Extroversion, mental practice and imagery in the acquisition of the cartwheel

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Abstract

This work is aimed at (1) investigating the effects of physical practice (PP) added to mental practice (MP) with internal imagery (II) and external imagery (EI) on learning the cartwheel and (2) establishing correlations among scores of extroversion and task performances. Thirty female adolescents (mean age 12.93 ± 0.73 years) were assigned to one of two groups of PP followed by MP with either II (n=15) or EI (n=15). There were five experimental phases: pre-test, acquisition, post-test, retention, and transfer. Movements were filmed in all phases, but the acquisition. A checklist was used to assess the movements and extroversion was evaluated by means of the Eysenck Personality Questionnaire. The analyses showed significant intragroup improvements from the pre-test to the other tests but no intergroup differences were detected in any of the phases. Yet a positive and moderate correlation was detected between extroversion and performance in the tests for those who practiced with EI. These findings reinforce the importance of MP as a complimentary tool to PP and show the existence of relationships between extroversion, cartwheel performance and imagery.

Keywords: Motor learning; Motor skill; Personality; Individual differences; Gymnastics.

Introduction

Mental practice (MP) has been defined as the imaginative cognitive rehearsal of the task goal without real observable physical execution[1-2]. Studies have pointed out that MP, in particular when combined to physical practice (PP), contributes to optimize motor skill learning when compared to exclusive regimes of MP and PP. In general, when compared to a no-practice condition, studies have shown that less learning occurs for no-practice followed by MP, PP and MP+PP - in this order. It is important to note that no-practice and MP are considerably worse than PP and PP+MP[3-14]. The effectivity of MP has been explained in two ways. According to a neuromuscular approach, MP triggers muscle activation and reinforces motor representations of the intended skill[15-17]. From a cognitive approach, during MP, the learner focuses attention on relevant aspects of the intended skill and strengthens information processing mechanisms, that is, identification and perception of the stimulus and subsequent selection, programming, and execution of the motor response[18-21].

Mentally picturing a movement can involve distinct types of imagery[9,13,22-25], or imagery perspectives, which are the focus of the present work. Internal imagery (II) is performed in the first person, from an internal perspective, as if the person was performing physically; external imagery (EI) is performed in the third person, as if the individual was recording her/himself. Hale[26] concluded that the electrical activity of the biceps was higher during mental practicing weightlifting with II than with EI. Mahoney and Avener[27] also pointed out that gymnasts that pictured their skills with II, when compared to EI, showed performance advantages in competition. Nevertheless, Hardy and Callow[28] showed that transfer and retention performance of karate and climbing skills was higher when MP was performed with EI. The same authors[28] investigated EI, II and kinesthetic imagery

(KI - in which the learner imagines movement sensations while picturing the skill) in learning an artistic gymnast sequence. Four experimental groups were created (EI, II, EI+KI and II+KI) and the sequence was relatively simple, composed of five continuous movements. Before practicing, each participant watched a video of the one of the four imagery conditions (from the group to which she/he was allocated). During acquisition, they pictured the steps of the sequence during six blocks of three sequences, with two minutes of rest in the interval of each block. Four weeks later, a retention test was performed, with the learners physically performing the sequence three times, with no instructions. To evaluate the performance, two referees graded the sequence with scores from 0 to 10 and the data analysis indicated that the EI+KI group received the higher grades in retention in comparison to the other groups. The difference in the findings from the aforementioned studies is that the first two[26-27] were performance studies while the last one[28] was a learning study which used tests of retention and transfer. In addition, there is a number of studies with mental practice and motor learning[29-32] that inspired the formulation of our hypotheses (last paragraph of the introduction section). Furthermore, our hypotheses incorporated the fact that external and internal imagery can be influenced by different ways of imagining, as showed by questionnaires from studies which evaluated such ways of imagining[33-34].

Individual differences can influence motor skill learning, and specifically the effectiveness of mental practice[18, 35]. The performance in tasks has been associated to stable aspects of the individuals, named traces, which are permanent and consistent in several situations, predisposing individuals to act in a given way regardless of the circumstances. The focus of the present work is the individual difference of extroversion (E), a dimension of personality that is related to sociability and that has been an important characteristic to differentiate individuals in the motor domain[36-42]. Extroverts tend to be more sociable, sensation "hunters", expansive, enthusiastic, assertive and talkative; they sacrifice precision for velocity, and prefer to perform with other people short-term tasks that do not require attention to details. Rather, introverts tend to be shy, quiet, reserved and thoughtful; they sacrifice velocity for precision, prefer to work individually and can pay attention for longer periods. However, predisposition is not a certainty since extroverts and introverts do not always act in a given way; instead, they probably act in a given way[37-41, 43]. In the present study, E will be approached in the light of Eysenck's personality model[37-38]. A key concept in this model is arousal, which reflects the state of being awoken, alertness or the cortico-psychophysiological activation required for basic cortical process such as perception, attention, memory, learning and reasoning. Individuals differ in the arousal baseline. For example, extroverts are chronically under-activated and are reactivated by high intensity stimuli. In turn, introverts are chronically over-activated and are reactivated by smooth and low-intensity stimuli[44].

These differences that define distinct personality traits between persons have been associated to performance in motor tasks. The effects of E in the motor domain have been linked to issues of sequential movement planning and execution[45-51], target accuracy[52], speed-accuracy trade-off[53-55] and practice schedule in motor learning[55]. The present study contributes to the knowledge on the relation between E and skill acquisition by investigating MP with distinct perspectives of imagery. Our main purpose was to study the effects of PP associated with MP with II or EI in learning the cartwheel. Given that extroverts and introverts have different levels of cortical activation, we sought to determine relationships between E scores and task performance. According to Hardy and Callow[28], we tested the hypothesis that PP combined with MP through EI would result in better retention and transfer cartwheel scores. Furthermore, provided the particular characteristics of introverts (introspective, self-centered and more focused on the task details) and extroverts (externally-centered, and more focused on the general aspects of the task), we expected a strong negative correlation between E and retention/transfer performance when MP was internally centered (II), but a high positive correlation between the same scores when MP was externally centered (EI)[37,41].

Methods

Sample

Thirty female adolescents (12.93 ± 0.73 years) with no experience in the task volunteered to participate in the study. The study rigorously followed the Declaration of Helsinki on human research ethics - version VII (2008), published by the World Health Organization. The participation was authorized by parents/tutors, who signed the informed consent form.

Task, apparatus and procedures

The Eysenck Personality Questionnaire (EPQ) - validated for Brazilian population[56] - is composed of 88 questions and was used to quantify E levels. The variation amplitude in the score of this trait is from 0 to 18.

The cartwheel was chosen as the experimental task, which consists of six submovements described as follows[6]: 1) upright position with arms high in the air and straight, step forward; 2) push off of the front leg; 3) place hands on the ground; 4) kick legs up and over the torso and head as the body goes inverted; 5) legs stay apart during the rotation; set one foot on the ground, followed by the other foot, landing in a lunge; 6) finish the movement in the upright position with arms/hands straight and high, and legs apart.

Four one-minute videos were recorded with the movements of an experienced gymnast performing the task. Two videos represented the internal perspective, recorded with the camera fixed on the forehead with a special helmet in the model's head. The other two videos represented the external perspective, with the recording being performed with a camera positioned 2 meters away, laterally to the model. One video of each perspective was recorded with the cartwheel from left to right and the other from right to left. The videos were used to familiarize participants with the task at the beginning of the experiment and to instruct them about the key points of the task during the acquisition phase. Participants were allowed to watch the videos as many times as they wished.

During the experiment, the recordings were performed with a SONY HDR-PJ340 camera placed on a tripod 2 meters away from the movement execution. A 4 meters long straight line was fixed on the floor with adhesive tape to help participants to orientate themselves.

A score was given to each movement according to the movement pattern evaluation checklist from Velloso[57], resulting in four values in the pre-test, four values in the posttest, four values in retention and four values in transfer. The scores varied between 3 and 10 and were attributed by two specialists in artistic gymnastics (intra and interobserver reliability are presented in the data analysis section). The checklist was as follows:

Write "x" in one of the three items of evaluation for each movement phase.

Scores: 9, 8 or 7 = Great (3)
6, 5 ou 4 = Good (2)
3, 2 ou 1 = Bad (1)

3 - Vertical movement of the legs
3 - Aligned support of the hands
3 - Balanced ending

2 - Leg movements close to vertical
2 - Slight misalignment in the hand support
2 - Slight unbalanced ending

1 - Leg movements too low (close to the horizontal)
1 - Great misalignment of the hand support
1 - Unbalanced ending

Final score: _____ + _____ + _____ = _____

MP was performed in a closed and isolated room. Participants were instructed to sit in an armchair, with eyes closed, and to perform the MP of the cartwheel with either II or EI (depending on the group to which the participant was allocated). In addition, the participants received the instruction that the MP must focus clearly on the cartwheel, which must be mentally practiced as vividly as possible, with real sequential and temporal aspects of the movement so that to obtain a successful mental trial.

Experimental design

Participants were randomly assigned to PP + MP groups: The II group (GI) started with PP and then performed MP with II (n=15), while the EI group (GE) started with PP and then performed MP

with EI (n=15). The experiment consisted of the following phases: pre-test, acquisition 1, acquisition 2, acquisition 3, posttest, retention and transfer. We opted for using PP before MP based on the theoretical idea that one must have PP before MP[23].

In the pre-test, participants learned about the task by visual instruction and by watching a video depicting a model performing the skill from an external perspective with the preferred side of the learner. Along with the video, an audio highlighted relevant aspects of the task. The one-minute video was reproduced five times. Next, participants physically performed four complete trials of the cartwheel using their preferred side.

In acquisition 1, the identical visual instruction used in the pre-test was provided for both groups. Then, each participant performed two blocks of 20 physical repetitions, with a five-minute resting interval between blocks, during which she watched the same instructional video. Acquisition 2 was administered on the same day as acquisition 1, with participants of GE watching the pre-test video; for GI's participants, the video was shown from an internal perspective, with the model performing with a camera fixated on the forehead so that to give the impression that the skill is being performed in the first person. GI's participants were informed that the MP must be performed in the first person (II), whereas GE's participants informed that the MP must be performed in the third person (EI). After watching the video, the GE group mentally practiced with EI and the GI group with II. Both groups performed 40 trials (20 trials, five-minute rest, 20 trials).

Acquisition 3 took place in the second day using the same procedure as acquisition 2. The posttest was performed five minutes after the end of acquisition 3. Each participant performed the posttest following the same procedures of the pre-test. In the third day, participants performed the retention and transfer tests. In the retention test, participants performed physically four trials of the complete cartwheel with their preferred side, with no feedback. After ten minutes, transfer test was run with participants being submitted to the same retention procedure, but performing with the non-preferred side. All trials were video recorded.

Data analysis

Reliability of the checklist[57] was performed via intra and interobserver correlations (Cronbach's[58] α). Ten movements recorded were randomly selected, three from pre-test, three from posttest, two from retention test, and two from transfer test. The observers analyzed each set of trials twice, with an interval of 20 days between them.

The scores for each recorded movement were compared within and between groups through descriptive (mean and standard deviation) and inferential statistics (pre/posttest and retention/transfer tests). For each step of the inferential analysis, we used a two-way [2 (groups) x 2 (tests)] analysis of variance (ANOVA). η^2 values were reported to indicate effect sizes for the significant results.

Relationships between extroversion and type of mental imagery were established with the use of Pearson correlation's (r) for each test per group. To achieve this goal, we used the scores of each personality trait and the task performance. For all analyses, alpha was set at 5%. Statistical procedures were performed on SPSS 17.0.

Results

Cronbach's α indicated very reasonable reliability of the instrument. The intraclass correlations were α=0.967 ($p<0.0001$) for the first observer and α=0.947 ($p<0.0001$) for the second one. The interobserver correlation was α=0.902 ($p<0.0001$).

Performance in each phase are represented by the scores (mean ± standard deviation) of each group showed in TABLE 1.

TABLE 1 - Mean ± standard deviation of the grades obtained for each group (GI: internal imagery group; GE: external imagery group) in each experimental phase.

	Pre-test	Posttest	Retention	Transfer
GI	17.9 ± 4.9	25.5 ± 4.2	26.03 ± 3.5	21.53 ± 4.4
GE	18.1 ± 5.9	25.0 ± 5.0	25.66 ± 5.0	22.16 ± 3.0

ANOVA did not identify significant differences between groups. Nevertheless, a significant main effect for "Block", from pre to posttest [$F(1,28)=105.99$; $p=0.002$; $\eta^2=0.79$], was detected. This performance change can be interpreted as an indicative of learning[1]. No significant effect was found from posttest to retention (persistence), whereas there was a significant difference between posttest and transfer (adaptability), regardless of group [$F(1,28)=14.95$; $p=0.001$; $\eta^2=0.35$].

In GE group, the retention correlation between extroversion and performance scores was significant, negative and moderate ($r=-0.61$; $p=0.016$). In the transfer test, the correlation also reached significance, but of low magnitude ($r=-0.46$, $p=0.023$). No significant relationships were found for the GI group.

Discussion

The main purpose of the present study was to investigate the imagery perspective, internal or external, during MP combined with PP in the cartwheel learning. We expected that PP with MP through EI would lead to better scores in both retention and transfer. However, we did not detect significant differences between groups in any of the experimental phases. The hypothesis, set according to a study with adult women practicing artistic gymnstics[28], was refuted. It seems that the development level of the participants, as well as the task complexity, were responsible for distinct results in both studies. Despite the fact that both tasks can be categorized as serial skills (chain of discrete movements)[1], the cartwheel bears fewer components when compared to the floor event. The developmental difference of the participants (adolescents x adults) might be another factor for distinct effects in terms of imagery perspective. It is worth noting that in Hardy and Callow's[28] study, the EI was effective only when the learner imagined the sensations of the movement; this was not the case in the present study because our participants were not instructed to employ kinesthetic imagery in any of the experimental groups. Future research should address this issue.

Even though we could not detect significant differences between groups, there were intragroup differences for both groups. Both internal and external imagery groups showed remarkable increase in performance from pre to posttest. This improvement has been interpreted as one of the criteria for inferring motor learning. Another criterion for learning occurrence is persistence, reflected in the lack of differences between posttest and the retention test (performed 24h later)[1]. However, the change in the task employed in the transfer test (performed with the non-preferred side) caused significant performance decrement. Therefore, MP + PP enhanced cartwheel's performance, regardless of imagery perspective (first or third person).

The beneficial cognitive effect of mental rehearsal is that the learner draws attention to relevant aspects of the target-skill so that information processing mechanisms are strengthened. These cognitive mechanisms might facilitate the means to reach the goals of the target-skill, as well as to consolidate strategies for error detection and correction in more advanced stages[20]. Also, MP yields the activation of muscles that would be responsible for the real execution of the movement. In fact, some studies reported brain activation in areas which are responsible for the real movement during MP[15, 59]. These neural and cortical explanations are grounded on the idea that mental images and their correspondent mental representations share the same properties and, consequently, play the same role of PP in generating motor representations[16-17]. It is recommended thus to use PP combined with MP, yet to optimize PP time in a practice session.

The order between PP and MP during practice has generated debate. The argument for "MP before PP" highlights that MP effects might be hindered by previous PP[60]. Mental rehearsal would overload the learner's capacity to extract relevant information from the task and, as a result, the learner would be engaged in positive higher cognitive effort (or demand)[61]. However, this hypothesis is in contrast to previous literature[10-11, 62-63]. In the present study, PP was performed prior to MP, in line with the assumption that one should first experience the real execution of the movement as a prerequisite for MP[23, 64]. In summary, the implementation of PP first seems to optimize the effects of MP, probably because PP (1) entails relationships between error detection/correction and intrinsic feedback[1-2], (2) does not require conscious control of the action[15, 61-64], and (3) provides relevant afferent organization to integrate perception and action[65-69]. As these aspects are absent from MP, this type of practice is less effective than PP. Nevertheless, MP is more effective than no practice whatsoever and it seems to enhance learning when implemented after PP.

The secondary goal of the present study was to describe the significance and the magnitude of correlation between E scores and groups' performance. A discrepancy was detected between correlations' values/directions obtained and what was expected. Retention and transfer correlations were significant, negative and moderate between E scores and performance only for those who mentally practiced in the third person. The correlations' direction for this group was opposite to the direction stated in our hypothesis: lower values of E (introversion) were associated with higher performance, while higher values of E (extroversion) were associated to poorer performance. According to the particular characteristics of extroverts and introverts, higher E scores would be associated to better performance with EI. Rather, our findings give evidence as to the opposite. It is theoretically arguable that our introverted participants, because they are over-activated (higher levels of basal arousal), were self-reactivated to optimal points of performance with EI, an imagery perspective that might have been perceived by them as a lower intensity stimulus[44]. It also appears plausible to believe that EI must have served as a useful stimulation effect for introverts to engage more actively in the tests.

In conclusion, the present findings gave evidence to the effect that there is a negative correlation between E scores and the cartwheel performance when, next to PP, MP is performed through external imagery.

Resumo

Extroversão, prática mental e perspectivas de mentalização na aquisição da estrela da ginástica artística

O presente trabalho teve como objetivos (1) investigar os efeitos da prática física (PF) associada à prática mental (PM) com mentalização interna (MI) e externa (ME) na aprendizagem da habilidade "estrela" da ginástica artística e (2) correlacionar escores de extroversão e de desempenho na tarefa. Trinta adolescentes (12,93 ± 0,73 anos) foram designadas a dois grupos: 1) PF seguida de PM com ME (n=15) e 2) PF seguida de PM com MI (n=15). O delineamento constou de pré-teste, aquisição, pós-teste, retenção e transferência (todas as fases foram filmadas, exceto a aquisição). Os registros em vídeo foram analisados por meio de uma lista de checagem da estrela. O Eysenck Personality Questionnaire foi utilizado para classificar as participantes quanto a níveis de extroversão. As análises apontaram que houve melhora de desempenho dentro de cada grupo (do pré-teste para os outros testes), mas que em nenhuma das fases houve qualquer diferença significativa entre os grupos. No entanto, uma correlação positiva e moderada foi detectada entre os escores de extroversão e de desempenho no grupo ME. Esses achados reforçam a importância da PM como estratégia complementar à PF e sinalizam a existência de relação entre extroversão, desempenho da estrela e perspectiva de mentalização.

Palavras-chave: Aprendizagem motora; Habilidade motora; Personalidade; Diferenças individuais; Ginástica artística.

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