Coordination of soccer players during preseason training

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Abstract

This study aimed to verify whether coordination improves as a result of a preseason soccer training. During 5 experimental sessions (days 1, 6, 11, 15, and 19), 16 semiprofessional male soccer players (22.0 ± 3.6 years) were administered 3 specific soccer tests (speed dribbling, shooting a dead ball, and shooting from a pass) and an interlimb coordination test (total duration of a trial: 60 seconds), consisting of isodirectional and nonisodirectional synchronized (1:1 ratio) hand and foot flexions and extensions at an increasing velocity of execution (80, 120, and 180 b·min-1). Furthermore, subjective ratings were monitored to assess the recovery state (RestQ) of the players, their perceived exertion (rating of perceived exertion [RPE]) for the whole body, and the perceived muscle pain (rating of muscle pain [RMP]) for the lower limbs and the internal training load by means of the session-RPE method. The ratios between post and pretraining RPE and RMP increased only during the first 2 experimental sessions and decreased after the second week of the training camp ($p = 0.001$). The Rest-Q showed increases ($p < 0.05$) for general stress, conflict/pressure, social recovery, and being in shape dimensions. Conversely, decreases ($p < 0.05$) were observed for social stress, fatigue, physical complaints dimensions. Throughout the preseason, the players improved their speed dribbling ($p = 0.03$), Shooting from a Pass ($p = 0.02$), and interlimb coordination ($p < 0.0001$) performances. These coordination tests succeeded in discriminating coordination in soccer players and could integrate field test batteries during the whole soccer season, because they were easily and inexpensively administrable by coaches.

Introduction

Within the multifacet aspects of soccer, crucial aspects to success are the players' capabilities to finely control the ball with the feet and to shoot a goal with accuracy. These skills strongly rely on a fine multijoint control for proper timing and transfer of energy between segments (9,15,16,34). To explain how the central nervous system manages the control of complex interlimb tasks, research studies on coordination have included manipulations of the directions and the velocity of execution of synchronized hand and foot movement associations, analyzing the phase transitions that occur when the foot fails to mirror the movement of the hand (3,7,8-10,25,31). In particular, soccer players proved to be more proficient than sedentary individuals in maintaining both the more natural (i.e., isodirectional) and the more difficult (i.e., nonisodirectional) coordination patterns under time pressure (11), indicating that chronic soccer training enhances executive function of players who heavily depend on the fine control of their foot to cope with movement constraints.

To increase the ecological validity of soccer-specific coordination tests, researchers designed tests including activities that resemble those performed during the game, such as dribbling under time pressure (35,42), and kicking a dead or a moving ball (9,16,27,35). Findings proved that skill level affects dribbling performances (35,42) and movement variability and outcome goals in kicking (9,16,22). Interestingly, skilled players tend to score more during a moving-ball condition than during a dead-ball condition with respect to their less skilled counterpart (16). Although a constant ball trajectory condition represents a potentially useful model to examine coordination patterns of soccer players at different skill levels (16), it has to be considered that during matches players perform many variations of kicks, adapting their highly complex and dynamic coordination patterns in relation to ball speed, ball position, and the intent of the task goals. Thus, kicking skills should also consider a ball passed from a team mate (35) and a combination of height and accuracy constraints (9,35).

In considering that fatigue could disturb the effective action of lower limbs leading to poorer intersegmental coordination (2,21), and contribute to increase the player's susceptibility to injury (1,44), the examination of changes in the performance of multisegmental tasks after fatigue is worthwhile (23). Unfortunately, performance of multisegmental tasks has been mainly examined under nonfatigued conditions (9,16,27,35), and few studies examined the changes in interlimb coordination (10) and technical capabilities of players after acute exercise (23,36). Besides physical fitness (i.e., aerobic and anaerobic power, sprint ability, etc.), a sound training plan should enhance coordination, foot control, and timing of complex movement patterns of soccer players. In general, coaches make use of several tests to evaluate the effectiveness of their training plan on fitness parameters (18,34,41), whereas the evaluation of the effects of cumulative training on foot control and soccer-specific performances is often neglected (22,29). This issue is particularly relevant in semiprofessional players who enter the preseason period presenting significant off-season deconditioning effects (6,28). In Italy, the preparation phase for a long competitive season (several months) is usually rather short (a few weeks) and often includes a higher frequency of training sessions (2 daily units), which pose a heavy physiological and psychological burden on players (6,26,40). Because it is uncertain whether a preseason training results in positive responses in foot control and soccer-specific performances (22), there is a need for an ecological study incorporating aspects of practical settings while maintaining experimental control.

Thus, this study aimed to verify whether a 3-week preseason soccer training had positive effects on soccer-specific skills and nonspecific coordinative tasks of semiprofessional players. It has been hypothesized that the coordination performances of semiprofessional players fluctuate during the preseason, reaching highest values at the end of this period.

Methods

Experimental Approach to the Problem

The local Institutional Review Board approved the within-subjects study design to assess the effects of a 3-week preseason soccer training on the coordinative capabilities of players. It was hypothesized that examining soccer-specific skills and nonspecific coordinative performances by means of an experimental design with a high ecological validity including field tests would increase the relevance and the applicability of the results.

To monitor the progress of soccer skills of players, we selected 3 soccer-specific tests (i.e., speed dribbling, shooting a dead ball, and shooting from a pass) of the Federation Internationale de Football Association Medical Assessment and Research Center (35), which represent an integral part of the game of soccer at all levels of practice and competition. In particular, the Speed Dribbling test proved to discriminate coordinated dribbling under time pressure between age, skill level, and positional role of players (35,42). Shooting a Dead Ball provides a baseline measure of kicking ability, which is required to perform free kicks, corner kicks, and penalties. In considering that in the game of soccer players have to frequently adjust their movements to kick a ball from a pass, the Shooting from a Pass provides a measure of a high level of perceptual skill and successful motor coordination (16). Because the success of a soccer kick depends on height and accuracy with which performers hit the ball at the target (9), in this study distinct accuracy constraints were used to provide a useful movement model in examining coordination differences between individuals. Using ropes to divide the goal into 6 equal parts, more points were assigned when the ball entered the top right or left external areas of the goal, with respect to when the ball entered the goal from the top middle area or from the lower areas (35).

To evaluate the foot control of soccer players, we selected an interlimb coordination field test (8), which included manipulations of the directions and the velocity of execution of synchronized hand and foot movement associations. Considering the time of correct execution (i.e., the foot synchronized with the hand movement) as the main dependent variable, this test explains how the central nervous system manages the control of complex tasks (3,25,37) and assesses the attentional control of the individual in maintaining the less stable antiphase (AP) movement patterns with respect to the inphase (IP) ones (3). In particular, this test showed high test–retest stability intra-class correlation coefficients (ICC) for both IP (ICCs = 0.95–0.96) and AP (ICCs =0.72–0.98) conditions (7), and proved to be a precious tool in discriminating coordination performances among soccer players (11) and acute effects of game play in the coordination of young (10) and old (12) team sport players.

Because dribbling and kicking are an integral part of the game of soccer at all levels of practice and competition and the literature (7) reported no learning effect for synchronized hand and foot movement associations, changes in coordination during the preseason period were attributed to the effects of cumulative preseason training. To enhance the positive engagement of participants, players were informed about the aims of the study and encouraged to perform the tests with full concentration and maximum effort, arousing their competitive instinct with respect to both their own individual condition and their standing among peers (35). In this study, the coordination tests were administered in a randomized order at the end of the morning training session as exercise proved to enhance the efficiency of those executive and attentive control functions involved in complex motor behaviors (10,12,13,32).

To enhance physical fitness (i.e., aerobic and anaerobic power, sprint ability, etc.), coordination and foot control of players, and timing of team movement patterns, coaches make an extensive use of group exercises in training sessions. Because several factors (i.e., athlete's fitness level, psychological status, recovery condition, appreciation of training, etc.) can influence the internal training load of players, according to the literature (19,20) the session–rating of perceived exertion (RPE) has been used to quantify the individual training load, multiplying the duration of the whole training session by the player's RPE (5). This method is considered a good indicator of global internal load of soccer training and demonstrated significant correlations (range 0.50–0.85) with respect to methods based on the HR response to exercise (19). Furthermore, in considering that players are in a cyclic state of training-fatigue adaptation, during the experimental period the player's RPEs for the whole body and muscle pain (rating of muscle pain [RMP]) for the lower limbs (5) were recorded before (i.e., pretraining) and after (posttraining) the training sessions and the ratio between post and pretraining was calculated. In particular, these ratios allow comparisons between trainings taking into account the initial status of the athlete, controlling for confounding factors between sessions because of differences in the internal training load associated with increased fitness level or cumulative fatigue. Finally, the Questionnaire of Recovery Stress for Athletes (RestQ) (24) was selected because it indicates the recovery–stress state of athletes considering 19 dimensions, representing subjective stress (i.e., general stress, emotional stress, social stress, conflicts/pressure, fatigue, lack of energy, physical complaints, disturbed breaks, emotional exhaustion, and injury) and subjective recovery (i.e., success, social recovery, physical recovery, general well being, sleep quality, being in shape, personal accomplishment, self-efficacy, and self-regulation), respectively. High scores in the subjective stress dimensions reflect intense stress. Conversely, high scores in the subjective recovery dimensions reflect plenty of recovery. Each of the 3 weeks of the preseason residential soccer camp included 6 training days and one day of rest. During the training days, the players underwent two 120-minutes daily training units (i.e., 10:00–12:00 and 17:00–19:00 hours) with a 5-hour rest in between. Training sessions and experimental evaluations were performed on an artificial turf, which is little influenced by weather conditions (38). Baseline data were collected at the beginning of the preseason period, after a 15-minute warm-up. Then during the preseason camp, four standardized morning sessions (temperature: 25 ± 3°C; humidity: 67 ± 12%) were organized (days 6, 11, 15, and 19), keeping constant the duration (120 minutes) and content of training. The standard morning training included 20-minute warm-up and stretching, 15-minute plyometrics exercises, 10-minute reaction time drills, 20-minute individual technical soccer drills, 20-minute team technical soccer drills, 20-minute small-sided game (4 vs. 4, 6 vs. 6), and 15-minute lower back and abdominal strengthening exercises and cooldown. Furthermore, a standard 120-minute afternoon training was administered before the training sessions under investigation. It consisted of a 15-minute warm-up, 25-minute individual technical drills, 20-minute agility drills, 30-minute tactical drills, 30-minute friendly match. Because appropriate diet and fluid intake enhance training adaptations (17), during the residential training camp a medical doctor nutritionist with 15 years of experience with soccer players planned the athlete's diet. In considering that dehydration could cause impairment in soccer-specific skills (30), the players were provided with individual water bottles and were encouraged to drink as much water as possible during the training session.

Subjects

Sixteen semiprofessional male soccer players (age: 22.0 ± 3.6 years; height: 177.2 ± 6.5 cm; body mass: 72.5 ± 6.8 kg) signed an informed consent to participate in the study. They were members of the Italian fifth league (i.e., Serie D) team, and had at least 10 years of previous soccer training (four 1.5-hour training sessions and a match weekly). Seven players joined this team for the first time. The players started the preseason training camp after 8 off-season weeks.

Speed Dribbling Test

For the Speed Dribbling test (Figure 1), players had to lead the ball along a 50-m path around several posts following a known sequence (35). The player started with the ball from behind the line on the ''Ready—Go'' signal. After 5 m, he had to run to the right to start dribbling around cones following a set order. After 10 m, he had to dribble around a 70 × 30 × 20 block placed vertically in the middle of the testing area. After 8 m, he had to play the ball around one side of a 30 × 20 × 70-cm block placed longitudinally in the middle of the dribbling area and run around the other side to collect it. Finally, he had to sprint through a gate. The time elapsed from the start to the finish line was measured by means of infrared reflex photoelectric cells (Polifemo; Microgate, Udine, Italy). To familiarize with the test sequence, the players walked the path twice before the testing trial.

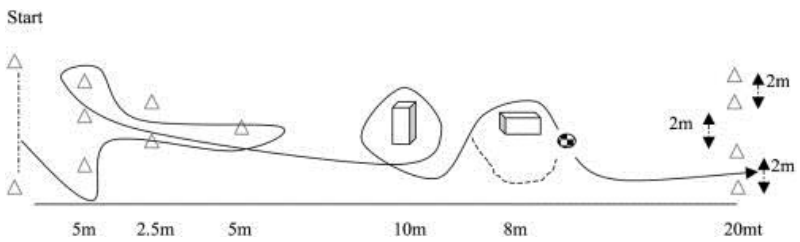

Figure 1. Schematic representation of the speed dribbling test. The horizontal distance between cones is 2 m. Dimensions of blocks are 70 × 30 × 20 cm.

Shooting Accuracy Tests

To evaluate the accuracy of shots, the soccer goal was divided into 6 areas, placing a rope horizontally between the posts at a height of 1.5 m and dropping from the crossbar 2 ropes at 0.5 m from each post. For the shooting a dead ball test (Figure 2), the player had 6 attempts of scoring a goal with the ball placed at 16 m from the middle of the goal. He had to aim first for the top right, then for the top left segment. The examiner measures a total of 3 attempts each at the top right and top left segments. Three points were scored when the ball entered the top right or left external areas of the goal, and 1 point when the ball hit the crossbar or a goalpost, or entered the goal from the top middle area. No point was assigned when the ball entered the goal in the lower areas or went out. The final score was the sum of points from the 6 attempts (35).

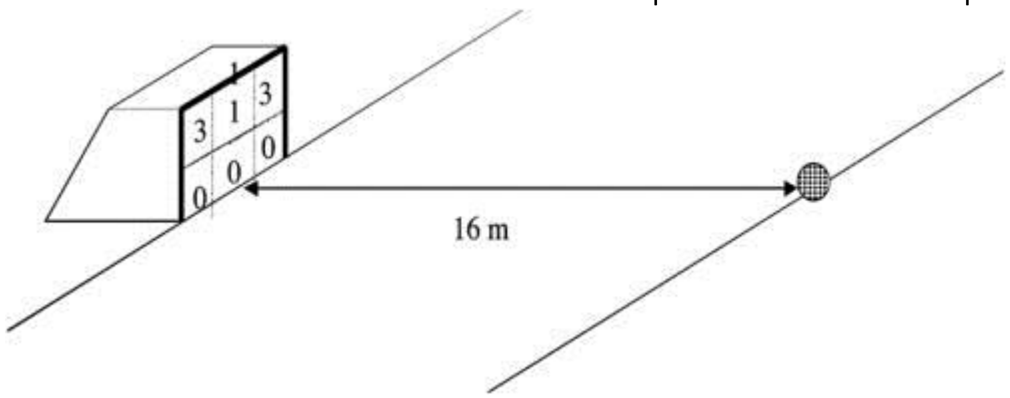

Figure 2. Schematic representation of the shooting a dead ball test.

For the Shooting from a Pass test (Figure 3), the player had 5 attempts of shooting from a 20-m ground pass after performing a 5-m run-up. From the edge of the penalty area, at the level with the goalkeeper's box, the examiner passed the ball to the penalty spot (i.e., 11-m distance from the goal, middle edge of the penalty area). In case the player declared that the pass was not accurate enough, then the attempt was repeated. Six points were assigned when the shot entered the top right or left external areas of the goal, 1 point when the ball hits the crossbar or a goalpost, 2 points when the ball entered the goal from the top middle or the lower areas, and no point when the ball went out. The final score was the sum of the 5 attempts (35).

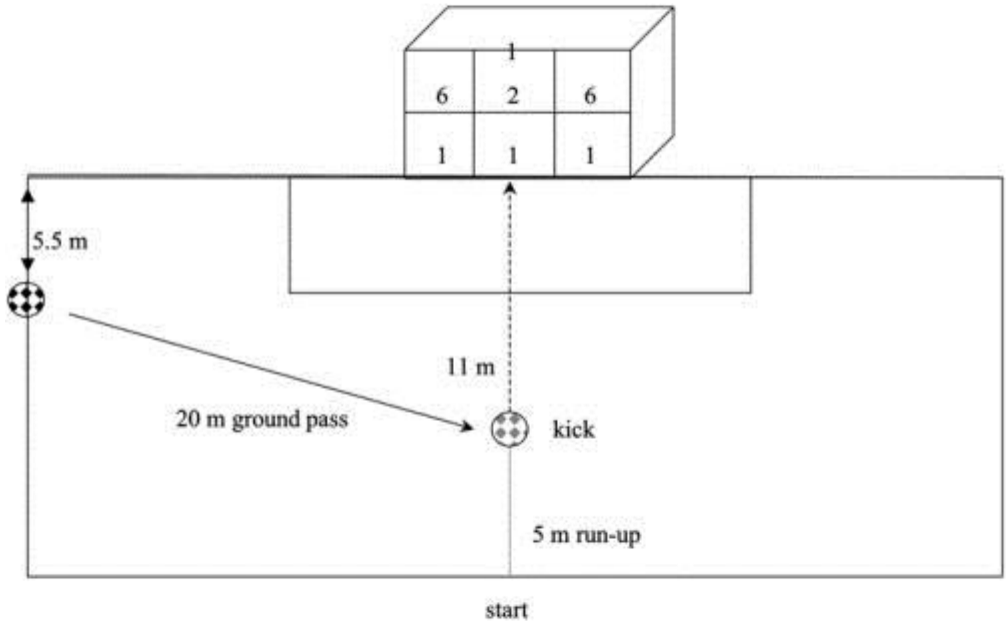

Figure 3. Schematic representation of the shooting from a pass test.

The performances of the shooting a dead ball and shooting from a pass tests were recorded by means of a video camera (JVC DL 107, Yokohama, Japan) positioned at a side of the pitch, at the level of the penalty, at a height of 6 m and at a distance of 5 m from the sideline. The videotape was later replayed (VHS "JVC BR 8600"), and performances were evaluated by a single observer, who previously showed no difference in assessing technical–tactical parameters of soccer competitions.

Interlimb Coordination Test

Before beginning the interlimb coordination field test (7), the players were asked to sit on a table with their elbows and knees flexed at 90°. The position allowed independent motion of the hands and lower limbs in the sagittal plane. The player had to perform cyclic ipsilateral flexion and extension movements around the wrist and ankle joints with a 1:1 ratio for the total duration of a trial (60 seconds), preserving the spatial and temporal requirements of the movement patterns. The present coordination test consisted of 2 execution modes (Figures 4A, B): IP, associating hand extension with foot dorsal flexion and hand flexion with foot plantar flexion, and AP, associating hand flexion with foot dorsal flexion and hand extension with foot plantar flexion. According to the literature (7), the player was free to choose to perform the test with his preferred foot.

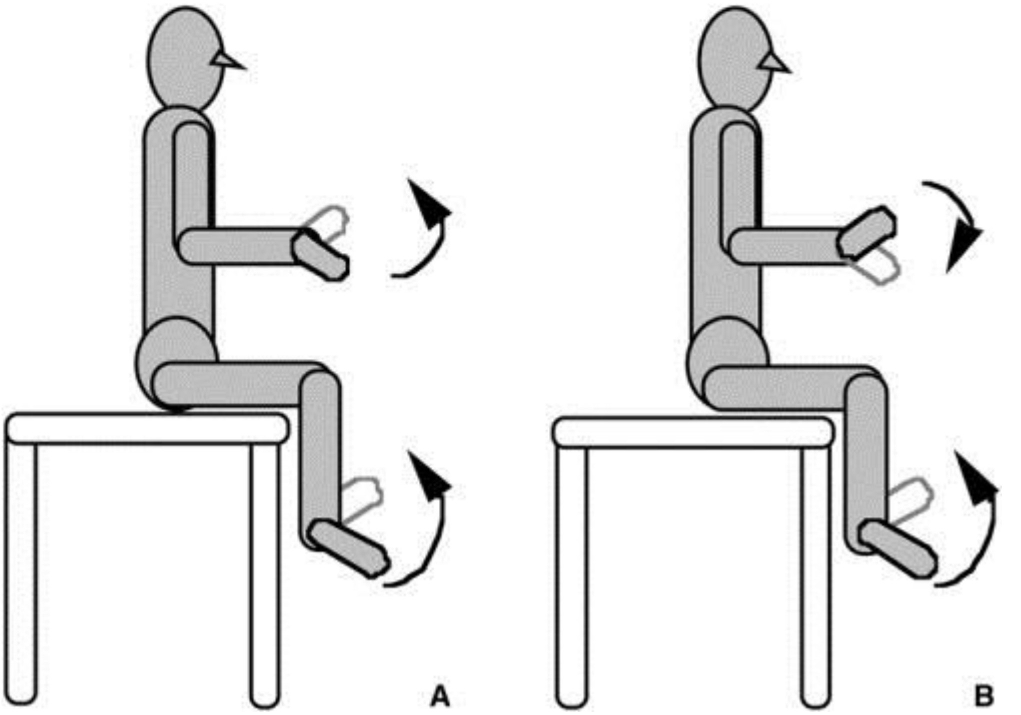

Figure 4. Schematic representation of the inphase (A) and antiphase (B) modes of the interlimb coordination test.

Three frequencies of execution (80, 120, and 180 b·min^{-1}) dictated by a metronome were selected. A 2-minute rest was given between test conditions allowing the athlete to stand. A counterbalanced order of trials between IP and AP coordination modes was administered to the players. After 15 seconds of the required metronome pace, a "ready-go" command led to the start of a trial. Using a stopwatch, an observer measured the time of correct execution (seconds) of the ipsilateral hand and foot coordination, that is, the time from the beginning of the movement up to when the individual failed to meet either the spatial or the temporal task requirements. To avoid disagreement among observers, a single competent observer (intraindividual reliability coefficients: 0.89–0.95) evaluated the performances. Before the test session, the players were familiarized with the test, allowing them to perform the coordination modes at different velocities.

Subjective Ratings

Before and 30 minutes after the training sessions under investigation, the players were administered the RPE scale (ranging from 6 "no exertion at all" to 20 "maximal exertion") for the whole body and the 11-point RMP scale (ranging from 0 "nothing at all" to 11 "maximum pain") for lower limbs, which showed a high (r = 0.90) test–retest reliability (5).

Before the training sessions under investigation, the players were also administered the RestQ, with a 0.79 test–retest reliability coefficient (24). The 52 items of the Rest-Q are assessed on a 7-point Likert scale, ranging from ''never'' (0 points) to ''always'' (6 points). The items represent 19 scales. Because the interpretation of the RestQ profile should refer to either a reference group of the athletes or the mean and variability of single samples, the 19 scales were analyzed separately.

Statistical Analyses

An alpha level of 0.05 was selected throughout the study. Means and SDs were calculated for each studied parameter, and analysis of variance with repeated measures was applied to subjective ratings and coordination performances. If the overall F-test was significant, post hoc Fisher protected least significant difference comparisons with Bonferroni corrections were used. Cohen's effect sizes (ESs) were also calculated, considering trivial ES = 0.2, small ES from 0.3 to 0.6, moderate ES < 1.2, and large ES > 1.2.

Results

No difference emerged for internal training load (659 ± 264 AU) between the experimental sessions. Conversely, differences emerged for pretraining RPE ($F(4,48) = 32.0$, $p < 0.0001$; ES range: 0.42–0.82). Post hoc analysis showed that the soccer players started the first 2 training sessions under investigation feeling less fatigued (i.e., day 1: 8 ± 3, “extremely light”; day 6: 11 ± 2, “very light”), with respect to the following ones (day 11: 14 ± 2, “some hard”; day 15: 15 ± 3, “hard”; day 19: 15 ± 2, “hard”). Also pretraining RMP showed a progressive increase ($F(4,48)=51.4$, $p < 0.0001$; ES range: 0.08–0.76) from the first (i.e., just noticeable) to the fourth (i.e., hard) studied training sessions. However, differences for RPE ($F(3,36)=7.7$, $p = 0.0004$; ES range: 0.3–0.7) and RMP ($F(3,36)=11.1$, $p < 0.0001$; ES range: 0.3–0.7) ratios showed increases during the first 2 training sessions under investigation and an opposite trend after 2 weeks of the training camp (Table 1).

Post–pretraining ratio	Day 6	Day 11	Day 15	Day 19
RPE	1.19 ± 0.26	1.25 ± 0.21	1.03 ± 0.18†	0.88 ± 0.21†‡
RMP	1.13 ± 0.26	1.30 ± 0.30	0.96 ± 0.13†	0.81 ± 0.18†‡

*RPE = ratings of perceived exertion; RMP = ratings of muscle pain.
†Difference ($p < 0.001$) with respect to day 6.
‡Difference ($p < 0.02$) with respect to day 11.

Table 1. Means and *SD*s of the post–pretraining ratios of RPE and RMP during the 4 experimental sessions of the preseason soccer training.

The 19 stress–recovery state dimensions (Table 2) showed differences between training sessions only for general stress ($F(4,48) = 3.2$, $p = 0.02$; ES range: 0.09–0.36), social stress ($F(4,48) = 6.3$, $p = 0.0004$; ES range: 0.22–0.53), conflicts/pressure ($F(4,48) = 5.4$, $p = 0.001$; ES range: 0.03–0.55), physical complaints ($F(4,48) = 10.5$, $p < 0.0001$ ES range: 0.08–0.68), social recovery ($F(4,48) = 3.7$, $p = 0.01$; ES range: 0.20–0.44), and being in shape ($F(4,48) = 3.8$, $p = 0.01$; ES range: 0.11–0.42). Furthermore, the subscales fatigue and sleep quality approached significance ($p = 0.08$). In general, post hoc analysis maintained differences with respect to day 1. Negative variations were observed for general stress, conflicts/pressure, social recovery, and being in shape dimensions. Positive variations were observed for social stress and physical complaints dimensions.

Dimensions	Day 1	Day 6	Day 11	Day 15	Day 19	p
Subjective stress						
General stress	3.3 ± 1.2	3.5 ± 1.0	4.2 ± 1.1*	4.0 ± 1.4*	3.9 ± 1.0*	0.0215
Emotional stress	2.2 ± 0.9	2.4 ± 1.1	3.1 ± 1.8	2.7 ± 1.8	2.4 ± 0.8	0.11
Social stress	2.9 ± 1.0	2.3 ± 0.6*	2.0 ± 0.7*	1.9 ± 0.8*	1.7 ± 0.9*	0.0004
Conflicts/pressure	1.3 ± 0.9	1.9 ± 1.0	2.7 ± 1.2*	2.6 ± 1.5*	2.5 ± 1.3*	0.0011
Fatigue	3.6 ± 1.1	3.3 ± 1.4	2.8 ± 1.0	2.7 ± 0.9	2.7 ± 0.9	0.08
Lack of energy	2.9 ± 1.1	3.0 ± 1.6	2.9 ± 1.5	2.9 ± 1.4	2.7 ± 1.3	0.49
Physical complaints	2.3 ± 0.6	1.7 ± 0.7*	1.3 ± 0.7*†	1.4 ± 0.7*	1.2 ± 0.6*†	<0.0001
Disturbed breaks	2.0 ± 0.9	2.1 ± 0.9	2.1 ± 0.5	2.0 ± 0.7	1.8 ± 0.7	0.79
Emotional exhaustion	1.2 ± 1.2	0.8 ± 0.7	0.8 ± 0.7	0.7 ± 0.5	0.9 ± 0.7	0.14
Injury	1.9 ± 0.3	2.3 ± 0.3	2.4 ± 0.2	2.1 ± 0.2	2.2 ± 0.2	0.56
Subjective recovery						
Success	0.8 ± 0.9	0.7 ± 0.6	0.6 ± 0.5	0.7 ± 0.7	0.7 ± 0.7	0.85
Social recovery	1.7 ± 0.9	1.2 ± 0.8*	1.0 ± 0.8*	1.3 ± 0.6	1.0 ± 0.7*	0.0102
Physical recovery	1.3 ± 0.8	0.9 ± 0.8	1.0 ± 0.9	1.1 ± 0.6	1.2 ± 1.1	0.64
General well-being	2.2 ± 1.0	2.3 ± 1.1	2.3 ± 0.9	2.2 ± 0.9	2.1 ± 1.1	0.89
Sleep quality	2.4 ± 1.5	2.0 ± 1.2	2.4 ± 1.3	2.5 ± 1.4	2.4 ± 1.3	0.08
Being in shape	3.3 ± 1.0	2.6 ± 1.1*	2.3 ± 1.3*	2.2 ± 1.3*	2.6 ± 1.3*	0.0096
Personal accomplishment	3.5 ± 1.7	3.9 ± 1.7	3.5 ± 1.6	3.8 ± 1.7	3.7 ± 1.7	0.52
Self-efficacy	2.8 ± 0.7	2.8 ± 0.9	3.0 ± 0.8	3.1 ± 1.0	3.0 ± 1.0	0.40
Self-regulation	3.1 ± 1.0	3.0 ± 1.4	3.0 ± 1.3	3.1 ± 1.7	3.0 ± 1.4	0.92

*Difference with respect to day 1.
†Difference with respect to day 6.

Table 2. Means and *SD*s of the stress–recovery subscales during the preseason soccer training.

Coordination Tests

Table 3 shows the means and SDs of the soccer-specific tests. For the Speed Dribbling test, differences emerged between sessions ($F(4,60) = 2.7$, $p = 0.03$; ES range: 0.02–0.45). Best performances were found at baseline (19.57 ± 0.98 seconds) and after the last training session under investigation (19.43 ± 0.83 seconds), with significant decrements for days 6 and 11. During the experimental period, the test Shooting a Dead Ball showed no difference between scores. Conversely, differences between the experimental sessions emerged for Shooting from a Pass ($F(4,60) = 3.2$; $p = 0.02$; ES range: 0.12–0.27), with significant lower values recorded at baseline (12 ± 5 points) with respect to the other sessions (16 ± 6 points).

Soccer-specific tests	Day 1	Day 6	Day 11	Day 15	Day 19
Speed dribbling (s)	19.57 ± 0.98	20.20 ± 0.75*†	20.05 ± 1.11*†	19.84 ± 1.48	19.43 ± 0.83
Shooting a dead ball (*n*)	8 ± 4	10 ± 3	9 ± 3	9 ± 4	9 ± 3
Shooting from a pass (*n*)	12 ± 5	17 ± 8*	17 ± 4*	19 ± 6*	17 ± 7*

*Differences with respect to day 1.
†Differences with respect to day 19.

Table 3. Means and *SD*s of the soccer-specific performances during the 4 experimental sessions.

Interlimb coordination performances showed main effects for coordination mode ($F(1,13) = 72.5$, $p < 0.0001$), Execution Frequency ($F(2,26) = 96.7$, $p < 0.0001$), and experimental condition ($F(4,52) = 27.9$, $p < 0.0001$). Significant interactions ($p < 0.0001$) emerged also at the second and third interaction levels. Thus, further analysis was performed only on the 3-way coordination mode × execution frequency × experimental condition interaction (Figures 5A, B). Because players always completed the test at 80 and 120 b·min-1 in the IP condition and at 80 b·min-1 in the AP condition, post hoc analysis was performed only for IP at 180 b·min-1 and AP at 120 and 180 b·min-1 data. Regarding the IP at 180 b·min-1 condition, differences ($F(4,52) = 3.3$, $p = 0.017$; ES = 0.4) in time of correct execution emerged between the first week (48 ± 14 seconds) and the last 2 training sessions under investigation (58 ± 6 seconds). In the AP coordination mode, progresses emerged from the first session for both the 120 b·min-1 ($F(4,52) = 24.6$, $p < 0.0001$; ES range: 0.5–0.7) and 180 b·min-1 ($F(4,52) = 11.0$, $p < 0.0001$; ES range: 0.3–0.6) frequencies of execution. At 120 b·min-1, the players steadily improved the time of correct execution from the first session (27 ± 22 seconds) to day 15 of the training camp when they succeeded in completing the whole test. At 180 b·min-1, the time of correct execution increased more stepwise, with the best performances (34 ± 21 seconds) found at the end of the experimental period.

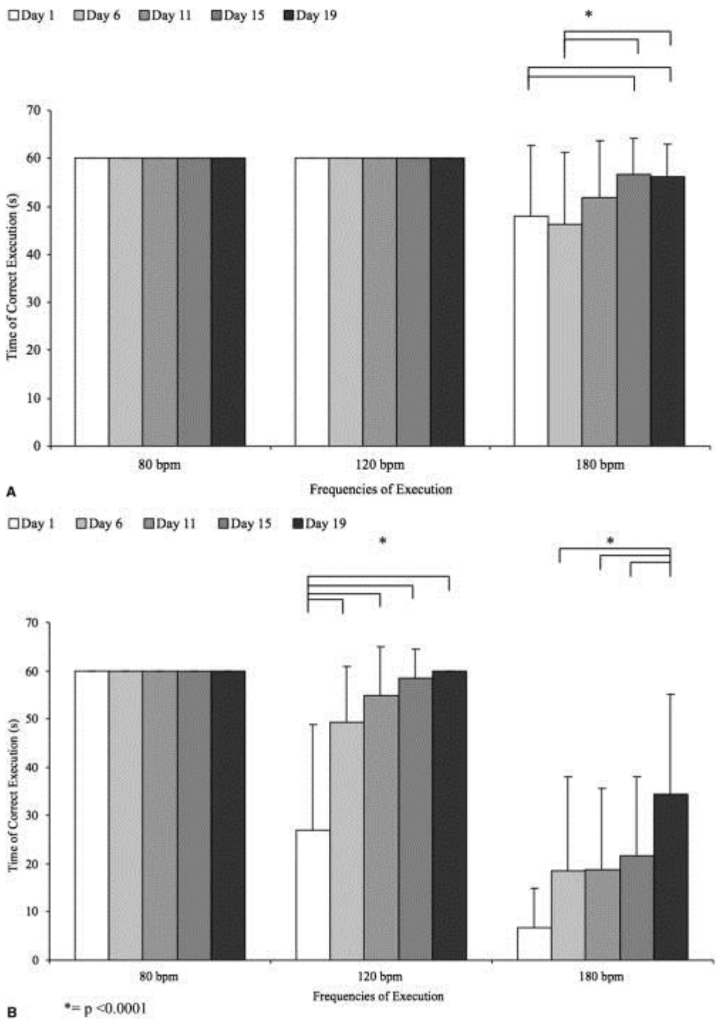

Figure 5. Means and *SD*s of the inphase (A) and antiphase (B) interlimb coordination performances during the 4 experimental sessions of the preseason soccer training.

Discussion

To our knowledge, this is the first attempt to evaluate coordination capabilities of soccer players during their actual preseason training. In fact, previous studies investigated the effects of acute physical work on technical soccer capabilities (36) and of chronic soccer training on interlimb coordination of players (7,9,10). Incorporating the aspects of practical settings while maintaining experimental control, this investigation supports a high ecological validity of findings that might be of assistance to the coaches in objectively monitoring the potential benefits of their training program on coordinative capabilities of players. The main findings of this study were as follows: (a) the preseason soccer training had a positive effect on the player's ability to shoot a ball from a pass and on synchronized interlimb coordination tasks and (b) the dribbling capability of players decreased with increasing fatigue. Thus, the soccer-specific and the interlimb coordination tests proved to be effective in monitoring the player's coordination.

The main limitation of this study was the lack of the players' evaluation just before the beginning of the off-season period (started), because of a considerable turnover of players for the next season. Unfortunately, teams do not share information collected on their players during the previous competitive season so that at the beginning of the preseason period coaches and physical trainers are unaware of the best performances of the players who recently joined their team. Thus, it was not possible to quantify the actual detraining of the players. According to the literature (6), in the study, it was hypothesized that the players were deconditioned after an 8-week off-season, and increases in coordination were attributed to training effects.

Because of the nature and properties of the player–surface and the ball–surface interactions to the playing characteristics of soccer, in this study, the findings relative to soccer-specific performances refer to performances collected on artificial turf, which allows for a better control of maintenance status, soil moisture, and frequency of use (38). Because also the intensity, duration, and frequency of the soccer trainings can compromise the working capacity of players, to better interpret the player's coordinative performances the session-RPE, the pretraining RPE and RMP, and the post–pretraining RPE and RMP ratios were used to evaluate the training load, the cumulative fatigue, and the reconditioning process, respectively. The present session-RPE data showed an internal training load comparable to that reported for young Italian (19) and professional soccer players during the first few days of a competitive week (20). The progressive increases in pretraining RPE and RMP data might support the hypothesis that the players were detrained entering the training program. Conversely, the decreases in RPE and RMP ratios observed after 2 weeks of training might indicate that players tended to sustain better the same training load because of a reconditioning process, which is the basis of effective training programs leading to a positive adaptation to the training load when the acute fatigue is combined with adequate rest (31). Because other dimensions besides the exercise-stress could affect the stress–recovery status of players during the preparatory period for a competitive season, subjective indices were also explored. The negative effect observed only for general stress, conflicts/pressure, social recovery, and being in shape might reflect the psychological burden suffered by players when their position in the team is not completely defined. Conversely, the positive effect observed for social stress, fatigue, and physical complaint subscales might indicate that the players considered appropriate the exercise load of their training. Overall, these findings support the speculation that the coach's plan for the preseason training program distributed the workload to avoid overstressing the athletes. In fact, semiprofessional and professional teams rely on staff that ensure technical and medical support for players. Furthermore, the young age and the high fitness level of players might have positively affected the recovery process (4,43). Because the occurrence of fatigue in soccer has a practical importance, and studies applying fatigue protocols reported a reorganization of the segmental movement pattern (23), and impairment of soccer performance (36), the examination of changes in soccer-specific and nonspecific coordinative skills of players under real-life intensive training seems worthwhile.

The fundamental principle of soccer is to score more goals than the opposing team. The success of the soccer kick depends on the accuracy with which players hit the ball at the target so that this skill is crucial regardless of playing position or competitive level. Therefore, assigning more points when a ball entered the top right or left corners of the goal made the players aware that we considered accuracy an important variable in assessing their shooting capability. The present findings indicate that shooting a dead ball is a rather stable technical ability in semiprofessional players. In fact, this skill is needed to successfully perform free kicks, corner kicks, and penalties and is often practiced toward the end of the training units. Instead, the 8-week off-season period significantly affected the player's capability to shoot the ball from a pass. Actually, to find a proper timing for shooting an up-coming ball, the player needs a high executive control under time pressure to coordinate his movements. Although it could be argued that passing precision could have influenced test results, it has to be considered that an attempt was not considered valid when a player declared that the pass was not accurate enough. Furthermore, the proportion between the means and *SD*s of this test was comparable to that of the shooting a dead ball test, demonstrating a similar stability between the 2 conditions, Thus, the rapid increase of this skill during preseason confirms that the preseason training succeeded in enhancing the shooting capabilities of players, who functionally adapt their dynamic coordination to the speed and position of an approaching ball to suit the constraints of the shooting task (16). Considering that a high velocity of execution characterizes modern soccer (14), this test could be a precious tool to monitor this technical aspect of soccer.

Dribbling is essential for retaining possession and could be a precursor for an action leading to a shot. The dribbling performances of the semiprofessional soccer players were better than those reported for top-level players (35), although a decrement has been observed in the first 10 days of the preseason training. These findings are in line with the impaired speed dribbling performances observed after a 45-minute match play (39). Actually under fatigue, changes in muscle stimulation and segmental movement pattern in sprinting could be expected (33). However, the best dribbling performances were shown during the last training session, indicating that despite temporary decreases in performance during reconditioning, after 3 weeks the preseason program induced positive agility adaptations.

The interlimb coordination test used in this study not only confirmed that it discriminates exercise mode and frequency of execution but also succeeded in detecting acute training effects. At the beginning of their preseason period, the soccer players showed high interlimb coordination values for both the more natural (i.e., IP) and the more difficult (i.e., AP) test modalities. Better performances were shown on isodirectional tasks and at slower execution frequencies, which require a lower level of attentional monitoring for the executive function (25). In particular, soccer players showed a ceiling effect for IP performance at 80–120 b·min^{-1} execution frequencies, which was not present in previous studies on young adults (7,11). This high expertise confirms that chronic soccer practice improves even the more natural interlimb coordination pattern observed in adults (11). The positive effects of soccer training become more intriguing when comparing the 180 b·min^{-1} performance of players at the beginning and at the end of the preseason training. Although a limited margin for improvement might be expected when the baseline performance is rather high with respect to sedentary adults (7,11), already after 10 days of the preseason training, the players significantly improved their performances.

Also in the AP condition at 80 b·min^{-1}, soccer players were able to maintain for 60 seconds the correct hand and foot synchronization, showing a higher proficiency than active adults (7,11). Conversely, the players' performances at the beginning of the preseason period were comparable to those recorded in sedentary and active adults when faster executions were required (7,11). During the preseason period, relevant improvements in performances were observed, especially evident for the 120-b·min^{-1} condition where all players succeeded to accomplish the whole test. Therefore, a 3-week intense soccer practice succeeded in increasing the player's attentional control (32) and executive inhibitory function (13) necessary to overrule the easier movement patterns, which spontaneously emerge under strict temporal constraints. Finally, considering that soccer performances heavily depend on the player's ability to control his foot and phase transitions (i.e., from AP to IP) in interlimb coordination occurs when the foot fails to mirror the movement of the hand (3), this test could represent a precious tool for the field evaluation of the coordination abilities of the players in relation to the different phases of a soccer season because it is inexpensive, easy to set up, and to administer.

Practical Applications

The proposed coordination tests have the potential to be integrated in field test batteries for monitoring training programs, being easily and inexpensively administrable by coaches. In particular, during the whole soccer season, a good understanding of the training process is crucial to avoid intense exercise, which might lead to imprecise and uncontrolled movements (4) and might increase the risk of injuries (1,45). This issue is particularly relevant during the preseason period, which traditionally includes a high training volume organized in a ‘rebuilding period’ and a ‘maintenance period.’ To avoid intense exercise in the ‘rebuilding period’ from burdening the deconditioned player's perception and reaction to a training stimulus, coaches have to strictly monitor their recovery stress state and athletic capabilities. Furthermore, the analysis of an individual player's coordination profile might be of assistance to the coach in objectively evaluating the effects of a specific training program to modify the training load or to administer specific recovery interventions. Finally, the interlimb coordination test may also be of use to the responsible physician and physical therapist in monitoring the player's progress during rehabilitation after injuries, in relation also to mean values for a similar age group and skill level.

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