.5 94.5 3.1	10 634 32	1.4 94.0 4.7
LIVING CONDITION Alone With spouse only With families	107 238 1105	7.3 16.5 76.2	64 143 567	8.1 18.5 73.3	44 95 537	6.3 14.1 79.6

TABLE I Characteristics of the sample

Total may not equal 100% given rounding

(F=4.96,  $\eta^2 = 0.004$ , p=0.03), and 'environmental' (F=19.63,  $\eta^2 = 0.01$ , p<0.001). Males had the higher levels of 'physical' and 'independence' wellbeing than in females and females possessed the higher grade of 'environmental' well-being. Both genders reported the lowest level of subjective well-being in 'material' dimension. In contrast, the gap in other dimensions did not reach significance. Although the patterns of different subscales of well-being across age groups were not identical, they share similar features. Age differences were significant for most of dimensions except 'material' (F=0.76,  $\eta^2=0.001$ , p=0.47) (See Table II). Based on the post hoc tests, participants aged 70+ possessed the lowest level of well-being on 'independence', and 'learning & growth'. In contrast, people aged 50-59 enjoyed the lowest level of 'environmental' well-being. Additionally, participants aged 60-69 reported the highest level of 'social' well-being. Moreover, MANOVA showed that dimensions of subjective well-being also significantly differed by some socio-demographic variables, including educational level, monthly income, and employment status (p < 0.05), which was not reported in the Table II.

The mean scores of physical activity and sedentary time by different genders and age groups were presented in Table III. Significant main effects were both observed for gender (F=13.10,  $\eta^2$ =0.02, p<0.001) and for age (F=7.71,  $\eta^2$ =0.01, p<0.001). Moreover, the interaction was also identified although it seemed weak (F=2.71,  $\eta^2$ =0.004, p=0.03). For total physical activity, males spent more energy than females (p<0.001). The energy expenditure decreased with advancing age. Post hoc tests showed that the oldest group spent the lowest physical activity energy expenditure. As for time spent in sedentary mode, it seemed that males were more sedentary than females (p=0.007). Post hoc comparisons also indicated that participants aged 50-59 were more sedentary than those aged 60-69. Given the observed interaction effect, the means of both males and females for each age group was shown in Table IV.

Results of the Pearson correlation analysis for the total sample, both genders and different age groups are summarized in Table V. Except 'material' and 'environmental' well-being, estimations of total physical activity were weakly and positively associated with dimensions of subjective well-being. Closer scrutiny of the subgroup correlations indicates that associations were more striking in older adults aged 70 (e.g. 'physical': r=0.25) or more in comparison with younger population (e.g. 'physical' in age group 50-59: r=0.15, age group 60-69: r=0.02). The amount of time spent sedentary was negatively and weakly related to several dimensions of well-being except 'social' wellbeing. These relationships were stronger among women (e.g. 'physical': r=0.19) than men (r= -0.12).

	Male	Gender Female			MANOVAª			ר	Jnivariate te	st
Dimension	M(SE)	) M(SE)		ГЦ	$\eta^{2b}$	d		Ц	ľ	d
Physical Psychological Independence Learning & growth Material Environmental Social	3.76(0.0 3.84(0.0 4.02(0.0 3.77(0.0 3.37(0.0 3.37(0.0 3.57(0.0 3.98(0.0)	3)         3.65(0.03           3)         3.77(0.03           3)         3.77(0.03           3)         3.77(0.03           3)         3.77(0.03           3)         3.82(0.04           4)         3.33(0.04           3)         3.78(0.03           3)         3.78(0.03           3)         3.78(0.03           3)         3.78(0.03		7.04	0.03	<0.001		8.46 1.82 4.96 0.02 19.63 0.55	0.01 0.001 0.004 <0.001 <0.001 <0.001 <0.001	0.004 0.18 0.03 0.89 0.55 <0.001
	50-59	Age group 60-69	+04		₩	ANOVA			Jnivariate te	st
Dimension	M(SE)	M(SE)	M(SE)	1	ц	η²	d	Щ	η²	d
Physical Psychological Independence Learning & growth Material Environmental Social	$\begin{array}{c} 3.69(0.03) \\ 3.71(0.03)^+ \\ 4.04(0.03)^+ \\ 3.87(0.03)^+ \\ 3.31(0.04) \\ 3.58(0.03)^+ \\ 3.58(0.03)^+ \\ 3.99(0.03)^+ \end{array}$	$\begin{array}{c} 3.80(0.04)^+\\ 3.92(0.04)^+\\ 4.07(0.03)^0\\ 3.88(0.04)^9\\ 3.41(0.05)\\ 3.81(0.04)^+\\ 3.12(0.03)^{+0}\\ \end{array}$	$\begin{array}{c} 3.64(0.05)^+\\ 3.82(0.04)\\ 3.81(0.04)^{+\varphi}\\ 3.60(0.05)^{+\varphi}\\ 3.36(0.06)\\ 3.71(0.05)^{\varphi}\\ 3.71(0.05)^{\varphi}\\ 3.94(0.04)^{\varphi}\end{array}$		7.87	0.04	<0.001	5.62 8.17 15.06 10.51 0.76 8.55 6.47	0.01 0.01 0.02 0.02 0.01 0.01	0.004 <0.001 <0.001 <0.001 0.47 0.001 0.002
a: The model: Intercept b: Partialn <sup>2</sup> : Partial eta- +and <sup>+9</sup> : Pairwise compa	+ gender + age $\xi$ squared risons, p< 0.05	group + gender*	age group; Inté	eraction: g	gender*age g	roup (Wilk'	s	<sup>2</sup> =0.004, p=0.5	57)	

TABLE II

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		Grender							
	1	Male T	temale	M/	ANOVAª		Uni	variate t	est
Variable	N	I(SE)	M(SE)	Ц	$\eta^{2b}$	d	Ц	η²	d
Physical activity (kcal/wk) Sedentary time (hours/day)	1523.95	5(62.08) 1261 2(0.08) 3	75(62.08) 5.93(0.08)	13.10	0.02	<0.001	15.30 7.37	0.01 0.01	<0.001 0.007
	50-59	Age group 60-69	70+	Μ	ANOVA	в	Ur	ivariate	test
Variable	M(SE)	M(SE)	M(SE)	щ	η²	d	Ц	η2	d
Physical activity (kcal/wk) Sedentary time (hour/day)	$1514.02(74.95)^{+}$ 4.31(0.10)^{+}	1477.30(78.81) <sup>9</sup> 3.78(0.09) <sup>+</sup>	1104.60(60.40) <sup>+9</sup> 4.26(0.12)	7.71	0.01	<0.001	9.25 6.30	$\begin{array}{c} 0.01 \\ 0.01 \end{array}$	<0.001 0.002
a: The model: Intercept + genuble: Partialn <sup>2</sup> : Partial eta-square <sup>+</sup> and <sup>+Q</sup> : Pairwise comparisons	der + age group + ger d t, p< 0.05	nder*age group; In	teraction: gender <sup>*</sup> age gi	liW) quo	k's λ: F=	2.71, η <sup>2</sup> =0.00	)4, p=0.03)		

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	n	Physical Activity (kcal/week)	Sedentary Time (hour/day)
Male	774	1523.95(62.08) <sup>a</sup>	4.32(0.08)
50-59	321	1555.94(103.25)	4.44(0.14)
60-69	208	1807.98(137.38)	4.10(0.14)
70+	245	1241.00(62.08)	4.34(0.14)
Female	676	1261.75(62.08)	3.93(0.08)
50-59	329	1473.02(108.65)	4.19(0.13)
60-69	234	1183.75(80.80)	3.50(0.11)
70+	113	808.51(84.57)	4.07(0.21)

 TABLE IV

 Means of total physical activity, sedentary time by gender and age group

a: Mean (SE)

The fully adjusted models of multiple linear regression for the total sample and each gender are presented in Table VI. Similar significant patterns of association were evident, even after adjustment for key socio-demographic variables. Positive relationships of physical activity with several dimensions of subjective well-being were witnessed, particularly 'physical', 'psychological', 'independence', 'learning and growth', and 'social' well-being. The inverse associations between physical activity and age group sedentary time and subjective well-being were also observed. The associations of sedentary time with different dimensions of subjective well-being were also estive well-being were stronger in women than in men. The interaction between sedentary time and gender was tested and found to be (marginally) significant in several dimensions, including 'physical' (p=0.07), 'independence' (p=0.04), 'learning & growth' (p=0.07) and 'environmental' well-being (p=0.01).

The same analyses, with adjustment of potential confounders, by different age groups can be found in Table VII. Although the relationships of sedentary time with dimensions of subjective well-being were similar across age groups, the strongest associations among physical activity and elements of subjective well-being are observable in the oldest group. For participants aged 70+, physical activity was significantly associated with almost all dimensions of well-being. The interaction between sedentary time and gender was tested and found to be (marginally) significant in 'physical' (p=0.04), 'independence' well-being (p=0.07).

## Discussion

This study demonstrated that total physical activity was positively related to several dimensions of subjective well-being, including 'physical', 'psychological', 'independence', 'learning and growth', and 'social' well-

		u	PA	Sedentary	YHY	ΡSΥ	QNI	LEA	MAT	ENV	SOC
Physical activity	Total Male Female 50-59 60-69 70+	1450 774 676 774 676 650	1.00 1.00 1.00 1.00 1.00 1.00	-0.12*** -0.11** -0.16** -0.16*** -0.12*	0.14*** 0.14*** 0.12** 0.15*** 0.02 0.25***	$\begin{array}{c} 0.09 ** \\ 0.10 ** \\ 0.07 \\ 0.09 * \\ 0.05 \\ 0.16 ** \end{array}$	0.19*** 0.20*** 0.17*** 0.16*** 0.16*** 0.23***	$\begin{array}{c} 0.11 * * * \\ 0.14 * * * \\ 0.09 * \\ 0.08 * \\ 0.08 \\ 0.08 \end{array}$	0.05 0.05 0.04 0.05 0.05 0.05	-0.01 0.04 -0.05 -0.01 0.07 0.08	$\begin{array}{c} 0.09^{**} \\ 0.16^{***} \\ 0.01 \\ 0.10^{*} \\ 0.10^{*} \\ 0.20^{***} \end{array}$
Sedentary time	Total Male Female 50-59 60-69 70+	1450 774 676 676 650	-0.12*** -0.11*** -0.16*** -0.16*** -0.12*	1.00 1.00 1.00 1.00 1.00	$-0.15^{***}$ $-0.12^{**}$ $-0.19^{***}$ $-0.13^{**}$ $-0.14^{**}$ $-0.15^{**}$	-0.111*** -0.09* -0.15*** -0.12** -0.08	-0.06* -0.02 -0.12** -0.05 -0.08	-0.07* -0.02 -0.11** -0.09 -0.08	0.06* 0.11** 0.05 0.07 0.07	-0.08** -0.01 -0.15*** -0.11** -0.07 0.00	-0.05 -0.02 -0.03 -0.03 -0.03
PA: physical activ	vity, 1 1		-								

TABLE V Pearson's Correlation Coefficients for Relationships Between Physical Activity, Sedentary Time and Subjective Well-Being

PHY: Physical; PSY: Psychological, IND: Independence; LEA: Learning & growth; MAT: Material; ENV: Environmental; SOC: Social. \*\*\* p < .001, \*\* p < .01, \* p < .05.

Dimensions of Well-being	Predictors <sup>a</sup>	Total (n=	=1450) <sup>a</sup>	Male (n	1=774) <sup>b</sup>	Female (	n=676) <sup>b</sup>
		β	р	β	р	β	Ь
Physical	Physical activity	0.11	<0.001	0.13	<0.001	0.09	0.02
Psychological	Physical activity	0.08	0.004	11.0- 60.0	0.01	0.06	0.14
Independence	Physical activity	0.16	<0.001	0.18	<0.001	0.12	0.002
Learning & growth	Physical activity	-0.06 0.10	0.02 <0.001	-0.01 0.13	0.001	-0.12	0.21
Material	Sedentary time Physical activity	-0.08 0.04	$0.01 \\ 0.15$	-0.03 0.04	0.44 0.20	-0.13 0.02	0.002 0.56
Environmental	Sedentary time Physical activity	0.02 0.01	0.57 0.77	0.06 0.04	0.11 0.24	-0.03 -0.04	0.39 0.26
1	Sedentary time	-0.05	0.09	0.02	0.56	-0.13	0.001
SOCIAI	r nysical activity Sedentary time	-0.04	0.12	-0.02	0.69	-0.08	0.06
a: Adjusting for gender, age , b: Adjusting for age group, e	educational level, income level and ducational level, income level and e	l employmer employment	ut.				

TABLE VI Adjusted associations of subjective well-being dimensions by physical activity and sedentary time for each gender

Dimensions of Well-being	Predictors <sup>a</sup>	50-59 (n	=650) <sup>a</sup>	n) 69-09	(=442) <sup>a</sup>	70+ (n	=358) <sup>a</sup>
		β	Ь	β	Ь	β	Ь
Physical	Physical activity	0.12	0.004	0.00	0.99	0.24	<0.001
	Sedentary time	-0.12	0.002	-0.15	0.002	-0.15	0.005
Psychological	Physical activity	0.05	0.19	0.04	0.40	0.17	0.003
	Sedentary time	-0.12	0.003	-0.08	0.12	-0.09	0.09
Independence	Physical activity	0.13	0.001	0.14	0.005	0.23	<0.001
	Sedentary time	-0.05	0.24	-0.05	0.30	-0.10	0.06
Learning & growth	Physical activity	0.05	0.20	0.07	0.14	0.19	<0.001
)	Sedentary time	-0.10	0.02	-0.09	0.07	-0.03	0.58
Material	Physical activity	0.01	0.79	0.05	0.28	0.05	0.35
	Sedentary time	0.00	0.94	0.05	0.29	0.03	0.58
Environmental	Physical activity	01	0.72	-0.05	0.28	0.10	0.07
	Sedentary time	-0.09	0.23	-0.03	0.51	0.03	0.055
Social	Physical activity	0.09	0.03	-0.03	0.55	0.20	<0.001
	Sedentary time	-0.02	0.66	-0.06	0.23	-0.05	0.36
a: Adjusting for gender, educ	ational level, income level and emp	oloyment.					

TABLE VII Adjusted associations of subjective well-being dimensions by physical activity and sedentary time for each age group

being. With multivariate adjustment, linear regression analyses indicated that the associations, especially 'physical' and 'independence' well-being, were stronger in the older group (70+ years). Time spent in sedentary mode produced negative and low-to-moderate correlations with subjective well-being. particularly 'physical', 'independence', 'learning and growth', and 'environmental' well-being. These relationships were stronger in females. Older people, especially females and those 70 years and older who are more physically active and spent less sedentary time experience higher levels of well-being. Previous research has largely focused on the impact of structured exercise and leisure activity on well-being in these age groups. Less attention has been paid to the total physical activity in daily life which for older adults tends to be dominated by daily tasks such as shopping, household chores, personal business, and social engagement. This study addressed total physical activity through the assessment of engagement in active transport and activities of daily living in addition to leisure-based activity. It also assessed the association of sedentary time with well-being in older adults after adjusting for physical activity as this has rarely been investigated. The majority of research in this area has been conducted with westernized populations. In contrast, this study provided insight into these relationships with an east Asian culture with a purpose and designed and rigorously tested instrument to assess subiective well-being (Ku, et al., 2008; Ku, Fox, McKenna, & Peng, 2006).

Results clearly showed that for this population, physical activity is positively associated with several dimensions of subjective well-being. These relationships remained after controlling for key socio-demographic variables. The relationships were similar for each gender, which is consistent with McAuley and Rudolph's (1995) findings, but were stronger among the older group aged 70+, especially in 'physical' and 'independence' well-being. A recent qualitative study in Taiwan with older adults indicates that they feel that regular physical activity is beneficial for several domains of their lives (Ku, McKenna, & Fox, 2007). The data in the present study provide supportive evidence of this finding and also the negative associations of sedentary time with well-being through a large nationally representative sample. All the main sources of activity were included in the physical activity assessment so it is not possible to determine the types and contexts of physical activity that produce subjective well-being benefits. There is evidence that older Chinese are more likely to be physically active than middle-aged and younger generations in their leisure (Hui & Morrow, 2001; Ku, et al., 2006). This is partly due to the popularity of social group-style physical activities such as Tai Chi, Qigong, folk dancing, jogging, and hill walking among older Chinese in Hong Kong, mainland China, and Taiwan (Hui & Morrow, 2001;

Yu, Liaw, & Barnd, 2004). These physical activity events provide important opportunities to build social capital (Putnam, 2000) by bonding with close friends, neighbors and family and bridging to individuals, which might help in daily functioning. Active neighbors, friends and families are important support systems for participating in physical activities (Litwin, 2003; Pate et al., 1995). Therefore, these localized group-style physical activities may enhance well-being, particularly for retired older adults who possess more free time. These may partly explain why the relationships of physical activity with well-being are stronger among the older group aged 70+.

Although the findings contradicted with the conclusions of a metaanalysis based on intervention trials, which suggested a gradual decline in the effect size of physical activity on well-being as one ages (Netz, Wu, Becker, & Tenenbaum, 2005). Notably, the 'physical activity' in the meta-analysis primarily referred to programmed and structured exercise instead of overall lifestyle physical activity. These reviewed studies were mainly conducted in westernized populations. Additionally, this is an observational study assessing the relationships in stead of examining the effect of physical activity intervention on well-being.

However, in order to understand the specific contribution of elements of activity to subjective well-being in eastern cultures, more research is needed. To date, there is also a paucity of studies examining the association of sedentary behaviors with well-being, particularly for older adults. This study found that sedentary time was negatively associated with subjective well-being. This supports a recent study using accelerometry in the Better Aging Project, revealing time spent sedentary was negatively related with several mental health indicators (Fox, et al., 2007). It is possibly that high levels of sedentary time are a result of low activity or poor health, and declining physical function. This in turn encourages social isolation, and limits the development of social support networks, thereby reducing the level of mental well-being (Hamer, et al., 2010). The inverse associations of sedentary time with subjective well-being were stronger in older females, who tend to be more physically inactive.

The present findings must, however, be interpreted with some caution. The physical activity data are self-reported rather than objectively measured. IPAQ has mainly been validated on populations aged 15 to 69 years old and there has been limited application of this instrument with older adults aged 70 or older (Bassett, Schneider, & Huntington, 2004; Wetherbee, et al., 2001).

These data are cross-sectional and the reasons for these low-tomoderate but significant and intuitively plausible associations remain
unclear. There are several competing or contributory explanations for the observed relationships. Physical function and health/disease status are likely to contribute to this relationship but were not assessed in this survey. Those with poorer health and lower physical function may also be less active and less likely to experience higher levels of subjective well-being. On the other hand, regular physical activity helps older adults avoid serious disease and maintain physical function. It is possible that greater daily movement allows greater independence and more opportunities for attending learning and growth activities. Prospective cohort studies and other long term experimental designs, where physical function and health are used as adjuster variables will be necessary to unravel such tightly knit relationships between daily activity, sedentary time and mental health. However, findings support the increasing evidence that avoiding increases in sedentary time and maintaining physically active lifestyles are important targets for mental health promotion.

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# Discontinuity and variability in the development of the overarm throwing skill in 3- to 18-year-old children

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> Changes of coordination of an overarm throw were investigated in 418 children from 3 to 18 years old. Overarm throws were analysed by a stage classification based on five components. The motor development during childhood and adolescence shows discontinuities with a marked improvement between 4 and 6 years of age, followed by an ascendant plateau between 7 and 18 years of age. From 7 to 9 there appears a first stagnation followed by irregular changes (with regression and acceleration) and lastly a second stagnation occurs longer than the previous one. The regression is short and more marked for boys than for girls and overlapping waves induce changes. Variability in coordination reflects the many processes of development by activation and inhibition of the selection of a relevant response.

> KEY WORDS: Development, Discontinuity, Throwing skill, Motor patterns, Variability.

# Introduction

Describing qualitative forms of coordination constituted repertoires of standard steps of development that are useful to teachers, researchers (Gallahue, 1982) and therapists (Parker & Larkin, 2003). Changes in the motor patterns of gross motor skills were described throughout life span and allowed one to identify developmental states according to their chronological order. They are described using two theoretical viewpoints: the global and the component models. Throwing is a fundamental motor skill assimilated *via* various sporting activities, such as striking (Langendorfer, 1983) and the overhead serve in tennis (Messick, 1991). The global model, which

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takes into account the whole body, implies linear changes, whereas the component model, taking into account each part of the body separately, suggests discontinuity in the development of coordination. The aim of our study is to show the development of throwing from infancy to adulthood and more particularly the characteristics of discontinuity.

First analyses of gross motor skills offered a linear model of the development. Motor patterns, depicted according to global description, constitute a repertoire of qualitative movements. Development of coordination of the overarm throwing has been one of the first motor skill analyses (Wild, 1938). Roberton (1977) has statistically tested the validity of the description of Wild's stages of development. From this research, Seefeldt (1980) illustrated the throwing figures of coordination according to five developmental steps. Later, gross motor skills were depicted as involving either three steps (Gallahue, 1982) or five steps (Wickstrom, 1983). In these models, each stage was "a uniform sequence of structural or functional neural change" (Roberton, 1978), more efficient than the previous stage, and the development was considered as linear.

Studies of changes in the motor development of locomotion are continual and normalised in different motor pattern categories (Gesell, 1929). The stage theory (Piaget, 1936/1977) predicts that movement develops in immutable step sequences, which is consistent with a hierarchical view. Already, Wallon (1941) contested the notion of cumulative progress because of alternate functions, namely anticipation and regression of actions. In fact, many studies showed that not all children systematically follow the stages described by the Piagetian model. Indeed, the scale of temporal discrepancy in the study of Fantz (1961) showing the precocious representations of infants (aged one month) and the precocity of sensorimotor coordination (Bower, 1966) raised doubts about the stage order. Subsequent studies based on this assumption demonstrated that there were gaps in the development of many processes (Wohlwill, 1973). In fact, regression implied the disappearance and resurgence of abilities throughout child development (Bower, 1977). Each characteristic of the Piagetian model, universality (all children), intransitivity (invariant order) and stability (one structure for one stage) was questioned by the inadequacy of abilities at each age (Bower, 1977; Fantz, 1961; Meltzoff, 1977). In this context, theories of child development evolved into a pluralistic conception of developmental changes, implying that for each age, a number of processes were functional and interact. They produce adaptive choices among variants and children have to select the right solution to resolve cognitive or motor tasks (Houdé et al., 2000). Response variability was a function of environmental conditions in interaction with an organism. It depended on the capacity to generate a choice among variations of motor patterns (Manoel & Connolly, 1995). Developmental changes were not achieved by sudden shifts, but were in a constant transitional state illustrated by overlapping waves. Alternative strategies compete with each other and, over time, children selected the most appropriate. Some strategies are used less and less until they disappeared completely, while others, more efficient, are used more and more (Siegler, 1994).

Oualitative changes of development were dependent on the previous state, but did not constitute a new one and evolved from the rearrangement of active knowledge. Different knowledge implied different ways of changing and no linear dynamic representation of development. The course of action to go from one level to another one involved transition phases, which explained the discontinuity of development. Catastrophe theory (Thom, 1989) explained discontinuity by a shift toward an attractor. The origin of discontinuity could be due to intrinsic reorganization or discontinued change of independent variables, which revealed internal reorganisation of the dynamic system (Van der Maas & Molenaar, 1992). Transitions feature more or less marked leaps of change or regressions during adolescence for instance. Dynamic systems theory may be of help in investigating qualitative changes in development from nonlinear dynamics. This approach is an attempt to study the field of motor performance and development (Thelen, 1995; Turvey & Fitzpatrick, 1993). The height and length of the transition phase were criteria used to measure discontinuity of change (Van Geert, 1994).

Roberton (1978) observed the variability of development among children and Roberton and Langendorfer (1987) showed the discontinuity of developmental sequences of throwing motor patterns. These authors suggested a motor development based on body components. A description of each component illustrated discontinuity and variability of coordination changes. Change can occur in a component of the body but not in another one. In this way for each child, each element of the body has its own developmental speed (Roberton & Halverson, 1984). Discontinuity is due to variability of speed of development of each process, which could be illustrated with overlapping waves (Langendorfer, 1988). Motor development can affect the overlapping wave of change established within prelongitudinal screening by evaluating frequencies of occurrence of each component related to the age of the children (Roberton, Williams, & Langendorfer, 1980). Changes of motor patterns appeared by selection of the most appropriate components of coordination.

Variability is a fundamental factor for motor skill behaviour, development and learning. It concerned intra-individual measures from one phase of the development to another (Fiske & Rice, 1955) and promoted the development of motor control (Eckert, 1974). Theories of development and motor control lend support to similar hypotheses about variability. Bernstein (1957/1986) argued that neuromuscular system and movement were a permanent cycle between perception and action as a function of conditions of variability, which implied controlling the numerous and redundant degrees of freedom of the organism to convert it into a controllable system. Variability is related to redundant motor synergies that an organism had to explore and select by matching possible motor commands (Sporns & Edelman, 1993). The motor patterns are an emergent property of constraints strained by the environment (Newell, Kugler, van Emmerik, & Mc Donald, 1989) and development is consistent with the state of the attractor, which unified elements of the system (Thelen, 1995). Change during development is characterized by passage from one attractor to another one. Indeed, variability may promote the creative exploration of new performances (Van der Maas & Molenaar, 1992). Thelen (1986) suggested eight processes interacting with their own changing time scales (articulation differentiation, postural control, visual flow sensitivity, tone control, pattern generation, extensor strength, body constraints and motivation) to explain the emergence of new motor skills. The specificity and the speed of development of each process are at the root of variability.

The performance improvement of throwing skill depended on various anthropometric characteristics (weight, size, joints, muscles and skinfolds), on parts of the body (Nelson, Thomas, Nelson, & Abraham, 1986) and on practice (Dusenberry, 1952; Nelson, Thomas, & Nelson, 1991). In addition to these constitutive factors, the proximo-distal coordination could only explain arm speed (Neal, Snyder, & Kroonenberg, 1991). The ball speed increased when the coordination of the overarm throw changes. Step length and humerus, forearm action and trunk positioning were good predictors for the performance and the ball speed (Roberton & Konczak, 2001). The variability of the throwing development could be shown by the "en bloc" movement of the "arm dominated" throw and the differentiated "sequentially linked" movement (Marques-Bruna & Grimshaw, 1998). Children 3 and 4 vears of age initiate the throwing action using their arm, and then use their trunk before their arm at 6 years of age (Yan, Payne, & Thomas, 2000). The action components of trunk and foot contribute to changing performance from 6 to 8 years of age (Nelson et al., 1991).

The aim of our study was to determine the invariant sequences and the transitory period of the developmental changes of coordination according to a statistical probability view (Roberton, 1982; Langendorfer, 1987). The variability of the coordination changes across development was investigated from three- to nineteen-year-olds to show the discontinuity of the developmental sequences of a gross motor skill, *i.e.* the overarm throw.

# Method

#### PARTICIPANTS

In order to screen the discontinuity of development, a cross sectional sample of 418 children (aged between 3 and 18 years) was achieved from four state schools from a suburb of Paris. All administrative authorisations were obtained and parents gave informed consent for their child's participation.

#### PROCEDURE

Children were filmed performing three trials of a forceful overarm throw. The task was explained to each participant and two practice trials (familiarisation) were made to ensure the understanding of the task. The investigator used such encouragement as "hit the ball hard" or "crash the ball into the wall". The entire test was filmed with an S VHS video tape recorder (50 Hz). The camera was placed on the side of the throwing arm. The camera was shifted for the left-handed session.

#### DATA REDUCTION AND ANALYSIS

Two observers independently analysed throws frame-by-frame. The best coordination level (point sums) of the three overarm throws was kept. A single throw was retained because one of them could be totally missed. The agreement between the observers was established by couple permutation of observers to harmonize our analysis. Interjudge agreement of the two researchers ranged from 85% to 90% when authors considered the threshold of 80 per cent (Langendorfer & Roberton, 2002; Messick, 1991). The analysis of the overarm throw coordination was assessed using Roberton and Halverson's classification (1984). This classification comprise five components: preparatory movement of the arm, humerus action, forearm action, trunk action and leg action, divided into 4, 3, 3, 3 and 4 levels, respectively. In our study, the performance of trunk action was divided into four levels, three from Roberton and Halverson (1984) and an additional level, which is step 2 divided into steps 2 and 3 (Table I).

In steps 2 and 3 we showed the role of differentiated motion in two anatomical girdles (Keller & Ripoll, 2004). We noted a numerical value for each qualitative level of coordination, which corresponded approximately to the coordination level of the component being consid-

TABLE I

Developmental Of Postural Step Category. AN Extra Level Of Coordination Was Added In Reference To Roberton And Halverson (1984): Step 3 Corresponded To Step 2, Which Was Doubled. Level 2 Of Roberton And Halverson (1984) Was The Block Rotation. Our Level 2 Is The Rotation Of The Upper Part Of The Trunk At The End Of The Movement.

Points	Configuration
1 2	No trunk action: feet do not move, only arm action. Upper trunk rotation: rotation of the upper part of the trunk, which accompanies the forward arm motion.
3 4	Total trunk <i>en bloc</i> rotation: anatomical belts rotate together. Differentiated rotation: the pelvic girdle precedes the scapular one.

ered. The addition of the five component values determined the global coordination score for the general development of the throwing. However the same global score can mask the different individual combination of components, *i.e.* two children with the same score can exhibit a different pattern. That is why an inter-individual analysis of components was subsequently performed by studying overwhelming waves.

Statistical analyses were conducted with Statistica 6.0 software for the developmental change and the degree of variability with a level set at p = .05 throughout the statistical tests. The behavioural change in coordination was determined by non-linear and linear regression. The logarithmic function of change is a consequence of cognitive theory (Newell, Liu, & Mayer-Kress, 2001). The  $\chi^2$  test was performed to investigate the degree of variability in the patterns of coordination. Coordination levels were analysed by mean and standard deviations for age and sex.

All statistical tests had the level of significance at  $\alpha = .05$ .

# Results

As the Kolmogorov-Smirnov test, d = .114, was inferior to the level of significance at .01, these data had not a normal distribution, and the Kruskal-Wallis test was used.

#### Developmental analysis

Results of the 16 (age) Kruskal-Wallis test showed levels of motor patterns were different according to age for girls, H(15, 219) = 80.7, p < .001and for boys, H(15, 199) = 86.8, p < .001, and according to gender, H(1, 418) = 19.8, p < .001. The level of the motor pattern related to throwing increased with age: from 3 to 18 years (Fig. 1). Boys showed a higher coordination level than girls (Fig. 1) and the greater increase could be situated from four to six years old. It showed a punctual break of the coordination level for boys at 11 years of age, which attained 14.1 points then decreased to 12.6 points at 12 years of age. Another break increased to a maximal level at 14.6 points at 13 years of age. A trough occurred at 10 years of age from 11.9 points to 11.3 points, then increased to 13.2 points between 11 and 13 years of age.

Curves showed two parts of the plateaus (between 7-9 and 16-18 years of age) disrupted by discontinuous changes. The comparison of these two age periods by Kruskal-Wallis test identified the following factors as significant for boys, H(1, 60) = 8.9, p < .001, and girls, H(1, 76) = 6.2, p < .05. The coordination level at 7 to 9 years of age (for boys, around 12 points and for girls 11 points) was weaker than at 16 to 18 years of age (for boys, around 13 points and for girls 12 points). The coordination level of girls was weaker than that of boys for all age groups tested.



Fig. 1. - Changes in the coordination levels of 3- to 18-year-old children.

#### Adjustment

Generally, changes in the coordination level for age and throwing did not display linear regression, but logarithmic regression fitted to the data [level = b + Ln(age)]. The logarithmic model was fitted for boys, r(15) =0.94, p < .001, with a = 2.92 and b = 6.58, and for girls, r(15) = 0.93, p < .001, with a = 2.25 and b = 6.87.

#### VARIABILITY ANALYSIS

There were many motor patterns used for each category of age and sex. The number of motor patterns used was similar to the number of children tested ( $\chi^2$  test between these two numbers was not significantly different for boys,  $\chi^2(15, N = 199) = 14.1$ , p > .05 and for girls,  $\chi^2(15, N = 219) = 18.5$ , p > .05 (Table II).

The many motor patterns used by each category of age and sex provided evidence to the variability of changes for each component depicted by overlapping waves (Fig. 2).

		Boys	Girls			
Age (years)	Sample	Number of used strategies	Sample	Number of used strategies		
3	8	6	12	6		
4	14	10	13	9		
5	12	9	14	11		
6	13	10	11	10		
7	10	7	13	8		
8	9	8	13	9		
9	9	6	13	9		
10	13	8	11	9		
11	18	13	22	14		
12	14	11	15	12		
13	17	13	13	11		
14	14	13	19	12		
15	16	14	13	13		
16	11	9	15	13		
17	14	10	12	7		
18	7	3	10	10		

 TABLE II

 Number Of Motor Patterns Used According To The Number Of Children.

#### Discussion

This study assessed the increase in the coordination development of the overarm throwing skill among children aged from three to eighteen years. It is regarded as discontinuous and variable. Periods of slow or fast progress display plateaux, troughs and declines. Our work shows that boys have better coordination levels than girls the same age, which is in accordance with Halverson, Roberton, and Langendorfer (1982).

Before children reach the age of four, changes in coordination levels require minimal processes of development of fundamental skills (Seefeldt, 1980), as shown by analysis of catching a ball (Keller, Fleurance, & Candau, 1987). Accelerated changes in coordination levels are continuous from 4 to 6 -7 years of age. Coordination levels from about 7 to 18 years of age show an irregular ascendant plateau with regression and acceleration. Halverson Roberton, Safrit, and Roberts (1977) reported that a mature throwing skill was rarely attained before the age of 6 or 7 years, but was achieved at 7 to 9 years of age (Halverson et al., 1982; Seefeldt, 1980). In contrast to these reports, our findings show coordination levels continue to progress between 7 to 9 years and 18 years of age.

The set of developmental levels looks like an ascendant plateau. For boys and girls the plateau values of motor patterns increase significantly between 7-9 years of age and 16-18 years of age. The beginning of the plateau constitutes a proficiency barrier between fundamental skill and transitional motor skill (Seefeldt, 1980). The plateau reveals temporary breaks as peaks, troughs and declines, which show the instability of the skill during adolescence. Our curve shows stagnation from 6 to 9 years of age for girls and from 7 to 10 years of age for boys, comparable with the findings of Loovis and Butterfield (1995) for the striking skill. Seefeldt and Haubenstricker (1982) also showed a gap of mature skills between girls (age 5) and boys (age 9). The break is more marked and shorter for boys than for girls. For boys, the coordination level at 11 years of age attains 14.1 points, then declines to 12.6 at 12 years of age (*post hoc*, .06) and finally increases to a maximal level at 14.6 at 13 years of age (.01). The break is more precocious, lasts longer and declines less for girls than for boys. The trough in the coordination level occurs at 10 years of age (from 11.9 points to 11.3 points) then increases to a maximal value (13.2 points, post hoc, .01) between 11 and 13 years of age. This temporary regression could be explained by the growth acceleration, which modifies the body schema. The growth maturation is more precocious for girls, which can



Fig. 2. - Overlapping waves showed by percentage of step of each coordination level of arm preparation.

explain this finding. Only for girls does another decline appear at the age of 15 years of age (11.5, post hoc, .05). The improvement could not extend after 18-year-olds for women because of immature patterns of throwing skill, as indicated by Leme and Shambes (1978).

The qualitative changes in motor development ought to be analyzed by frequencies of occurrence described by prelongitudinal screening (Roberton et al., 1980) and gap model (Langendorfer, 1987). This study shows a large scale of variability in motor development and lends support to the hypothesis of Halverson and Williams (1985) for hopping and Langendorfer (1987; 1988) for striking. The continuity of development models is questioned by overlapping waves.

Among each component, humerus, forearm, trunk and step length (Roberton & Konczak, 2001) the roles of the trunk and the arm are particularly valuable / important (Nelson et al., 1991; Nelson et al., 1986). The throwing motor patterns improve when the movement starts from the trunk then ends with the arm (Yan et al., 2000). Marques-Bruna and Grimshaw (1997) depicted a progress from an *en bloc* motion (an arm-dominated movement) to a tied sequence motion. The mature throwing skill is achieved by both the back swing and then the propulsion of the arm. The timing and sequencing of muscle actions is a proximo-distal coordination (McDonald, Emmerik, & Newell, 1989; Neal et al., 1991; Yan et al., 2000). The action of the elbow in relation with the arm amplifies the efficiency of forearm motion (Bowne, 1960) and angular speed of arm. The throwing skill improves by the freezing of degrees of freedom (McDonald et al., 1989).

Variability is a construct addressed with discontinuity of performance during development. Variability is a stability index of the sensorimotor system (Newell & Corcos, 1993). The standard deviation from the mean of a group reflects the variation in improvement on motor skills. The latter type of variation is characterized by two particular periods of variability, whose features of change correspond to characteristics of the developmental curve simulated by van Geert (1994). We suggest a curve of development with floor and ceiling of performance translated by an asymptotic function as (A+B\*tang(x+C))\*(1+cos(w\*x)/D when A, B, C, D and w are constant values. The cosine displays oscillations (of regressive and growing variations).The first transition is characterized by a strong acceleration from age 3 to age6. Other transitions are during adolescence with leaps of change, regarded asbig variation of coordination levels.

Our analysis shows that during the acceleration period of development (from 4 to 7-8 years of age), the standard deviation of coordination level is higher than during the plateau period (from 9 to 18 years of age) despite the

discontinuity. However, Keogh (1969) established that variability is relative to specificities of motor skills (throw, standing long jump, five hops and grip strength). Our findings confirm the discontinuity of motor development and corroborate the model of overlapping waves.

The variation of changes suggests a differentiated interaction (Thelen, 1986). Factors acting on motor skill can be space, posture, anticipation and body. Bodily factors are positive for size, which increases during adolescence, and for strength (increase until thirty-years-old) and negative for fat, which can be obesity and motivation, which decreases early in childhood (Espenschade, 1963; Latchaw, 1954; Malina, 1978; Rarick & Smoll, 1967). These body-like factors play a significant role in the coordination of the segments for the throwing skill.

Variability elicits from noise and is a constitutive factor of coordination (Newell & Corcos, 1993). The organism is a system that is essentially unsteady, labile, but human beings have an adaptive system and flexible behavior to stabilize it. The variability has a role to reveal the way of changes in motor development. Repertoires of changes of motor patterns show variability, which implies numerous mechanisms in competition. It implies adaptive choices among variants.

The hypothesis of developmental variability suggested by Thelen (1986) is derived from complex interactions of many heterogeneous processes. These processes involve differentiated changes in transition periods. Transition periods of developmental levels of motor skills reflect fluctuations and generate unstable phases of coordination (Kelso, Scholz, & Schöner, 1986). The transition periods can be revealed by developmental curve (van Geert, 1994). He suggests a first transition from age 3 to age 6 characterized by some acceleration. A second transition during adolescence reveals temporary breaks as picks, troughs and declines of change of coordination levels. Our results show leaps of coordination levels and in this way a significant variability in the strategies. These variations are not only age-specific, but also within an age group.

Organism is an unstable system due to the complexity of various processes, which displays the variability of behaviour. The flexibility of the movement results in adjusting motor patterns to changing context. As discontinuity and new forms emerge from interaction of processes, Thelen (1986) suggests some of them. Variations in the sequence timing, in the tempo of development and in the level of proficiency are related to a variety of biomechanical and neuromuscular constraints (neuronal growth, body size and weight, and metabolic) composition, cognitive abilities and affective past (educational style, motor activity opportunities), which interact in a dynamic manner with a specific environment (Malina, 2004). Temporary regression could be explained by increase of body fat mass (Harrison, Weiner, Tanner, & Barnicot, 1977; Zonderland et al., 1984) associated with the loss of motivation for sport.

The preferred patterns which emerge are the most economical in terms of energy expenditure, making full use of passive forces (*e.g.*, gravitational) to enhance the efficiency of the active muscular forces that have been implemented (Vereijken, van Emmerik, Whiting, & Newell, 1992). The non-viable occurrences derived from the association of immature levels with a mature level as shown with the above example.

More than a descriptive approach, repertoires of motor patterns of the child allowed an analysis of motor processes of the development. Motor patterns could not be viewed as a single type of movement, but implied complex processes interacting with affective and social context. The variability of the motor development contributes to the discontinuity of the development of the throwing skill by the emergence of motor patterns.

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# Pre- and post-performance emotions in gymnastics competitions

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> The study investigated the relationship between emotional states experienced before and after performance events during gymnastics competitions within the framework of the Individual Zones of Optimal Functioning (IZOF) model and the directional perception approach. Intensity, functional impact, and hedonic tone of emotions were assessed retrospectively in 10 Italian high-level gymnasts before and after two, three, or four events throughout a competition. Three levels of performance (poor, average, and good) were derived from retrospective self-ratings to enable intra-individual analyses. Findings showed that when gymnasts' emotional level was near to their optimal zones, a good performance was observed and emotional intensity was perceived to be more facilitative and pleasant. Conversely, when gymnasts' emotional level was near to their dysfunctional zones, a poor performance was observed and emotional level was perceived to be more debilitative and unpleasant. Gymnasts also experienced optimal-pleasant emotions after good performances, and dysfunctional-unpleasant emotions after poor performances. Effective coping strategies were generally associated with good performance and optimal-pleasant emotions, whereas performance difficulties tended to be related to poor performance and dysfunctional-unpleasant emotions.

> KEY WORDS: coping strategies, directional perception approach, gymnastics, IZOF model.

The emotion-performance relationship has been investigated in the light of different approaches including the multidimensional theory of anxiety (Martens, Vealey, & Burton, 1990), the catastrophe model (Hardy, 1990), the reversal theory (Kerr, 1997), the Individual Zones of Optimal Functioning (IZOF) model (Hanin, 2000), and the directional interpretation approach (Jones & Swain, 1995). Several authors (e.g., Robazza, 2006; Vallerand &

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Blanchard, 2000) have employed the Deci's (1980) definition of emotion as "...a reaction to a stimulus event (either actual or imagined). It involves change in the viscera and musculature of the person, is experienced subjectively in characteristic ways, is expressed through such means as facial changes and action tendencies, and may mediate and energize subsequent behaviors." (p. 85). Lazarus (2000) placed emphasis on the person-environment interaction and conceived emotion as a part of a changing person-environment relationship arising when individuals appraise a situation as positive or negative for their personal well-being. In applying Vygotsky's conceptualization of experience to performance emotions in sport, Hanin (2007) argued that emotional experience is an indivisible component of total human functioning reflecting the nature of past, ongoing, or anticipated person-environment interactions.

Current research in sport psychology has mainly examined pre-competition emotions, although several authors have advocated the study of the temporal patterns of emotions pre-, during, and post-competition (e.g., Cerin, Szabo, Hunt, & Williams, 2000; Hanin, 1997, 2000; Johnson, Edmonds, Moraes, Filho, & Tenenbaum, 2007; Robazza, Bortoli, & Nougier, 2002; Sève, Poizat, Saury, & Durand, 2006; Sève, Ria, Poizat, Saury, & Durand, 2007). The study of the temporal pattern can shed light on the mechanisms by which emotions influence performance and, conversely, on the effects of performance toward the individual's emotional reactions. Therefore, the focus of our study was on emotions experienced before and after different performances across a competition. The IZOF model and the directional perception approach were used as theoretical frameworks to examine preperformance emotions (both theoretical views) and post-performance emotions (the IZOF model).

The IZOF model underlines the role of the individual's experience of competitive emotions and suggests that the interaction between emotion and performance is dynamic and bidirectional; namely, emotions are expected to influence performance while on-going performance outcomes would influence the content and intensity of emotions (Hanin, 2004). The model aims to describe, predict, explain, and enable control of an athlete's optimal and dysfunctional experiences related to individually successful and poor performances (Hanin, 1997, 2000, 2007; Robazza, 2006). A key principle of this model is that functional or dysfunctional patterns of emotions are highly individual; that is, emotions can be helpful, harmful or both, depending on their content, intensity, and the individual's interpretation.

Emotional content is conceptualized within the framework of two interrelated factors: hedonic tone or valence (i.e., pleasure-displeasure) and performance functionality (i.e., optimal and dysfunctional effects on performance process and outcome). Four affect content categories derive from the interaction of these two factors: (a) optimal-pleasant, (b) optimal-unpleasant, (c) dysfunctional-unpleasant, and (d) dysfunctional-pleasant. Facilitative effects of emotions on performance are expected when optimal pleasant or unpleasant emotional states prevail over dysfunctional states (Hanin, 2007). The explanation of the functional impact that emotions can have on performance is based on the notion of a resource matching hypothesis. Functionalpleasant emotions (e.g., 'active' and 'self confident') are associated with optimal readiness to perform and an effective utilization of energy. Functional-unpleasant emotions (e.g., 'tense' and 'angry') reflect a state in which the athlete's resources are insufficient and there is a need to compensate for a lack of energy as may occur when task requirements are overwhelming. Dysfunctional-unpleasant emotions (e.g., 'insecure' or 'scared') reflect a state in which resources are lacking and energies lost, and the athlete is not able to cope with the situation, as may happen in cases of repeatedly poor performances or overtraining. Finally, dysfunctional-pleasant emotions (e.g., 'tranquil' or 'satisfied') would be associated with a loss or lack of energy, inefficient utilization of energy, a low level of attention, and inefficient information processing. The athlete would tend to underestimate the requirements of the task and over-evaluate his or her capacities as may occur after several successful performances or when facing a less proficient opponent.

The total impact of emotions on performance derive from their interactive effects, with good performance generally attained when functional emotional states prevail over dysfunctional states. The prediction of individually successful, average, or poor performance is also based on the in/out-of-thezone concept of the IZOF model. Athletes have specific intensity bandwidths of optimal or dysfunctional emotions, which may vary depending on the individual. A high probability of successful performance is expected when emotional intensity is within the optimal zones and outside the dysfunctional ranges. Conversely, when the emotional level falls outside the optimal zones and inside the dysfunctional zones, a poor performance will probably occur (for reviews, see Hanin, 2007; Robazza, 2006).

The emphasis of the IZOF model on individual differences in the functional interpretation of emotions is also endorsed in the directional perception approach. Direction (or perceived functionality) refers to the individual's perception of the facilitative or debilitative effects of emotions. Jones (1995) proposed a direction scale to rate the degree of intensity of each symptom on the Competitive State Anxiety Inventory-2 (CSAI-2; Martens, Burton, Vealey, Bump, & Smith, 1990) as facilitative or debilitative in relation to performance. The directional approach posits that intensity alone without a clearly established functional (directional) effect is inadequate in the prediction of athletic achievements. One performer may perceive a given level of precompetitive anxiety as facilitative while another performer may perceive it as debilitative (for reviews, see Hanton, Neil, & Mellalieu, 2008; Mellalieu, Hanton, & Fletcher, 2006). It should be noted, however, that the directional perception approach focuses on *between*-individual differences in the functional perception of emotions rather than on *within*-individual differences, whereas the IZOF model places emphasis on both. Furthermore, the directional perception approach is based on individuals' ratings of assumed anticipated effects of anxiety on performance, whereas the IZOF model considers previous, actual, and anticipated effects of a range of performance-related emotional experiences (see Hanin, 2007, for details). In a recent study, Robazza, Pellizzari, Bertollo, and Hanin (2008) have successfully extended the investigation of directional effects beyond anxiety to idiosyncratic emotions in high-level swimmers and track and field athletes. Assessment included intensity, functional impact, and hedonic tone of competitive anxiety, self-confidence, idiosyncratic emotions, and bodily symptoms concomitant with emotional reactions (e.g., enhanced heart rate, stomach butterflies, sweating). Findings showed a tendency of the athletes to experience less debilitative-unpleasant effects of cognitive anxiety and dysfunctional bodily symptoms, and more facilitative-pleasant effects of self-confidence and optimal emotions as they progressed from poor performance to average and good performances.

Davis and Cox (2002) argued that the IZOF model and the directional perception approach are intuitively related because both consider the anticipated and actual functional effects of emotions on athletic performance. The IZOF model predicts best performance when an athlete's emotional level is within the previously established zones of optimal functioning, while the directional approach posits that successful performance occurs when the intensity of pre-competition emotion is perceived to be facilitative. The two perspectives combined would predict that when emotional intensities are inside individual zones of optimal functioning, the athlete should perform optimally and perceive emotions as facilitative. Conversely, when emotional intensities are inside individual dysfunctional zones, the athlete should perform poorly and perceive emotions as debilitative. The intuitive link between the IZOF model and the directional approach has been recently supported (Robazza et al., 2008). Athletes whose intensity levels of emotions were near their optimal zones perceived their emotions as facilitative and pleasant, while athletes whose emotional levels were near their dysfunctional zones perceived their emotions as debilitative and unpleasant.

Coping strategies are strictly tied to emotions and performance. According to Lazarus and Folkman's (1984) transactional approach to psychological stress and coping, coping has been defined as the changing cognitive and behavioral efforts adopted by an individual to manage the specific external and/or internal demands of a specific person-environment transaction appraised as stressful, taxing or as exceeding the resources of the person. Folkman (1984) suggested that problem-focused coping strategies correlate positively with positive affect, whereas emotion-focused coping strategies correlate positively with negative affect. Problem-focused coping is intended to handle stressful situations through action aimed at changing the reality of a 'troubled' person-environment relationship. Seeking information, planning and setting goals, time management skills and assertive confrontation are examples of problem-focused strategies. Emotion-focused coping involves managing emotional responses to distress without changing the reality of the situation. Seeking social support, relaxation, and wishful thinking are examples of emotion-coping strategies. Eubank and Collins (2000) found that athletes who perceived their anxiety symptoms as facilitative used more problem- and emotion-focused strategies compared to athletes who perceived their anxiety symptoms as debilitative. In a study involving Olympic wrestlers, Gould, Eklund, and Jackson (1992a, 1992b) showed that the most successful wrestlers used 'blocking' distractions in a positive way, concentrated on goals, set routines, controlled arousal, and used mental imagery. In contrast, less successful wrestlers made no use of coping strategies (for a review, see Nicholls & Polman, 2007). In a recent study, Kaiseler, Polman, and Nicholls (2009) investigated the relationship between mental toughness (a personality trait-like construct characterized by perceived control of the situation, commitment, challenge, and confidence) and coping strategies. Findings showed positive correlations between mental toughness and problem-focused coping strategies, and negative correlations with emotionfocused coping strategies. The author suggested that mentally tough athletes perceive their efforts to deal with competitive demands as more effective when employing problem-focused coping rather than emotion-focused coping strategies. Therefore, coping effectiveness seems to be influenced by the coping strategy employed.

# Purposes of the Study

The study was conducted to examine emotions experienced pre- and postperformance events during a gymnastics competition within the frameworks of the IZOF model and the directional perception approach. Specifically, the first purpose was to examine the impact of emotions on performance. According to the in/out-of-the-zone principle of the IZOF model, the intensity of current emotions was expected to be near to optimal zones prior to good performance, and near to dysfunctional zones prior to poor performance. Furthermore, according to the directional approach emotions perceived as more facilitative and pleasant should be associated with good performance. Conversely, emotions perceived as more debilitative and unpleasant should be related to poor performance. Therefore, the two perspectives combined would predict good performance to be typified by a pattern of optimal content and intensity of emotions experienced as facilitative-pleasant, and poor performance to be characterized by a pattern of dysfunctional emotions perceived as debilitative-unpleasant.

The second purpose of the study was to investigate the impact of performance levels on emotions. According to the IZOF model, good performance after a single event during competition was expected to elicit a short-term pattern of emotions mainly typified by pleasant states with intensity levels near to recalled optimal intensity. In contrast, poor performance was hypothesized to induce a temporary pattern of unpleasant states predominantly characterized by emotions with intensity levels near to recalled dysfunctional intensity. However, a different pattern of emotions induced by performance outcomes should also be expected. Indeed, the IZOF model predicts that the effect of good performance on emotions may not always be optimal and, similarly, that the impact of poor performance on emotions may not always be dysfunctional (Hanin, 2000, 2007). For example, good performance may engender pleasant emotions leading to poor performance in a subsequent task due to complacency, underestimation of task demands, and insufficient focus of attention. In contrast, poor performance may elicit unpleasant emotional states, such as anger and tension, which are useful in mobilizing energies for task achievements.

Finally, the third purpose of the study was to examine the coping strategies adopted by athletes when facing competition demands. Effective strategies should enable the athlete to achieve, recover, and maintain his or her optimal condition to deal with competitive demands. Conversely, ineffective strategies (or a lack of strategies) should not produce these effects.

# Method

# PARTICIPANTS

Ten Italian high-level gymnasts, aged from 15 to 19 years (M = 17.5, SD = 1.5), took part in the study. The participants were six men and four women from north-eastern Italy and their

competitive experience ranged from 4 to 10 years (M = 7.6, SD = 1.9). They competed in regional and national tournaments and undertook a mean of 5/6 weekly practice sessions of 2/3 hours each. All participants, coaches, and the parents of participants under 18 years of age provided their informed consent prior to the study. The anonymity and confidentiality of individual results were assured. All procedures were conducted according to the ethical guidelines of the Italian Society of Sport Psychology.

#### MEASURES

Idiosyncratic emotions and bodily symptoms. In the assessment of emotions, Hanin (2000) recommended including additional dimensions, such as bodily symptoms associated with emotional responses. The assessment of bodily symptoms related to emotions is expected to provide a better understanding of states associated with performance and improve the validity of idiosyncratic measures (Bortoli & Robazza, 2002; Robazza & Bortoli, 2003, Robazza et al., 2008). Therefore, two lists of emotional and bodily symptom descriptors were used to help the gymnasts identify or generate the emotional states experienced during their recalled optimal, average, and poor performances. The emotion list contained 70 pleasant and unpleasant randomly-arranged emotional descriptors obtained by translating the emotions that Hanin and Syriä (1995a, 1995b) used with athletes. The bodily symptoms list contained 40 descriptors of somatic reactions concomitant with performance emotions (Bortoli & Robazza, 2002). In an Italian sample, Cronbach's alpha coefficients were reported to range from .78 to .86 on the emotion scales, and from .74 to .85 on the bodily symptoms scales (Robazza & Bortoli, 2003). Once the items were selected, they were scored in terms of intensity, functionality, and hedonic tone on a modified 11-point Borg scale (Borg, 2001). The verbal anchors of the scale were: 0 =nothing at all; 0.5 =very, very little; 1 =very little; 2 =little; 3 =moderate; 5 =much; 7 = very much; 10 = very, very much; # = highest possible intensity. A score of 11 was assigned to #. No verbal anchors were used for 4, 6, 8 and 9. This scale has been successfully used in psychophysical studies (see Borg, 2001) and to investigate emotions (Hanin & Syrjä, 1995a, 1995b). Direction (functionality) and hedonic tone scores were also assessed on the Borg scale. Scores ranged from -11 (extremely dysfunctional or unpleasant) to +11 (extremely functional or pleasant).

*Performance self-evaluation scale.* Self-evaluation was conducted using the 11-point Borg scale. Raglin (1992; Raglin & Morgan, 1988) suggested that self-assessed performance in athletes who are very familiar with their own abilities and have a good knowledge of their sporting discipline is more accurate than objective measures. Cerin et al. (2000) also contended that self-referenced criteria of performance rather than absolute performance outcomes should be used to predict athletes' emotional states. In our sample, high-level gymnasts were likely to assess their performance quality frequently, and therefore their self-referenced evaluation was expected to be accurate. The gymnasts were invited to evaluate their performances from one to three days after the competition with the help of a video-assisted recall of the performance. A number of studies have supported the validity of the recall method (Annesi, 1997; Hanin & Syrjä, 1996). For example, Tenenbaum and Elran (2003) showed congruence between actual and retrospective reports for pre- and post-competition emotional states following a 72-hr delay.

*Interview.* Interview guidelines were developed to allow for a full investigation of the research questions, to facilitate the acquisition of qualitative data, and to minimize biases (Pat-

ton, 2002). Interviews were conducted by the first author of the study who was also a gymnastics coach knowledgeable of the terminology and the rules of the discipline. From one to three days after competition, the gymnasts were invited to watch their videotaped performances and to freely report their thoughts, emotional states, experiences, and behaviors occurring prior to and after every event. Possible questions to stimulate the emergence of themes were: "Which emotions and bodily symptoms did you experience before (and after) each performance?", "What was the intensity level of your emotions and bodily symptoms?", "Did your emotions and bodily symptoms facilitate or hamper your performance?", "Were your emotions and bodily symptoms pleasant or unpleasant?" Additional questions were used when necessary to further clarify and understand the gymnasts' coping strategies such as: "How did you manage time during pauses?", "What did you do to recover or maintain your optimal condition?", "What routine did you follow to prepare yourself for the performance?"

#### PROCEDURE

The aims of the research were presented to coaches and then to the gymnasts. They were informed that they could withdraw from the research at any time. The research comprised three phases intended to: (a) establish an idiosyncratic emotional profile for each athlete based on the individuals' recall of their performance history, (b) obtain a pre- and post-performance self-evaluation of emotional states, and (c) identify coping strategies during competition.

*First phase: idiosyncratic emotion scaling.* The gymnasts were met at the end of a training session at their facilities far from competitive events. They were asked to identify idiosyncratic emotional and bodily descriptors associated with poor performance, average performance, and optimal performance. The two lists of emotional and bodily symptoms were used to help the gymnasts identify or generate idiosyncratic items. There was no limitation on the number of items the athlete could choose. Each idiosyncratic item was then scored in terms of intensity, functional effect, and hedonic tone. Specifically, the gymnasts were asked: "Thinking back to your poor performance, what was the intensity of your emotions (or bodily reactions) before that performance?", "Did your emotions (or bodily reactions) facilitate or hamper your performance (and to what extent)?", "Were your emotions pleasant or unpleasant (and to what extent)?" The same procedure was repeated for average and optimal performances. Descriptors chosen by each gymnast were then randomly arranged to create a personalized, emotional and bodily symptom list to be used in the following phases of the study.

Second phase: self-evaluation of emotional states and performance. Together with their coaches the athletes chose a competitive event in which the gymnasts had to perform two, three, or four exercises. The competition was videotaped with a video camera positioned to capture the entire body of the gymnast. Individual interviews were conducted with the participating gymnasts in a secluded room at their training complexes and they were reminded of the main aim of the study. A retrospective analysis of emotional states related to performance was conducted by the first author from one to three days after the competition using video recordings of the whole performance. Gymnasts could stop the video at any time and comment on their experience. The focus of the study was on: (a) the five minutes before starting an event, (b) the five minutes after the event, (c) the time elapsing from the five minutes after an event to the five minutes before a subsequent event.

Gymnasts were given report cards containing their personal list of randomly-arranged emotional descriptors and performance self-evaluation scales. They were required to choose up to a maximum of six descriptors from their personal list (i.e., three emotions and three bodily symptoms) best representing how they felt immediately before each event. They were then asked to: (1) score in terms of intensity each emotion and bodily symptom, (2) specify and score the functional effect (i.e., facilitative or debilitative) of each emotion and bodily symptom, and (3) specify and score the hedonic tone (i.e., pleasant or unpleasant). The gymnasts were then required to evaluate their performance of each event they had just concluded. Again, they chose up to a maximum of six descriptors from the personal list (three emotions and three bodily symptoms) to represent how they felt immediately after the event, and repeated the assessment procedure. The choice of only three emotions and three bodily symptoms was intended to prevent excessive lengthening of the overall assessment procedure.

*Third phase: identification of coping strategies.* An in-depth, semi-structured interview was conducted with each athlete during the videotaped presentation in order to examine: (a) the effects of emotion on performance, (b) the effect of performance on emotions, and (c) individual self-regulation and coping strategies. Examples of questions were the following: "What was your mental and physical condition before performance?", "What behaviors, thoughts, somatic procedures, etc. did you adopt to prepare yourself?", "Were you able to maintain (or recover) your optimal condition?"

#### DATA ANALYSIS

Three performance levels (i.e., good, average, and poor) were established to derive a descriptive analysis of the emotions experienced before and after performances and the use of coping strategies across the competition. Poor performance ranged from 0 to 2 on the Borg scale, average performance from 3 to 4, and good performance from 5 to 11.

To examine predictions of the in/out-of-the-zone concept – that is, whether intensities of current emotions before good (poor or average) performances were near to the intensities of recalled optimal (poor or average) performances – intra-individual scores were computed by subtracting emotional intensity scores associated with current performance from the scores related to recalled personal optimal, poor, or average performances. The means of the difference scores of the intensities of emotions related to optimal, poor, and average performance were calculated. To examine predictions of the directional perception approach – that is, whether emotions related to poor performance were perceived as facilitative-pleasant, and emotions related to poor performance were perceived as debilitative-unpleasant – the means and standard deviations of intensity and directional scores of emotions and bodily symptoms were calculated considering the three performance levels (good, average, and poor). Positive scores (from 1 to 11) were assigned to facilitative and unpleasant emotions.

A qualitative analysis of coping strategies was also carried out. The qualitative data were hierarchically analyzed, following the procedure adopted by Scalan, Ravizza, and Stein (1989) and subsequently by several authors (e.g., Gould et al., 1992a, 1992b). Specifically, the following procedure was adopted:

- 1. All interviews were tape-recorded and transcribed verbatim, resulting in 22 singlespaced pages of interview data.
- 2. Two researchers read and re-read all of the transcripts until each of them was fully familiar with the content. The researchers also listened to each recorded interview to interpret meanings associated with tone, pauses, use of sarcasm, etc.

- 3. Independently, two authors identified raw data themes reflecting on the gymnasts' comments, and grouped them into various major categories. Following extensive discussion, consensus was reached regarding the coping strategies adopted by each gymnast.
- 4. An inductive analysis was conducted on the raw data to identify common themes of a higher general order.
- 5. Each raw data theme was then classified as falling into one of four sub-categories: (a) emotion-focused coping strategies; (b) emotional difficulties; (c) problem-focused coping strategies; (d) task-related difficulties.
- 6. As an additional verification of the inductive analysis, the raw data themes and higher order themes were checked by the authors who went back to the original transcripts and verified that all the themes had been represented.

# Results

#### PRELIMINARY ANALYSIS OF EMOTIONS AND BODILY SYMPTOMS

Optimal-pleasant and dysfunctional-unpleasant emotions and bodily symptoms chosen by the gymnasts in reference to the three previously-established performance levels are reported in Table I. The gymnasts identified a total of 35 emotional descriptors and 25 bodily symptom descriptors. With regard to the emotional descriptors, 21 were optimal-pleasant, 12 dysfunctional-unpleasant, and 2 optimal-unpleasant ('doubtful', 'tense'). With regard to the bodily symptoms, 9 were optimal-pleasant, 18 dysfunctionalunpleasant, 1 was dysfunctional-pleasant ('thirsty'), and 1 optimal-unpleasant ('muscular tension'). A reversal in functional impact was shown for two emotions ('angry' and 'tense') and for three bodily symptoms ('sweaty hands', 'thirsty', and 'muscular tension'), which were experienced by different athletes as optimal or dysfunctional. In this case the same emotion was experienced in different ways depending on the interpretation given by the gymnast in a specific moment. According to the IZOF model, good performance was typified by more optimal-pleasant emotions than dysfunctionalunpleasant emotions, and poor performance was characterized by more dysfunctional-unpleasant emotions. An average performance contained a mixture of optimal-pleasant and dysfunctional-unpleasant emotions.

# **EMOTIONS EXPERIENCED ACROSS COMPETITION**

Twenty-eight events were examined: three gymnasts performed four exercises, two gymnasts performed three exercises, and five gymnasts performed two exercises in a competitive situation. Gymnast 1 alternated good

	Opt	imal-Pleasant	Dysfunctional-Unpleasant			
Performance level	Emotions	Bodily symptoms	Emotions	Bodily symptoms		
Good	Motivated (7) Confident (5) Determined (5) Active (4) Focused (3) Courageous (2) Happy (2) Optimistic (2) Proud (2) Calm (1) Capable (1) Cheerful (1) Excited (1) Powerful (1)	Energetic movements (4) Stiff movements (3) Fluid movements (2) Regular heart beat (2) Relaxed muscles (2) Thirsty (2) Muscular tension (1) Sweaty hands (1)	Agitated (3) Tense (2) Tired (2) Nervous (1) Uncertain (1) Worried (1)	Sweaty hands (6) Muscular tension (4) Sweaty (4) Cold hands (3) Cold feet (2) High heart rate (2) Thirsty (2) No thirsty (1) Rigid movements (1)		
Average	Tranquil (6) Confident (2) Focused (2) Motivated (2) Angry (1) Calm (1) Capable (1) Determined (1) Reactive (1) Satisfied (1)	Regular heart beat (2) Muscular tension (1) Relaxed muscles (1) Stiff movements (1)	Tense (5) Nervous (4) Uncertain (3) Disappointed (2) Unsatisfied (2) Agitated (1) Angry (1) Unconfident (1)	Muscular tension (3) Sweaty hands (3) High heart rate (2) Sweaty feet (2) Fatigue (1) Legs tension (1) Stomach problems (1) Sweaty (1) Thirsty (1)		
Poor	Focused (1) Tranquil (1)	Relaxed muscles (1) Sweaty hands (1)	Tense (5) Uncertain (4) Unsatisfied (3) Disappointed (2) Tired (2) Nervous (1) Stressed (1) Unconfident (1)	Loose legs (4) Stomach tension (4) High heart rate (3) Constant movement (2) Muscular tension (2) Smooth movements (2) Sweaty hands (2) Fatigue (1)		

 TABLE I.

 Idiosyncratic Descriptors Identified By The Gymnasts

Note: Number of items in parentheses.

and poor performance, gymnasts 2, 4, 5, and 8 improved their performance during competition, gymnasts 6 and 10 maintained a good performance level, gymnast 7 achieved the highest performance level, and gymnasts 3 and 9 performed poorly.

To determine the total impact of emotions and bodily symptoms, the sum of directional scores and the sum of hedonic tone scores of the three emotions and bodily symptoms of each gymnast were computed (Table II). In general, optimal-pleasant emotions, accompanied by optimal-pleasant or dysfunctional-unpleasant bodily symptoms were experienced before and after good performances, while dysfunctional-unpleasant emotions and bodily symptoms were experienced before and after poor performances. There

		Pre-performance			Post-performance	
Participants	Events	Emotions	Bodily symptoms	PSE	Emotions	Bodily symptoms
Gymnast 1	1 2 3 4	$\begin{array}{c} O = 12, P = 6 \\ D = -14, U = -13 \\ O = 1, P = 3 \\ D = -13, U = -16 \end{array}$	$\begin{array}{l} D=-8,U=-7\\ D=-6,U=-10\\ D=-5,U=-6\\ D=-15,U=-13 \end{array}$	5 2 6 2	$\begin{array}{c} O=5, P=5\\ D=-4, U=-5\\ O=10, P=10\\ O=6, P=5 \end{array}$	$\begin{array}{c} D = -4,  U = -2 \\ D = -2,  U = -2 \\ O = 6,  P = 6 \\ O = 6,  P = 6 \end{array}$
Gymnast 2	1 2 3 4	O = 5, P = 4 O = 3, P = 4 O = 7, P = 7 O = 5, P = 4	O = 3, P = 2O = 4, P = 3O = 4, P = 3O = 4, P = 3	3 3 6 6	O = 4, P = 3 O = 4, P = 4 O = 4, P = 4 O = 4, P = 4	$\begin{array}{c} O = 3, P = 3 \\ O = 4, P = 4 \\ O = 3, P = 3 \\ O = 3, P = 3 \end{array}$
Gymnast 3	1 2 3 4	$\begin{array}{l} D = -11,  U = -12 \\ O = 20,  P = 19 \\ O = 1,  P = 4 \\ D = -16,  U = -16 \end{array}$	$\begin{array}{c} D = -13, \ U = -12\\ O = 10, \ P = 3\\ D = -11, \ U = -11\\ D = -13, \ U = -13 \end{array}$	1 3 2 1	$\begin{array}{l} D = -16,  U = -16 \\ O = 10,  P = 10 \\ D = -16,  U = -16 \\ D = -14,  U = -14 \end{array}$	$\begin{array}{l} D=-10,U=-10\\ D=-4,U=-4\\ D=-6,U=-6\\ D=-6,U=-6 \end{array}$
Gymnast 4	1 2 3	O = 1, P = 1 D = -6, U = -6 O = 1, P = 1	O = 1, P = 1 D = -6, U = -6 D = -6, U = -6	4 8 8	$\begin{array}{l} D = -9,  U = -10 \\ O = 1,  P = 1 \\ O = 6,  P = 6 \end{array}$	O = 1, P = 1 D = -4, U = -4 D = -5, U = -5
Gymnast 5	1 2 3	$\begin{array}{l} D = -9,  U = -11 \\ O = 10,  P = 13 \\ O = 13,  P = 13 \end{array}$	D = -12, U = -10 O = 14, P = 18 D = -6, U = -6	3 9 7	$\begin{array}{l} D = -17,  U = -15 \\ O = 26,  P = 27 \\ O = 19,  P = 18 \end{array}$	D = -7, U = -8 D = -6, U = -4 D = -6, U = -7
Gymnast 6	1 2	D = -5, U = -17 D = -6, U = -4	D = -13, U = -11 D = -7, U = -7	4 7	O = 13, P = 15 O = 12, P = 14	D = -4, U = -6 O = 8, P = 8
Gymnast 7	1 2	O = 15, P = 17 O = 1, P = 1	D = -11, U = -8 D = -9, U = -8	8 8	O = 6, P = 6 O = 5, P = 5	D = -3, P = 4 D = -6, U = -7
Gymnast 8	1 2	O = 29, P = 28 O = 28, P = 26	O = 17, P = 15 O = 18, P = 17	11 11	O = 29, P = 30 O = 20, P = 21	O = 19, P = 17 O = 5, P = 4
Gymnast 9	1 2	D = -7, U = -2 O = 20, P = 18	D = -9, U = -9 O = 5, P = 5	4 6	D = -12, U = -16 O = 15, P = 11	D = -5, U =-6 O = 10, P = 1
Gymnast 10	1 2	D = -21, U = -21 D = -15, U = -30	D = -10, U = -20 D = -10, U = -10	1 3	D = -5, U = -13 D = -7, U = -7	D = -5, U = -7 D = -6, U = -6

 TABLE II

 Scores Of Emotions And Bodily Symptoms Experienced Before And After Performance

*Note.* PSE = performance self-evaluation, O = optimal, P = pleasant, D= dysfunctional, U = unpleasant.

were some exceptions: the total impact of emotions and bodily symptoms after poor performance experienced by gymnast 1 was optimal-pleasant; the total impact of emotions experienced by gymnast 3 before poor performance was optimal-pleasant; the total impact of emotions and bodily symptoms experienced by gymnast 6 before good performance was dysfunctionalunpleasant.

*Impact of Emotions on Performance.* Table III reports the means and standard deviations of emotional intensity, functional effect, and hedonic tone of pre- and post-performance emotions by performance levels. The difference in scores of emotional intensity between current and recalled performance (i.e., intra-individual scores) are also reported. Results showed that

	Pre-performance				Pos	t-performa	nce
	Good	Average	Poor		Good	Average	Poor
Variables	M SD	M SD	M SD		M SD	M SD	M SD
				Emotions			
Intensity Functional effect Hedonic tone Current-Recall intensity	6.3 2.2 4.0 5.4 4.0 5.2 1.0 0.7	6.0 1.0 0.4 5.9 0.7 5.5 2.3 0.8	5.6 1.4 -5.0 3.0 -6.2 4.0 1.0 1.0		7.0 2.0 6.8 3.4 6.7 3.4 1.8 0.7	6.1 1.7 -0.6 5.8 -0.7 5.9 2.4 3.5	7.0 2.1 -3.7 5.4 -3.9 5.1 1.5 1.2
				Bodily symptoms			
Intensity Functional effect Hedonic tone Current-Recall intensity	5.5 2.0 -0.4 5.5 -0.2 5.4 1.5 1.2	5.2 1.2 -1.4 -5.2 -1.9 4.4 1.8 1.2	5.4 1.4 -5.0 1.7 -6.0 1.9 1.7 0.6		4.7 1.9 0.7 5.6 -0.2 5.0 2.0 1.8	$\begin{array}{rrrr} 4.4 & 1.7 \\ 0.0 & 2.2 \\ 0.0 & 4.6 \\ 1.0 & 0.0 \end{array}$	5.0 1.5 -3.0 4.6 -3.0 4.6 2.3 0.7

TABLE III Descriptive Statistics Of The Emotional Variables Related To Three Pre- And Post-Performance Levels Across Competition

*Note.* Current-Recall intensity = difference scores between current intensity and recalled intensity.

the intensity of pre-performance emotions as related to good and poor outcomes were close to the respective recalled optimal or non-optimal scores, according to the in/out-of-the-zone predictions.

According to the directional approach, a high intensity of optimal emotions perceived as facilitative and pleasant was related to good performance. Furthermore, a high intensity of optimal emotions perceived 'very, very little' facilitative and pleasant was associated with average performance, and a high intensity of non-optimal emotions perceived as highly debilitative and unpleasant was related to poor performance. Regarding bodily symptoms, good performance was characterized by a high intensity of optimal descriptors, perceived as 'very, very little' debilitative and unpleasant. In addition, average performance was characterized by a high intensity of non-optimal bodily symptoms perceived as 'little' debilitative and unpleasant, while poor performance was typified by a high intensity of non-optimal bodily symptoms perceived as 'little' debilitative and unpleasant, while poor performance was typified by a high intensity of non-optimal bodily symptoms perceived as highly debilitative and unpleasant.

*Impact of performance on emotions.* Results showed that the intensity of emotions experienced after performance were close to the recalled optimal or non-optimal profile according to the predictions of the in/out-of-the-zone concept of the IZOF model (see Table III). In other words, gymnasts whose performance was good, poor, or average experienced an intensity of post-performance emotions very close to the intensity of recalled optimal, poor, or average emotions, respectively.

In line with the directional approach, after good performances gymnasts experienced a high intensity of optimal emotions perceived as highly facilitative and pleasant. After average performances, they showed a lower intensity of optimal emotions perceived as 'very, very little' debilitative and unpleasant. After poor performances, gymnasts reported non-optimal emotional levels perceived as moderately debilitative and unpleasant. Regarding bodily symptoms, after good performances gymnasts felt a high intensity of optimal bodily symptoms perceived as 'very, very little' facilitative and unpleasant. After average performances, gymnasts experienced a moderate intensity of optimal bodily symptoms perceived as neither facilitative nor debilitative and neither pleasant nor unpleasant. After poor performances, a high intensity of dysfunctional bodily symptoms was perceived as moderately debilitative and unpleasant.

In summary, results showed that before and after good performances gymnasts tended to experience optimal-pleasant emotional levels close to their recalled optimal emotions. These states were perceived as more facilitative and pleasant. Furthermore, before and after poor performances gymnasts tended to perceive dysfunctional-unpleasant emotional levels close to their recalled dysfunctional emotions. These states were perceived as more debilitative and unpleasant. Overall findings are in accordance with the IZOF model and the directional approach predictions. Bodily symptom results followed the trend of emotions, however with different directional scores regarding the functional impact and the hedonic tone before and after good performances. Specifically, bodily symptoms were perceived as slightly debilitative and unpleasant before good performances and slightly facilitative and unpleasant after good performances.

*Coping strategies.* Table IV reports emotion-focused coping strategies and emotional difficulties. The general theme of tension management encompassed a variety of techniques adopted to establish an appropriate level of tension to perform optimally. Some gymnasts tried to stay calm and relaxed, while others tried to follow a warm-up routine to stay focused and prevent stress. Isolation was the most frequently mentioned strategy. The gymnasts tried to remain isolated to maintain or establish an optimal pre-performance emotional level. The second most frequently adopted strategy, subsumed within the general dimension of seeking support, was seeking the coach's support to receive technical instructions and suggestions, positive reinforcement, and objective evaluation of the situation. As regards emotional difficulties, the most problematic situation was the inability to manage tension, worry, and fatigue (e.g., inability to plan recovery). In this case, gymnasts reported negative thoughts, visualizing mistakes, perceptions of not being well prepared, and feelings of worry, dysfunctional emotions, and low self-confidence.

Coping				
Raw data themes	General dimensions			
Isolation (21) Warm up (8) Keeping calm (6) Relaxing (5) Decreasing tension (4) Rest (3)	Tension management			
Seeking social support (12)	Seeking support			
Seeking coach support (7) Positive emotions (8) Confidence (5) Emotional control (3)	Emotion management			
Emotional detachment (1) Breathing (6)	Arousal control			
Increasing arousal(5) Focusing on avoiding mistakes (4)	Reaction to mistakes			
Difficulties				
Raw data themes	General dimensions			
Worry and tension (16)	Worry and tension			
Worrying about making mistakes (5) Inability to manage tension (2) Fatigue (12) Stomach tension (2)	Bodily symptoms awareness			
Self blame (5) Negative emotions (5) Insecurity (2)	Dysfunctional emotions			
Lack of confidence (1) Venting of unpleasant emotions (1) Awareness about poor preparation (4) Expecting poor performance (3) Awareness about poor training (2) Anticipating fatigue (1)	Negative expectations			
Thinking to mistakes (2) Expecting mistakes (1) Visualizing mistakes (1)	Focusing on mistakes			

 Table IV

 Emotion-Focused Coping Strategies And Emotional Difficulties

Note: number of raw data themes elicited by gymnasts are reported in parentheses.

Table V contains effective problem-focused coping strategies and difficulties related to the task. Data showed that the most frequently used strategies were subsumed into the general dimension of thought control. These included, among others, thinking positively, thinking about the next performance as soon as an exercise had ended, disengaging mentally, appraising positively a situation, and stopping thoughts. Preparatory routines were also important. Placing magnesia on hands and gymnastic apparatus, checking

Coping	
Raw data themes	General dimensions
Positive self-talk (11) Thinking to next performance (10) Mental disengagement (8) Positive appraisal (7) Thought stopping (5 Self control (3) Positive approximation (2)	Thought control
Placing magnesia on hands, checking leotard, etc. (21) Seeking automaticity (7) Competition like training (2) Routine (1)	Routine
Expecting good performance (11) Awareness of good training (6) Anticipating good execution (3) Awareness of good preparation (1)	Positive expectations
Focusing on exercise (14) Keeping concentrated (3) Distraction (1) Planning (1)	Attentional strategies
Visualizing performance (10) Mental rehearsal of performance (5) Visualizing perfect execution (2)	Mental practice
Goal setting (8) Time management (4)	Goal setting
Active coping (6)	Active coping
Raw data themes Difficulties	General dimensions
Thinking to previous exercise (4) Negative self-talk (2) Negative thinking (2) Loss of control (1)	Negative self-talk
Inability to manage time (4) No time to execute pre-performance routines (1)	Time management problems

Table V.	
Problem-Focused Coping Strategies And	Task-Related Difficulties

Note: number of raw data themes elicited by gymnasts are reported in parentheses.

the status of the apparatus, checking their own leotard, and seeking the right springboard position are examples of behavioral routines. As regards taskrelated difficulties, negative self-talk and time management problems were the general dimensions.

# CASE STUDIES

Two case studies are presented in detail to further elucidate the link between emotions, performance, and coping strategies. Table VI reports the temporal pattern of emotions, bodily symptoms, coping strategies, and per-

Participant	Event	PSE	Pre-performance state and coping	Post	-performance state and coping
Gymnast 1	1	5	CS Routine Em Tense $(2, 3, 2, -3)$ BS Sweety hands $(1, 6, 4, 4)$	Em BS	Tranquil (1, 4, 5, 5) Sweaty hands (4, 3, -4, -2)
	2	2	CS No strategy to stop negative thinking Em Agitated $(0, 6, -5, -5)$ BS Sweety hands $(1, 6, -2, -3)$	Em BS	Unconfident $(0, 5, -4, -5)$ Muscular tension $(1, 2, -2, -2)$ Thought stopping
	3	6	CS Focusing on exercise execution Em Confident $(1, 5, 5, 6)$ BS Sweaty hands $(3, 4, -3, -2)$	Em BS CS	Tranquil (2, 5, 5, 5) Fluid movements (0, 6, 6, 6) No strategy to stop negative thinking
	4	2	CS Routine Em Agitated (0, 6, -5, - 6) BS Sweaty hands (1, 6, -5, -5)	Em BS	Tranquil (3, 6, -6, -5) Fluid movements (2, 6, 6, 6)
Gymnast 8	1	11	CS Visualizing perfect performance Em Focused (1, 11, 10, 9)	Em BS	Proud $(1, 8, 9, 10)$ Energetic movements (1, 9, 9, 8)
	2	11	BS Energetic movements (1, 9, 9, 9) CS Emotional control Em Focused (0, 10, 9, 8) BS Energetic movements (0, 10, 9, 8)	CS Em BS	Isolation Proud (1, 10, 10, 11) Sweaty hands (0, 5, 5, 4)

TABLE VI Pre- And Post-Performance Emotions, Bodily Symptoms, And Coping Strategies Of Two Gymnasts

*Note.* PSE = performance self evaluation, Em = emotions, BS = bodily symptoms, CS = coping strategies. The following data are presented in bracket: difference score between intensity of current and recalled performance; intensity of emotions or bodily symptoms of current performance; functional effect of emotions or bodily symptoms; hedonic tone of emotions or bodily symptoms.

formance of two gymnasts. For the sake of simplification, the Table contains only one emotion, a bodily symptom, and a coping strategy.

Gymnast 1 was unable to maintain a linear, positive performance trend during the competition. Before the first event of the competition, he adopted effective coping strategies (e.g., anticipating good execution, mental rehearsal, visualizing a successful event) and experienced mainly optimalpleasant emotions; he also felt some 'tension', which was perceived as facilitative and a little unpleasant. This latter emotional condition, which was close to the recalled condition (according to the IZOF model), allowed him to perform well. After the first event, at first he felt tranquil. He was near his recalled optimal performance (IZOF model) and he perceived this emotional state as very facilitative and pleasant (directional approach). Nevertheless, he was unable to maintain this optimal emotional arousal; immediately after the first performance he tried to think positively and sought the support of his coach, but before the second event ineffective coping strategies prevailed. He was uncertain about two specific movements and he was unable to manage an increased level of tension perceived as debilitative and unpleasant. He was near his recalled worst performance (IZOF model) and perceived this agitation as very debilitative and unpleasant (directional approach). As a

consequence, his performance was poor. After the second event he felt very unconfident, was near his worst performance (IZOF model), and experienced this emotion as moderately debilitative and very unpleasant (directional approach). After the second event he tried to change the situation by recovering a moderate level of emotional arousal, stopping thoughts concerning his previous performance, anticipating good performance, and decreasing tension. He thought about the competition as if it was a training session so as to find an optimal arousal level. Confidence increased, he was near his recalled optimal performance (IZOF model), perceived this emotional intensity as highly facilitative and pleasant (directional approach), and performed well. After the third event he felt tranquil, optimistic, and relaxed. Before the fourth event, he again experienced dysfunctional-unpleasant emotions and become worried about the result of the performance. He felt insecure and tired and expected to make mistakes. Consequently, his performance was poor. Once the competition difficulties were over he felt quite tranguil and relaxed even though he experienced this state as dysfunctional and unpleasant because it had resulted in a poor performance.

Gymnast 8 maintained an excellent level of performance associated with high intensity levels of optimal emotions. Isolation, positive thinking, and positive self-talk, the visualization of successful execution, emotional control, and the recovery of energy were the effective coping strategies adopted. According to the IZOF model, she experienced emotions and bodily symptoms at the same or at almost the same intensity levels of the recalled optimal emotions and bodily symptoms. According to the directional approach, she experienced high intensity levels of emotions that were perceived as being very facilitative and pleasant.

# Discussion

Findings provided support for the hypotheses of the study in accordance with recent work with athletes in which the intuitive link between the IZOF model and the directional approach was investigated. Robazza et al. (2008) found that athletes tended to perceive emotional levels near to an individual's optimal zones as facilitative-pleasant, and emotional levels close to an individual's dysfunctional zones as debilitative-unpleasant. Similarly, in our study when gymnasts experienced emotional intensity close to their recalled optimal emotion intensity, they perceived their states as facilitative and pleasant, and performance was good. Conversely, when gymnasts' emotional intensity was near to their recalled dysfunctional emotional intensity, their states were
felt as debilitative and unpleasant, and performance was poor. Furthermore, in line with the IZOF model (Hanin, 2000) findings showed that when athletes experienced a low intensity of dysfunctional emotions (pleasant or unpleasant) and a high intensity of optimal emotions (pleasant or unpleasant), they tended to perform successfully. In contrast, when athletes experienced a high intensity of dysfunctional emotions and a low intensity of optimal emotions, they tended to underperform.

Regarding the impact of performance outcomes on emotions, findings showed that after a good performance there was a prevailing pattern of optimal emotions perceived as facilitative-pleasant, whereas poor performance was followed by a pattern of dysfunctional emotions that were perceived as debilitative-unpleasant. The IZOF model also predicts that good performance may lead to dysfunctional states (e.g., excessive complacency or selfconfidence) typified by loss of energy or ineffective resource recruitment and utilization, while poor performance may lead to functional states characterized by energy mobilization (e.g., tension or anger) (Hanin, 2007; Ruiz & Hanin, 2004). These contrasting effects of performance outcomes on gymnasts' emotions were not noted, probably because emotions were assessed with respect to single events during the competition and not only at the end of the competition. The reason for these results, however, is not clear and future research should address this issue. Concerning bodily symptoms, they were unexpectedly perceived as slightly debilitative and unpleasant before good performances. Interviews revealed that gymnasts regarded most of the bodily changes as necessary to perform, but they did not feel them as pleasant. For instance, some gymnasts perceived their 'sweaty hands' as a natural and usual condition prior to competing although this caused some grasping problems with the gymnastic apparatus. Hence, a variety of bodily symptoms can accompany good performance even though not all symptoms are functional or pleasant.

As shown in this study, the relationship between emotions and performance is dynamic and bidirectional. The continual reappraisal of a performance process during a competition may lead the athlete to reinterpret the meaning of the situation and to shift from optimal to dysfunctional emotions and vice versa. Research has indicated that athletes' emotions changed across the phases of the competition (Johnson et al., 2007; Robazza et al., 2002; Sève et al., 2006, 2007). Accordingly, the gymnasts' emotional states changed in content, intensity, functional effect, or hedonic tone. Interviews revealed that gymnasts dealt with a variety of competitive circumstances that continuously changed their appraisals of the situation and their emotional states throughout the competition. Athletes' self-appraisal of perceived emotions and bodilv symptoms seems to depend on past performances, level of preparation, and memories linked with the exercise. This contention is in accordance with Hanin's (2004, 2007) concept of meta-experience related to awareness, attitudes, and beliefs about emotional states that an individual develops over the course of successful and less than successful performances. Jones (1995) explained the facilitative or debilitative effects of anxiety relying on Carver and Scheier's (1988) control-process perspective on stress and coping. Jones's model attempts to explain how the anxiety symptoms related to stressors of the competition may be viewed as beneficial or detrimental with respect to performance. According to this perspective, dysfunctional anxiety and emotions would be experienced as less debilitative and less unpleasant as long as the performer's expectancies of being able to cope with the competitive demands remained favorable. If expectancies became unfavorable, dysfunctional emotions would be interpreted as debilitative and unpleasant. Therefore, a directional and hedonic interpretation of emotional states would depend on the performer's cognitive appraisal of being able to control the situation and his or her symptoms and thoughts (Jones & Hanton, 2001; Mellalieu, Hanton, & Jones, 2003).

With regard to the relationship between coping strategies, emotions, and performance, our findings were fairly close to those of other studies indicating that coping effectiveness was associated with improved performance (Haney & Long, 1995; Pensgaard & Duda, 2003), lower levels of anxiety (Campen & Roberts, 2001), and pleasant affective experiences (Ntoumanis & Biddle, 1998). At a group level, the gymnasts in this study displayed a range of preparatory procedures and coping responses. They also presented a combination of idiosyncratic coping strategies to meet the demands of the competition. Lazarus (1999) has conceptualized coping as a dynamic and recursive process, which involves interactions between personal beliefs regarding the self, goals, and values (i.e., internal factors) and the environment (i.e., external or situational factors). In the study of the phenomenological complexity of coping, researchers have identified a few coping dimensions accounting for different strategies derived from their function and intention (Anshel, 2001; Nicholls & Polman, 2007). Two main dimensions of coping strategies (i.e., emotion- and problem-focused) were represented in the narratives of the participants in this study. Emotion-focused coping, which is intended to handle emotional responses to distress associated with the situation, was reflected in the general dimensions of tension management, seeking support, emotion management, arousal control, and reaction to mistakes. Problem-focused coping, which is aimed at controlling the situation through actions on the environment and the self, was represented in the general dimensions of thought control, routine, positive expectations, attentional strategies, mental practice, goal-setting, and active coping. Notwithstanding the range of coping responses displayed by participants, several difficulties were identified as potential threats to competitive performance. Emotional difficulties were subsumed in the general dimensions of worry and tension, bodily symptoms awareness, dysfunctional emotions, negative expectations, focusing on mistakes, while task-related difficulties were comprised in the general dimensions of negative self-talk and time management problems.

# CONCLUSION AND PRACTICAL IMPLICATIONS

Additional research is needed to study the relationship between emotional states and coping both before and after performance using different methodologies. The recall method adopted in this study may be seen as a limitation because participants involved in retrospective data collection could tend to rationalize and interpret past events and experiences in a way that may depart from reality. As advocated by several authors (e.g., Cox, Russell, & Robb, 1998; Krane, 1994; Thomas, Hanton, & Jones, 2002), alternative paradigms may involve non-invasive assessment through short emotional scales that would be easy to apply and completed very quickly close to and during competition. Assessment should also examine in greater detail further components of the psychobiosocial states beyond emotions and bodily symptoms. According to the IZOF model conceptualization (Hanin, 2000, 2004), these include cognition, motivation, motor reactions, performance, and communication. The lists of emotional and bodily symptom items adopted in our study actually contained descriptors pertaining to these additional dimensions. There is therefore a need to improve assessment methodology by clearly differentiating emotions (e.g., 'happy', 'sad', 'angry') and bodily symptoms ('increased heart rate', 'sweaty hands') from cognition ('focused', 'concentrated'), motivation ('motivated', 'determined'), movement ('stiff movements', 'fluid movements'), performance ('self confident', 'secure'), and communication ('detached', 'communicative'). A comprehensive assessment of psychobiosocial states can provide insight into the emotional processes related to performance and competition.

A better understanding of the temporal changes in emotional states and coping processes is also necessary to enable sport psychologists and coaches to develop effective interventions and assist athletes to attain optimal performances. Despite the limitations outlined above, some practical suggestions

are available from the IZOF model and the directional perception approach. For example, the IZOF notion of zone suggests helping athletes become aware of and attain an optimal content and intensity of emotions during performance (Annesi, 1998; Robazza, Pellizzari, & Hanin, 2004), while the directional approach suggests the need to modify the individual's interpretation of the intensity levels of anxiety and emotions (Hanton & Jones, 1999). Behavioral, cognitive and somatic techniques should be used to assist athletes to enter their optimal zones (Annesi, 1998; Robazza et al, 2004), while restructuring techniques such as goal-setting, imagery, and self-talk should be used to change the perception of the debilitative emotional states to conditions that facilitate performance (Hanton & Jones, 1999). Sport psychologists and coaches can also educate performers regarding the use of coping strategies or their ability to cope more efficiently. Athletes should be helped to manage, apply, and improve pre-performance routines, recover physical and psychological energy between events, and anticipate unexpected events. This should lead to improved performance and positive experiences when participating in competitive sports.

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# The fallacy of directional anxiety

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Since the work by Jones and colleagues in the early 1990s the idea that feelings of anxiety could be interpreted as either facilitative or debilitative to athletic performance has been widely discussed in the sport psychology literature (e.g., Jones, 1995). Although this view has been promoted by a number of researchers (e.g., Hanton, Rich, & Mellalieu, 2008), we argue that this framework is based on flawed empirical research, and not supported by evidence from mainstream psychology literature (e.g., Fox, 2008; Lewis, Haviland-Jones & Feldman Barrett, 2008). As stated by Burton (1998), anxiety by definition is a negatively toned and unpleasant emotion that cannot be facilitative. Both the DSM IV and applied psychologists who have worked with individuals with anxiety or anxiety related disorders will attest to the debilitative influence of anxiety on human functioning. Their observations suggest that the notion of 'facilitative anxiety' is a contradiction in terms. An important reason for this misconception might be the notion that 'anxiety', as assessed by some instruments in the sport psychology literature, is not equivalent to 'anxiety' assessed by instruments in other psychology domains. Indeed, there is now strong evidence to suggest that in particular the CSAI-2, which has guided most of the initial research on facilitative/debilitative anxiety, has not been an adequate instrument to assess anxiety in sport (Craft, Magyar, Becker, & Feltz, 2003; Lane, Sewell, Terry, Bartram, & Nesti, 1999). The psychometric properties and factor structure of the CSAI-2 have been shown to be unreliable (e.g., Cox, Martens, & Russell, 2003; Lane et al., 1999; Lundqvist & Hassmen, 2005) and its validity has been equivocal. For example, the construct validity has been questioned. In particular the ambiguity of the word 'concern' (rather than 'worried') has been problematic because this could be interpreted either negatively (threat related, debilitative) or positively (challenge, facilitative) by indi-

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viduals (Burton & Naylor, 1997; Lane et al., 1999). In addition, the predictive validity of the CSAI-2 is relatively low and appears to be influenced by a number of moderators (Craft et al., 2003; Woodman & Hardy, 2003).

It was actually this lack of clear relationship between the CSAI-2 and performance which resulted in the development of the directional anxiety framework. As Lane (2009) correctly identifies, rather than questioning the validity of the CSAI-2 researchers added a facilitative/debilitative scale to explain their findings. More recently, the interdependence of intensity and direction scored on individual items on the CSAI-2 (or CSAI-2R) has been questioned. In their study Lundqvist, Kentta and Raglin (in press) showed that only facilitative responses were provided on items which were not experienced at all or scored low in intensity by athletes. The authors suggested that summing the items on the bipolar facilitative/debilitative scale results in misleading conclusions by exaggerating the significance and actual frequency of facilitative ratings of symptoms related to anxiety. The outlined limitations of the CSAI-2 and statistical techniques used suggest that results supporting the directional framework are at best spurious and most likely the results of measurement artefacts because of the instrument used and statistical techniques adopted. More worryingly, little psychometric or validity information is available for this additional facilitative/debilitative scale. Lundquest et al. (in press) demonstrated that the facilitative scale had little relationship to actual performance. This observation provides significant concern about the validity of the directional hypothesis. To further illustrate these arguments, no researcher would suggest adding a similar debilitative/facilitative scale to Spielberger's state/trait anxiety inventory or any other anxiety/emotion inventory for that matter.

Current evidence from neuroscience also does not support the idea that emotions are interpreted as facilitative or debilitative. For example, there is strong biological evidence that positive and negative emotional feelings emerge from ancient subcortical regions which are similar in all mammalian brains. These are the areas which light up when emotions like anger, sadness and fear are experienced. At the same time neocortical systems show reduced arousal levels (e.g., Panksepp, 2008).

The study by Pellizzari et al. (2010) attempted to extend the directional hypothesis to other emotions regularly experienced by athletes. In addition, the authors suggested that there is support for this interpretation. However, we argue that the emotions identified for the different performance states (optimal pleasant and dysfunctional unpleasant for good, average and poor performance), are characterised by dissimilar emotions for the different states rather than a different interpretation of the same emotion. Such an interpretation is in line with earlier findings by Folkman and Lazarus (1985) and Folkman (1997)

who observed that both positive and negative emotions can occur within the same stressful encounter. The co-occurrence of positive and negative emotions has mainly been observed in individuals with serious injury (e.g., spinal cord injury), disease (e.g., AIDS), or experiencing loss (e.g., sudden infant death syndrome). More recently Nicholls, Hemmings, and Clough (in press) made a similar observation in a sample of elite golfers. Therefore, we argue that this framework provides a more eloquent explanation of the findings by Pellizzari et al. as well as a more fruitful avenue for investigating the emotion - performance relationship. The co-occurrence of negative and positive emotions has both theoretical and practical implications. For example, Folkman (1997) provided a new model of the coping process. Also, to date it is unclear whether negative and positive emotions are bipolar or relatively independent in nature. This is an important issue because it has significant influence on coping behaviour (Folkman & Moskowitz, 2004). Researchers, therefore, could examine the relative strength of the different negative and positive emotions on appraisal, coping and event outcome. For example, the interaction of the different emotions would most likely influence the amount of stress experienced and primary appraisal of a stressful event with experiencing predominantly negative emotions resulting in appraising the situation as a threat, whereas predominately positive emotions would result in appraising the stressful event as a challenge. It is also likely that the interacting emotions influence secondary appraisal (perceptions of control over the situation), as well as the actual coping strategies used (directly or indirectly via the appraisal process), and their effectiveness with the stressful encounter and ultimately performance. Folkman and Moskowitz (2004) have identified the interest in positive emotions during both acute and chronic stress as one of the most exciting research developments. We concur with this assumption.

What is clear is that researchers will have to assess a number of negative and positive emotions (and possibly their strength) to provide a more comprehensive and meaningful interpretation of the emotion – performance relationship. In addition, there is a need for the development of valid and reliable instruments to assist researchers in this endeavour. Taking into consideration current theory and findings in main stream psychology, we argue that research on the directional hypothesis in sport and exercise psychology is just an empirical and theoretical cul-de-sac and other theoretical frameworks need to be considered to explain the emotion – performance relationship.

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# The effect of sports participation on the intensity of psychosocial problems of males with quadriplegia in Poland

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> The main purposes of the study were (1) to evaluate the influence of sport participation on the intensity of psychosocial problems in males with quadriplegia, and (2) to determine the range of psychosocial problems encountered by physically active and sedentary individuals with quadriplegia, respectively. The Witkowski Psychosocial Problems Spinal Cord Injury Scale (PP-SCI) was used to assess the intensity of psychosocial problems among 35 physically active and 36 sedentary individuals with quadriplegia. The t-test analysis showed significantly higher values of mean global score (t = -4.13, p = .000) for the sedentary than for the physically active group. In addition, significantly higher scores were found in relation to four spheres of personality (t = -3.69, p = .000), family (t = -3.94, p = .000), social contacts (t = -3.75, p = .000) and occupational (t = -3.67, p = .000). This suggests that individuals with quadriplegia who are regularly involved in sport, are likely to experience less psychosocial problems than sedentary males with quadriplegia.

> KEY WORDS: Psychosocial problems, Quadriplegia, Sport participation, Wheelchair rugby

# Introduction

Several studies have described the psychosocial benefits of sport for persons with disabilities over the past 50 years. Spinal cord injury (SCI) results in

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impairment or loss of motor and/or sensory function in the trunk and/or extremities due to damage to neural elements within the spinal canal. Injury to the cervical segments (C1-C8) results in quadriplegia, which causes impairment of function in the arms, trunk, legs, and pelvic organs (Figoni, 2009). Initially, research concerning benefits of physical activity for people with SCI focused on physiological responses to exercise in individuals with paraplegia (Shephard, 1990). Since the 1970s the psychosocial benefits of sport and physical activity for paraplegics have been analyzed in many studies (Block, 1999; Heflich-Piątkowska & Walicka, 1975; Hicks et al., 2003; Jacobs, Roswal, Horuat, & Gorman, 1990; Muraki, Tsunawake, Hiramatsu, & Yamasaki, 2000; North, 1999; Shephard, 1990; Tasiemski, Bergström, Savic, & Gardner, 2000; Tasiemski, Kennedy, Gardner, & Blaikley, 2004; Weiss & Beck, 1973; Witkowski, 1993). Jacobs et al. (1990) and Muraki et al. (2000) demonstrated that sports activity can improve the psychological status of persons with SCI.

Recently the number of individuals with traumatic quadriplegia has increased; alongside this, the numbers who survive following injury has increased (Wyndaele & Wyndaele, 2006; Yeo et al., 1998). There is a large variation in the number of cases of SCI from country to country. For example, following a review of literature published since 1995, Wyndaele and Wyndaele (2006) reported the incidence of SCI as lying between 10.4 and 83 per million inhabitants per year. However, within this group the ratio of individuals with quadriplegia to those with paraplegia, and the ratio between males and females, is comparable in different countries (Stedward, 1998; Stover & Fine, 1987; Wyndaele & Wyndaele, 2006). Moreover, the data from the review study by Wyndaele and Wyndaele (2006) showed that the reported incidence and prevalence have not changed substantially over the past 30 years. In Poland, approximately 50% of individuals with traumatic SCI have quadriplegia, and about 80% are males (Kiwerski, 1997).

In the perspective of the International Classification of Functioning (ICF) the theory of rehabilitation emphasizes the importance of viewing and understanding disability not only as a medical (biological) problem, but also as a psychosocial problem of the person with a disability. The ICF framework also leads us to look at people with disabilities as experiencing more functional limitation than physical difficulties (WHO, 2001). Functional limitations in different aspects of acting cause a range of psychosocial problems, which may vary depending on gender, age, marital status, socio-economical status, etc. In the last two decades there have been a number of studies, which state that different kinds of disability are related to a spectrum of psychosocial problems experienced by the person (Dewis, 1989; Gentile, Ten

Hoedt, & Bosch, 2010; Gulbrandsen, Hjortdahl, & Fugelli, 1998; Lezak, 1987; Livingstone, Rosenbaum, Russell, & Palisano, 2007; Loup et al., 2009; Proctor, Hasche, Morrow-Howell, Shumway, & Snell, 2008; Santo & Manuel, 2010).

Several studies have investigated the effects of sports participation on the psychological and social status of individuals with SCI (Jacobs et al., 1990; Muraki et al., 2000; Tasiemski et al., 2000). However, it should be noted that sample sizes in these studies usually combined persons with quadriplegia and paraplegia, and as a result their conclusions are limited to commenting on differences between individuals with high and low spinal cord lesions (including individuals with quadriplegia and high paraplegia). The results of some other studies have been inconsistent. For example Hicks et al. (2003) reported a positive association between physical activity and well being, while Tasiemski, Kennedy, Gardner, & Taylor (2005) have observed much smaller and even insignificant associations. Noreau and Fougeyrollas (2000) reported that the impact of the level of injury (cervical vs thoracolumbar) on the realization of life habits was more apparent in people with quadriplegia. For example, the weakness of hand grip ability and dexterity in quadriplegia could be an obstacle to the realization of some activities or require much longer execution time. Limited scientific evidence has been found in relation to the intensity of psychosocial problems exclusively in individuals with quadriplegia (Block, 1999; Witkowski, 1993). Both Block (1999) and Witkowski (1993) used the Witkowski Psychosocial Problems Spinal Cord Injury Scale (PP-SCI) to assess the intensity of psychosocial problems in individuals with SCI. However, although they investigated individuals with paraplegia and quadriplegia, they did not focus on differences between sedentary and physically active individuals with quadriplegia, or on the specific psychosocial problems encountered by either group of individuals with quadriplegia.

Sports activity for individuals with disabilities should be considered not only as sport training but also as training for the activities of daily living including changing and transferring from an active wheelchair to a sports wheelchair, and locomotion training including the proper technique for wheelchair propelling and wheelchair manoeuvrability. In addition it should be conceived as psychosocial training including making contacts in a group; taking joint responsibility for a team, and overcoming mental barriers that arise as a result of the disability (Morgulec & Skrzypczyk, 2003). Therefore, it is important to analyze the impact of sports participation on psychological, as well as social aspects of individuals with quadriplegia. Because one of the most popular sports activity for individuals with quadriplegia is wheelchair rugby - a team sport developed specifically to meet the needs of individuals with quadriplegia (Sherrill, 1998) it was decided to focus on wheelchair rugby players. Because of the above we decided to investigate the relationship between the range and intensity of psychosocial problems of sport participants and sedentary individuals with quadriplegia. In addition, by gathering demographic data, we were able to describe differences in the range and intensity of psychosocial problems that arise in relation to characteristics such as age and marital status, as well as length of time since injury.

The purposes of the present study were (1) to evaluate the influence of sport participation on the intensity of psychosocial problems among males with quadriplegia by comparing physically active and sedentary individuals; (2) to determine specific psychosocial problems encountered by physically active and sedentary individuals with quadriplegia, and (3) to establish the role of sport participation and other demographic characteristics (age, time since injury, lesion level, place of birth, marital status, education, place of living, employment) on the intensity of psychosocial problems of individuals with quadriplegia.

# Method

#### PARTICIPANTS

Participants were recruited from the database of the (Polish) Foundation of Active Rehabilitation (FAR) a large national nongovernmental organization for individuals with spinal cord injury and organizer of the Polish Wheelchair Rugby League. Inclusion criteria were as follows: gender - male; age - below 50 years; diagnosis - traumatic cervical SCI (C4-C8); time since injury – minimum 1 year; locomotion – manual wheelchair. The potential candidates for this study were 197 individuals with quadriplegia (46 wheelchair rugby players and 151 non wheelchair rugby players) listed on the FAR Database. The Witkowski Psychosocial Problems Spinal Cord Injury Scale (PP-SCI Scale) was sent out to 197 individuals with guadriplegia. with a letter explaining the purpose of the study and consent form. The overall response rate was 39%. There were 35 responses from wheelchair rugby players, accounting for 45% of the returned sample, and 42 questionnaires were completed by sedentary wheelchair users (55% of returned sample). Six sedentary wheelchair users were excluded, because over the last year they had occasionally participated in sport (e.g. by participating in sport camp for one week). Overall, 71 males with quadriplegia took part in this study. The participants were divided into two groups according to their participation in sport. The sedentary group consisted of 36 individuals who had not participated in any sport for at least one year. The physically active group comprised 35 sport participants (Polish Wheelchair Rugby League players) who were involved in sport at least twice per week (each session 60 min) for a minimum of one year. Sedentary males ranged in age from 19 to 47 years (M = 32.17, SD = 6.99) and the mean time since injury was 10.78 years (SD = 6.22). Physically active males ranged in age from 20 to 49 years (M = 30.29, SD = 6.75) and mean time since injury was 10.34 years (SD = 5.31). Demographics and injury characteristics of participants (lesion level, place of birth, martial status, education, place of living and employment) are provided in Table I.

The study was conducted in accordance with national research ethics governances and requirements. Written informed consent was obtained from each participant and the Ethics Committee of Józef Piłsudski University of Physical Education in Warsaw approved the study.

#### INSTRUMENTATION

The Witkowski Psychosocial Problems Spinal Cord Injury Scale (PP-SCI) (Witkowski, 1993) was used to assess the intensity of subjectively experienced psychosocial problems in individuals with quadriplegia. The PP-SCI Scale was developed using the Polish version of Wright and Remmers' Handicap Problems Inventory (HPI) (Wright & Remmers, 1960). The PP-SCI Scale contains 60 items grouped into four spheres: personality; family; social contacts,

	Physically active (n = 35)	Sedentary (n = 36)	
	f (%)	f (%)	
<i>Lesion level</i> High quadriplegia <sup>1</sup> Low quadriplegia <sup>2</sup>	15 (43%) 20 (57%)	24 (67%) 12 (33%)	
Place of birth Village Town (< 50 000 people) Town (50 000–150 000 people) City (> 150 000 people)	6 (17%) 9 (26%) 5 (14%) 15 (43%)	4 (11 %) 9 (25%) 9 (25%) 14 (39%)	
<i>Education</i> Primary Vocational Secondary Higher (bachelor degree) Higher (master degree)	0 (0%) 15 (43 %) 16 (46%) 1 (3%) 3 (9%)	2 (6%) 15 (42 %) 15 (42%) 2 (6%) 2 (6%)	
<i>Martial status</i> Single Married	28 (80%) 7 (20%)	32 (89%) 4 (11%)	
Place of living Village Town (< 50 000 people) Town (50 000–150 000 people) City (> 150 000 people)	6 (17%) 6 (17%) 4 (11%) 19 (54%)	8 (22 %) 9 (25%) 5 (14%) 14 (39%)	
<i>Employment status</i> Employed <sup>3</sup> Unemployed	29 (83 %) 6 (17 %)	21 (58%) 15 (42%)	

 TABLE I

 Demographics And Injury Characteristics Of Physically Active And Sedentary Males With Quadriplegia

<sup>1</sup>participants with lesion level C5/6 and higher, <sup>2</sup>participants with lesion level lower than C6, <sup>3</sup>includes: students and homemakers.

and occupational (vocational/school related). Each item is rated using a 6-point scale: it does not concern me; the problem intensity is very low; the problem intensity is low; the problem intensity is moderate; the problem intensity is high, and the problem intensity is very high, with values ranging from 0 to 5, respectively. Scores in relation to each sphere range from 0 to 75, where 0 corresponds to the absence of subjectively experienced problem and 75 corresponds to the highest intensity of experienced problems. Thus, the higher the score in each area, the higher the intensity of problems and the greater the impact of the disability on that area of one's functioning (Block, 1999; Witkowski, 1993). The global score is the arithmetic mean of the values corresponding to the 60 items. Global scores are divided by four in order to compare them with the results from four spheres. The PP-SCI has been shown to be reliable (ranging from .91 to .95 for the scales and .92 for the global score). Due to the procedure of choosing the items from HPI to construct the Witkowski Psychosocial Problems Spinal Cord Injury Scale, it was assumed that the validity is even higher for the PP-SCI than for the HPI (Witkowski, 1993).

In order to collect data for the description of the sample (age, time since injury, lesion level, place of birth, martial status, education, place of living and employment) the Inventory of Demographic Data (IDD) developed by Witkowski (1993) was used.

# DATA ANALYSIS

Data were analyzed statistically by using the STATISTICA 7.1 package (StatSoft, Poland). Non-parametric statistics (the Mann Whitney test and the Spearman rank order correlation coefficient) were used to analyze ordinal data (lesion level; place of birth; marital status; education; place of living, and employment status). Parametric statistics (the t-test for independent samples and the Pearson correlation coefficient) were used with the interval and ratio data (age, time since injury and SCI Scale results). The Mann Whitney test was applied to analyze difference in both groups with respect to the lesion level, place of birth, marital status, education, place of living and employment status. The t-test for independent samples was applied to test for differences in global score in each of the four spheres (personality; family; social contacts, and occupational) between the physically active and sedentary group. The effect size was determined by calculating the Cohen's *d* for all statistically significant results. Values of *d* > .80, > .50 and > .20 were typically considered to represent high, medium, and low meaningfulness of results, respectively.

To determine the specific psychosocial problems encountered by physically active and sedentary individuals, two approaches were used. The first used the determination of scores that suggested problem intensity. For example, an item with a score of 4 or more was taken to indicate high intensity, while 5 indicated very high intensity of the experienced problem. The second approach was related to the number/percentage of individuals in both groups who indicated high or very high intensity of experienced problems. Based on these, the psychosocial problems that were most frequently rated as high and very high intensity, were listed in each group (twenty). The above mentioned literature finding suggested that different kinds of demographic variables and injury characteristic lead to variations in psychosocial problem experienced by the person with disability. Correlations between age and time since injury and PP-SCI results were computed using Pearson's correlation coefficient within each group. Spearman rank order correlation coefficients were computed between lesion level; place of birth; martial status; education; place of living; employment, and SCI Scale results within each

group. The magnitude of the effect was determined by calculating the coefficient of determination ( $r^2$ ) for all statistically significant results. Values of  $r^2 > .25$ , > .05 and > .01 were typically considered to represent high, medium and low strength of relationships, respectively. The level of  $p \le .05$  was considered significant.

# Results

The population was homogenous. No statistically significant differences between the physically active and sedentary groups were found for demographic and injury characteristic variables such as: age (t = -1.15, p = .25); time since injury (t = -0.32, p = .75); lesion level (U = 480, p = .08); place of birth (U = 611, p = .83); educational level (U = 587.5, p = .62); marital status (U = 574, p = .52); place of living (U = 532, p = .26) and employment status (U = 475.5, p = .08). The intensity level of psychosocial problems in each group (physically active and sedentary) measured as the global PP-SCI score (M = 28.05, M = 39.95, respectively) as well as the scores for each sphere were found as moderate (Table II). This means that there were neither very low scores belonging to the lowest level (0-15) nor very high scores belonging to the highest level (60-75). Although both groups presented moderate levels of psychosocial problems, the scores of physically active males with quadriplegia were lower than those of sedentary males. The t-test analysis showed significantly higher values of mean global score (t = -4.13, p = .000, d= -.98) for sedentary than for physically active quadriplegics. In addition, it showed significantly higher results in the four spheres of personality (t = -3.69, p = .000, d = -.88; family (t = -3.94, p = .000, d = -.94); social contacts (t = -3.75, p = .000, d = -.89) and occupational (t = -3.67, p = .000, d = -.87)for sedentary than for physically active quadriplegics (Table II). The effect magnitude (d value) indicated a large difference between both groups for four spheres and the global score.

SCI Scale	Physically active (n = 35)	Sedentary (n = 36)	<i>t</i> value	<i>p</i> value	<i>d</i> value
	M (SD)	M (SD)			
Global score Personality Family Social contacts Occupational	28.05 (10.73) 26.97 (10.65) 27.63 (12.46) 24.71 (11.16) 32.89 (13.41)	39.95 (13.36) 38.92 (16.02) 40.39 (14.71) 36.67 (15.34) 43.83 (11.71)	-4.13 -3.69 -3.94 -3.75 -3.67	.000 *** .000 *** .000 *** .000 *** .000 ***	98 88 94 89 87

 TABLE II

 Differences In SCI Scale In Physically Active And Sedentary Group

*d* value represents the effect size. \*\*\*  $p \le .001$ 

The most frequently indicated 20 psychosocial problems with high and very high intensity scores (with score 4 and 5) by sedentary and physically active individuals are listed in Table III and IV, respectively. In both groups the majority of problems (8 of 20) were related to the occupational sphere. Six were common for both sedentary and physically active males with quadriplegia (for example: Find some jobs are beyond physical ability; Dislike depending on others at work; Need to get extra education for suitable job). In addition, sedentary individuals found it hard to make a living and felt unsure about earning a good income, while physically active individuals indicated that they would like to work where disability will be less noticed, and believed that it is important to try harder to please their "boss".

For both sedentary and physically active individuals, two items from 20 with high and very high intensity PP-SCI scores in the personal sphere, were common: "to do work the disability makes difficult" and "daydream about things beyond ability". Moreover, sedentary individuals could not accept the fact that disability is permanent; envied people who are not disabled; worried about overcoming disability, and needed extra courage, while those who were physically active felt comforted by the fact that some disabilities are worse; tried to forget about being disabled, and needed to feel more valued.

SCI Scale sphere	SCI Scale item	n	%
Occupational	Find some jobs are beyond physical ability	25	69
	Miss out on getting suitable work due to disability	21	58
	Work harder to succeed than if not disabled	20	56
	Dislike depending on others at work	20	56
	Need to get extra education for suitable job	20	56
	Need to get work suited to physical limits	19	53
	Find it hard to make a living	17	47
	Feel unsure about earning a good income	16	44
Personality	Daydream about things beyond ability Envy people who aren't disabled Can not accept fact that disability is permanent Worry about overcoming disability Feel it important to do work the disability makes difficult Need extra courage	25 20 20 19 19 18	69 56 53 53 50
Family	Fear loosing loved someone	25	69
	Cannot physically do some things around the house	24	67
	Regret not being able to do enough for family	22	61
	Fear may need to depend on loved ones for a living	19	53
Social contacts	Feel more need to help others	16	44
	Need to live where there are people who will help	16	44

TABLE III The Most Frequently Indicated 20 Psychosocial Problems With High And Very High Intensity Score (Score ≥ 4) By Sedentary Individuals With Quadriplegia

SCI Scale sphere	SCI Scale item	n	%
Occupational	Miss out on getting suitable work due to disability	15	43
	Dislike depending on others at work	15	43
	Find some jobs are beyond physical ability	13	37
	Need to get work suited to physical limits	13	37
	Work harder to succeed than if not disabled	13	37
	Want work where disability will be less noticed	12	34
	Need to get extra education for suitable job	11	31
	Try harder to please "boss"	10	29
Personality	Feel it important to do work the disability makes difficult	15	43
	Feel comforted by fact that some disabilities are worse	11	31
	Try to forget about being disabled	11	31
	Daydream about things beyond ability	10	29
	Need feel of more value	10	29
Social contacts	Get annoyed by people wanting to help too much	17	49
	Feel more need to help others	14	40
	Lack of opportunities to do sports	12	34
	Need friends to encourage	11	31
Family	Worry because disability works a hardship on family	12	34
	Regret not being able to do enough for family	11	31
	Fear loosing loved someone	10	29

TABLE IV The Most Frequently Indicated 20 Psychosocial Problems With High And Very High Intensity Score (Score ≥ 4) By Physically Active Individuals With Quadriplegia

In the family sphere two items from 20 with high and very high intensity PP-SCI scores were common for both groups: "regret not being able to do enough for family" and "fear losing loved someone". Additionally, physically active individuals worried because disability imposes hardship on family, while sedentary individuals could not physically do some things around the house and feared that they may need to depend on loved ones for a living.

Only one item in the sphere of social contacts from 20 with high and very high intensity PP-SCI scores was common for both groups: "feel more need to help others". Moreover, sedentary individuals needed to live where there are people who will help, while those who were physically active were often annoyed by people wanting to help too much; noticed lack of opportunities to do sports, and needed friends to encourage them.

The correlations between demographic data and the scores received from the PP-SCI also showed some differences between the two examined groups. Table V illustrates only correlations which were statistically significant. Significant positive Pearson correlations coefficients were observed among sedentary individuals with quadriplegia, between age and the global score in PP-SCI (r = .39, p = .019) as well as scores in sphere of personality (r = .39, p = .018); family (r = .40, p = .016) and social contacts (r = .36, p = .034). Negative correlations between time since injury and the global score (r = .38, p = .024)

Variables	Physically active		Sedentary	
	r	r <sup>2</sup>	r	r <sup>2</sup>
Time since injury – Global score	38*	.14	-	-
Time since injury – Family sphere	34*	.11	-	-
Time since injury – Occupational sphere	44**	.19	-	-
Age – Global score	-	-	.39*	.15
Age – Personality sphere	-	-	.39*	.15
Age – Family sphere	-	-	.40*	.16
Age – Social contacts sphere	-	-	.36*	.13
Age – Occupational sphere	39*	.15	-	-

TABLE V Statistically Significant Correlations Between Demographic Variables and SCI Scale Scores in Physically Active and Sedentary Individuals With Ouadriplegia

\*  $p \le .05$ , \*\*  $p \le .01$ 

and scores in family (r = -.34, p = .48) and occupational sphere (r = -.44, p = .008) were noted among physically active individuals with quadriplegia. Age also correlated negatively with sphere of occupation (r = -.39, p = .041) in the physically active group. The effect size ( $r^2$ ) indicated a medium strength of significant correlation in both the physically active and sedentary groups. In addition, marital status showed statistically significant Spearman correlation coefficients with global score ( $r_s = -.36$ , p = .031) and scores in sphere of personality ( $r_s = -.40$ , p = .017) and social contacts ( $r_s = -.40$ , p = .018) in the physically active group. The rest of the demographic variables did not show statistically significant correlations with PP-SCI scores in both groups.

# Discussion

The results of the present study indicated that males with quadriplegia who are physically active sportsmen presented a significantly lower level of psychosocial problems, than those who stay far away from physical activity (the sedentary group). These findings are in accordance with results of previous studies (Jacobs et al., 1990; Muraki et al., 2000; Tasiemski et al., 2000; Tasiemski et al., 2004). In both groups the highest scores were observed in the occupational sphere, while the lowest scores were reported for the sphere of social contacts. Interestingly, eight out of twenty of the most frequently indicated psychosocial problems with high and very high intensity scores were related to the occupational sphere in both groups. Krause (1992) has reported that persons with paraplegia are more likely to return to work than those with quadriplegia. The results of the present study suggest that although physically active individuals with quadriplegia face significantly less problems in the sphere of occupation than sedentary individuals with quadriplegia, occupation still remains a visible problem for physically active males with quadriplegia. It might be explained by limited employment opportunities for individuals with quadriplegia, who usually need further re-education or training, and very rarely return to their pre-injury job or profession. According to data published by the Central Statistical Office in Poland (GUS, 2009) the employment rate of people with severe physical disability equals 2.7%. Even worse, there is also a very low number of employers who are willing to hire such people (Bartkowski, Gąciarz, Giermanowska, Kudlik, & Sobiesiak, 2009). The negative correlations between time since injury and the global score, as well as that between age and sphere of occupation in the physically active group seems to support the belief that individuals with quadriplegia need more time for the process of returning to work.

The analysis of specific psychosocial problems encountered by physically active and sedentary males showed some similarities – eleven items from 20 with high and very high intensity PP-SCI Scale were common for two groups. This outcome is important for those who provide psychosocial rehabilitation services. They should remember that only 50% of physically active people with quadriplegia face the same psychosocial problems as sedentary individuals. Thus, there is a great need for individualisation in therapy, with regard to level of activity.

Interestingly, the important correlations between demographic variables and PP-SCI scores for physically active individuals with quadriplegia were not statistically significant for sedentary individuals with quadriplegia and significant relationships in sedentary group were irrelevant for the physically active group. The level of intensity of psychosocial problems (in global score and in the sphere of family and occupation) decreases with time since injury (years spent on a wheelchair) among males with quadriplegia who were physically active. These findings suggest that physically active individuals with quadriplegia may adapt better to their disability in the sphere of family and occupation than sedentary males with quadriplegia. Among individuals with quadriplegia who were not physically active, a statistically significant positive correlation was observed between their age and the total score in the PP-SCI, as well as in the sphere of personality, family and social contacts. This suggests that the intensity of psychosocial problems experienced by sedentary individuals with quadriplegia increases when they are getting older.

The results of this study first of all demonstrate the importance of the new way of viewing disability suggested by the ICF, which emphasises the functional limitations experienced by those with quadriplegia as the result of limitation or lack of motor functions, rather than simply focussing on medical problems. Based on the research we have conducted, we now have more knowledge about the kind and intensity of the specific psychosocial problems faced by this group of individuals with disability. The findings we have presented also support the conclusions of Muraki et al. (2000) that sports activity can improve the psychological status of persons with spinal cord injuries. Sport participation helps people with disabilities to be more independent and to function better as a part of society. It should be underlined that sport activity in special populations, especially team games such as wheelchair rugby, includes fitness training as well as training for the activities of daily living, locomotion training and psychological training. Thus, the multifaceted interaction of sports training may cause both improvements in physical performance and improvements in the quality of life of individuals with quadriplegia (Morgulec & Skrzypczyk, 2003). Therefore, it may be concluded that sports activity plays an important role in lowering the number and intensity level of psychosocial problems experienced by males with quadriplegia in sphere of personality, family, social contacts and occupation.

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#### 6. Tables and illustrations

The number of figures and tables is to be kept to a minimum.

Each *table* should be typed on a separate page. Tables should be self-explanatory, supplementing but not duplicating the text. A brief title should be provided for each. Abbreviations used in tables should be defined.

*Illustrations* should be numbered in the order in which they are first mentioned in the text and included in the text sent by the website. They should be marked on the back to indicate the first author's name, the figure number and the top edge.

#### 7. Ethics

The IJSP Editorial Board requires that authors strictly follow ethical guidelines from their country or state.

Submissions must comply with appropriate inoffensive language standards.

#### 9. Checklist for submission

- 1. Cover letter
- 2. Original manuscript First page [Title of article, Name of Author(s), affiliation, running head, e-mail address of lead author, grant and thanks] Each section should be separated by a page break:
  - Abstract (150 words)
  - Body of the manuscript
  - References
  - Tables and figures
  - Captions
- 3. Blind copy of the manuscript (delate first page, remove authors' information from the properties box of the electronic document)