*Ann Appl Sport Sci,* 12(S1): e1239, 2024.
**http://www.aassjournal.com; e-ISSN: 2322–4479; p-ISSN: 2476–4981.** 10.61186/aassjournal.1239

**ORIGINAL ARTICLE**

# The Impact of Social Context on Motor, Cognitive, and Affective Behaviors: A Pilot Study Among Physical Education Students

**[1]Maha Mnif, [1]Soufien Chikh, [2]Eric Watelain, [3]Mohamed Ben Aissa, [1,3]Mahmoud Rebhi, [3,4]Noomen Guelmami, [5]Ismail Dergaa*, [1]Mohamed Jarraya**

[1]Department of Human Sciences, Higher Institute of Sport and Physical Education of Sfax, University of Sfax, Sfax, Tunisia. Research Unit: Education, Motor Skills, Sport and Health (EM2S), UR15JS01. [2]University of Toulon, Laboratory IAPS 201723207F, 83041, Toulon, France. [3]Department of Human and Social Sciences, High Institute of Sport and Physical Education of Kef, University of Jendouba, Kef, Tunisia. [4]Department of Health Sciences (DISSAL), University of Genoa, Genoa, Italy. [5]Primary Health Care Corporation (PHCC), Doha, Qatar.

**Submitted July 30, 2023; Accepted in final form October 04, 2023.**

## ABSTRACT

**Background.** In sports and physical education, success requires a range of competencies. Structuring activities within a cooperative or competitive social context can enhance motivation and performance. **Objectives.** The study aimed to investigate the influence of different social contexts, specifically competition and cooperation, on motor, cognitive, and affective behaviors among physical education students. **Methods.** We focused on two predominant social contexts: cooperation and competition. For this purpose, seventy participants (Age: 21.96±1.92 years, Height: 1.69±0.09m, Weight: 64.67±10.37kg, 28 males) voluntarily participated in the present study. Each was paired and given instructions to either work collaboratively with their partner or compete against them. For motion analysis, we utilized Adobe Premier software; its suitability for this study was determined by its capability to capture detailed motion kinematics. Affective states were gauged through a specialized deep-learning model designed for facial expression recognition. Further details about the model's training and specificity are provided within the main manuscript. **Results.** Participants exhibited shorter movement durations in cooperative (679±320 ms; $p<0.001$) and competitive contexts (707±356 ms; $p<0.001$) compared to individual scenarios. Similarly, the accuracy was enhanced in cooperative and competitive conditions. Reaction time was notably quicker in the competition setting (186 ±78 ms) compared to individual contexts, especially with positive (180±150 ms) and negative stimuli. Emotional correspondence was significantly higher in cooperative and competitive settings, particularly in response to positive stimuli. However, emotional stability did not significantly differ across social contexts. **Conclusion.** Drawing upon insights from neuroimaging, developmental, and social psychology, our results highlight the significant influence of social contexts, especially cooperation and competition, on motor function, responsiveness, and emotional well-being during dart-shooting tasks. In practical terms, educators and trainers in physical education can use these findings to optimize student and athlete performance. By designing activities that emphasize cooperative interactions, we can not only enhance motor skills but also improve emotional states. Furthermore, the implications of this study extend beyond sports. Other learning or professional environments could benefit from a thoughtful balance between cooperative and competitive elements, potentially transforming training methodologies and team dynamics across various fields.

**KEYWORDS:** ***Behavioral Response, Dart-Shooting, Emotional Correspondence, Emotional Stability, Individual Performance, Kinematic, Movement Duration, Physical Tasks, Psychomotor Effects, Reaction Time.***

*. Corresponding Author:
**Ismail Dergaa**, Ph.D.
**E-mail:** idergaa@phcc.gov.qa

## INTRODUCTION

Human development encompasses cognitive, motor-perceptual, and social aspects (1, 2). In the context of sports and physical education, the honing of psychomotor, emotional, cognitive, and mental abilities, along with grit, becomes imperative for achieving success. The perennial debate among scholars revolves around the best approach to these activities: should they be framed cooperatively or competitively to enhance motivation and performance? (3)

Both cooperation and competition are foundational components of human interaction, albeit with distinct behavioral outcomes. Cooperation is characterized by trust, open communication, and a willingness to share, expecting mutual benefits from collective actions (4). Conversely, competition surfaces when a unique goal is in play, one that cannot be achieved by all concurrently (5). Whereas competition might stimulate advancements in numerous societal sectors, cooperation is pivotal for unified growth (6, 7).

It's well-acknowledged that the nature of social situations can differ based on the surrounding context (4). The mere presence of others doesn't equate to having a cooperating partner or a competitor. Research has underscored that such social scenarios can influence motor and cognitive performances (5). Previous studies have delineated two primary social contexts: cooperation and competition. Findings from these studies indicate unique kinematic parameters in cooperative and competitive situations compared to solo tasks. Notably, cooperation was linked to an increase in movement duration (8), greater trajectory amplitude (7), and extended upper limb opening time (8), while competition correlated with increased maximum velocity (9), heightened velocity amplitude (8), and quicker acceleration latency (10). These studies also revealed that cooperative pairings yielded better task facilitation than competitive ones.

Diving deeper into the emotional dimension, the field of social psychology has spotlighted the important influence of emotions in shaping social relationships. Emotions often find more robust expression in closer social ties. Every social engagement is paired with a specific emotional state, with the relationship's nature influencing the emotional undertone (11). The depth of the relationship can give rise to specific emotions, subsequently affecting the relationship overall dynamics (8).

Given this backdrop, it becomes compelling to examine the impact of relationship types, grounded in their social contexts, on emotional processes and, subsequently, on motor and cognitive performance. Thus, the main aim of the present study was to investigate the influence of different social contexts, specifically competition and cooperation, on motor, cognitive, and affective behaviors among physical education students.

## MATERIALS AND METHODS

**Participants.** A total of 336 students from the Institute of Sport and Physical Education of Sfax, all right-handed with normal or corrected-to-normal vision, were initially approached. Of these, 72 students agreed to participate, but two were later deemed ineligible. The final sample consisted of 70 students (Age: 21.96±1.92 years, Height: 1.69±0.09m, Weight: 64.67±10.37kg, 28 males). These participants provided written informed consent to participate in the study.

**Actor model.** A 24-year-old student from another institution, unfamiliar with the participants, partook in the experiment, acting as a partner for the second and third conditions.

**Materials and Procedure.** The experiment was conducted in an enclosed room illuminated at a brightness of approximately 500 LUX, ensuring optimal visibility. Participants were tasked with throwing darts after the display of an emotional stimulus, which was projected onto a white screen (2.2 m) in alignment with the target and situated 2.37 m from the thrower. The target was subdivided into 21 sectors, representing 3 zones (single, double, and triple). Scoring for a dart varied between 0 and 50 points. To document the procedure, two Galaxy a21S smartphones were utilized. Each phone is equipped with a 32-megapixel primary sensor and can record at 30 FPS. The first phone was placed 3 m to the participant's right and elevated to 1.2 m to monitor hand movements. In contrast, the second was set up 1.5 m in front though outside the participant's direct line of sight, and raised to 1.6 m, focusing on capturing facial expressions.

**Procedure.** Participants started with arms resting naturally by their sides. Emotional stimuli, sourced from the International Affective Picture System (IAPS) (12), were chosen based on valence and intensity and projected on a screen. The sequence of stimuli was randomized and counterbalanced. Before every trial, a white screen was displayed for 6 seconds, followed by an emotional face for another 6 seconds, after which the participant executed their throw. This protocol was adapted from a previous study (13) study. Emotional stimuli comprised:

- Positive images: 1410-1721-1731-1750-1811-1920-1999-2035-2208-2009-2216-2222-2224-2260-2274-2299-2300-2304-2306-2311-2395-2398.
- Negative images: 2800-3000-3001-3010-3266-3301-3350-3530-9940-9433-9413-9412-9075-6520-6350-6313.
- Neutral Images: 1930-2200-2210-2272-2279-2396-2397-2399-2400-2410-2440-2446-2480-2490-2493-2512-9913-9926.

Participants encountered three scenarios:

1. The individual situation: Participants threw darts solo against emotional stimuli.
2. Cooperative situation: Participants, in the company of a partner, aimed for higher scores together.
3. Competitive situation: Challenged by the prior score of a competitor, participants strived for superior outcomes.

In all scenarios, an experimenter was present but remained outside the direct experimental setting. The actor was situated 1.5 m to the participant's right, maintaining passive engagement without any interaction.

**Recording techniques.** Reaction time and movement duration analysis employed video frame extraction using Adobe Premiere software version 2021. Meanwhile, facial expression processing ascertained emotional correspondence and stability. A micro-facial expression recognition approach discerned emotional states at specific moments. This involved deploying deep learning (14), algorithms that mimic human cognitive functions on three universal datasets: SAMM (15), CASME-I (16), and CASME-II (17). Then, the datasets were merged to create one training dataset named “CMicro_DS”. Each data set contains several video sequences. Each video sequence presents only one type of the three types of facial expressions.

It is important to mention that each video sequence will be converted into a sequence of images. Using the HAAR CASCADE algorithm (18), the face is automatically located on each image.

In the classification step, deep learning (14) was applied on the FER2013 (19) to create the first model named “MacFacialNet”. Using the transfer learning (20), the knowledge acquired in the creation of the “MacFacialNet” model was applied to the “CMicro_DS” dataset to build the micro-expression model named “AkidNet”. The validation of the model “AkidNet” shows its effectiveness with an accuracy rate of 81.15%. Compared to some famous competitive state-of-the-art approaches (21, 22), the proposed solution proved its performance in terms of accuracy.

**Data processing.** The primary objective of this research is a tri-fold analysis: motor skills as indicated by movement duration and precision, cognitive responses measured via reaction time, and affective performance through emotional correspondence and stability across varying emotional and social circumstances.

- Emotional Correspondence: This is defined as the degree of congruence between the participant's detected emotional state and the projected image. Leveraging the facial micro-expression recognition model previously detailed, the alignment between a subject's emotional response and the projected stimulus at specific intervals was ascertained. The intervals of interest were at the beginning (T1=0s), midpoint (T2=3s), and conclusion (T3=6s) of the image projection. Once the emotional state was determined for each interval via facial recognition, we utilized the (NB.SI) function in Excel to verify if the participant's emotional state matched the projected stimulus's emotional valence.
- Emotional Stability: This metric determines the consistency of a participant's emotional response throughout the image projection. Stability was gauged by analyzing whether the subjects sustained a consistent emotional state across the three previously mentioned intervals (T1, T2, and T3) or varied in their reactions.
- Reaction Time: Defined as the duration between the emotional image's onset and the participant's motoric response. It was computed by noting the difference between 'T0' (when the

white screen vanishes) and 'T' initial (the point when hand movement from the starting position is first noted).

- Movement Duration: This indicates the time the participant takes to complete the action, calculated as the duration between 'T' initial (start of the movement) and 'T' final (the instant the dart leaves the hand).
- Precision: Precision was evaluated based on the scores secured on the dartboard during each emotional stimulus and social condition.

**Statistical analysis.** After testing the normality of the data distribution by Shapiro's test, nonparametric tests and 2-condition Kolmogorov-Smirnov tests were analyzed to study the social effect (cooperation and competition) and the emotional effect (positive and negative emotion). Likewise, Kruskal Wallis on 2 conditions (individual condition, cooperation, and competition) and (positive, negative, and neutral emotions) has been used. The same principle was applied to analyze the interaction effect between emotions and social conditions. These tests were carried out using Statistica 10 software (Statsoft©) to clarify the nature of the effects. All significance tests were based on a 0.05 level.

## RESULTS

### Motor performance

**Movement duration.** Both cooperative and competitive conditions significantly influenced movement duration. In the cooperative condition, participants recorded a movement duration of 679±320 ms (p<0.001), while in the competitive condition, they recorded 707±356 ms (p<0.001). These durations were notably shorter than the 817±299 ms observed in the individual condition.

Without considering the social context, there was a significant variation in movement duration across different stimuli. The joy stimulus induced the longest movement duration at 827±285 ms. This was significantly longer when compared to the fear stimulus, which had a duration of 682±312 ms (p<0.001), and the neutral stimulus, which recorded 693±341 ms (p<0.001).

In analyzing each stimulus under different social conditions, specific trends emerged. For the positive stimuli, the cooperative condition resulted in a movement duration of 665±342 ms (p<0.001), while the competitive condition produced 734±375 ms (p<0.001). Both these values were considerably shorter than the 1081±480 ms seen in the individual condition. However, the competitive condition showed a marginally longer duration than the cooperative one (p<0.05). For the negative (p=0.9) and neutral stimuli (p=0.3), there were no significant interactions effects across different conditions (Table 1) (Figure 1).

**Accuracy.** Accuracy too was impacted by the social conditions. Participants in the cooperative condition scored 23±13 (p<0.05), and in the competitive condition, they scored 24±15 (p<0.05). Both these scores were significantly higher than the 20±15 recorded in the individual condition. However, when looking at the influence of emotional stimuli on accuracy, no significant effects were found. This was consistent across positive (23±15; p=0.2), negative (22±17; p=0.2), and neutral stimuli (21±14; p=0.8). Further analysis, considering both the type of stimuli and the social conditions, did not reveal any significant interactive effects on accuracy of positive (p=0.8), negative (p=0.4), or neutral stimuli (p=0.08) (Table 1) (Figure 2).

### Cognitive performance

**Reaction time.** The social context had a clear impact on reaction time. Participants in the competitive condition recorded a reaction time of 186±78 ms, which was significantly shorter than the 223±88 ms seen in the individual situation (p<0.01).

Upon analyzing without considering the social context, emotions played a role in influencing reaction times. Neutral stimuli led to a reaction time of 233±100 ms, which was significantly longer than the times seen in a positive (200±107 ms; p<0.05) and negative stimuli (176±93 ms; p<0.05).

There was also a significant interaction effect based on the type of stimuli and the social condition. For positive stimuli, the cooperative condition saw a reaction time of 180±150 ms, which was notably shorter than the 239±161 ms in the individual condition (p<0.05). Conversely, for negative stimuli, the competitive condition recorded a shorter time of 148±128 ms compared to 204±156 ms in the cooperative condition (p<0.05). Neutral stimuli did not show any significant effect (p=0.7) (Table 1).

**Table 1. Effect of social context and interactive effect between emotion and social context on movement duration, reaction time, accuracy, correspondence and emotional stability**

| Parameters analyzed | Social condition | | |
|---|---|---|---|
| | **Individual** | **cooperation** | **competition** |
| ***Effet social*** | | | |
| **Movement duration (ms)** | 817 (299) | 679(320) *** | 707 (356) ††† |
| **Reaction time (ms)** | 223 (88) | 201 (84) | 186 (78) †† |
| **Accuracy** | 20 (15) | 23 (13) * | 24 (15) † |
| **Emotional correspondence (%)** | 68 (25) | 81 (18) *** | 81 (15) ††† |
| **Emotional stability (%)** | 58 (25) | 57 (24) | 63 (27) |
| ***Interactive effect of positive emotion and social context*** | | | |
| **Movement duration (ms)** | 1081 (480) | 665 (342)*** | 734 (375) †††# |
| **Réaction time (ms)** | 239(161) | 180 (150)* | 180 (158) |
| **Accuracy** | 23 (25) | 20 (20) | 26(25) |
| **Emotional correspondence (%)** | 84 (37) | 99 (12)** | 99 (9) †† |
| **Emotional stability (%)** | 49 (50) | 41 (50) | 49 (50) |
| ***Interactive effect of negative emotion and social context*** | | | |
| **Movement duration (ms)** | 678 (362) | 653 (343 ) | 717 (316) |
| **Réaction time (ms)** | 177 (148) | 204 (156 ) | 148 (128) # |
| **Accuracy** | 20 (24 ) | 22 (26) | 22 (23) |
| **Emotional correspondence (%)** | 40 (37) | 58 (43)*** | 55 (24) †## |
| **Emotional stability (%)** | 41 (50) | 40 (49) | 51 (50) |
| ***Interactive effect of neutral emotion and social context*** | | | |
| **Movement duration (ms)** | 693 (377) | 718 (398) | 669 (392) |
| **Réaction time (ms)** | 252 (164 ) | 218 (162)** | 230 (155) |
| **Accuracy** | 17 (19 ) | 25 (28) | 22 (26) |
| **Emotional correspondence (%)** | 79 (34) | 88 (32)** | 88 (32) †† |
| **Emotional stability (%)** | 84 (37) | 90 (30) | 90 (30) |

Note: Parameters analyzed are presented on mean (SD); *: $p$<0.05, **: $p$<0.01, ***: $p$<0.01 for comparison between the individual and cooperative condition; †: $p$<0.05, ††: $p$<0.01, †††: $p$<0.01 for comparison between the individual and the competitive condition; #: $p$<0.05, ##: $p$<0.01, ###: $p$<0.01 for comparison between cooperative and competitive condition.

### Affective performance

**Emotional correspondence.** There was a significant effect of the social conditions on emotional correspondence. Both cooperative and competitive conditions resulted in higher emotional correspondence, with scores of 81±18% (p<0.001) and 81±15% (p<0.001) respectively, compared to the individual condition's 68±25%.

Differences were also seen when considering the type of emotional stimuli. Positive stimuli had the highest correspondence at 94±14%, which was significantly higher than both negative (51±25%; p<0.001) and neutral stimuli (85±27%; p<0.001). Moreover, neutral stimuli had a higher correspondence than negative stimuli (p<0.001).

Interaction effects were evident when projecting positive stimuli. Both cooperative and competitive situations resulted in high correspondences of 99±12% (p<0.01) and 99±9% (p<0.01) respectively, compared to the individual scenario. For negative stimuli, the cooperative and competitive conditions showed higher correspondences when compared to the individual scenario, with respective scores of 58±43% (p<0.001) and 55±24% (p<0.05). Additionally, the competitive setting saw slightly lower correspondence compared to the cooperative one (p<0.01). Neutral stimuli in both cooperative and competitive conditions had scores of 88±32% (p<0.01), which was higher than the individual scenario (Table 1).

**Emotional stability.** Emotional stability did not show significant variation in either the cooperative (57±24; p=0.6) or competitive conditions (63±27; p=0.2). However, when presented with neutral stimuli, participants displayed greater emotional stability at 88±20%, which was notably higher than the stability seen with positive (46±27%; p<0.001) and negative stimuli (44±31%; p<0.001). Further analysis across different stimuli in the social contexts did not reveal significant interactive effects for positive, negative, or neutral stimuli (Table 1) (Figure 3).

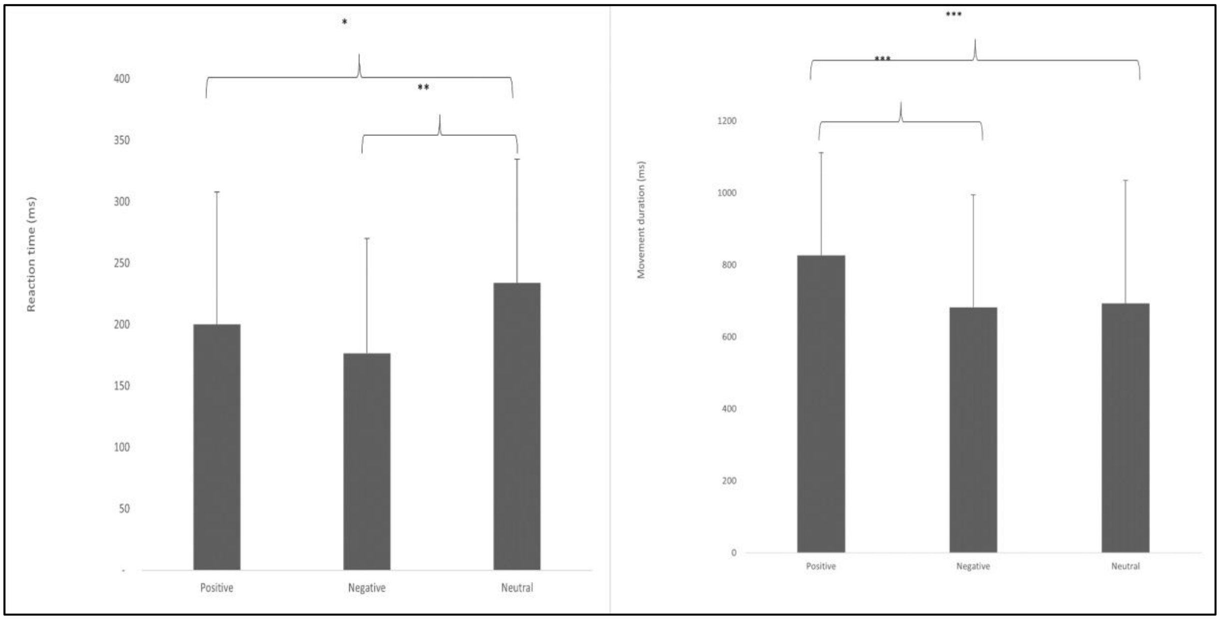


**Figure1.** Movement duration and reaction time to positive, negative and neutral stimuli.
Note. A bracket indicates a difference between two conditions. *:p<0.05, **:p<0.01, ***:p<0.001

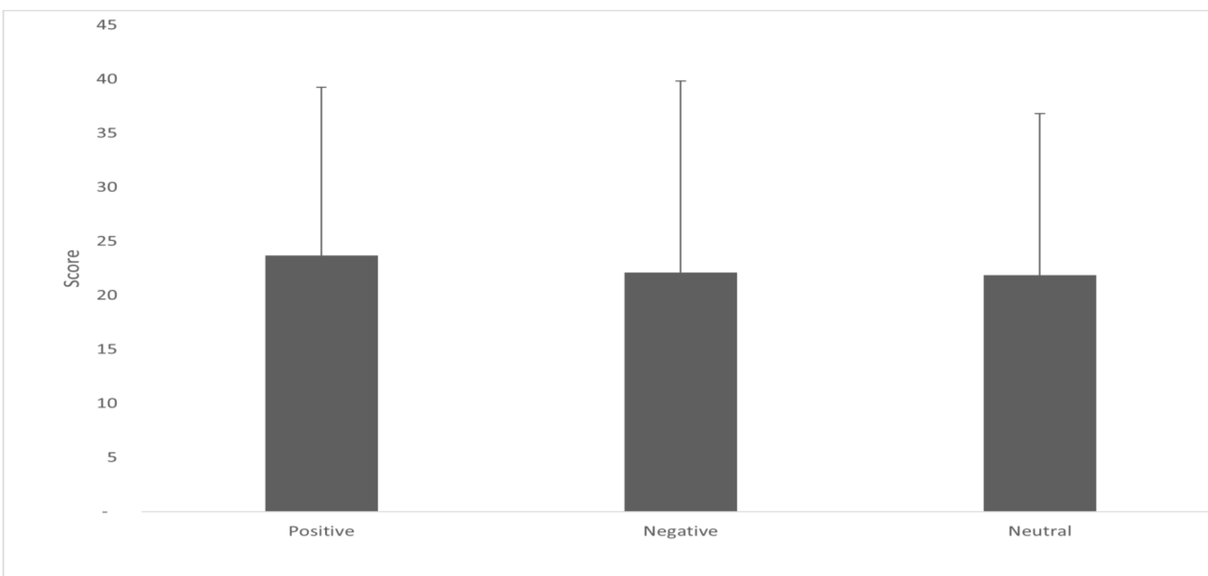


**Figure2.** Accuracy to positive, negative and neutral stimuli.
Note. A bracket indicates a difference between two conditions. *:p<0.05, **:p<0.01, ***:p<0.001

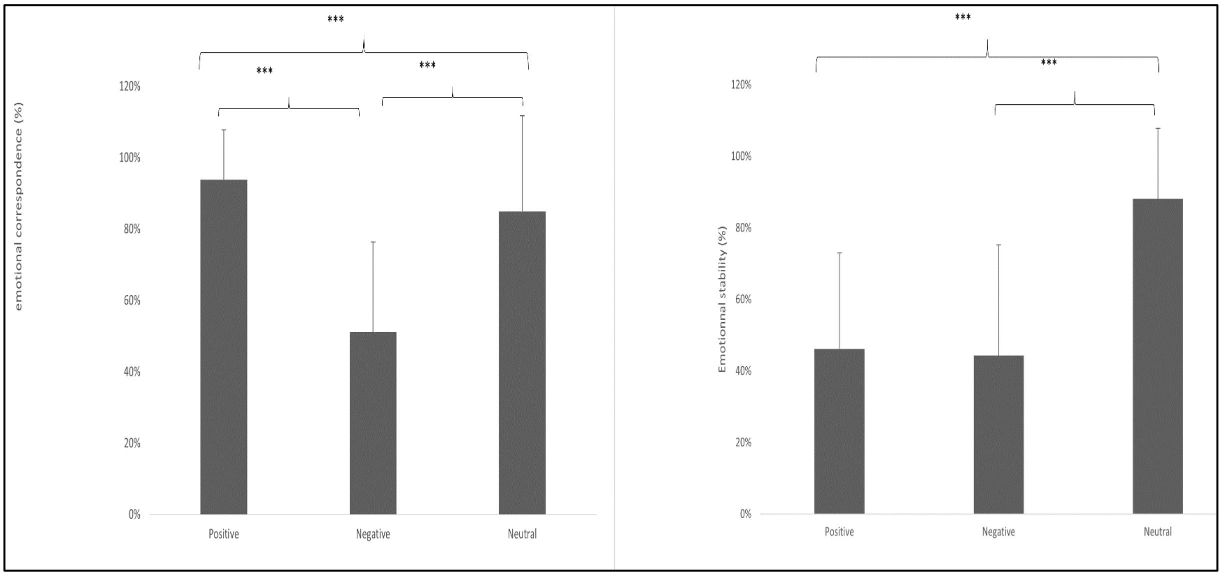


**Figure3.** Emotional correspondence and stability to positive, negative and neutral stimuli.
Note. A bracket indicates a difference between two conditions. *:p<0.05, **:p<0.01, ***:p<0.001

## DISCUSSION

The present study aimed to investigate the influence of different social contexts, specifically competition and cooperation, on motor, cognitive, and affective behaviors among physical education students.

### Motor performance

**Movement duration.** Consistent with our predictions, participants demonstrated faster movement times in both cooperative and competitive settings compared to solitary performance. This suggests that social contexts, whether cooperative or competitive, enhance movement duration relative to solo tasks. Such findings corroborate prior studies that documented reduced movement duration in group-based contexts compared to solitary conditions (10, 11, 23).

Our data imply that social environments distinctly alter action kinematics. Actions performed solo exhibit different kinematic patterns than those intended for subsequent social interactions, be they competitive or cooperative. A plausible reason is that action planning varies based on the overarching intention. Past research has evidenced that intention mechanisms can shape, movement kinematics (10, 24). Specifically, kinematics seems attuned to prior intentions i.e., pre-formed intentions that dictate the action's end goal (25). Dart-shooting, in this case, is motivated by both intention and the rationale behind the action (25). Hence, prior intentions' influence on kinematics is worth noting. The act of dart-shooting within distinct contexts (like cooperation or competition) is guided by these prior intentions, which in turn affect movement kinematics.

Another perspective centers on the role of motivation present in both settings. Should participants receive compelling rewards, analogous behaviors might emerge in competitive scenarios. Another consideration is whether the observed distinctions are mere reflections of the motor demands intrinsic to the tasks. It is conceivable that the nature of cooperative and competitive actions necessitates divergent control strategies.

However, this doesn't negate the role of distinct motor strategies. If prior intentions indeed sculpt action kinematics, it logically follows those varying strategies guide these actions. For instance, a cooperative intention in dart-shooting could entail a different motor strategy than a competitive one. In terms of emotional stimuli, movements were quicker in response to negative and neutral stimuli than positive ones. This aligns with contemporary studies that tie negative stimuli to decreased movement duration (26–29). Such reductions can be attributed to heightened defensive system activation in response to negative images (30–32), or even phobic vertigo (33). The similar acceleration observed with neutral images might stem from the facilitating effects of imagined social scenarios (34, 35), given that our neutral stimuli depicted social settings.

When examining the interplay of social context and emotion on movement duration, there was a pronounced impact specifically in response to positive stimuli. In both cooperative and competitive contexts, movements were quicker than when actions were performed alone. Strikingly, the cooperative setting demonstrated even swifter movement durations than its competitive counterpart. This is consistent with our hypothesis, which proposed that positive emotional stimuli enhance movement kinematics.

This enhancement might be attributed to mechanisms that underline the effects of social contexts (cooperative and competitive) on the movement, complemented by the influence of positive stimuli. Several studies highlight how positive emotional images can boost motor tasks, from initiating gait to facilitate upper limb movements (36, 37). The prevailing theory among these researchers is that positive emotions drive us toward pleasant situations and stimuli (37–39). Thus, the display of positive images provides the necessary momentum for movement, culminating in reduced durations.

Furthermore, the enhanced movement duration in cooperative scenarios, as opposed to competitive ones, prompts contemplation of the psychological state's role in social contexts (40). It's possible that in cooperative settings, participants foster a more affirming attitude both towards themselves and their counterparts. This spirit of collaboration can usher in a positive interpersonal mindset (41). Such observations resonate with the social-psychological theory asserting that cooperation stems from a belief in harmonized objectives, while competition arises from an adversarial perspective, where one's success is at the cost of another's failure (42, 43).

An evolutionary and developmental psychology lens offers another perspective. From this vantage point, cooperation seems more socially rewarding than competition, positioning it as a wellspring of both collective and individual positive feedback (44). This aligns with the concept that the act of social sharing is intrinsically rewarding (45), suggesting that this sentiment might be more prevalent in cooperative than in competitive contexts due to the inherent social value of collaboration.

There's also a neurological dimension to these differences. Earlier studies, such as one by (46), have indicated that while cooperation engenders social motivation associated with right orbitofrontal activation, competition, albeit less socially rewarding, demands on heightened mentalization resources and correlates with medial prefrontal areas (47).

**Accuracy.** On the accuracy front, participants demonstrated heightened precision in both social scenarios as opposed to individual tasks. This uptick in accuracy, irrespective of the context being cooperative or competitive, could be attributed to heightened motivation. The urge to excel, either in collaboration or in competition, seems to be paramount (10, 11). In neutrally charged interactions, this focused engagement might wane. However, when participants are actively aligned to a specific mode, is it cooperative or competitive, their attention intensifies. This underscores the pivotal role of motivation in both settings. Contextual cues or priming could further elucidate this trend (48, 49). Goals driven by a particular context might subsequently steer behavior. Therefore, participants primed with a specific objective (cooperation or competition) outperform those acting in isolation.

However, emotions didn't significantly sway accuracy, possibly due to the overriding emphasis on the task's endpoint. Prior research underscores how an action's objective can profoundly impact movement (24). Here, a fervent commitment to achieving the best outcomes might have shifted focus away from weaker stimuli, thereby neutralizing any emotional influences.

**Cognitive performance**

**Reaction time.** The data highlights a discernible social impact on reaction times. Competing participants responded quicker than those acting solo, a finding that seemingly diverges from previous studies (50–53). Those earlier works concentrated on how social intent, entwined with anticipated negative outcomes in competitive scenarios, affected action planning. While these researchers proposed that competitive contexts could delay reactions due to potential pitfalls, our study found competitive actions were faster than solo endeavors. This discrepancy might stem from our unique methodological approach, which incorporated emotional image stimuli. The confluence of emotional states with social contexts might enhance response agility. This suggests that the impetus to outpace an opponent might fuel these quicker reactions.

The results notably underscore the intricate relationship between emotional states and reaction times. A pronounced shorter reaction time was observed when participants were exposed to positive stimuli as compared to neutral stimuli. Such findings lend credence to the motivational direction hypothesis, emphasizing the intrinsic human tendency to approach positive stimuli (54–56). The compelling aspect of our study is the pronounced influence of positive emotion on reaction time.

The results notably underscore the intricate relationship between emotional states and reaction times. A pronounced shorter reaction time was observed when participants were exposed to positive stimuli as compared to neutral stimuli. Such findings lend credence to the motivational direction hypothesis, emphasizing the intrinsic human tendency to approach positive stimuli (54–56). The compelling aspect of our study is the pronounced influence of positive emotion on reaction time.

Furthermore, participants demonstrated a quicker reaction time to negative stimuli than to neutral ones. This aligns with the theory that threats or aversive signals prime our motor system for quick action, thus accelerating our motor responses (57-60). Exposure to such negative stimuli typically triggers our defense mechanisms (61, 62), perhaps manifesting as the instinctual "fight or flight" response, which could explain the briskness in reaction to negative images over neutral ones (63, 64).

Qualifying and extending the hypothesis, our reaction time results indicate that the movements were faster in response to negative images compared to neutral images.

A particularly intriguing finding was the difference in reaction time between cooperative and individual contexts when exposed to positive stimuli. It's plausible that the blend of positive emotions and a cooperative intent could spur quicker reactions. As is well-documented, positive stimuli naturally induce a behavioral propensity to approach pleasant situations (37–39). In cooperative scenarios, the anticipation of achieving joint success seems to quicken one’s responsiveness (5, 42, 43).

In contrast, competitive contexts resulted in quicker reactions to negative stimuli than cooperative ones. Drawing parallels to a study by (65), it’s posited that heightened performance in cognitive tasks during competition might be attributed to the overpowering effect of negative stimuli over cooperative intent. The drive to outperform rivals in competitive situations appears to override any lag introduced by negative stimuli, catalyzing quicker responses.

**Affective performance**

**Emotional correspondence.** Further exploring neurology, competitive situations have been linked with heightened activity in key frontal areas including the medial prefrontal cortex, the right prefrontal cortex, and the anterior cingulate cortex. These insights suggest that competition demands enhanced focus, introspection, motivation, and understanding of opponents' intentions than cooperative contexts (66-68).

The results underscore a pronounced influence of social context on emotional resonance. When engaged in cooperative or competitive situations, participants exhibited a heightened emotional response compared to solitary settings. This heightened response seems rooted in the participants' focus on achieving success, given the motivational pull in cooperative or competitive social contexts (11). The drive to outperform an opponent and obtain a reward intensified their attention to targets and stimuli, thereby sharpening their emotional perception.

Participants displayed a stronger affinity with neutral stimuli than with negative ones. This may be attributed to the neutral images resonating more with the experimental environment (69), resulting in an enhanced engagement with these neutral stimuli.

Yet, positive stimuli overshadowed both negative and neutral ones in terms of emotional resonance. This is consistent with the understanding that positive emotions are associated with an appetitive system while negative ones align with a defensive system related to emotions like fear and sadness (70). Therefore, positive stimuli naturally command a deeper emotional connection.

Delving deeper, an intricate relationship emerges between emotional states and social contexts. Whether confronting positive or negative stimuli, participants' emotional resonance was amplified in cooperative and competitive scenarios compared to solo ones. This phenomenon is likely influenced by the close association of emotions with motivation (39). On one side, emotions naturally carry motivational weight, either drawing us towards positivity or away from negativity (70). Concurrently, the inherent motivation in social contexts, be it to surpass adversaries or to triumph alongside allies, plays a substantial role (10, 11).

Furthermore, when faced with neutral stimuli, participants' emotional responses were enhanced in both cooperative and competitive contexts. This could be attributed to the phenomenon of emotional contagion. Interestingly, the only distinct interaction between cooperative and competitive contexts was evident in response to negative stimuli, possibly indicative of the ego effect. Prior research has indicated that individuals with a stronger ego orientation tend to be more competitive, especially in sports (71-73).

**Emotional stability.** It's noteworthy that social contexts, or their interplay with emotional states, didn't significantly alter emotional stability. This could be because of a deficiency in emotional regulation, potentially tied to the chosen situational methodologies. The study focused on interpersonal interactions of one-on-one cooperation or competition. However, there are also intergroup dynamics, which have been observed to be more influential than one-on-one settings (4, 43, 74). The absence of a broader group identity could explain the observed emotional instability.

Moreover, emotional states distinctly affect emotional stability. Participants were more stable when exposed to neutral stimuli compared to positive or negative ones. This variability could be tied to the intricate neural processes involved in emotion processing (75). Different emotions involve disparate visual processing, cognitive control mechanisms, and emotional regulation techniques (76, 77).

**Limitation**

This study has undoubtedly enriched our understanding of the interplay between social contexts, emotional states, and emotional stability. However, scrutiny warrants several limitations and avenues for future exploration. One critical limitation stems from the reliance on verbal instructions to delineate between cooperative and competitive scenarios. Such an approach may not encapsulate the intricacies and nuances inherent to genuine human interactions. Instead, results derived from authentic situations where participants are engrossed in tangible acts of cooperation or competition could paint a more comprehensive picture. Additionally, the study's scope was confined to one-on-one interactions, potentially missing out on the broader dynamics of group interactions. Prior research suggests that intergroup contexts could wield more considerable influence than individualized settings (2, 44, 75). Thus, a broader exploration encompassing group dynamics could unearth varied or amplified effects. Another methodological concern pertains to the potential overlooking of certain factors pivotal for emotional regulation. Some settings or tasks, if designed differently, might have engendered a sense of group identity or membership, leading to distinct impacts on emotional stability. Further introspection reveals a potential over-reliance on self-report measures. This reliance could introduce biases or misrepresentations, given that participants' self-perceptions might not always align with their physiological or behavioral manifestations. Future endeavors could harness physiological markers or other objective metrics to quantify emotional responses, ensuring enhanced validity. Homogeneity of participants, if not adequately controlled, might present another limitation. Should participants originate from similar cultural or demographic cohorts, the findings' generalizability to a broader populace could be circumscribed. Recognizing that emotional and social response can oscillate across cultures or age brackets, a more diverse participant pool might yield more universally applicable results. Moreover, while the study touched upon neural processes related to emotional states (77), an in-depth foray using advanced neuroimaging modalities might unravel the intricate neural tapestry underpinning these interactions.

In light of these reflections, future research might benefit from a more immersive experimental design, simulating real-world cooperative or competitive situations. Such an approach, when coupled with neuroimaging, can proffer a multifaceted and profound comprehension of the neural, emotional, and social intricacies of play during interpersonal engagements.

## CONCLUSION

The findings of this study highlight the multifaceted relationship between emotions, social contexts, and emotional stability. As the results underscore, the reaction to cooperative and competitive settings can vary widely among individuals. Some may find cooperative settings, particularly beneficial, experiencing enhanced motor skills and heightened emotional responses, while others may flourish within a competitive atmosphere.

From a practical standpoint, educators, trainers, and coaches should consider these variations when designing programs or interventions. By identifying and understanding the preferences of individuals, activities can be tailored to optimize outcomes. For instance, if a particular group of students or athletes exhibits better performance in cooperative scenarios, it would be advantageous to incorporate more team-based tasks into their routine.

The notable improvements observed in the cooperative context also serve as a testament to the power of teamwork and collaboration. While the immediate context of this study revolves around sports and physical education, the implications of these findings extend far beyond. Collaboration is a skill that is immensely valuable in various professional and personal settings. Therefore, incorporating more cooperative tasks into educational and training programs can ensure that participants are well-equipped with essential skills like communication, problem-solving, and empathy, which will serve them well in numerous life situations. While both cooperative and competitive contexts have their unique merits, this study emphasizes the importance of considering individual differences and the broader, lifelong benefits of fostering collaboration.

## APPLICABLE REMARKS

- Educators can improve student and athlete performance through cooperative activities, benefiting motor skills and emotions.
- Integrating competition can boost motivation and reaction times, but balance is essential to maintain a positive learning atmosphere.
- Facial recognition can monitor student emotions in real-time during physical activities.
- Balancing cooperation and competition can enhance performance and well-being in various learning and professional settings.

## ACKNOWLEDGMENTS

Open access provided by Qatar National Library. The authors would like to express their sincere gratitude to the students for their participation in the experiment and their enthusiasm throughout the study.

## AUTHORS' CONTRIBUTIONS

Study concept and design: MM, SC, ID, MR and MJ. Acquisition of data: NG. Analysis and interpretation of data: SC, EW and MB. Drafting the manuscript: MM, SC, ID and MJ. Critical revision of the manuscript for important intellectual content: MR, SC, EW and MB. Statistical analysis: NG. Administrative, technical, and material support: MJ. Study supervision: MJ.

## CONFLICT OF INTEREST

the authors reported no potential conflicts of interest.

## REFERENCES

1. Eliassy M, Khajavi D, Shahrjerdi S, Mirmoezzi M. Associations Between Physical Activity and Gross Motor Skills with Social Development in Children with Learning Disabilities. International Journal of Sport Studies for Health. 2021;4(1). [doi:10.5812/intjssh.120844]
2. Masoomi H, Taheri M, Irandoust K, H'Mida C, Chtourou H. The relationship of breakfast and snack foods with cognitive and academic performance and physical activity levels of adolescent students. Biological Rhythm Research. 2020;51(3):481–8. [doi:10.1080/09291016.2019.1566994]
3. Katz L, Finestone L, Paskevich DM. Competition when cooperation is the means to success: Understanding context and recognizing mutually beneficial situations. Cogent Psychology. 2021;8(1):1878984. [doi:10.1080/23311908.2021.1878984]
4. Sanfey AG, Gong X. Social rank and social cooperation: Impact of social comparison processes on cooperative decision-making. PLoS One. 2017;12(4):0175472. [doi:10.1371/journal.pone.0175472] [PMid:28388684]
5. Deutsch M. Cooperation and competition. In: Deutsch M, Coleman PT, Marcus EC, editors. The handbook of conflict resolution: Theory and practice. 2nd ed. Jossey-Bass; 2006. p. 23–42.
6. Bacaria J. Competition and cooperation among jurisdictions: The case of regional cooperation in science and technology in Europe. European Planning Studies. 2007;2(3):287–302. [doi:10.1080/09654319408720269]

7. Quintana-Garcia C, Benavides-Velasco CA. Cooperation, competition, and innovative capability: A panel data of European dedicated biotechnology firms. Technovation. 2004;24(12):927–38. [doi:10.1016/S0166-4972(03)00060-9]
8. Mnif M, Chikh S, Jarraya M. Effect of Social Context on Cognitive and MotorBehavior: A Systematic Review. Journal of Motor Behavior. 2022;54(5):631–47. [doi:10.1080/00222895.2022.2060928] [PMid:35379082]
9. Becchio C, Sartori L, Bulgheroni M, Castiello U. The case of Dr. Jekyll and Mr. Hyde : A kinematic study on social intention. Consciousness and Cognition. 2008;17:557564. [doi:10.1016/j.concog.2007.03.003] [PMid:17446089]
10. Georgiou I, Becchio C, Glover S, Castiello U. Different action patterns for cooperative and competitive behaviour. Cognition. 2007;102(3):415–33. [doi:10.1016/j.cognition.2006.01.008] [PMid:16516188]
11. Quesque F, Lewkowicz D, Delevoye-Turrell YN, Coello Y. Effects of social intention on movement kinematics in cooperative actions. Frontiers in Neurorobotics. 2013;7:14. [doi:10.3389/fnbot.2013.00014] [PMid:24109450]
12. Vesper C, Soutschek A, Schubö A. Motion coordination affects movement parameters in a joint pick-and-place task. Quarterly Journal of Experimental Psychology. 2009;62(12):2418–32. [doi:10.1080/17470210902919067] [PMid:19499488]
13. Lang PJ, Bradley MM, Cuthbert BN. International Affective Picture System (IAPS): Affective ratings of pictures and instruction manual. Gainesville, FL: NIMH, Center for the Study of Emotion & Attention; 2005. 8. [doi:10.1037/t66667-000]
14. Debnath T, Reza MM, Rahman A, Beheshti A, Band SS, Alinejad-Rokny H. Four-layer ConvNet to facial emotion recognition with minimal epochs and the significance of data diversity. Scientific Reports. 2022;12(1):6991. [doi:10.1038/s41598-022-11173-0] [PMid:35484318]
15. Davison AK, Lansley C, Costen N, Tan K, Yap MH. Samm: A spontaneous micro-facial movement dataset. IEEE Transactions on Affective Computing. 2016;9(1):116–29. [doi:10.1109/TAFFC.2016.2573832]
16. Yan WJ, Wu Q, Liu YJ, Wang SJ, Fu X. CASME database: A dataset of spontaneous micro-expressions collected from neutralized faces. In: 2013 10th IEEE International Conference and Workshops on Automatic Face and Gesture Recognition FG. 2013. p. 1–7.
17. Yan WJ, Li X, Wang SJ, Zhao G, Liu YJ, Chen YH, et al. CASME II : An improved spontaneous micro-expression database and the baseline evaluation. PloS one. 2014;9(1):86041. [doi:10.1371/journal.pone.0086041] [PMid:24475068]
18. Viola P, Jones M. Rapid object detection using a boosted cascade of simple features. In: Proceedings of the 2001 IEEE computer society conference on computer vision and pattern recognition CVPR 2001. 2001. p.
19. Goodfellow IJ, Erhan D, Carrier PL, Courville A, Mirza M, Hamner B, et al. Challenges in representation learning: A report on three machine learning contests. In: Neural Information Processing: 20th International Conference, ICONIP 2013, Daegu, Korea, November 3-7, 2013 Proceedings, Part III 20. Springer; 2013. p. 117–24. [doi:10.1007/978-3-642-42051-1_16]
20. Kurková P, Nemček D, Bendíková E. Curricular transformation from the perspective of the trends in the education of pupils who are deaf or hard of hearing in Czech republic. European Researcher Series A. 2018;(9–1):24–33. [doi:10.13187/er.2018.1.24]
21. Guermazi R, Abdallah TB, Hammami M. Facial micro-expression recognition based on accordion spatio-temporal representation and random forests. Journal of Visual Communication and Image Representation. 2021;79:103183. [doi:10.1016/j.jvcir.2021.103183]
22. Zhang S, Yao L, Sun A, Tay Y. Deep learning based recommender system: A survey and new perspectives. ACM computing surveys (CSUR). 2019;52(1):1–38. [doi:10.1145/3158369]
23. Fawver B, Beatty GF, Naugle KM, Hass CJ, Janelle CM. Emotional state impacts center of pressure displacement before forward gait initiation. Journal of Applied Biomechanics. 2015;31(1):35–40. [doi:10.1123/JAB.2013-0306] [PMid:25322476]
24. Ansuini C, Santello M, Massaccesi S, Castiello U. Effects of end-goal on hand shaping. Journal of Neurophysiology. 2006;95(4):2456–65. [doi:10.1152/jn.01107.2005] [PMid:16381806]

25. Searle JR. Intentionality: An essay in the philosophy of mind. New York: Cambridge University Press; 1983. [doi:10.1017/CBO9781139173452]
26. Coudrat L, Rouis M, Jaafar H, Attiogbé E, Gélat T, Driss T. Emotional pictures impact repetitive sprint ability test on cycle ergometer. Journal of Sports Sciences. 2014;32(9):892–900. [doi:10.1080/02640414.2013.865253] [PMid:24479679]
27. Naugle KM, Joyner J, Hass CJ, Janelle CM. Emotional influences on locomotorbehavior. Journal of Biomechanics. 2010;43(16):3099–103. [doi:10.1016/j.jbiomech.2010.08.008] [PMid:20828698]
28. Naugle KM, Hass CJ, Joyner J, Coombes SA, Janelle CM. Emotional state affects the initiation of forward gait. Emotion. 2011;11(2):267. [doi:10.1037/a0022577] [PMid:21500896]
29. Naugle KM, Coombes SA, Cauraugh JH, Janelle CM. Influence of emotion on the control of low-level force production. Research Quarterly for Exercise and Sport. 2012;83(2):353–8. [doi:10.1080/02701367.2012.10599867] [PMid:22808722]
30. Azevedo TM, Volchan E, Imbiriba LA, Rodrigues EC, Oliveira JM, Oliveira LF, et al. A freezing-like posture to pictures of mutilation. Psychophysiology. 2005;42(3):255–60. [doi:10.1111/j.1469-8986.2005.00287.x] [PMid:15943678]
31. Facchinetti-Mannone V. Gares exurbanisées et développement urbain: Le cas des gares TGV bourguignonnes. Revue Géographique de l’Est. 2006;46(1–2). [doi:10.4000/rge.1221]
32. Stins JF, Beek PJ. Effects of affective picture viewing on postural control. BMC Neuroscience. 2007;8(1):1–7. [doi:10.1186/1471-2202-8-83] [PMid:17916245]
33. Adkin AL, Frank JS, Carpenter MG, Peysar GW. Postural control isscaled to level of postural threat. Gait & Posture. 2000;12(2):87–93. [doi:10.1016/S0966-6362(00)00057-6] [PMid:10998604]
34. Cottrell NB. Social facilitation C. In: McClintock, editor. Experimental Social Psychology. New York: Holt, Rinehart & Winston; 1972. p. 185–236.
35. Triplett N. The dynamogenic factors in pacemaking and competition. The American Journal of Psychology. 1898;9(4):507–33. [doi:10.2307/1412188]
36. Eder AB, Rothermund K. When do motorbehaviors (mis) match affective stimuli? An evaluative coding view of approach and avoidance reactions. Journal of Experimental Psychology: General. 2008;137(2):262. [doi:10.1037/0096-3445.137.2.262] [PMid:18473659]
37. Lavender T, Hommel B. Affect and action: Towards an event-coding account. Cognition & Emotion. 2007;21(6):1270–96. [doi:10.1080/02699930701438152]
38. Bouman D, Stins JF. Back off! The effect of emotion on backwardstepinitiation. Human Mmovements Science. 2018;57:280–90. [doi:10.1016/j.humov.2017.09.006] [PMid:28919167]
39. Frijda NH. Emotion experience and its varieties. Emotion Review. 2009;1(3):264–71. [doi:10.1177/1754073909103595]
40. Frijda NH, Kuipers P, Ter Schure E. Relations among emotion, appraisal, and emotional action readiness. Journal of Personality and Social Psychology. 1989;57(2):212. [doi:10.1037/0022-3514.57.2.212]
41. Lang PJ. The emotionprobe:Studies of motivation and attention. American Psychologist. 1995;50(5):372. [doi:10.1037/0003-066X.50.5.372] [PMid:7762889]
42. Kilner JM, Friston KJ, Frith CD. Predictive coding: an account of the mirror neuron system. Cognitive processing. 2007;8:159–66. [doi:10.1007/s10339-007-0170-2] [PMid:17429704]
43. Hove MJ, Risen JL. It’s all in the timing: Interpersonal synchrony increases affiliation. Social Cognition. 2009;27(6):949–60. [doi:10.1521/soco.2009.27.6.949]
44. Deutsch M. A theory of co-operation and competition. Human Relations. 1949;2(2):129–52. [doi:10.1177/001872674900200204]
45. Johnson DW, Maruyama G, Johnson R, Nelson D, Skon L. Effects of cooperative, competitive, and individualistic goal structures on achievement: A meta-analysis. Psychological Bulletin. 1981;89(1):47–62. [doi:10.1037/0033-2909.89.1.47]
46. Barron G, Erev I. Small feedback-based decisions and their limited correspondence to description-based decisions. Journal of Behavioral Decision Making. 2003;16(3):215–33. [doi:10.1002/bdm.443]
47. Elliott R, Dolan RJ, Frith CD. Dissociable functions in the medial and lateral orbitofrontal cortex: evidence from human neuroimaging studies. Cerebral cortex. 2000;10(3):308–17. [doi:10.1093/cercor/10.3.308] [PMid:10731225]

48. Balconi G, Spagnuolo R, Dejana E. Development of endothelial cell lines from embryonic stem cells: A tool for studying genetically manipulated endothelial cells in vitro. Arteriosclerosis, thrombosis, and vascular biology. 2000;20(6):1443–51. [doi:10.1161/01.ATV.20.6.1443] [PMid:10845856]
49. Quesque F, Mignon A, Coello Y. Cooperative and competitive contexts do not modify the effect of social intention on motor action. Consciousness and Cognition. 2017;56:91–9. [doi:10.1016/j.concog.2017.06.011] [PMid:28697981]
50. Balconi M, Vanutelli ME. Interbrains cooperation: Hyperscanning and self-perception in joint actions. Journal of Clinical and Experimental Neuropsychology. 2017;39(6):607–20. [doi:10.1080/13803395.2016.1253666] [PMid:27841088]
51. Bargh JA, Gollwitzer PM, Lee-Chai A, Barndollar K, Trötschel R. The automated will: nonconscious activation and pursuit of behavioral goals. Journal of Personality and Social Psychology. 2001;81(6):1014. [doi:10.1037/0022-3514.81.6.1014] [PMid:11761304]
52. Légal JB, Meyer T. When others' loss of control is... contagious: the effects of initiating a context of lack of control on performance and emotions ]. Lorsque la perte de contrôle d'autrui est... contagieuse: effets de l'amorçage d'un contexte de manque de contrôle sur les performances et les émotions. Bulletin de Psychologie. 2007;60(3):195–210. [doi:10.3917/bupsy.489.0195]
53. Karsh EB. Punishment: Effect on learning and resistance to extinction of discreteoperantbehavior. Psychonomic Science. 1964;1(1):139–40. [doi:10.3758/BF03342831]
54. Karsh EB, Williams JP. Punishment and reward in children's instrumental learning. Psychonomic Science. 1964;1(1):359–60. [doi:10.3758/BF03342956]
55. Miller NE. Learning resistance to pain and fear: Effects of overlearning, exposure, and rewarded exposure in context. Journal of Experimental Psychology. 1960;60(3):137. [doi:10.1037/h0043321] [PMid:14422565]
56. Cacioppo JT, Priester JR, Berntson GG. Rudimentary determinants of attitudes: II. Arm flexion and extension have differential effects on attitudes. Journal of Personality and Social Psychology. 1993;65(1):5. [doi:10.1037/0022-3514.65.1.5] [PMid:8355142]
57. Chen M, Bargh JA. Consequences of automatic evaluation : Immediate behavioral predispositions to approach or avoid the stimulus. Personality and Social Psychology Bulletin. 1999;25(2):215–24. [doi:10.1177/0146167299025002007]
58. Duckworth KL, Bargh JA, Garcia M, Chaiken S. The automatic evaluation of novel stimuli. Psychological science. 2002;13(6):513–9. [doi:10.1111/1467-9280.00490] [PMid:12430834]
59. Coombes SA, Janelle CM, Duley AR. Emotion and motor control: Movement attributes following affective picture processing. Journal of Motor Behavior. 2005;37(6):425–36. [doi:10.3200/JMBR.37.6.425-436] [PMid:16280313]
60. Coombes SA, Cauraugh JH, Janelle CM. Emotion and movement: activation of defensive circuitry alters the magnitude of asustained muscle contraction. Neuroscience Letters. 2006;396(3):192–6. [doi:10.1016/j.neulet.2005.11.048] [PMid:16376016]
61. Coombes SA, Cauraugh JH, Janelle CM. Dissociating motivational direction and affective valence: Specifice motions alter central motor processes. Psychological Science. 2007;18(11):938–42. [doi:10.1111/j.1467-9280.2007.02005.x] [PMid:17958705]
62. Coombes SA, Cauraugh JH, Janelle CM. Emotional state and initiating cue alter central and peripheral motor processes. Emotion. 2007;7(2):275. [doi:10.1037/1528-3542.7.2.275] [PMid:17516806]
63. Gray JA. BrainSystems that mediateBoth emotion and cognition. Cognition & Emotion. 1990;4:269–88. [doi:10.1080/02699939008410799]
64. Öhman A, Soares JJ. Emotional conditioning to masked stimuli: expectancies for aversive outcomes following nonrecognized fear-relevant stimuli. Journal of Experimental Psychology: General. 1998;127(1):69. [doi:10.1037/0096-3445.127.1.69] [PMid:9503652]
65. Crenna P, Frigo C. A motor programme for the initiation of forward-orientedmovements in humans. The Journal of Physiology. 1991;437(1):635–53. [doi:10.1113/jphysiol.1991.sp018616] [PMid:1890653]
66. Hillman CH, Rosengren KS, Smith DP. Emotion and motivated behavior: postural adjustments to affective picture viewing. Biologicalpsychology. 2004;66(1):51–62. [doi:10.1016/j.biopsycho.2003.07.005] [PMid:15019170]

67. Funane T, Kiguchi M, Atsumori H, Sato H, Kubota K, Koizumi H. Synchronous activity of two people's prefrontal cortices during a cooperative task measured by simultaneous near-infrared spectroscopy. Journal of biomedicaloptics. 2011;16(7):077011–077011. [doi:10.1117/1.3602853] [PMid:21806291]
68. Astolfi L, Toppi J, Vico Fallani F, Vecchiato G, Salinari S, Mattia D, et al. Neuroelectrical hyper scanning measures simultaneous brain activity in humans. Brain topography. 2010;23:243–56. [doi:10.1007/s10548-010-0147-9] [PMid:20480221]
69. Babiloni C, Binetti G, Cassetta E, Dal Forno G, Del Percio C, Ferreri F, et al. Sources of cortical rhythms change as a function of cognitive impairment in pathological aging: a multicenter study. Clinical neurophysiology. 2006;117(2):252–68. [doi:10.1016/j.clinph.2005.09.019] [PMid:16377238]
70. Babiloni C, Cassetta E, Binetti G, Tombini M, Del Percio C, Ferreri F, et al. Resting EEG sources correlate with attentional span in mild cognitive impairment and Alzheimer's disease. European Journal of Neuroscience. 2007;25(12):3742–57. [doi:10.1111/j.1460-9568.2007.05601.x] [PMid:17610594]
71. Lahnakoski JM, Glerean E, Salmi J, Jääskeläinen IP, Sams M, Hari R, et al. Naturalistic fMRI mapping reveals superior temporal sulcus as the hub for the distributed brain network for social perception. Frontiers in human neuroscience. 2012;6:233. [doi:10.3389/fnhum.2012.00233] [PMid:22905026]
72. Bradley MM, Codispoti M, Cuthbert BN, Lang PJ. Emotion and motivation I : defensive and appetitive reactions in picture processing. Emotion. 2001;1(3):276. [doi:10.1037/1528-3542.1.3.300] [PMid:12934687]
73. Clancy RB, Herring MP, MacIntyre TE, Campbell MJ. A review of competitive sport motivation research. Psychol Sport Exerc. 2016;27:232–42. [doi:10.1016/j.psychsport.2016.09.003]
74. Newby JL, Klein RG. Competitiveness reconceptualized: psychometric development of the competitiveness orientation measure as a unified measure of trait competitiveness. Psychol Record. 2014;64:879–95. [doi:10.1007/s40732-014-0083-2]
75. Roberts GC, Ommundsen Y. Effect of goal orientation on achievement beliefs, cognition and strategies in team sport. Scandinavian Journal of Medicine & Science in Sports. 1996;6(1):46–56. [doi:10.1111/j.1600-0838.1996.tb00070.x] [PMid:8680944]
76. Puurtinen M, Mappes T. Between-group competition and human cooperation. In: Proceedings of the Royal Society B: Biological Sciences. 2009. p. 276. [doi:10.1098/rspb.2008.1060] [PMid:18826935]
77. Lindquist KA, Wager TD, Kober H, Bliss-Moreau E, Barrett LF. The brain basis of emotion: a meta-analytic review. Behavioral and brain sciences. 2012;35(3):121–43. [doi:10.1017/S0140525X11000446] [PMid:22617651]