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DEVELOPMENT AND PRELIMINARY VALIDATION OF AN INSTRUMENT TO MEASURE METACOGNITION APPLIED TO PHYSICAL ACTIVITY DURING EARLY ADOLESCENCE

Michele SETTANNI[1], Daniele MAGISTRO[2], Emanuela RABAGLIETTI[1]*

[1]Department of Psychology, University of Turin, Turin, Italy
[2]Center of Research of Motor Sciences S.U.I.S.M.
(University School Interfaculty of Motor Sciences), University of Turin, Turin, Italy

ABSTRACT

In physical activity and sport domains, movement learning is linked to the repetition and refining of gestures, but the processes carried out for learning and organizing motor tasks, despite their importance, have rarely been investigated to date (Schmidt & Wrisberg, 2008). Beginning with the acknowledgement of the importance of metacognition during development and especially during school years (Brown, 1987), we are interested in investigating an analogous metacognitive approach in the field of physical activity in early adolescents. Specifically, our aims are: a) to propose and preliminarily validate an instrument to measure metacognition applied to physical activity (Metacognition Applied to Physical Activity Scale – MAPAS); b) to explore differences for gender, age-group, time spent practicing physical activities, and types of sports practiced (in terms of individual and/or team disciplines); c) to analyze the relationship between the metacognitive approach in the physical activity domain and sports-related motivations and goals. The sample consisted of 320 students, aged 11 to 15 (M = 12.5; SD = .99) attending the sixth to eighth grades of secondary school in northwestern Italy, who practice physical education during school hours as a part of their normal school curriculum. We administered a self-report questionnaire including questions regarding socio-demographic characteristics, MAPAS, sport activities practice, and sport motivations and goals. The factor analyses showed the presence of a one-dimensional structure of MAPAS. MAPAS construct validity was analyzed looking at relationships among MAPAS scores and the other study variables. Relevant differences were found as regard gender, school grade and sport practice; these differences were quite consistent with theoretical expectations. We even analyzed correlations between MAPAS and sport

[*] Corresponding author:
E-mail: michele.settanni@unito.it

motivations and goals: As expected the two constructs showed to be positively correlated. The results of the present study seem to indicate the substantial adequacy of the newly developed instrument (MAPAS) to measure metacognition in the domain of physical activity.

KEYWORDS: *metacognition, adolescence, physical activity, motivation, validation*

INTRODUCTION

Metacognition overview

In the field of school education the importance of metacognition has long been recognized in terms of the role played by knowledge, control mechanisms and regulation on cognitive processes. Metacognition represents the awareness that individuals have of their own cognitive abilities (and limitations) and of their and others' mental functioning; such awareness is developed in relation to different areas of learning such as linguistic, mathematical, emotional-affective, and physical activity areas.

Metacognition was first introduced by John Flavell in 1971 and since then it has been studied in a variety of fields such as educational, cognitive, and developmental psychology. Metacognition lays its basis on information processing and general intelligence theories and is defined in many different ways. Flavell (1979) defined metacognition as the individual knowledge of one's own cognition and the relative control one can exercise over it. Moreover, metacognition refers to thinking about thinking (Jacob & Paris, 1987), and has been defined as the knowledge and the control that children have over their own thinking and learning activities (Cross & Paris, 1988). The ability to monitor thinking (metacognitive monitoring, or comprehension monitoring) and to modify one's own thoughts and thinking strategies (metacognitive control) develops gradually and unevenly in different areas (social, academic, physical activity) through childhood and across the lifespan (Schraw, 1998).

Metacognition is considered the highest level individuals can reach according to their knowledge, learning strategies, self-regulation and control of their work to cognitive and mental functioning (Flavell, 1976; Brown, 1987; Cornoldi, 1995; Salatas Waters & Schneider, 2010).

Metacognition includes two components: knowledge about cognition and regulation of cognition (Gagné, 1985; Brown, 1987). On the one hand, knowledge of cognition includes three processes: first, declarative knowledge, which refers to knowledge of the self and of personal strategies; second, procedural knowledge, which refers to knowledge of how to use these strategies; last, conditional knowledge, which refers to knowledge of the when and why of using these strategies. On the other hand, regulation of cognition includes activities aimed at controlling learning such as planning, information management strategies, comprehension monitoring, debugging strategies, and an evaluation of the learning process (Baker, 1989, Artz & Armour-Thomas, 1992; Theodosiou & Papaioannou, 2006). Moreover, planning includes the selection of necessary strategies to attain specific goals, monitoring includes regulations or the periodic self-testing of an individual's actions during task performance, and evaluation includes an analysis of the products resulted and personal abilities on the task (Paris, Lipson, & Wixson, 1983; Schraw & Moshman, 1995).

Several studies have demonstrated that students who demonstrate good metacognitive skills are more strategic and perform better than students who show poor metacognitive skills (Garner & Alexander, 1989). Moreover, research findings showed a positive relationship between self-reported metacognitive activities and achievement outcomes such as reading comprehension, transfer of learning, and solving new problems (Volet, 1991). In fact, students who are recognized as gifted in their specific academic tasks usually demonstrate high levels of prior knowledge and great access to the task (Steiner & Carr, 2003); their knowledge is better organized and they are more prepared to interconnect new knowledge to prior knowledge in numerous ways in comparison to other less-prepared students.

Metacognition in physical and sport activity

Motor learning is a complex process that involves a variety of factors in relation to the functioning modalities of skill acquisition's underlying mechanisms, to the task's characteristics, and to particular didactical conditions and individual differences (Bortoli & Robazza, 1991; Schmidt & Lee, 2005). Thus, an approach to motor learning based on the solution of a problem-situation, which hinges on the ability to adequately solve a specific task, is needed. Facing a motor task/problem, the answer may be found by asking questions aimed at understanding, experimenting, comparing, and searching for the most adequate solutions (Combs, 1981). The execution of a motor task is essentially based on sensorial and/or perceptual data, on decisional aspects, and on movement control (Bridgeman, Kirch, & Sperling, 1981). Having synthesized these three elements it is possible to reach a movement that solves the task with a minimum level of energy, minimum time, and maximum efficiency. On this basis we found a parallel with metacognition in terms of the knowledge a person has about his/her cognitive functioning and the strategies he/she uses for controlling this process (Brown, Armbruster, & Baker, 1986). For example in physical activity tasks, Martini and Shore (2008) have shown that proficient performers verbalized a more detailed level of declarative and procedural knowledge with respect to the task performed. In addition, research findings suggest that experts and novices differ in their self-regulation of a new motor skill and that certain types of cognitive strategies may be adapted to a particular level of expertise (Ferrari, 1996; Thomas & Thomas, 1994).

Wall (1986) found out that when a person is familiar with a motor skill, the individual is more likely to use either conscious or unconscious metacognitive strategies. This have been shown in some studies conducted in different physical activity domains such as typing, dancing, and tennis (McPherson & Thomas, 1989), or basketball (Theodosiou, Mantis, Papaioannou, 2008; Winne & Perry, 2000), where the difference between experts and novices is evident during its performance.

So far, no clear relationship between gender and metacognitive skills has been established by researchers (for example, Hyde, Fennema, & Lamon, 1990). The study by Maccoby and Jacklin (1974) stressed the presence, at the academic cognitive level, of some gender differences: girls show higher verbal ability than boys; boys show higher numerical and visual-spatial ability than girls. However, more recent meta-analysis reviews (Hyde, 1981; Hyde & Marcia, 1988; Hyde, Fennema, & Lamon, 1990) and experimental studies (Feng, Spence, & Pratt, 2007) showed that gender differences in all cognitive and academic abilities were very small, if any. At the same time, the few gender differences seem to decline precipitously over the years, and especially at the high school level. For instance, with respect to attitudinal aspects, boys showed a higher interest in problem solving than girls (Rae, 1999), but girls reported a greater use of self-regulated learning strategies involving personal regulation or optimizing the environment than boys (Ablar & Lipschultz, 1998). Additionally, girls seem to use the skills of rehearsal, organization, metacognition and time management more frequently than boys (Bidjerano, 2005). As regards physical activities, Ommundsen (2003) found that boys used more metacognitive/elaboration strategies in physical education settings more frequently than girls.

With respect to age, Lee and Chen (1996) demonstrated that children of different ages (from 9 to 13 years old), presented different levels of metacognitive knowledge in basic motor tasks like walking, with older children showing more mature ratings than younger children. The ability to walk is the same for all children, but older children understand and better report sequences of movements while walking. Another study by Sperling and colleagues (2002) showed that as children grow up, learning and knowledge as well as strategic processes become more specific to the type of physical activity. It seems reasonable that older children develop more domain-specific metacognition when attending physical activity classes.

With respect to motor activity, some studies investigated the association of goal orientation and intrinsic motivation of students, perceived competence, effort, and achievement (Theodosiou, Mantis, & Papaioannou, 2008). Achievement goals are conceptualized as the purpose or cognitive–dynamic focus of the individual's competence-relevant engagement and performance goals and they are differentiated in terms of approach and avoidance, and personal achievement goals (Elliot, 1999; Elliot & McGregor, 2001). There are few studies about the connection of these aspects when applied to physical activity with individual metacognitive ability. Theodosiou and colleagues (2008) suggest that goal achievement is associated with students' use of metacognitive strategies in physical activity. Hence, there is evidence that highly task-oriented students are intrinsically motivated, they evaluate the process of learning in and of itself, and they adopt self-regulatory cognition and behaviors in physical education (Papaioannou, Marsh, & Theodorakis, 2004).

The present study refers to metacognitive processes underlying motor skills involved in physical activity. Motor skill can be defined as the number of actions that, through experience and repetition, have been learned and have become consolidated assets of the individuals (Musella et al., 2009). It also represents the final result of a learning process that develops and changes as a result of past experiences, and the progressive refinement of accuracy and movement coordination (Schmidt & Lee, 2005). Moreover, we are interested more specifically to how a person's knowledge about the process of how he relates a movement to its consequence. As indicated in the researches carried out by Toward (1996), Augustyn and Rosenbaum (2005), Theodosiou and colleagues (2008), the above mentioned aspects of metacognition, applied in movement field, could refer to a second-level concept of physical activity, i.e. metacognition applied to physical and sport activity. When referring to metacognition in the physical activity field, the dialectical relationship between declarative and procedural knowledge systems is crucial, particularly in the development period that ranges from late childhood to preadolescence, which is the focus of our study. It is between the ages of 10 and 14 that the organization of 'conceptual' thought is formed and this organization is characterized by the emergence of more abstract connections (Mounoud et al., 2007). In fact, during this period preadolescents are able to use action strategies they have learned in a different domain and also to improve the use of said strategies in its original domain. For a better understanding of this phenomenon among pre-teens who attend the first years of secondary school and perform physical activity and sports, the present study is based on the assumptions explained above, that we already investigated in previous researches (Rabaglietti et al., 2010a & b).

Many methods for the assessment of metacognition are being used, such as questionnaires (Pintrich & de Groot, 1990; Thomas, 2003), interviews (Zimmerman & Martinez-Pons, 1990), the analysis of thinking-aloud protocols (Afflerbach, 2000;), observations (Veenman & Spaans, 2005), stimulated recall (cf. Van Hout-Wolters, 2000), on-line computer-logfile registration (Veenman et al., 2004), and eye-movement registration (Kinnunen & Vauras, 1995). We opted for offline questionnaires for a fundamental reason: Differently from the other cited instruments, questionnaires are easy to administer even to large groups and do not require individual assessments. Thus, if the MAPAS validity is verified, the scale will represent a feasible and useful instrument to assess metacognitive competencies of individuals or groups (e.g. school classes).

In the current study we intend to go a step further by proposing a new tool specifically dedicated to the metacognitive approach in the context of motor and physical activity.

In view of the above-mentioned literature, we hypothesized the presence of some gender differences for metacognition related to physical activity, likewise found in studies on self-regulated learning. In addition, we think that the relationship between metacognition applied to physical activity and achievement is not as strong in younger students as in later years with regards to the different levels of experience in specific sport/physical activity. For the same reason, we expect a higher metacognitive approach in children who practice sport even outside of school.

METHOD

Participants

The study was carried out with pupils attending secondary school in northwestern Italy. The sample consisted of 320 students from the sixth to eighth grade (*M* = 12.5 years, *SD* = .99), 46% (*N* = 147) girls, 54% (*N* = 173) boys. All of the participants practiced physical education at school as part of their normal school curriculum. Of the participants, 72% (*N* =230) even practiced a sport outside the school context. Among those who practiced sports, 63% of the subsample practiced a team sport, and 37% an individual sport.

Measures

The Metacognition Applied to Physical Activities Scale (MAPAS)
The initial pool of items prepared to test the examined construct was adapted from a pre-existing instrument, the Metacognition Applied to Study Scale, developed by Cornoldi and colleagues (2001). Items from this questionnaire, originally concerning school study activities, were adapted to the physical education context by changing the wording and references in the items. Response categories were the same as Cornoldi's instrument, ranging from 1 (Disagree completely) to 4 (Agree completely). This initial pool, consisting of 40 items, was then submitted to six field experts – two physical trainers of competitive sports, two motor activities teachers, and two sports psychology professors – in order to assess the face and content validity of the proposed instrument. In particular, each evaluator assessed the applicability to the physical education context, the comprehensibility and the

essentiality of each item to measure the construct. Items were retained on the basis of concordance between the evaluators measured with Lawshe's Content Validity Ratio (CVR). Items were retained only if their CVR was higher than 0.

At the end of this process 10 items were retained (listed in the Appendix). This set of items was then administered to the study sample.

Sport activities practice

The practice of sport activities was investigated by means of single items. Firstly, students were asked if they practice sport activities outside school hours. In the case of an affirmative response they were then asked about what kind of sport they practiced (team or individual sport) and how many hours they spent practicing it.

Sport Motivations and Goals

In order to measure sport-related motivations and goals we used the Achievement Goals Questionnaire (AGQ; Elliot & McGregor, 2001), originally used in a school-competence context, and we adapted it to the physical and motor learning field. This questionnaire consists of 12 items which explore motivations and objectives that the individual locates within the learning situation, and is composed of four subscales 1) *performance approach goals*; 2) *performance avoidance goals*; 3) *mastery approach goals*; 4) *mastery avoidance goals*. All responses ranged from 1 (Disagree completely) to 4 (Agree completely).

Procedure

In accordance with Italian law, because the children were minors we obtained the active and informed consent from all parents for their children to participate in the study. In each of the involved schools, classrooms as units were randomly selected to take part in the study. Children were asked to anonymously respond to the questionnaire in their classrooms the hour after they took their physical education lesson (which typically lasts two hours). This choice was made in order to allow the children respond in a more aware manner to the questions regarding physical activity.

RESULTS

Data analysis strategy

Preliminary descriptive analyses were conducted in order to describe the sample with regards to their socio-demographic characteristics. After that, a preliminary exploratory factor analysis (EFA) was performed to evaluate the dimensionality of the instrument. The EFA was conducted using Mplus 6.11 (Muthen & Muthen, 2007). Given the ordinal nature of the items (4-point scales) we chose to use the robust weighted least square estimator (WLSMV) which is preferable for use with ordinal and non-normally distributed variables. As a rotation technique we employed the Geomin. The number of factors to retain was decided on the basis of Eigenvalues, looking at the scree plot, and the interpretability of the factor solution. The selected factor solution was then further tested using a confirmatory factor analysis (CFA). Even in this case we respectively employed the WLSMV and Geomin as the estimation method and rotation technique. Then, the reliability of the scale was computed using Cronbach's alpha.

In order to find evidence for construct validity, the next step of the analysis was to investigate the relationship of the measured construct with the other study variables. The relationships between gender, age, sport practice, and type of sport were studied using t-tests and one-way analyses of variance (ANOVAs), while the relationship with the motivation and goals related with the physical activities were inspected using Pearson correlation coefficients computed between the construct measure and AGQ subscales.

Descriptive statistics

Table 1 shows the frequency percentage of the responses to the 10 items composing the MAPAS scale. In Table 2 the polychoric correlation coefficients between the items are reported. All the reported correlations are significant: $p < .05$.

Table 1.
Response frequencies

	Disagree completely	Disagree moderately	Agree moderately	Agree completely
Item 1	10.3%	20.3%	36.7%	32.7%
Item 2	10.1%	21.0%	44.5%	24.4%
Item 3	6.3%	16.4%	38.6%	38.6%
Item 4	9.2%	17.3%	37.3%	36.1%
Item 5	12.2%	16.6%	37.5%	33.7%
Item 6	10.1%	25.9%	36.5%	27.6%
Item 7	7.8%	15.2%	34.5%	42.5%
Item 8	5.5%	16.7%	40.8%	37.1%
Item 9	8.1%	14.4%	32.6%	45.0%
Item 10	13.3%	17.1%	39.6%	30.1%

Table 2.
Polychoric correlations among items

	SP14	SP16	SP27	SP51	SP54	SP28	SP6	SP34	SP15
Item 1									
Item 2	0.50								
Item 3	0.37	0.44							
Item 4	0.39	0.31	0.38						
Item 5	0.32	0.35	0.35	0.29					
Item 6	0.39	0.32	0.49	0.37	0.34				
Item 7	0.38	0.35	0.47	0.39	0.30	0.32			
Item 8	0.38	0.36	0.45	0.42	0.36	0.43	0.48		
Item 9	0.36	0.27	0.46	0.37	0.30	0.35	0.55	0.51	
Item 10	0.44	0.36	0.23	0.35	0.20	0.37	0.43	0.38	0.36

Notes. N = 130. All correlations are significant at $p < .05$.

Exploratory Factor Analysis

An exploratory factor analysis was employed in order to assess the dimensional structure of the measured construct. The EFA was performed using the adjusted WLSMV estimation method and an oblique Geomin rotation. The oblique rotation technique was selected because we expected to find, in the case of multidimensionality, correlated (non orthogonal) factors. The number of factors to retain was determined by examining the scree plot (Cattell, 1966), as well as Kaiser criterion and factor structure interpretability. All the employed criteria indicated a substantial unidimensional structure (see Table 3 and Figure 1). Even model fit indices of the one-factor solution were adequate according to cut-off values proposed by different authors (Hu & Bentler, 1995; Brown, 2006): $\chi^2(35, N = 320) = 81.71, p < .01$; RMSEA = .065; CFI = .98; SRMR = .048. MAPAS items showed adequate communality size and, given the identified one-dimensional structure, there were no cross-loading items.

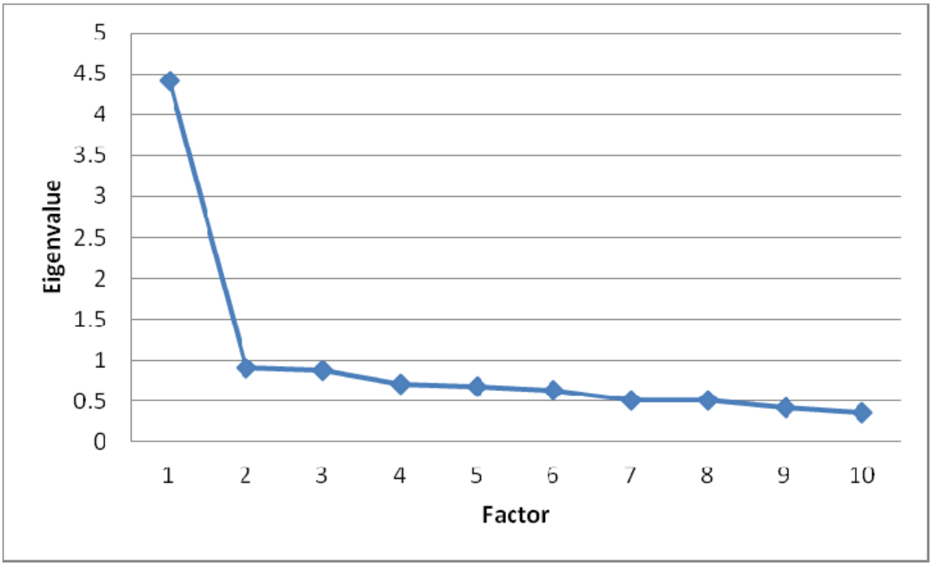

Figure 1.
Exploratory factor analysis on MAPAS items: Scree plot

Table 3.
Exploratory factor analysis (EFA) loadings for the MAPAS items

Item	*Loading*	h^2
Item 1	0.64	0.41
Item 2	0.59	0.35
Item 3	0.67	0.45
Item 4	0.59	0.34
Item 5	0.50	0.25
Item 6	0.61	0.37
Item 7	0.68	0.46
Item 8	0.69	0.47
Item 9	0.66	0.44
Item 10	0.57	0.32

Notes. MAPAS = Metacognition Approach to Physical Activities Scale. Values represent loadings from a one-factor solution using weighted least squares mean and variance-adjusted estimation (WLSMV). Item communalities (h^2) are shown in the last column (computed as 1 — estimated residual variance).

Confirmatory factor analysis
On the basis of the EFA results, we conducted a CFA on the scale, hypothesizing the presence of only one factor. The data fit the model well: $\chi^2(35, N = 320) = 75.814, p < .01$; RMSEA = .061; CFI = .97. The freely estimated parameters were all significant (see Table 4).

Table 4.
Confirmatory factor analysis (CFA) standardized loadings for the MAPAS items

Item	*Loading*	S.E.	Est./S.E.	P-Value
Item 1	0.64	0.041	15.774	<.01
Item 2	0.59	0.043	13.835	<.01
Item 3	0.67	0.038	17.642	<.01
Item 4	0.59	0.044	13.243	<.01
Item 5	0.50	0.048	10.370	<.01
Item 6	0.61	0.042	14.673	<.01
Item 7	0.68	0.037	18.144	<.01
Item 8	0.69	0.036	18.981	<.01
Item 9	0.66	0.039	17.118	<.01
Item 10	0.57	0.045	12.463	<.01

Relationships between MAPAS and other study variables
Gender differences. With regards to gender, we found a significant difference in MAPAS scores. Girls showed higher levels of metacognition applied to physical activities than boys: $F(1,318) = 5.73$, $p = .017$, $\eta^2 = .02$ (see Table 5).
School grade differences. Even with respect to school grades we found significant differences: $F(2,317)=8.80$, $p < .001$, $\eta^2 = .05$.
Tukey post-hoc comparisons of the three groups indicate that the eight-grade students ($M = 27.79$, 95% CI [26.52, 29.07]) reported significantly lower MAPAS scores than both sixth grade ($M = 31.44$, 95% CI [30.41, 32.47] , $p < .001$) and seventh grade pupils ($M = 30.16$, 95% CI [29.12, 31.20]), $p = .003$). Comparison between sixth and seventh grade students was not significant at $p<.05$ (see Table 5).
Time spent practicing physical activities. The number of weekly hours spent practicing physical activities and sports (both in and/or outside school) showed a significant impact on MAPAS scores: $F(3,316)=8.04$, $p < .001$, $\eta^2 =.07$.

Post hoc tests revealed that MAPAS scores significantly increased with the number of hours spent practicing physical activity. Tukey post-hoc comparisons of the four groups show that the students who spend 1 hours per week practicing physical activity ($M = 26.22$, 95% CI [23.47, 28.97]) reported significantly lower MAPAS scores than students practicing physical activity for a higher number of hours per week (2/3 hours: $M = 28.67$, 95% CI [27.55, 29.79] , $p = .042$; 4/5 hours: $M = 30.66$, 95% CI [29.43, 31.90] , $p < .001$; 6 or more hours: $M = 31.40$, 95% CI [30.24, 32.55] , $p < .001$). Comparison was significant even between the 2/3 hours per week group and both the 4/5 hours per week group (p = .023) and the 6 or more hours per week group (p = .002). Comparison between the 4/5 hours per week group and the 6 or more hours per week group was not significant at $p<.05$ (see Table 5).

Table 5.
MAPAS scores: Relationship with studied variables

		M	*SD*	*N*
*Gender**	*Female*	*30.72*	*5.45*	*147*
	Male	*29.09*	*6.36*	*173*
*School grade**	*6th*	*31.44*	*4.86*	*89*
	7th	*30.16*	*6.32*	*145*
	8th	*27.79*	*5.95*	*86*
*Hours per week spent practicing physical activities**	*1*	*26.22*	*7.63*	*33*
	2 to 3	*28.67*	*5.45*	*98*
	4 to 5	*30.66*	*5.88*	*92*
	6 or more	*31.40*	*5.61*	*97*
*Involvement in sport activities**	*No*	*27.84*	*6.42*	*90*
	Yes	*30.60*	*5.60*	*230*
Type of sport	*Team*	*30.32*	*5.31*	*147*
	Individual	*30.91*	*6.22*	*83*

Note: * indicates the presence of significant differences ($p < .05$) between the categories.

Involvement in sport activities. With respect to sport activities and in accordance with our expectations we found a significant difference in MAPAS scores in favor of pupils who do sport activity in their extra-curricular time: $F(1,318)=13.14$, $p<.001$, $\eta^2 = .04$. Descriptive statistics are reported in Table 5.

Type of sport. The type of sport practiced did not influence the scores obtained by the students. No differences were found between pupils practicing team or individual sports: $F(1, 225) = .57$, $p = .451$.

Sport-related motivations and goals. We analyzed the relationship of MAPAS scores with the AGQ subscales by means of Pearson's correlation coefficients. As expected, we found significant correlations. In particular, the highest correlations were found with the mastery approach (r = .64, p < .001) and performance avoidance (r = .50, p < .001), while lower but still significant correlations were found with the performance approach (r = .34, p < .001) and mastery avoidance (r = .15, p = .01).

DISCUSSION

The present paper was aimed to propose and preliminarily validate a scale to measure metacognition applied to physical activities (MAPAS). The content validity of the scale was carefully assessed by means of the evaluation of field experts. The items retained after the expert evaluation were then administered to a sample of early adolescents in order to test factor structure and construct validity. The results of the factor analyses showed the presence of a unidimensional structure, thus we can consider the new instrument to be an overall measure of metacognition and no subscales were identified.

Regarding the relationship of the MAPAS with other study variables we observed noteworthy patterns. Some of the significant relationships were in the expected direction. Firstly, we found slightly higher MAPAS scores in girls compared to boys, as was expected due to the particular stage of development investigated. In fact, during early adolescence girls seem to be cognitively, and thus even metacognitively, more developed than boys. This finding is in line with the literature, which highlights both small differences between males and females in cognitive academic abilities (Hyde, 1981; Hyde & Marcia, 1988; Hyde, Fennema, & Lamon, 1990; Feng, Spence, & Pratt, 2007) and a greater metacognitive learning approach in girls than in boys (Ablar & Lipschultz, 1998; Bidjerano, 2005).

With regards to the practice of sport activity, we found higher MAPAS scores for individuals who practiced sport. In the same direction, we observed that pupils who spend more hours per week practicing physical or sport activity report higher levels of MAPAS scores. As in Martini and Shore (2008), our findings suggest that experts in self-regulation learning and performing physical and sport activity differ with respect to novices.

We had some unexpected findings in regards to the relationship of MAPAS scores with school grade. More precisely, older students show lower levels of MAPAS scores. This finding could be justified within an integrated perspective between the stadial theory of Piaget (1977) and the following contribution of studies about metacognition in learning (Cornoldi, 1995; Salatas Waters, & Schneider, 2010). In fact, the subjects who participated in the research are in the formal operational stage, which begins at about 11 to 12 years old and is usually accomplished during the entirety of adolescence. The stage of formal operations is characterized by the appearance and consolidation of hypothetical deductive thinking, which is shown in the ability to perform logical operations with mental contents expressed in any language (words, mathematical symbols, etc.) and without the support of perception and experience (Piaget, 1977). It is during this period that boys and girls build conceptual organization of thought, characterized by the emergence of more abstract connections, by using strategies of action in a domain different from that in which they were learned, and improve the use of strategies in the domain that have been learned (Mounoud et al., 2007). This process corresponds exactly to thinking about thinking – metacognition – as well as reflecting on movement and other kinds of behaviors and strategies. Younger children, having a more limited repertoire of study strategies (Hartley, 1998), are in a stage of motor learning in which they can start to implement meta-processes. At the same time, expertise studies (De Lisi & Staudt, 1980; Glaser, 1999) have highlighted that individuals with specialized knowledge in some domains tend to have higher metacognitive performance than those who are not expert. Nonetheless, in the school context younger students could be more inclined to compensate lower level of knowledge of physical activity tasks with higher attention and concentration, thus showing higher levels of MAPAS score.

However, if they are not adequately supported and controlled, as it often occurs in the physical and sport dimension because the metacognition issue is absent in the curricula of Italian physical education teachers, the children's strategies may lose effectiveness over time, instead of becoming more efficient, as it is to be expected on the basis of the occurrence of developmental trends. Furthermore, we cannot exclude that even in the physical and sport dimension what was already found in the cognitive field by Schneider and Pressley (1989) and in the sport field by Solomon and Lee (1997) occurs in the older children. That is, from 7 to 18 years when an advancement in the methods of information processing usually occurs. This advancement leads to both more planned and consistent material to be learned, and to great automatism and less control of learning processes, especially for those skills that apparently have low levels of difficulty as occurs in most cases in physical and sport-related activity.

Thus, it is especially important in this field that teachers and instructors are able to sustain a course of development that supports the metacognitive processes of the students in order to result in motivated and skilled youths.

A less relevant unexpected result was the absence of a significant relationship between the type of practiced sport (team vs. individual) and MAPAS scores. We expected to observe higher MAPAS levels in students who practice an individual sport, but we found no significant differences. It is likely that our tool enables us to capture metacognitive processes that cut across the different sports, without differentiating between individual and team sports. However, further studies are needed to explore this topic.

Overall this preliminary study seems to indicate the adequacy of the developed MAPAS to measure the metacognition applied to physical education. The usefulness of the new proposed instrument will be evaluated in future studies with respect to the implications of metacognition applied to physical activities regarding phenomena such as dropping out from sport and physical activity in adolescence. Our hypothesis is that even in the physical activity context, as it generally happens in school (Smith, Rook & Smith, 2007; Schunk & Mullen, 2012), high levels of metacognition could be protective against dropout from motor and physical activity, which typically occurs in adolescence. Because of the well-known indirect and direct positive effects that continued participation in physical and sport-related activity have on healthy lifestyles and physical and psychosocial adjustment, we think that continuing to explore the use of metacognition applied to physical activity may contribute not only to obtaining high levels of performance and low levels of dropout in sports fields but also, and certainly much more importantly, to promote high levels of overall wellbeing in all individuals.

A possible limitation of the present study is represented by the use of a self-report questionnaire as the only way to measure metacognitive skills. As mentioned above, other types of instruments, such as interviews, analysis of thinking-aloud protocols and observations, have been quite successfully employed in previous studies on metacognition. Thus, even if the presented results are encouraging as regards the adequacy of the developed instrument, a further validation based on the comparison of MAPAS scores with metacognition measures obtained by means of other instruments may be needed.

Another potential limitation is linked to the fact that MAPAS is not intended as a domain-specific instrument (i.e., it is not intended to measure metacognition applied to specific physical activities), but its aim is to obtain an overall measure of metacognition applied to physical activity. We chose a non-domain-specific approach because it permits to assess individuals with different physical activity experiences. However, it is possible that metacognition applied to physical activity is a multi-faceted construct: individuals could show different metacognition levels that vary along with specific physical tasks and activities. If this was the case, the use of multiple indicators, instead of a single measure, could be more appropriate. Hence, further studies are needed to investigate the relationships between MAPAS and domain-specific measures.

APPENDIX

Metacognition Applied to Physical Activity Scale (MAPAS)

1. When I cannot accomplish something I attempted, I want to understand the reason why.
2. I like to find an explanation for the reason why sometimes I succeed in a movement and other times I do not.
3. When I workout, I think of the best way to tackle the task.
4. When I prepare for a physical activity test, I keep in mind what the teacher considers important.
5. If I fail in a physical activity test, I try to understand the causes.
6. I try to have a clear picture of my training schedule.
7. When I work out, I repeat what I was taught step by step.
8. When I work out, I always try to understand what I am taught.
9. When the teacher speaks I pay attention in order to remember and understand better.
10. In my personal preparations, I always devote time to verify what I am capable of doing.

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