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ORIGINAL ARTICLE

Interpersonal emotions in team sports: Effects of emotional contagion on emotional, social and performance outcomes of a team

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ABSTRACT

This research explores how emotional contagion within a team impacts emotions, team cohesion, collective efficacy perception, effort perception, perceived performance, and actual performance outcomes. Forty-seven non-competitive amateur cross-fit participants were split into two experimental groups: high pleasantness-high arousal (HH) and low pleasantness-low arousal (LL). To stimulate these mood states, two trained associates were engaged, which served as catalysts for the teams' "*emotional contagion*". Participants from the HH group outperformed and exerted more effort than those from the LL group, though they perceived their effort levels to be similar. They demonstrated greater collective efficacy and team cohesion, had a more positive emotional state, and perceived their team's performance as superior. Emotional contagion plays a significant role in team dynamics and physical outcomes. The practical implications of emotional contagion are discussed.

Keywords: Sport Psychology, Emotional contagion, Team cohesion, Collective efficacy, Perceived performance, Actual performance outcomes, Mood states in team sports.

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INTRODUCTION

Team performance depends on the motor and emotional synchronization of its team members (Hatfield et al., 1993). Synchronization can express itself in the form of emotions, thoughts, and motor actions, and is a product of the extent of task and social-emotional related knowledge shared by its members (i.e., team shared mental models; TMM; Eccles & Tenenbaum, 2004). A shared emotional experience among team members is imperative to their functioning as a team and to task accomplishment (Janelle, 2018). Shared emotions during social engagement are classically considered to evoke collective sensations and perceptions that strengthen common ideas, values, and actions (Durkheim, 1912). Emotions of team members influence the team's interpersonal relationships, and by extension their social and task cohesion and identification, coordinated efforts, and problem solving toward the achievement of common goals (Van Kleef & Fischer, 2015). However, despite their importance, emotions have mainly been studied in individuals before, during, and after competitive events (Hanin, 2000; Vallerand, 1983).

The purpose of the current study was to experimentally elucidate how emotion contagion changes team members' emotions, and affects team members' collective efficacy, team cohesion, perceived effort, perceived performance, and team performance. The process of transferring interpersonal emotions among members of a team (i.e., "*emotional contagion*") develops "*collective emotions*" (Barsade & Gibson, 1998, 2007), and takes place either intentionally or unintentionally. Several mechanisms contribute to emotion contagion. Mimicry and nonconscious emotional synchronization enable individuals to unconsciously mimic the emotional expressions and behaviours of other members, leading to shared emotional experiences. Empathy plays a crucial role, as individuals mentally simulate the emotional states of others, thus experiencing similar emotions (Barsade & Gibson, 1998, 2007). Moreover, through facial expressions, body language, and verbal communication, people enable other members of the team to observe and feel their own emotions, which are then transferred to them (Hatfield et al., 1994). For example, if one member of a team reflects the emotion of fear, this emotion is transferred to the other members. Emotional contagion is more robust in team members who identify with the team and its goals (Doosje et al., 1998; Leach et al., 2003), and affects the work dynamic of the team (Barsade, 2002).

Two mechanisms are thought to underlie emotion contagion: *imitation* and *feedback*.

When team members share the same positive emotion, this can make them united and persevere in achieving their common goals (Barsade & Gibson, 1998). Team members who manage their emotions efficiently increase the likelihood of achieving their goals because they invest more effort than teams whose members' emotions are negative and dysfunctional (Sy et al., 2005). Barsade (2002) demonstrated the ripple effect of emotional contagion on group behaviour, and Kramer et al. (2014) provided experimental evidence of massive-scale emotional contagion through social networks.

When team members watch each other, mirror neural circuits are activated and transfer to them similar moves or feelings which are expressed by them (Hatfield et al., 2011). Emotional contagion is thought to be triggered by mirror neurons that are activated by an action or observation of an action (Gallese, 2009), and enable the observer to see and feel what the other team member feel, in that they make it possible to sense empathy toward someone and anticipate other people's feelings, which in turn enable bodily and verbal communication (Lacoboni et al., 2005).

The current study examined team members' shared pleasant and unpleasant emotional valence. Specifically, we explored how pleasant and unpleasant emotional contagion along with high and low arousal level would affect members’ perception of physical effort, team cohesion, collective efficacy, and the performance of physically demanding tasks. Pleasantness and arousal (i.e., activation) form the core concept of the current study’s “*emotional contagion*” and stem from the Circumplex Model of affect (Russell, 1980). This two-dimensional model posits that all affective states arise from two fundamental neurophysiological systems; one related to valence and the other to arousal, or alertness. Accordingly, perceived experiences, and hence emotions within these dimensions, are not at the same level for all individuals. Arousal (or intensity) is the level of autonomic activation engendered by an event, and ranges from calm (or low) to excited (or high). Valence, on the other hand, is the level of pleasantness an event generates and is defined along a continuum from negative to positive. Discrete emotions extend from a positive through negative pleasantness valence accompanied by a low to high arousal/excitation state (see Russel, 1980 for details).

Mood states and team members' discrete emotions influence, and are influenced, by social-cognitive processes and the team's dynamics. Specifically, team members' collective efficacy beliefs are affected by the feelings the members convey to each other through mutual observations and communication (Bandura, 1997). Shared goals are usually accompanied by feelings of closeness and intimacy among the members, which in turn increase social and task cohesion (Duffy & Shaw, 2000). When faced with physically demanding tasks (e.g., workload), team members feel strong exertion, which stems from coping with aversive physiological sensations, the motivation to engage in the task, perceived exertion, attention allocation, and pleasantness (see Alvarez-Alvarado et al., 2019 for a review and research findings). Shared positive emotions among the members can positively affect their feelings, collective efficacy, feeling of cohesiveness, perceived exertion and even their perceived performance and collective outcomes.

Perceived team performance is related to shared feelings among team members (Rhee, 2007). For example, a team’s mental toughness when linked with positive feelings was shown to enable team members to cope with aversive states, recover from distress and failure, and accomplish tasks more efficiently (Tugade & Fredrickson, 2004). Teams sharing positive emotions such as excitement, optimism, satisfaction, and serenity tended to accept new adventures and persevere longer on tasks (Meneghel et al., 2016). Thus, perceived, and actual team performances are associated with positive emotions, which can be intentionally transferred to the members of the team by a coach, a leader, or an external member of the team.

In most cases the team’s leader plays a major role in shaping the emotions of the team members, but intentionally or unintentionally, each member can spark an emotional contagion in his/her team members (Sy et al., 2005). In the current study we recruited professional actors, who are experts in creating mood states, to convey pleasant feelings along with a high arousal level to team members in one condition, and unpleasant feelings along with low arousal level to another team in another condition, to test the notion that extremely different mood states will have a differential effect on the way team members perceive team cohesion, collective efficacy, perceived effort and performance, and actual physical performance.

This study is grounded in the conceptual assumption that positive or negative emotional contagion creates a state of mind that increases or decreases team members’ perceived togetherness (i.e., social and task cohesion) and collective efficacy when engaged in a demanding task. For example, study of 143 teams for four months revealed that jealousy among team members resulted in team idleness and decreased collective efficacy in addition to lower team cohesion and engagement that negatively affected performance (Duffy & Shaw, 2000). Collective efficacy was also found to directly determine physical and motor performance (Myers et al., 2004), and along with team cohesion can mediate the relationship between shared team emotions and perceived and actual performance.

Because the team members in the current study were asked to perform a physically demanding CrossFit task together, the hypothesized conceptual relationship between the members' shared emotions and performance as mediated by collective efficacy and team cohesion needed to consider the members' perceived exertion during task engagement. Recently, Alvarez et al. (2019) tested rate of perceived exertion (RPE), attention allocation, feelings of pleasantness during an aerobic cycling task and on a dynamometer hand-grip squeeze until voluntary exhaustion. The findings indicated that in both tasks RPE increased linearly until voluntary exhaustion, but pleasantness increased until reaching the ventilatory threshold (VT) after which pleasantness decreased sharply. Attention allocation shifted flexibly from dissociative to associative until the VT and became strictly associative following the VT until voluntary exhaustion. These findings were replicated in a companion study showing that in addition to RPE, pleasantness, attention allocation, and motivation to adhere to the tasks decrease after reaching VT (Alvarez et al., 2019). Members who felt positive emotions became more determined to meet their common goals and could better overcome obstacles and adhere to the demanding conditions than their counterparts who experienced negative emotions (Tugade & Fredrickson, 2004; Meneghel et al., 2016; Rhee, 2007). Thus, we assumed that in a condition involving the contagion of pleasant emotions accompanied by high arousal, the perceived exertion of the task would be lower than for unpleasant emotional contagion accompanied by a low arousal state, despite the higher level of physical investment in the former condition.

Thus overall, the goal was to test the notion that the contagion of positive and negative mood states results in contrasting social state of minds (e.g., task and social team cohesion, collective efficacy), perception of exertion, which in turn would lead to contrasting perceived and actual physical performance. To test this notion, 47 team members were randomly assigned to two conditions: high pleasantness-high arousal (HH) and low pleasantness-low arousal (LL) and were exposed to positive or negative emotional contagion conditions, respectively and were asked to perform a demanding cross-fit physical task.

MATERIAL AND METHODS

Participants

A power analysis using G*Power 3 program (Faul et al., 2007) was performed to determine the sample size. Assuming a small-moderate effect size due to lack of comparable studies in the literature and using repeated measures (RM) ANOVA design with $f_{(V)}$ = 0.25, α = .05, power $(1-\beta)$ = .80, two experimental conditions, yielded a required sample size of N = 40. Thus, forty-seven participants were recruited for the study. All participants were volunteers and received no compensation.

The participants were 47 men and women ranging in age from 18 - 53 (M = 30.20 years, SD = 7.83) who had worked out regularly at a cross-fit gym for more than one year, for four session per week. The participants were divided randomly into two experimental conditions: high arousal and high pleasantness (HH), and low arousal and low pleasantness (LL). Participants were first given a lecture on exercise psychology at a day and time of their convenience. The trainees were from middle-socio-economic backgrounds. Of the participants, 36% and 18.2% were women in the HH and LL conditions, respectively.

Measures

Demographic questionnaire

The questionnaire included the following items: gender, age, years doing cross-fit, number of hours of workout per week, weight, and height.

Arousal and pleasantness level (Russel ,1980; Larsen & Diener, 1992)
The two dimensions of the Circumplex Model were used to measure the degree of *pleasantness* and *arousal* on two independent continua. The two independent dimensions created a space where positive and negative emotions (which correlated), such as displeasure, distress, depression excitement and others are perceived by people experiencing them. The Circumplex Model with two orthogonal axis consists of one *displeasure-pleasure* continuum and another *level of arousal* continuum. A principal component analysis of 343 reports of current affective states validated the two-dimensional special concept (Russel ,1980). The two items are rated on a Likert-type scale, ranging from 1 (*very low*) to 10 (*very high*).

Emotional Contagion (EC; Doherty, 1997)
The EC measures the psychological disposition of emotional contagion using 15 items representing five dimensions: *happiness, love, fear, sadness, and anger*. Each dimension consists of 3 items rated on a 5-point Likert-type scale, ranging from 1 (*never*) to 5 (*always*). The average rating represents the emotional intensity on each dimension. The authors reported an internal consistency of Cronbach's α = .90 and the factor loadings ranged from .46 - .69. Positively related emotions were related to reactivity, emotionality, sensitivity to others, social function, and self-esteem. Negatively related emotions were correlated with alienation, self-assertiveness, and emotional stability. The EC was low to moderately correlated (.30 - .47) with measures of responsiveness and self-reports of emotional experiences following exposure to emotional expressions. Temporal stability after a 3- week interval ranged from .80 to.82 for positive and negative emotions, respectively and .84 for the entire scale. Women were found to be more susceptible to emotions than men.

Sport Emotion Questionnaire (SEQ; Jones et al., 2005)
This questionnaire consists of 22 items representing 5 dimensions: *anxiety, depression, anger, excitement,* and *happiness* to measure pre-competitive emotions. Participants respond to 22 emotions on a Likert-type 5-point scale ranging from 0 (*not at all*) to 4 (*extremely*). The questionnaire was successfully used to assess emotions athletes recalled in the context of sports (Vast et al., 2010). Face, factorial, and construct validities have been examined on hundreds of athletes. A CFA indicated that the 22 items and 5-factorial structure resulted in a satisfactory model-data fit (*RCFI* = 0.93, *RMSEA* = .07) and very strong factorial loadings. Concurrent validity was tested through the SEQ correlations with the BRUMS (Terry et al., 1999, 2003) and TOPS (Thomas et al., 1999), resulting in low to moderate correlations. The SEQ shared 77% items with the PNA, 50% with the POMS (McNair et al., 1971), 27% with the BRUMS, and 23 with the PANAS. The Cronbach's α internal consistency reliability coefficients were anxiety (α = .87), depression (α = .82), anger (α = .84), excitement (α = .81), and happiness (α = .88).

Physical Activity Group Environment Questionnaire (PAGEQ; Estabrooks & Carron, 2000)
The PAGEQ questionnaire measures the individual distribution of group cohesion in fitness groups (exercise classes). The questionnaire consists of 21 items that are divided into 4 dimensions: *group attraction - task* - 6 items, *group attraction - social* - 6 items, *group integration - task* - 5 items, and *group integration – social* - 4 items. Participants respond to 21 sentences pertaining to their group on a 9-point Likert scale, ranging from 1 (*strongly disagree*) to 9 (*strongly agree*). The average represents the score on each of the PAGEQ's four dimensions. The Cronbach's α reliability values reported by the authors were: *group attraction - task* (α = .90), *group attraction - social* (α = .91), *group integration - task* (α = .75), and *group integration - social* (α = .82).

Collective Efficacy (CE; Bandura, 1997)

Group Efficacy is measured by one item based on Bandura (1997) and Feltz and Chase (1998). Participants were asked to rate their perceptions that their team would perform the most effectively on the task. Specifically, *"How confident are you in the team's capacity to perform the task and complete as many rounds as possible?"* on a scale ranging from 0 (*not sure at all*) to 100 (*very sure*). The team's collective efficacy score consists of the mean ratings of its team members.

Rate of Perceived Effort (RPE; Borg, 1998)

Effort perception is rated on a scale ranging from 0 (*no effort*) to 10 (*very strong effort*). The RPE scale is used to measure effort perception during exercise. The higher the RPE rating, the higher the perceived effort level. Borg reported strong temporal stability (r = .83 - .94) and strong correlations with several physiological and biochemical measures of exertion including lactic acid (LA), heart rate (HR), and oxygen consumption VO_2 (Borg, 1982, 1998).

Perceived Performance in Team Sports Questionnaire (PPTSQ; Gershgoren et al., 2012)

The original PPTSQ consisted of 16 items and was designed to measure the perception of team members' performance on three factors: *perceived outcome* that includes 5 items, *perceived skill execution* that contains 5 items, and *perceived effort investment* represented by 6 items. Each item on the PPTSQ is rated on a Likert-type scale ranging from 1 (*disagree*) (1) to 5 (*strongly agree*). EFA and CFA were employed to test the validity and reliability of the 3-dimensional original construct. A 2-dimensional model-data fit emerged resulting in two dimensions: *perceived outcome* and *perceived effort investment*. McDonald's internal consistencies of the two scales were strong $.75 < \omega < .89$. A temporal stability of .80 and .85 were noted for perceived outcome and perceived effort investment, respectively. The PPTSQ correlated moderately with the GEQ and the Team Assessment Diagnostic Instrument; namely, 0.47 with objective performance, .56 with the TADI (shared mental model questionnaire), and .24 with the GEO.

Physical task performance

The physical task started with a 10-minute physical warmup. Immediately after the warmup, all members of the team were asked to complete four exercises together. The full completion of the four exercises was considered as one round and consisted of a total of 6,800 repetitions. The mission was to complete as many rounds as possible in 30 minutes. The four exercises were: (a) team rowing using four rowing machines simultaneously. The participants were required to complete 6 km before advancing to the next exercise (6,000 repetitions), (b) throwing a "*medicine ball*" weighing 9kg (20 lb.) for men and 6kg (14lb.) for women to a target (wall-ball). The goal was completing 400 repetitions in four stations – one ball per station, (c) burpees – the goal was accumulating a total of 200 repetitions, and (d) run - team members were required to complete a 200 meter run together (200 repetitions). To move from one exercise to the next, all 3 members of the team were required to complete the task. Upon completing the task, a 10-minute stretching and cooling down period took place.

Emotion contagion intervention

Two confederates conveyed the desired mood state of HH and LL with pleasantness and arousal, respectively. The confederates were certified cross fit trainers and amateur theatre actors who were experts in conveying verbal and non-verbal messages to an audience. Each confederate expressed a mood consistent with the HH or LL intervention conditions throughout the experiment. The two confederates detached themselves from the task demands and focused almost entirely on the emotional "*game*" they were assigned to reflect to the team members. The confederates had no personal interest in the experiment and were not aware of the study's purpose and/or hypotheses. Because the LL and HH conditions were provided to two separate groups, each confederate performed two roles, one for LL and one for HH.

The confederates were given specific instructions regarding the transfer of pleasantness and arousal to the respective HH and LL experimental conditions members. The verbal and non-verbal communications were adapted from the behavioural protocols in Bartel and Saavedra (2000). For example, in the positive pleasantness and high arousal (HH) condition, the confederate was told to smile often, encourage team members, make hand gestures, talk extensively, make physical contact with all the members, make extensive eye contact, and speak loudly and quickly. In the LL condition the actor blinked slowly, his eyes were half closed, he sighed extensively, his gaze was detached from the team members, he hardly ever made eye contacts with anyone, he spoke monotonously, murmured, his voice was soft, and his reactions were delayed to some extent. The confederate was stationary during most of the training, his hands were paced statically when he spoke, and he refrained from making physical contact with the teammates. In addition, the confederate/actor refrained from encouraging the teammates. The confederate was instructed to behave this way as soon as he or she entered the cross-fit gym.

Prior to engaging in the team tasks, the confederates were given several key phrases which they were asked to memorize and convey to the team members. The confederates were asked to improvise and be creative but to follow the HH or LL protocols as precisely as possible. The confederates' behaviour in the HH and LL conditions are presented in Table 1.

Table 1. Confederate/actor behaviours in the HH and LL mood conditions.

	High Pleasantness-High Arousal - HH	**Low Pleasantness-Low Arousal - LL**
Experimental condition	*Cheerful Enthusiasm* Characterized by confederate acting pleasant, happy, warm, optimistic, energetic, active, alert, cheerful and enthusiastic.	*Depressed Sluggishness* Characterized by the confederate being unpleasant, unhappy, low energy, somewhat depressed, sluggish, dull, and lethargic.

Procedure

The experiment was approved by the ethics committee of the university. After receiving approval, the questionnaires were translated from English into Hebrew by independent specialists in both languages. Following the first round of translation, they discussed the translation until full agreement was reached.

The participants met with the researcher at the beginning of the experiment in which he informed them of the purpose and procedure. The participants were told that they could withdraw from the experiment at any time without any consequences. Because the cross-fit gym could accommodate up to 15 trainees in each session, it was decided to administer the physical task in smaller teams, i.e., two teams per experimental condition. Before beginning the task, the participants filled out an informed consent form and signed it. Then, they completed the demographic questionnaire, the two-item measure of the pleasantness arousal level, the trait emotional contagion questionnaire (EC), the emotion questionnaire that measures the participants' emotions (SEQ) in the "*here and now*", the physical activity group environment questionnaire to assess the team cohesion (PAGEQ), and the group collective efficacy question (CE). The researcher then explained the physical task to the team members. The confederate played the same role in the training; that is, he or she was always in the same position during the exercises, did the same exercises during the training and invested the same amount of effort throughout. Thus, the confederates exercised similarly in the two experimental conditions. For example, the confederates rowed similarly on the rowing machine in the HH and LL conditions. The confederate was treated identically by the researcher and was not perceived as the leader of the team. Following 30min of task engagement, the participants rated the "*arousal*" and "*pleasantness*" items (manipulation check), how they felt in the "*here and now*" (SEQ), the physical activity group environment questionnaire (PAGEQ), the collective efficacy (CE), the rate of perceived effort (RPE) and performance perception (PPTSQ). Upon completion of the experiments the participants were debriefed and thanked.

Data analysis

Emotional profile, team cohesion, collective efficacy, effort perception, and group performance were subjected to a mixed repeated measures (RM) MANOVA followed by a RM ANOVA, separately. The "*emotional contagion*" condition (LL vs HH) was considered the between-subject factor and time (pre-post intervention) as the repeated within- subject factor. Prior to performing the statistical tests, the variance in all variables from each condition (kurtosis, skewness) was examined. Levene's test was applied to examine variance differences between the two conditions. Cohen's d coefficients were computed to evaluate the magnitude of the significant (p <.05) effects. Means and standard deviations were calculated for all the variables for each condition in each time frame.

RESULTS

Testing the emotional contagion intervention

To test the impact of the confederates' arousal and pleasantness on their team participants (e.g., emotional contagion), the means and SDs of arousal and pleasantness were calculated before and after the respective interventions for the LL and HH conditions. RM ANOVAs performed on arousal and pleasantness separately resulted in significant time by condition interactions for arousal, *Wilks'λ* = .53, F (1,45) = 40.35, p =.00, η_p^2 = .47, and for pleasantness, *Wilks'λ* = .85, F (1,45) = 7.94, p < .01, η_p^2 = .15. These interactions are presented in Figure 1a,b.

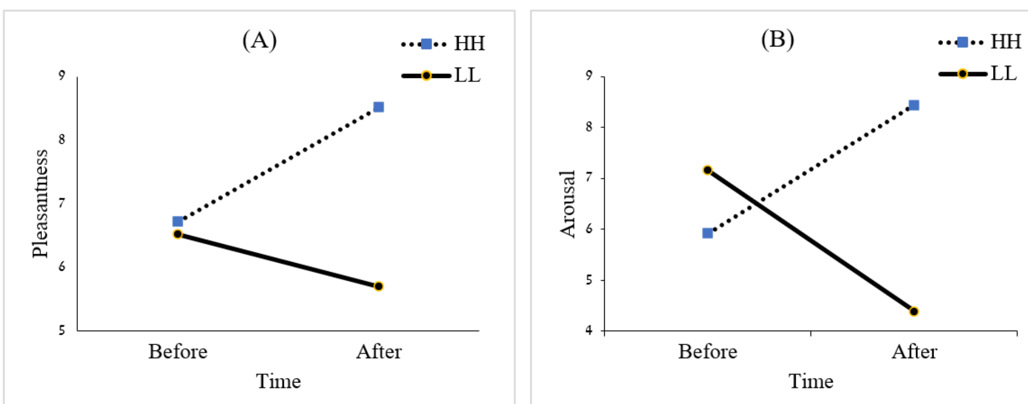

Figure 1. Means for pleasantness (A) and arousal (B) before and after the confederates' emotion contagion intervention for LL and HH conditions.

Pleasantness increased from M = 6.72, SD = 2.11 to M = 8.52, SD = 1.32, d = 1.02 in the HH condition and decreased from M = 6.52, SD = 2.12, M = 5.70, SD = 3.19, d = -.30 in the LL condition. The mean difference between the HH and LL conditions following the intervention and controlling for the pre- intervention differences was d = 1.24. Arousal increased from M = 5.92, SD = 2.00 to M = 8.44, SD = 2.12, d = 1.22 in the HH condition and decreased from M = 7.16, SD = 1.83 to M = 4.39, SD = 2.96, d = -1.13 in the LL condition. The mean difference between the HH and LL conditions following the intervention and controlling for the pre-intervention differences was *d* = 2.76. Thus, the HH team members felt higher arousal and pleasantness than the LL participants following the emotional contagion intervention.

Testing the equality of dispositional emotional contagion between the LL and HH conditions

The participants in the HH and LL conditions were compared on the dispositional measure of the emotional contagion (EC) scale using a MANOVA followed by a post-hoc LSD for each of the five emotional dimensions. The MANOVA revealed a non-significant condition effect, *Wilks' λ* =.84, F (5,41) = 1.50, p = .21, η_p^2 = .16.

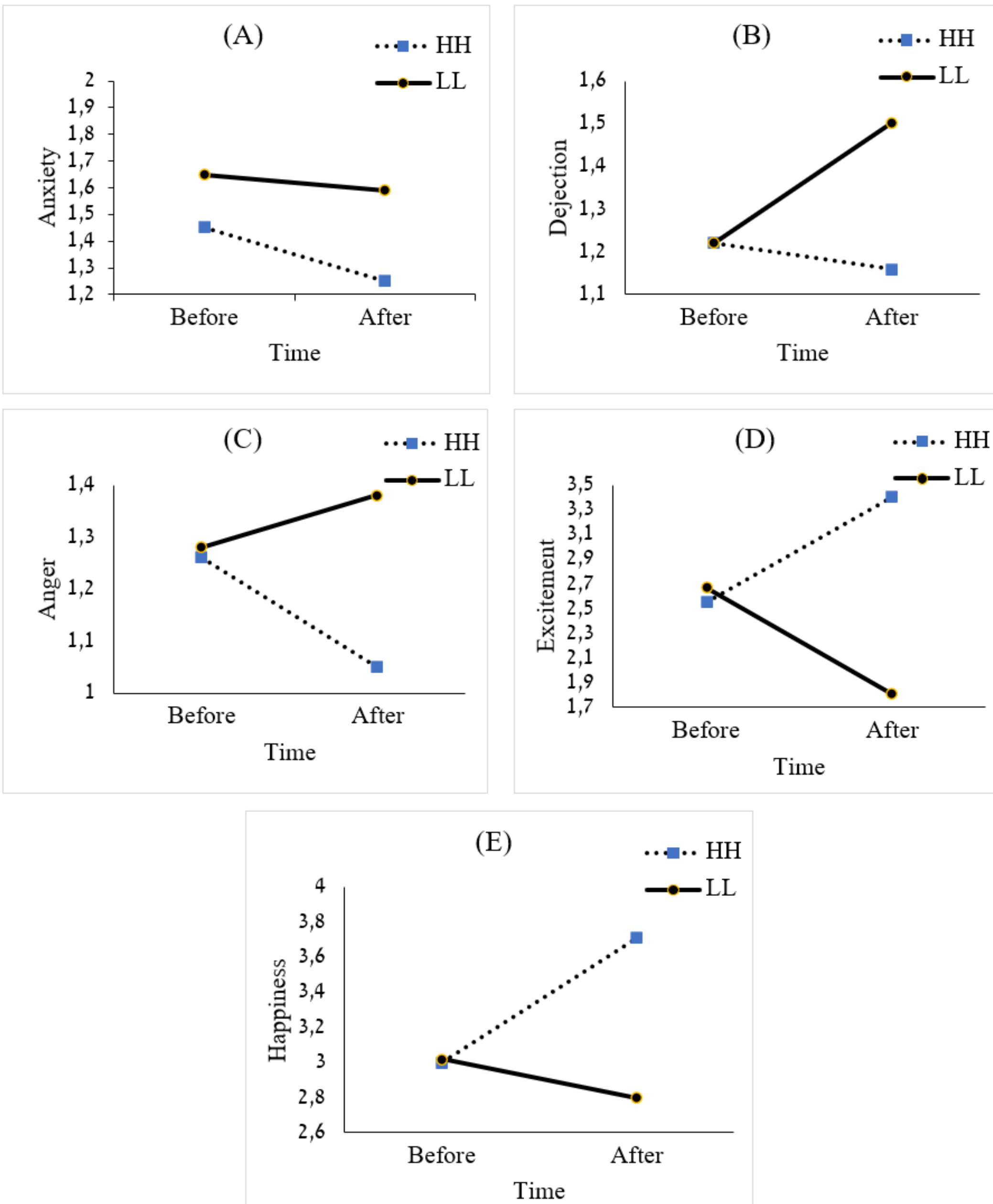

Figure 2. Emotions (anxiety, dejection, excitement, anger, happiness) before and after the EC intervention in the HH and LL conditions.

Emotional Contagion (EC) effect on emotional profile

To test the effect of the EC intervention on the emotional profile of the LL and HH participants, the means and SDs of anxiety, dejection, excitement, anger, and happiness before and after the intervention were subjected to RM MANOVAs. The means for each emotion before and after the EC intervention are presented in Figure 2a,b,c,d,e.

A significant time by emotional dimension by experimental condition effect was revealed for emotional profile, *Wilks' λ* =.49, *F* (4,42) = 10.82, *p* =.001, $\eta_p{}^2$=.51. Follow-up RM ANOVAs for each of the five emotional dimensions revealed a non-significant effect for time by experimental interaction effect for anxiety, *Wilks' λ* =.99, *F* (1,45) = .55, *p* =.46, $\eta_p{}^2$=.01. Similar anxiety reports were expressed by HH and LL participants. HH participants experienced less anxiety after the EC intervention than at the outset of the intervention, *M* = 1.45, *SD* = .51 vs. *M* = 1.25, *SD* = .32, *d* = .47 respectively, and participants in the LL condition also experienced lower anxiety at the end of their respective intervention, *M* = 1.65, *SD* = .69 vs. *M* = 1.59, *SD* = .60, *d* = .01. The mean difference between the HH and LL conditions following the intervention and controlling for the pre-intervention differences was *d* = -.33. The RM ANOVA for feeling dejection revealed a significant time by experimental condition interaction, *Wilks' λ* =.88, *F* (1,45) = 6.15, *p* =.02, $\eta_p{}^2$ =.12. HH participants felt less dejection after the EC intervention compared to the outset of the intervention, *M* = 1.22, *SD* = .32 vs. *M* = 1.16, *SD* = .20, *d* = .22, respectively, whereas LL participants felt increased dejection from the outset to the end of the intervention, M = 1.22, SD = .25 vs. *M* = 1.50, *SD* = .60, *d* = .61. The mean difference between the HH and LL conditions following the intervention and controlling for the pre- intervention differences was *d* = -1.17.

A significant experimental condition by time effect was revealed for the emotion of anger, *Wilks' λ* =.88, *F* (1,45) = 6.10, *p* = .02, $\eta_p{}^2$ = .12. HH participants reported less anger after the EC intervention, *M* = 1.26, *SD* = .40 vs. *M* = 1.05, *SD* = .22, *d* = .65, respectively, whereas LL participants reported increased anger from the outset to the end of the EC intervention, *M* = 1.23, SD = .35 vs. *M* = 1.38, *SD* = .64, *d* = -.29. The mean difference between the HH and LL conditions following the intervention and controlling for the pre-intervention differences was *d* = -.95. There was a time by experimental condition interaction effect for excitement, *Wilks' λ* =.56, *F* (1,45) = .35.99, *p* =.001, $\eta_p{}^2$=.44. HH participants experienced more excitement after the EC intervention, *M* = 2.55*, SD* = 1.11 vs. *M* = 3.40, *SD* = .90, *d* = -1.09 respectively, whereas LL participants felt decreased excitement from the outset to the end of the intervention, *M* = 2.67, *SD* = .81 vs. *M* = 1.81, *SD* = .77, *d* = 1.09. The mean difference between the HH and LL conditions following the intervention and controlling for the pre- intervention differences was *d* = 2.76.*d* = 2.11. Finally, a significant time by experimental condition was obtained for happiness, *Wilks' λ* = .81, *F* (1,45) = 10.38, *p* = .002, $\eta_p{}^2$ = .19. HH participants felt happier after the EC intervention compared to the outset of the intervention, *M* = 3.00, *SD* = .93 vs. *M* = 3.71, *SD* = .73, *d* = -.85, respectively, whereas LL participants felt less happiness from the outset to the end of the intervention, *M* = 3.02, *SD* = .74 vs. *M* = 2.79, *SD* = 1.04, *d* = .25. The mean difference between the HH and LL conditions following the intervention and controlling for the pre-intervention differences was *d* = 1.11.

Effect of the EC intervention on team cohesion

A RM MANOVA applied to the four dimensions of team cohesion by time and EC intervention indicated a significant experimental condition by time effect, *Wilks' λ* = .84, *F*(1,45) = 8.73, *p* =.005, $\eta_p{}^2$=.16., but not for the cohesion dimension by time by experimental condition, *Wilks' λ* = .86, *F*(3,43) = 2.31, *p* = .09, $\eta_p{}^2$=.14. The means for the four-dimensions before and after the EC interventions are shown in Figure 3a,b,c,d.

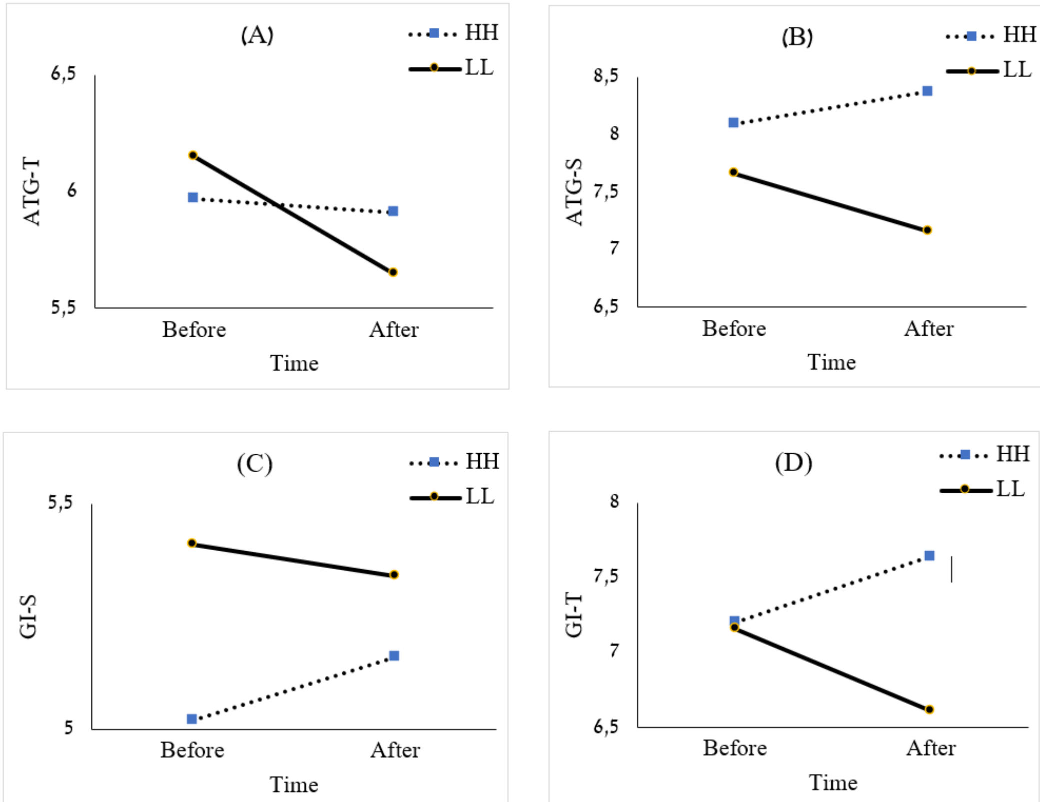

Figure 3. Means for ATG-S (A), ATG-T (B), GI-T (C), and GI-S (D) prior and after the EC intervention for the HH and LL experimental conditions.

A follow- up RM ANOVA for ATG-S revealed a significant experimental by time interaction effect, *Wilks' λ* = .91, *F* (1,45) = 4.50, *p* = .04, η_p^2 = .09. HH participants reported increased ATG-S after the EC intervention compared to the outset of the intervention, *M* = 8.09, *SD* = .89 vs. *M* = 8.37, *SD* = .72, *d* = -.35, respectively, whereas the LL participants reported decreased ATG-S from the outset to the end of the intervention, *M* = 7.66, *SD* = 1.49 vs. *M* = 7.16, *SD* = 1.74, *d* = .31. Moreover, the time by experimental condition interaction effect was significant for GI-T, *Wilks' λ* = .81, *F* (1,45) = 10.59, *p* = .002, η_p^2 = .19. HH participants felt increased GI-T after the EC intervention compared to the outset of the intervention, *M* = 7.20, *SD* = 1.18 vs. *M* = 7.64, *SD* = 1.03, *d* = -.40, respectively, whereas LL participants felt decreased GI-T from the outset to the end of the intervention, *M* = 7.16, *SD* = 1.40 vs. *M* = 6.61, *SD* = 1.50, *d* = .38. However, this interaction was non-significant for ATG-T, *Wilks' λ* = .97, *F* (1,45) = 1.60, *p* = .21, η_p^2 = .03. A non-significant interaction effect was also found for GI-S, *Wilks' λ* = .99, *F* (1,45) = 0.63, *p* = .43, η_p^2 = .01.

EC effect on collective efficacy

To test the effect of the EC intervention on the collective efficacy of the LL and HH participants, the means and SDs before and after the intervention were subjected to RM ANOVAs. A significant time by experimental interaction was revealed, *Wilks' λ* =.86, *F* (1,43) =7.16, *p* =.01, η_p^2=.14. HH participants experienced higher collective efficacy after the EC intervention than at the outset of the intervention, *M* = 7.48, *SD* = 1.90 vs. *M* = 8.66, *SD* = 1.12, *d* = -.76. respectively, whereas LL participants felt decreased collective efficacy from the outset to the end of the intervention, *M* = 7.45, *SD* = 1.53 vs. *M* = 6.82, *SD* = 2.73, *d* = .28. The mean difference between the HH and LL conditions following the intervention and controlling for the pre-intervention differences was *d* = 1.04. The interaction is presented in Figure 4.

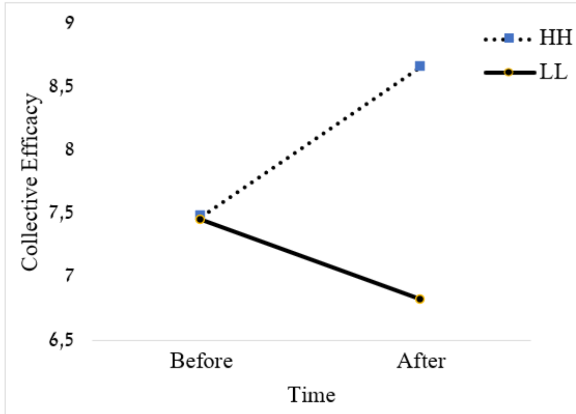

Figure 4. Means for collective efficacy before and after the EC intervention in HH and LL participants.

Effect of EC on effort perception

To test the effect of EC intervention on the perceived effort of the LL and HH participants, the means and SDs before and after the intervention were subjected to a one-way ANOVA. The HH participants perceived the same effort as the LL participants after the EC intervention, *M* = 7.62, *SD* = 2.90 vs *M* = 7.73, *SD* = 2.21, *d* = -.04, respectively.

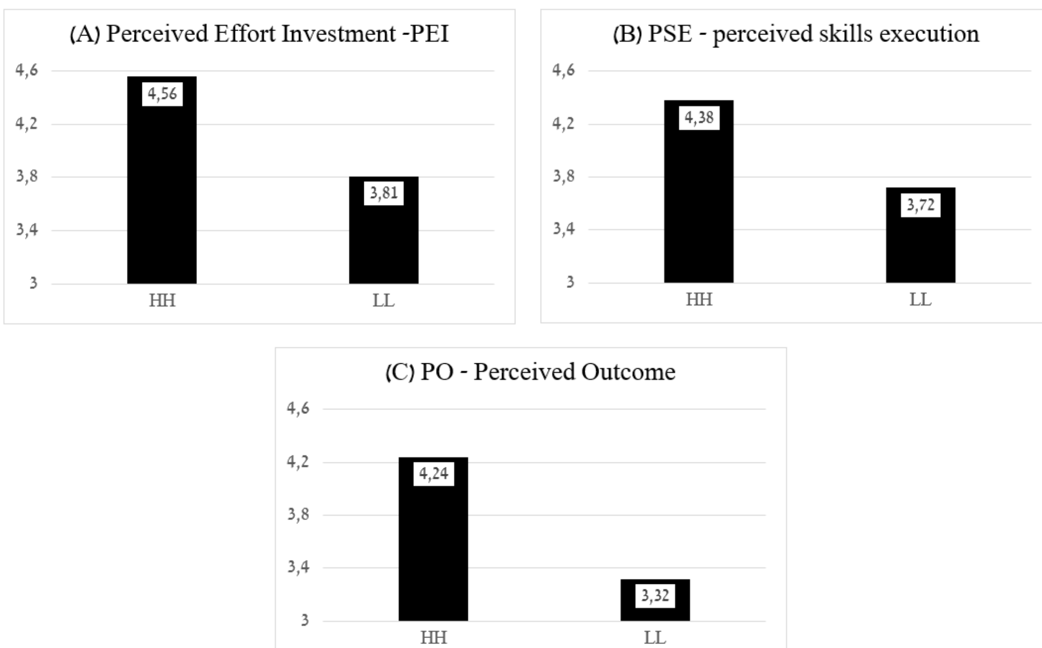

Figure 5. Perceived Performance dimensions means by experimental conditions.

Perceived performance

A MANOVA applied to the three perceived performance dimensions revealed a significant experimental condition effect, *Wilks' λ* =.72, *F* (3,43) = 5.59, *p* = .001, η_p^2 = .28. The means of the three perceived performance dimensions for HH and LL participants are presented in Figure 5a,b,c.

Follow-up ANOVAs for each of the perceived performance dimensions resulted in a significant experimental condition effect for perceived effort investment (PEI), F (1,45) = 11.73, p =.001, η_p^2=.21. HH participants reported making more effort following the EC intervention than the LL participants, M = 4.56, SD = .57 vs. M = 3.81, SD = .91, d = .99. Moreover, a significant EC intervention effect on perceived skill execution (PSE) was revealed, F (1,45) = 9.34, p =.004, η_p^2=.17. HH participants perceived their skill execution as higher following the EC intervention than their LL counterparts, M = 4.38, SD = .55 vs. M =3.72, SD = .92, d = .87. Finally, HH participants reported a higher perceived outcome (PO) after the EC intervention than the LL participants, F (1,45) = 14.38, p = .001, η_p^2=.24. M = 4.24, SD = .70, vs. M = 3.32, SD = .96, d = 1.09.

Performance outcomes of the team

The performance scores for the LL and HH conditions are shown in Figure 6. The HH participants scored higher than the LL participants by 27%.

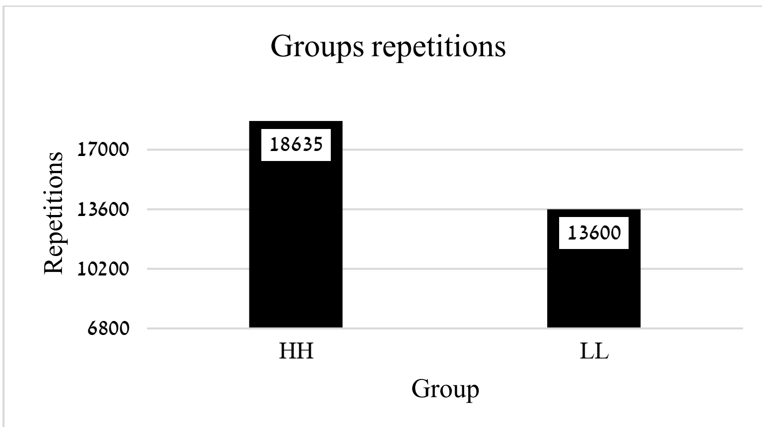

Figure 6. HH and LL physical performance scoring.

DISCUSSION

The goal of this study was to test the notion that when team members share emotions, this affects a broad range of social, cognitive, and physical factors related to accomplishing their goal. To do so, we applied a mood contagion intervention, which created a "*collective emotional state*" (Barsade & Gibson, 1998, 2007; Barsade, 2002). Through facial expressions, body language, and verbal communication (Hatfield et al., 1994), actors allowed "*their*" team members to observe their mood and successfully transmit it to the other team members. In previous studies, collective emotions were found to play an essential role in determining team performance (Barsade, 2002). Team members who harness emotions effectively felt stronger in accomplishing the tasks they performed together (Rhee, 2007). In contrast, team members who shared unpleasant emotions struggled when faced with challenging tasks (Barsade & Gibson, 1998). However, the effect of emotional contagion on team physical task performance has rarely been studied, if at all (Van Kleef & Fischer, 2015). The current study was designed to examine the effect of mood contagion on emotions, team cohesion, collective efficacy, effort perception, perception of performance, and teams' work outcome in two conditions: high pleasantness - high arousal (HH) and low pleasantness - low arousal (LL) as generated by mood contagion of an actor to the other team members.

The findings revealed that mood contagion affected the team members' emotional state in a manner consistent with the mood state transmitted through the collaborator. Emotional profile, team cohesion, collective efficacy, perception of performance, effort perception, and task outcome changed in a way that positively affected team dynamics and performance under HH mood contagion and negatively impacted team dynamics and performance under the LL mood contagion. Specifically, the level of pleasantness and arousal conveyed by the actor affected the members' four discrete emotions (e.g., anger, dejection, happiness, excitement) but not anxiety in each of the experimental conditions. Emotional contagion, which was transferred to the members by the actor through the processes of empathy, mimicry, identification, understanding and affiliation with the intentions of others (Hess & Fischer, 2014), resulted in a corresponding emotional profile in the HH and LL mood conditions, respectively. When the actor transferred high pleasantness and arousal, the members felt elevated excitement and happiness, and lower levels of anger and dejection, whereas the opposite was evidenced when the actor transferred low pleasantness and low arousal. LL contagion resulted in experiencing low levels of excitement and happiness, and stronger feelings of dejection and anger. These results support the claim that direct perception-action mapping can take place via mirror neurons (Gallese, 2009), where the mood state of one member is transferred to others, and then shared through mimicry and empathy among the team members.

Mirror neurons function in a way that enables members to feel empathy, identification, and sensitivity to each other via mimicry of bodily and verbal expressions (Lacoboni et al.,2005). Consequently, the empathy of the team members with the actor in the HH and LL conditions elevated positive and negative feelings in their respective conditions. As in Sy et al. (2005), the emotions conveyed by the actor were felt by the team members whether positively or negatively. Research has shown that a dominant member of a team can affect the team members' emotions (Price & Weiss, 2011), a phenomenon evidenced clearly in the current study. The process and outcome of emotional contagion has been supported elsewhere in the literature (Barsade, 2002; Barsade & Gibson, 1998, 2007; Hatfield et al., 1993).

Tasks that require collaborative effort increase teammates' perceived relationships and social support (Garcia & Rime, 2019), and ultimately reduce stress responses prior and during task engagement (Cohen et al., 2009). Moreover, emotions shared among team members play a significant role in developing and maintaining interpersonal relationships, developing team cohesion and identity, sharing responsibilities, negotiating power roles, solving ongoing problems, and coordinating joint efforts to achieve common goals (Van Kleef & Fischer, 2015). The findings here revealed that low pleasantness and arousal increased feelings of anger and dejection while decreasing feelings of happiness and excitement. Concurrently, the emotional changes were associated with decreased perceptions of collective efficacy, team cohesion and perception of task difficulty, which resulted in performance decline. In contrast, emotional contagion which resulted in a state of high pleasantness and high arousal led to elevated positive emotions and the suppression of negative ones, which positively affected team dynamics (e.g., elevated collective efficacy and team cohesion) as well as its members' perceived performance and physical output.

The findings also indicated that positive emotions facilitated and negative emotion hampered the dynamic, social, and motor performance outcomes of the team members engaged in the CrossFit collaborative task. A decline in team cohesion was experienced by the participants who experienced a drop in pleasantness and arousal. In this condition, an increase in anger and dejection were shared by the team members; feelings of happiness and excitement declined. Under these conditions the team's sense of cohesion, commitment, and performance suffered (Daffy & Shaw,2000). Daffy and Shaw found that intergroup jealousy led to a decline in collective efficacy, social loafing, and low cohesion, which together were linked to the team's performance decline. Similarly, emotions and collective efficacy were found to determine the group members' well-being and functioning (Barsade, 2002; Gully et al., 2002). Comparable team dynamic processes were evident in the current study when team members were exposed to either HH or LL mood contagion conditions.

The results here suggest that emotional contagion affected the emotional, social, and physical states of the team members, but also buffered the degree of effort perception. Effort perception under high pleasantness and high arousal condition was reported at a high level of exertion 7.62/10, whereas under low pleasantness and low arousal (LL), it averaged 7.73/10. Thus, a similar perception of effort was reported in the two teams, although one outperformed the other significantly (e.g., physical effort investment). Specifically, team members who experienced high pleasantness and arousal produced significantly more work and felt a similar effort as their counterparts who felt a decline in both feelings of arousal and pleasantness. Thus, feeling highly pleasant and excited reduced the team members' perceived effort and exertion and equalized it to members of a team who produced a lower work output. These findings may hint that teammates' feelings can buffer physical effort through both team dynamics and the teams' shared emotions.

Studies on adaptation to physical effort have explicitly shown that an adverse change in emotional pleasantness occurs after reaching the respiratory threshold (Alvarez-Alvarado et al., 2019). Perceived effort, visual attention (from dissociative to associative), and the rate of perceived exertion were shown to increase linearly to allow for adequate coping with physical workload, whereas emotional pleasantness greatly declined as the feelings of exertion and fatigue increased. The perceived effort reported by members of both the HH and LL mood contagion conditions was rated as 'hard.' Under these physical conditions, the motivation to continue the effort and the feeling of pleasantness decreased, and attention turned to the internal and associative mode (Alvarez-Alvarado et al., 2019; Tenenbaum, 2001). However, these findings pertained to individuals who were engaged in incremental physical effort which lacked any social facilitating or hampering effects. When required to work out collaboratively, the team members who felt high pleasantness and high arousal (HH) resulting from mood contagion, invested more effort in the task and perceived their accomplishment more positively. The sense of "*togetherness*" led to an increase in collective efficacy, social and task cohesion, and as a result, higher teams' outcomes. In contrast, when the emotional contagion resulted in low pleasantness and low arousal, the team members felt anger and dejection that adversely affected teamwork and hence their perceived outcomes. These findings further support the notion that emotional contagion influences both individual-level attitudes and group processes. The group members exposed to positive emotional contagion experienced improved cooperation, decreased conflict, and increased perceived task performance (Barsade, 2002). Other studies have shown that teams sharing positive emotions such as excitement, optimism, satisfaction, and serenity accepted new adventures and persevered longer on tasks (Meneghel et al., 2016), suggesting that perceived team performance is related to the shared team members' feelings (Rhee, 2007).

CONCLUSIONS

Team coaches and leaders can affect their team members' emotional state, and hence enhance their self and collective efficacy, as well as their sense of social and task cohesion, effort investment and competitive outcomes. Performers under positive emotional contagion will invest more effort in the task they are committed to accomplish. Coaches can convey emotions and efficacy by themselves or by using the team captain or other teammates who enjoy a leadership status among their team members. Emotional contagion is a process which is unconsciously present in team locker rooms, but also on the field and in practice. The findings here show that this process can be deliberately and intentionally practiced and contribute significantly to a team's emotional, social, and physical functions.

Research limitations and future studies

Several limitations of this study must be noted. First, the findings pertain to CrossFit, and should be tested on other tasks tapping team members' common goals and combined efforts. Second, the low familiarity among the team members may not fully represent teams where members already know each other, and an external actor may be perceived in less favourable manner. Thus, different team settings, gender composition, and age cohorts must be studied to further explore the influence of emotional contagion on teams' social, emotional, cognitive, and physical outcomes. Professional athletics as well as the recent rise in electronic sports (e-sport) should be examined to better comprehend the relationships between how members of a team feel, and their common performance processes and outcomes as mediated by team dynamics and collective efficacy.

AUTHOR CONTRIBUTIONS

Omer Eldadi: conceptualization, data collection, analysis, writing, funding acquisition, project management. Omer Eldadi is the lead researcher and was instrumental in formulating the original idea for the research. Hila Sharon-David: data collection, analysis, writing, reviewing. Collaborated closely with the lead and co-researcher in all phases of the research process. Gershon Tenenbaum: analysis, reviewing. Collaborated closely with the lead and co-researcher in all phases of the research process. All authors have read and approved the final manuscript.

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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