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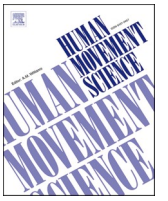

Differential performance on a motor task according to the preference for task-irrelevant elements that are chosen or assigned: A randomized controlled study

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ABSTRACT

This study explored the impact of choice and preference for what is chosen or assigned on performance on a motor task. Using an experimental design with a dart-throwing task, 90 novice participants were randomized into four groups: Choice-Like condition, Choice-Dislike condition, Assigned-Like condition, and Assigned-Dislike condition, resulting of the manipulation of choice (vs. assignation) of a task-irrelevant element and preference (irrelevant element: darts color and design). The study found that participants who were given the opportunity to choose their own dart for a throwing task performed better than those who were not given the choice. Participants who threw a dart they preferred also had better scores than those who threw a dart they did not like. However, the interactive effects of choice and preference on performance were inconclusive, and whereas being assigned with a disliked element was the worst condition for performance, and being allowed to choose preferred elements the most facilitatory one, nothing else can be concluded on the impact of both conditions alone or in combination. These results suggest that both choice and preference can positively impact performance in closed motor learning tasks and have practical applications for training and execution in athletic performance. Further investigations are warranted to delve into the interplay of choice and preference in diverse contexts and populations.

1. Introduction

Choice can enhance motivation and task engagement (Patall, 2013). Some studies (Ikudome et al., 2019) have found that choice can increase an individual's willingness to engage in a task if they have an interest in the task. Previous research has found that allowing participants to make seemingly non-task-related choices (i.e., Choices that do not directly affect the task), such as choosing the color of a ball or the pictures in a room (Lewthwaite et al., 2015; Wulf et al., 2014), can improve learning and motor execution in

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tasks such as target throwing and golf putting, even in a similar vein to pertinent choices for the task (such as opting to observe a demonstration video of the skill) (Wulf et al., 2018). There is also evidence suggesting that task-irrelevant choices lead to superior performance compared to task-relevant choices (Patall et al., 2008). This suggests that choice can have a positive effect on performance even when the chosen element is not directly relevant to the task.

Contrariwise, other studies (Carter & Ste-Marie, 2017; Grand et al., 2017; McKay & Ste-Marie, 2022) have unearthed that pertinent choices pertaining to the task (i.e., choices directly impacting the task) lead to enhanced learning and performance compared to conditions irrelevant to the task or lack of choice. They also remarked that prior research on choice and motor skill learning had not adequately controlled for task-relevant decision-making or psychological factors. These findings suggest that the informative value of task-relevant choices might be more crucial for learning than motivational factors, thereby questioning the notion that the advantages of self-controlled learning are primarily driven by motivation. Furthermore, McKay and Ste-Marie (2022) study has replicated experiments concerning irrelevant element choices with improved research designs and a larger number of participants, and their results did not support the evidence described in Wulf et al. (2018), for instance.

Nevertheless, choices that are relevant to the task and similar in attractiveness may increase intrinsic motivation (Williams, 1998), while challenging and personally significant choices may lead to burnout and negative effects on motivation, effort, performance, and learning (Muraven & Baumeister, 2000). Unimportant choices may make the individual feel insecure (Reeve et al., 2003; Stefanou et al., 2004). These findings suggest that other qualities of the task elements can have an influence besides choice.

Despite the issue of choice for task relevant or irrelevant aspects being questioned in the research, the influence of preference (liking/disliking) for the chosen or assigned elements on motor learning and performance has not been sufficiently studied. In this sense, as far as we know, the only study in the field of motor learning is the work by Bund and Wiemeyer (2004), who investigated whether self-controlled practice enhances motor learning and self-efficacy beliefs more when referring to an aspect of the learning situation that the learner prefers compared to an aspect that is not preferred. Although the study did not find significant differences between the preferred practice conditions and the non-preferred ones, it did not explore sufficiently how the preference for choosing an irrelevant element in the task can influence performance.

Therefore, it is important to examine the role of preference in motor task performance. As mentioned above, previous research has only shown how choosing task-relevant or task-irrelevant items affects the outcome (e.g., Grand et al., 2017; Ikudome et al., 2019; Lewthwaite et al., 2015; McKay & Ste-Marie, 2022; Patall et al., 2008; Wulf et al., 2014). It is generally assumed that choice leads to the selection of preferred elements, while the control group is assigned non-preferred elements. However, the control group may also be assigned preferred elements, which could impact the differential effect of choice on performance. In this sense, according to the OPTIMAL theory (Wulf & Lewthwaite, 2016), personal preferences, such as liking or not liking a particular choice, can affect intrinsic motivation and attention in motor tasks. When individuals are given the opportunity to choose something they like, they are more likely to feel motivated and engaged in the task, which can lead to better motor performance. However, simply having a choice is not

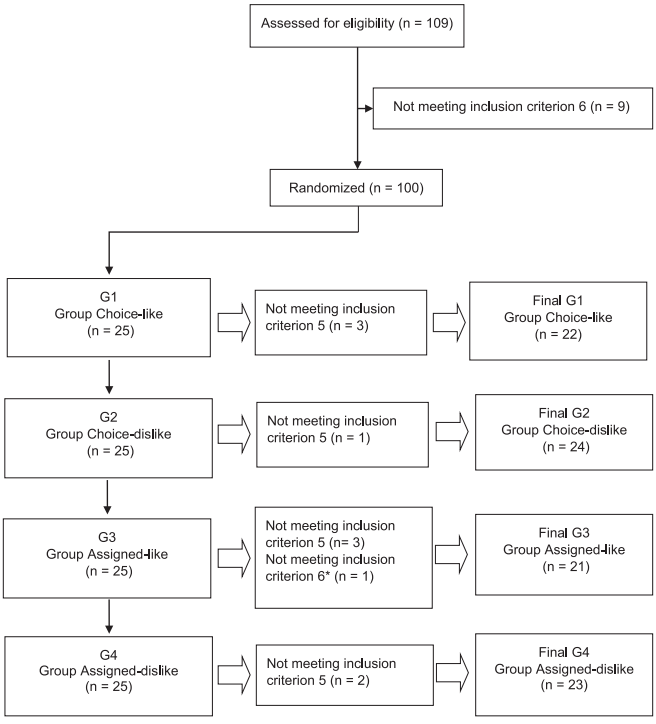

Fig. 1. Flow diagram showing the recruitment, group assignment, and composition of the final study participants.
Notes: * This participant got COVID-19 from baseline to the first experimental session.

enough to improve performance –it is the choice of something that the individual likes that is more important. Thus, it is crucial to consider personal preferences when assigning tasks to individuals, as this can impact their motivation and attention, ultimately affecting their learning and performance.

Consequently, the present study sought to build on the available knowledge on the influence of choosing task-irrelevant items on motor performance in a throwing darts task by exploring the role played by preference (liking/disliking) for the chosen or assigned item. We expected to find that participants allowed to choose regarding an irrelevant task feature (choice group) would outperform their yoked control counterparts (assigned group) (Hypothesis 1). Furthermore, the participants who threw darts they liked (like group) would show better performance than those who threw with darts that they disliked (dislike group) (Hypothesis 2). In addition, we predicted that the participants who could choose darts they liked (choice-like condition) would obtain higher throwing scores than the other groups (i.e., choice-dislike, assigned-like, and assigned-dislike conditions) (Hypothesis 3). Finally, we anticipated that participants who have been assigned darts they do not like (assigned-dislike group) would obtain the lowest throwing scores compared with the remaining conditions (Hypothesis 4).

2. Method

2.1. Design

The study was conducted using a double-blind, randomized controlled design with four groups: G1.- Choice-Like group, G2.- Choice-Dislike group, G3.- Assigned-Like group (yoked with G1), and G4.- Assigned-Dislike group (yoked with G2). The motor task was a dart-throwing task and was completed by each of the study groups across two sessions, 24 h apart: Session 1, including Phase 1 to Phase 3; and Session 2, including Phase 4 and Phase 5 (5 phases × 45 throws). The dependent variable was the throwing sum score obtained at each phase. As independent variables, we manipulated whether participants could choose irrelevant task elements (choice/assignment), and their preference (like/dislike) for these elements, specifically the color and drawing on the dart feather. Several psychological variables relevant to motor learning and performance were also controlled.

2.2. Sample

A sample of 90 university students (53.3% women) completed the study (see Fig. 1). The mean age of the final sample was 22.93 years ($SD = 3.14$), with no significant differences in age between males ($M = 23.05$, $SD = 2.92$) and females ($M = 22.83$, $SD = 3.35$) ($t = 0.321$, $p = .749$). Participants were randomized into four groups (G1 = 22; G2 = 24; G3 = 21; G4 = 23).

The sample size necessary for this study was calculated using G*Power software (version 3.1), based on addressing Hypothesis 1, which is the hypothesis for which there is previously literature reporting effects. An a priori analysis was conducted to determine the minimum number of participants per group needed to achieve a power of 0.95 at a significance level (α) of 0.05. The sample size calculation was based on a mixed ANOVA design with four groups and five measurements. The results indicated that a total sample size of 68 participants (17 participants per group) would be required to detect a significant medium-sized effect (Cohen's f = 0.20), which has been observed in studies of general experiments as a reasonable estimation (Brysbaert, 2019).

To participate in the study, individuals had to meet the following criteria: 1) be 18 years of age or older, 2) complete the informed consent form, 3) score 2–8 on a 0–10 scale of dart-playing experience (with no experience in competitive dart throwing sports), 4) complete a pre-evaluation test of self-efficacy, 5) complete two sessions of dart throwing and all measures during the throws, and 6) not have any severe illness or physical or mental disability or be taking any medications that could interfere.

2.3. Variables and instruments

For the initial screening of meeting the inclusion criteria, an ad hoc protocol was used to gather basic personal information (year of birth and gender), current diseases, and intake of medication that could interfere with motor performance, and thus participation. Participants were also asked to rate their experience in dart-throwing on a scale from 0 ("I have never played darts") to 10 ("I have a lot of experience, I even compete/have competed"). In addition, they were asked regarding their most recent practice ("Approximately, how many times do you estimate you have played darts in the last two years?" 0 = Fewer than five times, 1 = between 6 and 15 times, 2 = between 16 and 25 times, 3 = >25 times).

A series of potentially confounding variables were also assessed to introduce both experimental and analytical control. Self-efficacy was assessed using the General Self-Efficacy Scale (GSES) (Baessler & Schwarzer, 1996; Spanish version by Sanjuán-Suarez et al., 2000). Higher scores are indicating greater self-efficacy. In the present study, the scale obtained a Cronbach's *alpha* of 0.78.

The State subscale of the State-Trait Anxiety Inventory (STAI) (Spielberger et al., 1970; Spanish version by Buela-Casal et al., 2011) was used to assess state anxiety. The higher the scores, the higher the level of state anxiety. In this study, the Cronbach's *alpha* for the state anxiety subscale was 0.87.

External/internal attentional focus (Schorer et al., 2012; Wälchli et al., 2016; Wulf, 2013) was assessed by asking the participants about where they had focused their attention during the throws with the question: "In this phase, during the dart throws where did you focus your attention? a) on the dartboard, where you wanted to aim the dart (external focus); b) on the arm-hand position, i.e., the sensations and movement of the body and arms (internal focus), or c) mixed or alternating between both (mixed focus)".

Similarly, to control for whether the participants had perceived pressure to obtain the maximum score in throwing, they were asked to quantify perceived pressure on a scale from 0 ("I have not noticed any pressure") to 7 ("I have noticed a lot of pressure").

2.4. Procedure

Recruitment phase – Session 0: participants for this study were recruited by asking for volunteers in university classrooms at the University of Huelva. Participants were informed about the study purpose, and, after signing a consent form, they completed a pre-evaluation protocol, which included personal data, a self-report on their dart-throwing experience, and the self-efficacy scale. The final sample was determined, and participants were randomly assigned to the study groups and scheduled for the two sessions at the researchers' lab at the University of Huelva.

Manipulation of expectations: the researchers manipulated participants' expectations about the true purpose of the study to reduce the impact of demand characteristics (Lindheimer et al., 2019). The participants were not aware of the true goal of the study and were told that it was focused on the effect of recording dart-throwing on performance. The researchers also used a camera to simulate recording and informed all participants that they were in the "no-recording group". After the task, they asked the participants what they thought the objective of the activity was to ensure that the true purpose was successfully concealed.

The collaborators who collected data and interacted with participants were unaware of the true aims of the research and were only informed of a "simulated" objective. They were Psychology courses students who had been prepared for their roles in the study, including receiving participants and collecting and recording scores.

Randomization of the sample and factorization of self-efficacy: the participants were then randomized by the following procedure: after randomizing the order of the four study groups (resulting in the following order: G1, G4, G2, and G3), and after ordering the participants based on their scores on the GSES, the participant with the highest GSES score was assigned to G1, the next highest to G4, the third-highest to G2, and the fourth-highest to G3; this process was repeated until all participants were distributed among the groups. The first participant of G3 was then paired (i.e., yoked) with the first participant of G1, and so on until the pairs were completed. In G4, the same procedure was followed to pair the participants with the G2 participants.

Dart-throwing program – Session 1 (Phases 1 to 3) and Session 2 (Phases 4 & 5): after the recruitment phase (session 0), each of the participants returned to the lab for performing the experimental tasks. At Session 1, Phase 1, the Anxiety-State subscale of the STAI was administered and the choice and preference of the darts, in this order, were asked before the dart-throwing task began.

Before the dart-throwing phase, participants in all study groups ranked seven similar darts based on preference for color and feather design pattern on a scale from 0 (least liked) to 6 (most liked). For the first throwing task, Phase 1, the dart ranked 3 (not liked/not disliked) was used. This served as a baseline for each participant and ensured that all participants used the same dart based on their own judgement.

In subsequent phases, each participant in G1 had to choose between the darts located in positions 5 or 6 of their ranking. In G2, the choice had to be made between the darts located in positions 0 or 1. G3 participants, who could not choose, were assigned the dart that occupied, in their own ranking, the same position as the choice made by the G1 participant with whom they had been paired. Finally, G4 participants, who also had no choice, were assigned the dart that occupied, in their own ranking, the same position as the choice made by the G2 participant with whom they had been yoked.

The study involved a throwing task using darts. Participants threw the darts with their dominant arm (the right arm) at a target consisting of concentric circles numbered from 1 to 9, with a central point worth 10. The target was 42 cm in diameter and the rules of the task followed standard dart game rules (World Darts Federation, 2018).

During the first session, after completing an initial warm-up consisting of three series of three consecutive throws, three phases of fifteen series of three throws each were carried out (3 series × 45 throws). At the end of Phase 1 (dart in position 3) as described above the dart was changed according to the group to which the participant belonged (in G1 they chose between the darts in positions 5 or 6 of their ranking; participants in G2 chose between the darts in positions 0 or 1 of their ranking; participants in G3 were assigned the dart that occupied the same position as the one chosen by their yoked participant from G1; and participants in G4 were assigned the dart that occupied the same position as the one chosen by their yoked participant from G2), and Phase 2 and Phase 3 were then completed. Phases 2 and 3 consisted of a throwing task of fifteen series of three throws. No augmented feedback regarding the technique or the accuracy scores was provided during practice or acquisition.

After completing both Phase 2 and Phase 3, participants were asked for information about where they had focused their attention

<table>
<tr><td>University Classrooms</td><td colspan="8">Sports Science Laboratory</td><td rowspan="2"></td><td colspan="3">Sports Science Laboratory</td></tr>
<tr><td>Session 0
Recruitment/Information/
Informed consent</td><td colspan="8">Session 1</td><td colspan="3">Session 2</td></tr>
<tr><td>Personal data</td><td>Remind on simulated scenario (recording)</td><td>Warm-up</td><td>Phase-1</td><td>Phase-2</td><td></td><td>Phase-3</td><td></td><td>Phase-4</td><td>Phase-5</td><td rowspan="3">Perceived objective of the study</td></tr>
<tr><td>Dart-throwing experience scale</td><td>Anxiety-State subscale of the STAI</td><td rowspan="2">3 series x 3 throws

Dart in Position 3</td><td rowspan="2">15 series x 3 throws

Dart in Position 3</td><td>15 series x 3 throws

Dart in Position G1/G3: 5/6 G2/G4: 0/1</td><td>Attention focus (E/I/M)

Perceived pressure (0-7)</td><td>15 series x 3 throws

Dart in Position G1/G3: 5/6 G2/G4: 0/1</td><td>Attention focus (E/I/M)

Perceived pressure (0-7)</td><td rowspan="2">24 h</td><td>15 series x 3 throws

Dart in Position G1/G3: 5/6 G2/G4: 0/1</td><td>15 series x 3 throws

Dart in Position G1/G3: 5/6 G2/G4: 0/1</td></tr>
<tr><td>Frequency darts play in the last 2 years</td><td>Darts personal liking classification (0-6)</td></tr>
<tr><td>GSES</td><td colspan="11"></td></tr>
<tr><td>Factorization of self-efficacy & Randomization</td><td colspan="11"></td></tr>
</table>

Fig. 2. Procedure outline.
Notes: G1: Group Choice-Like; G2: Group Choice-Dislike; G3: Group Assigned-Like (yoked with G1); G4: Group Assigned-Dislike (yoked with G2). GSES: General Self-Efficacy Scale; STAI: State-Trait Anxiety Inventory; E/I/M: External/Internal/Mixed attentional focus.

during the throws, to control for possible effects of attentional focus. They were also asked to quantify the level of perceived pressure.

The second session occurred after 24 h, with Phases 4 and 5 each with fifteen series of three throws (2 series × 45 throws). In these, the throws were made with the same dart as in Phases 2 and 3. No augmented feedback was provided. To conclude, they were asked at the end of Phase 5, "What do you consider to be the objective of the study?"

The procedure is displayed in Fig. 2.

The present study was conducted in accordance with the ethical principles for research involving human subjects, and informed consent was obtained from all the participants. The study protocol was approved by the Andalusian Ethics Committee for Biomedical Research (Evaluation Committee of Huelva).

2.5. Data analyses

Preliminary data analyses confirmed the absence of missing or out of range data, so that no case or value was excluded from the analyses. Parametric assumptions for all main study variables were also confirmed. In addition, analyses were conducted to confirm that randomization matched the four groups in the main control variables. For this purpose, between-subjects one-way Analyses of Variance (ANOVAs) were carried out for age, dart-throwing experience, perceived self-efficacy, pre-execution state anxiety, and perceived pressure. Chi-square tests were used to analyze the distribution of categorical variables.

To test the study hypotheses, the dependent variable was the sum of dart-throwing scores in each phase. A mixed Analysis of Covariance (ANCOVA) was conducted prior the analyses for testing the study hypotheses, with P1 (baseline scores, no manipulation) as covariate of P2 to P5 scores. Given the results, we decided to use one-way ANCOVAs with average P2 to P5 scores and P1 as a covariate. To test the Hypotheses 1 and 2, ANCOVAs were performed with the combination of the study groups according to each hypothesis: G1 and G2 versus G3 and G4 to test Hypothesis 1 (relevance of choice), and the combination of G1 and G3 versus G2 and G4 to test Hypothesis 2 (relevance of preference). The assumptions of normality and sphericity were checked. In the case of non-sphericity, the Greenhouse-Geisser correction was applied. Effect sizes were reported in terms of partial eta^2 (η_p^2). In addition, post-hoc comparisons from the first one-way ANCOVA served to evaluate differences between G1 and the rest of the groups (Hypothesis 3), and G4 against the rest of the groups (Hypothesis 4). As a prerequisite, homogeneity of variances was tested with Levene's test. Effect sizes were reported in terms of Cohen's *d*.

The analyses were conducted using the SPSS statistical package (IBM version 20.0, SPSS Inc., Chicago, IL, USA). For all the analyses, the level of significance was $p < .05$.

3. Results

3.1. Preliminary analyses

As shown in Table 1, there were no significant differences by any of the control variables analyzed. Therefore, none of these variables was included as covariate in further analyses. Importantly, there were no differences between the groups in terms of Phase 1 Pre-Intervention throwing scores (throwing a neutral dart) ($F_{(3, 86)} = 0.705$, $p = .552$, $\eta_p^2 = 0.024$), which confirmed the equivalence of the study groups also in this term and served as a preliminary control condition. (See Tables 2 and 3.)

Furthermore, the majority of participants in Phase 5 believed that the purpose of the research was to examine the effect of external pressure, while only a small minority (an average of 13.3% across the four groups) believed that the study was focused on the influence of the type of dart on their throwing performance.

Table 1
Socio-demographic (age, gender) and baseline screening variables (recent practice, experience in dart throwing and self-efficacy), along with ANOVA and Chi-Square results for the controlled variables.

	G1	G2	G3	G4	Total or Average (SD)	Test	*p*
Women	11 (50.0)	12 (50.0)	12 (57.1)	13 (56.5)	48 (53.3)	$\chi^2_{(3, 90)} = 0.422$	0.936
Men	11 (50.0)	12 (50.0)	10 (46.9)	10 (43.5)	42 (46.7)		
Age	22.18 (2.11)	23.50 (2.75)	23.19 (4.37)	22.83 (3.08)	22.93 (3.14)	$F_{(3, 89)} = 0.728$	0.538
GSES	32.09 (4.05)	30.67 (3.71)	30.52 (3.56)	31.00 (4.44)	31.07 (3.94)	$F_{(3, 89)} = 0.706$	0.551
Recent Practice-2						$\chi^2_{(9, 90)} = 3.538$	0.939
≤ 5	13 (59.1)	15 (62.5)	9 (42.9)	12 (52.2)	49 (54.4)		
6 to 15	5 (22.7)	5 (20.8)	6 (28.6)	6 (26.1)	22 (24.4)		
16 to 25	1 (4.5)	2 (8.3)	2 (9.5)	3 (13.0)	8 (8.9)		
> 25	3 (13.6)	2 (8.3)	4 (19.0)	2 (8.7)	11 (12.2)		
Experience Darts	3.18 (1.40)	3.42 (2.26)	3.76 (1.67)	3.74 (1.79)	3.52 (1.81)	$F_{(3, 89)} = 0.513$	0.674
STAI-S	12.73 (9.11)	12.08 (6.29)	14.62 (6.67)	13.78 (11.05)	13.27 (8.42)	$F_{(3, 89)} = 0.389$	0.761

Notes: Number and percentage of cases for categorical variables. Mean and standard deviation for continuous variables. G1: Group Choice-Like; G2: Group Choice-Dislike; G3: Group Assigned-Like (yoked with G1); G4: Group Assigned-Dislike (yoked with G2); GSES: General Self-Efficacy Scale; STAI-S: State-Trait Anxiety Inventory-State; Recent Practice-2: Recent practice in darts throwing in the last two years; Experience Darts: Self-rating in experience with darts.

Table 2
Performance scores across phases and sessions for experimental groups, including ANOVA and chi-square results for controlled variables (attentional focus types, pressure scores) of each group in each phase.

	G1	G2	G3	G4	Total or Average (SD)	Test	*p*
Phase 1 Pre-Intervention	227.32 (56.33)	237.04 (69.05)	277.95 (53.46)	215.304 (58.66)	229.32 (59.66)	$F_{(3,\ 89)} = 0.705$	0.552
Phase 2							
External AF	12 (54.5)	15 (62.5)	11 (52.4)	11 (47.8)	49 (54.4)	$\chi^2_{(6,\ 90)} = 8.711$	0.190
Internal AF	7 (31.8)	7 (29.2)	2 (9.5)	6 (26.1)	22 (24.4)		
Mixed AF	3 (13.6)	2 (8.3)	8 (38.1)	6 (26.1)	19 (21.1)		
Pressure	4.05 (2.15)	3.92 (2.39)	4.14 (2.29)	3.26 (2.54)	3.83 (2.34)	$F_{(3,\ 89)} = 0.645$	0.588
Phase 3							
External AF	12 (54.5)	12 (50.0)	8 (38.1)	11 (47.8)	43 (47.8)		
Internal AF	3 (13.6)	5 (20.8)	3 (14.3)	2 (8.7)	13 (14.4)	$\chi^2_{(6,\ 90)} = 3.277$	0.773
Mixed AF	7 (31.8)	7 (29.2)	10 (47.6)	10 (43.5)	34 (37.8)		
Pressure	4.41 (2.04)	3.83 (2.33)	3.90 (2.41)	3.78 (2.91)	3.98 (2.42)	$F_{(3,\ 89)} = 0.311$	0.817
Session 1							
Phase 1	227.32 (56.33)	237.04 (69.05)	237.95 (53.46)	215.30 (58.66)			
Phase 2	250.77 (37.76)	246.50 (66.19)	238.00 (59.36)	212.13 (38.31)			
Phase 3	258.73 (28.69)	246.96 (60.12)	255.24 (47.46)	211.70 (32.14)			
Session 2							
Phase 4	253.73 (30.51)	241.21 (56.86)	246.19 (57.58)	205.61 (47.34)			
Phase 5	249.91 (33.83)	245.63 (64.53)	243.29 (62.43)	211.78 (51.83)			
Mean Phase 2 to Phase 5	253.28 (29.02)	245.07 (59.42)	245.67 (53.07)	210.30 (29.42)			

Notes: Number and percentage of cases for categorical variables. Mean and standard deviation for continuous variables. G1: Group Choice-Like; G2: Group Choice-Dislike; G3: Group Assigned-Like (yoked with G1); G4: Group Assigned-Dislike (yoked with G2); AF: Attentional focus.

Table 3
Average scores and standard deviations of sum throwing score for experimental groups under choice vs. no choice and preference vs. no preference conditions.

	G1	G2	G3	G4	Average (SD)	Test	*p*
Groups average scoring							
Choice	192.06 (21.57)	184.92 (43.94)			188.33 (34.89)	$F_{(1,\ 87)} = 10.405$	0.002
No choice			186.11 (38.83)	158.61 (26.98)	171.73 (35.59)		
Preference (like)	192.06 (21.57)		186.11 (38.83)		189.15 (30.98)	$F_{(1,\ 87)} = 10.143$	0.002
No preference (dislike)		184.92 (43.94)		158.61 (26.9)	172.04 (38.61)		

Notes: Mean and standard deviation. G1: Group Choice-Like; G2: Group Choice-Dislike; G3: Group Assigned-Like (yoked with G1); G4: Group Assigned-Dislike (yoked with G2).

3.2. Between-groups differences

The assumption of normality was tested for the dependent variable. A two-way ANCOVA was conducted which included P2 to P5 scores and four groups with their corresponding scores. Additionally, P1 scores were used as a covariate in the analysis. After testing for sphericity (Mauchly's $W = 0.856$; $p = .023$), the assumption for univariate tests was not met, so the Greenhouse-Geisser epsilon was used for adjustment. The analysis revealed no simple effect of Phase ($F_{(2.692,\ 228.816)} = 1.974$, $MSE = 892.921$, $p = .125$, $\eta_p^2 = 0.023$) and no significant interaction between Group and Phase ($F_{(8.076,\ 228.816)} = 1.060$, $MSE = 479.315$, $p = .393$, $\eta_p^2 = 0.036$), and therefore the score obtained did not differ between the phases for all study groups. Analysis of the simple effect of the between-subjects variable (group) showed that there were differences in the scores obtained according to the group to which the participants were assigned ($F_{(3,\ 85)} = 7.772$, $MSE = 18{,}445.173$, $p < .001$). The effect size was large ($\eta_p^2 = 0.214$). Likewise, the covariate has significant effect ($F_{(2.692,\ 228.816)} = 5.569$, $MSE = 2519.171$, $p = .002$, $\eta_p^2 = 0.061$).

The means and standard deviations of the dependent variable (sum throwing score of each phase) for the four groups are displayed in Table 1.

Fig. 3 displays the findings obtained for each group with the evolution observed across the five phases of dart throwing.

Once a main effect of the Phase variable (within-group factor) and the existence of an interaction Group x Phase were discarded, with the purpose of avoiding an unnecessary increase in type I error, the averages of the scoring across phases P2 to P5 for each group were calculated to obtain a single score. Besides, P1 throwing score was considered as a covariate of P2 to P5 scores. Subsequently, a new one-way ANCOVA was conducted to validate our decisions, which included the single, averaged P2 to P5 score for each group as dependent variable and the between-group factor as independent variable, with four groups. Additionally, P1 score was included as a

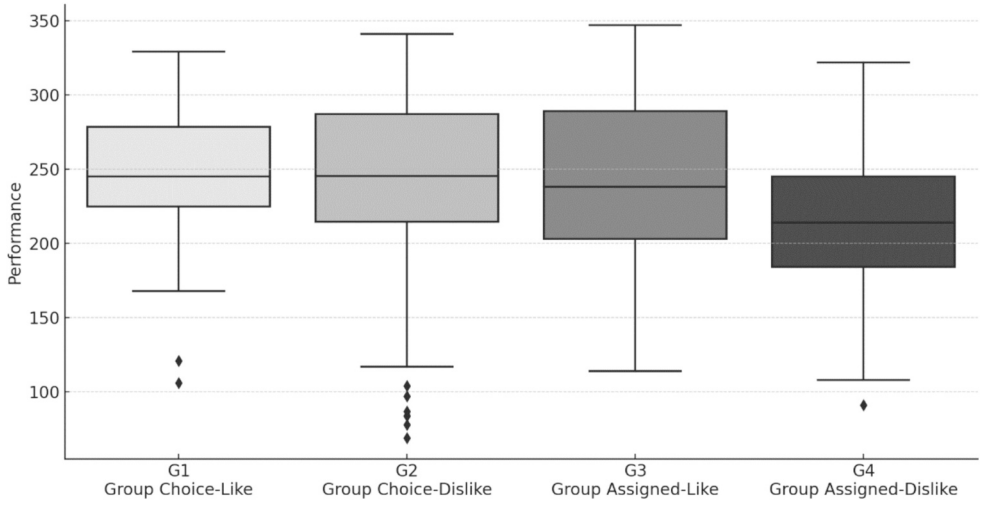

Fig. 3. Performance distribution across different experimental conditions.

covariate in this analysis. The analysis revealed a significant effect of Group ($F_{(3,\ 85)} = 7.722$, $MSE = 4611.293$, $p < .001$). The effect size was large ($\eta_p^2 = 0.214$). The covariate has significant effect ($F_{(1,\ 85)} = 232.213$, $MSE = 138{,}674.337$, $p < .001$, $\eta_p^2 = 0.732$).

Therefore, we decided to use the P2 to P5 average scoring as dependent variable and include the P1 score as a covariate in subsequent analyses.

Hypothesis 1. Choice.

A one-way ANCOVA with post-hoc comparisons was then conducted to explore the effect of the between-subjects independent variable choice for testing the Hypothesis 1. In this analysis, G1 + G2 throwing scores –choice groups– were averaged and compared to G3 + G4 throwing score average –non-choice groups– as dependent variable, and P1 throwing score was introduced as a covariate. Note that P2 to P5 for each group were averaged previously.

The results revealed that there were significant differences in the scores obtained based on the choice's groups, with higher scores for the condition where participants could choose ($F_{(1,\ 87)} = 10.405$, $MSE = 6900.070$, $p = .002$). The effect size was medium ($\eta^2 p = 0.107$). The effect of the covariate was significant ($F_{(1,\ 87)} = 220.537$, $MSE = 146{,}250.683$, $p < .001$, $\eta_p^2 = 0.717$).

Hypothesis 2. Preference.

A similar ANCOVA was conducted to explore the effect of the between-subjects independent variable preference for testing the Hypothesis 2. In this analysis, G1 + G3 scores –preference groups– were averaged and compared to G2 + G4 score average –non-preference groups–, with P1 score as covariate.

The findings revealed that there were significant differences in the scores obtained based on the preference's groups ($F_{(1,\ 87)} = 10.143$, $MSE = 6744.587$, $p = .002$), favoring the condition where the participants liked the darts. The effect size was medium ($\eta_p^2 = 0.104$). Likewise, the effect of the covariate was significant ($F_{(1,\ 87)} = 220.175$, $MSE = 146{,}404.127$, $p < .001$, $\eta_p^2 = 0.717$).

Hypothesis 3 and 4. Post-hoc Analyses Between Groups.

Hypotheses 3 and 4 were tested using Bonferroni's post hoc pair comparisons, based on Levene's test, from the first ANCOVA reported above.

The results indicated that G1 scores were significantly higher than G4 scores ($MD = 34.934$, $p < .001$, $d = 1.430$), but there were no differences between G1 and G2 ($MD = 14.723$, $p = .268$, $d = 0.602$) or between G1 and G3 ($MD = 14.728$, $p = .311$, $d = 0.603$). Similarly, G2 showed significant differences compared to G4 ($MD = 20.210$, $p = .037$, $d = 0.827$), but it did not when compared to G3 ($MD = 0.004$; $p = 1.000$, $d = 0.000$). G3 showed significant differences compared to G4 ($MD = 20.206$, $p = .048$, $d = 0.827$). These results support Hypothesis 4. However, Hypothesis 3 was only partially supported.

4. Discussion

The present study aimed to contribute to the current literature on the impact of choosing task-irrelevant items on closed-skill motor tasks along with the way in which such performance could be influenced by the preference (liking/disliking) for chosen or assigned elements.

Regarding our first hypothesis, the results of this study found that participants who were given the opportunity to choose task-irrelevant elements (such as the color and design of the dart feather) had significantly better performance on a dart-throwing task than those in the no-choice control group. This effect was observed through the mean of the final scores after an initial baseline phase with no manipulation, implying that the selection of the dart might constitute a pivotal factor in learning and performance. However, it

also signifies our lack of knowledge regarding the impact of dart choice during different phases of the experiment or over time. These findings support the hypothesis that choice could enhance performance in the task.

The findings of this study do not align with those reported by other authors when employing spatiotemporal motor tasks (Carter & Ste-Marie, 2017; McKay & Ste-Marie, 2022), where no differences in performance were found between those who made irrelevant choices and those who did not. In contrast, our results are consistent with the literature showing that choosing the color of a dart can enhance performance (Ikudome et al., 2019), selecting the color of the ball improves putting (Lewthwaite et al., 2015) or throwing (Wulf et al., 2014), and choosing the color of the mat placed under the target is associated with superior outcomes (Wulf et al., 2018). Thus, evidence supports the notion that selecting irrelevant elements for the task has a positive impact on short-term performance (Patall et al., 2008). However, it must be acknowledged that most of these aforementioned studies have been criticized for their small sample sizes, which may compromise their results (McKay et al., 2022; McKay & Ste-Marie, 2022). Furthermore, unexpectedly, there were no group differences in the scores across phases 2 and 5. An inspection of Fig. 3 reveals that the effects of choice on performance were not immediately evident, and it is possible that they took time to translate into performance improvement. Additionally, the influence of choice may be transient and only beneficial for learning and performance until a certain level of skill is achieved. Further research is required to explore these results and potential alternative explanations.

Our second hypothesis predicted that participants who threw with darts they preferred had higher scores than those who threw with darts they did not like, regardless of whether they could choose their own darts or were assigned a dart. This hypothesis has been confirmed. These results suggested that the groups who threw the dart in accordance with their preferences exhibited higher mean scores than those who threw darts they did not prefer. These findings stand in contrast to those by Bund and Wiemeyer (2004) indicating that the efficacy of self-controlled practice remains unaffected by the learner's preferences regarding the practice situation. While this holds true, the disparity in outcomes might lie in their employment of relevant variables (e.g., video demonstrations of the skill), whereas we conducted our study with irrelevant factors for the task (i.e., the aspect of the darts).

Regarding the third hypothesis, we predicted that participants who chose darts they liked would score highest. This hypothesis was partially supported. Those who chose darts they liked did score better than those who were assigned darts they disliked. However, they did not score higher than those who chose darts they disliked or those assigned darts they liked. As we can discern, the influence of one's affinity for an element, even if it holds no relevance to performance, seems to wield a modulating effect on the capacity for choice.

Hypothesis 4 predicted that those assigned darts they disliked would score lowest. This was fully supported. Those assigned darts they disliked scored lower than those who chose liked or disliked darts or those who were assigned darts they liked.

The study unveiled that preference may wield an influence on task performance, irrespective of the act of choosing itself, while also seemingly remaining indifferent to the act of choosing. This is evidenced by the findings from G2 (Choice-dislike group) and G3 (Assigned-like group, yoked with G1). The results imply that, when considering the significance of choice in research concerning closed motor skills, the role of preference should also be regarded as a moderating factor, at the very least. In this regard, it is plausible that preference could affect the extent to which the act of choosing enhances performance, as a heightened preference for choice may amplify its effects on task performance, even if such an outcome was not explicitly observed. Furthermore, the study meticulously controlled for variables such as self-efficacy, anxiety, perceived pressure, and attentional focus, all of which appeared unaffected throughout the course of the study. However, further research is needed to fully understand the interactive effects of choice and preference on task performance.

In light of the referenced studies, which suggest that task-irrelevant choices may not affect motor learning and/or performance, we acknowledge the importance of considering the present findings. Studies such as Grand et al. (2017) and McKay and Ste-Marie (2022), which employed large sample sizes and pre-registered analysis plan, have contributed valuable insights to the field. Their rigorous methodologies provide robust evidence that helps to inform the discussion on the effects of task-irrelevant choices.

The present research employed a unique methodology, matched only by Bund and Wiemeyer (2004). Previous studies (e.g., Patall et al., 2008) often encouraged choice by offering a highly attractive option among less attractive ones, but in this study, all participants in the choice groups were able to choose from options of equal attractiveness and likelihood. Additionally, for participants in the assigned groups (yoked participants), the researchers ensured that although they could not choose, they would receive a dart that they liked or disliked to the same degree as those who had the opportunity to choose. This controlled for the possible influence of forced assignments and preference on the performance and outcomes of a motor task (Ikudome et al., 2019; Patall et al., 2008). We also found that the groups were similar concerning attentional focus, thus minimizing the possible influence of an interaction between attentional focus and feedback on task outcomes (Schorer et al., 2012; Wälchli et al., 2016; Wulf, 2013). Additionally, measures were taken to control for demand characteristics (Lindheimer et al., 2019). This was reflected in the low percentage (13.3%) of participants who correctly identified the study's objective of examining the effect of dart choice on performance scores.

Our findings unveiled a significant and positive impact of choice and preference for irrelevant elements pertaining to the task on participants' performance in closed motor learning. Both appeared to exert a similar effect on learning and performance, but their interactive effects remain inconclusive in the present study. While positive effects of task-irrelevant choices on motor task performance were observed, we recognize the need to consider the broader body of literature to gain a comprehensive understanding of the topic. The discrepancy between our findings and those of other studies warrants further investigation and critical examination of various factors that may contribute to these divergent results. These factors may include differences in experimental design, task characteristics, participant populations, and potential moderating variables such as skill level and individual differences. In addition, research on the effect of preference is warranted.

Some limitations of the study include the need to more effectively control for the influence of information provided to participants about the research objectives (Lindheimer et al., 2019; Simonton & Gran, 2020), the short-term nature of the study, and the lack of

consideration of error rate in the task. The sample only included amateur dart throwers, and it would be interesting to see if similar results would be obtained with expert participants. Furthermore, larger samples would enhance the statistical power, as it stands as one of the primary criticisms towards experimental approaches, as exemplified in the meta-analysis conducted by Bacelar et al. (2022) and McKay et al. (2022). In addition, we designed the procedures for including an acquisition phase and a retention phase, but we could not be able to find differences in the scoring across phases. Future research should use designs for assuring these learning-based processes to gain understanding of the temporal patterns-based trajectories. Additionally, it would be useful to explore the effects of relevant choice on open motor skill tasks and to study the long-term effects of the manipulation. It would also be beneficial to test the generalizability of the results to different types of athletes.

In conclusion, this study investigated the impact of choosing task-irrelevant items and the influence of preference on performance in closed-skill motor tasks. The results evidenced that choice of task-irrelevant elements had a positive effect on performance. Preference for chosen elements also improved performance. Further research is warranted to explore the interactive effects of choice and preference on performance across diverse contexts and populations. Additionally, controlling for variables such as self-efficacy, anxiety, and attentional focus may provide a more comprehensive understanding of the underlying mechanisms governing the relationship between choice, preference, and performance in motor task. Globally considering the findings, our results have practical derivations for training and execution in motor tasks, and thus can contribute to athletic performance.

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Helsinki declaration

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and the Declaration of Helsinki of 1975, revised in 2013.

Informed consent

The participants filled Informed consent.

Approved

By the Andalusian Ethics Committee of Biomedical Research (Evaluation Committee of Huelva. Internal Code: 2214-N-20. Date of approval: 04/05/2021; Act: 05/21).

Authorship

All authors made significant contributions to the study design, acquisition of data, drafting of the article, and final approval of the article.

CRediT authorship contribution statement

Félix Arbinaga: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Eduardo José Fernández-Ozcorta:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Irene Checa:** Writing – original draft, Formal analysis. **Ana García-Robles:** Writing – original draft, Investigation, Data curation. **Débora Godoy-Izquierdo:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization.

Declaration of competing interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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