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Set to fail: Affective dynamics in a resistance training program designed to reach muscle concentric failure

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Grounded in hedonic assumptions, evidence suggests that people tend to engage in activities they consider pleasurable and enjoyable, while trying to avoid pain and displeasure. This suggests that the dynamic between positive and negative affect can influence current behavior and the intentions to continue performing. Regarding resistance training (RT), research focusing on how to promote a better affective response is still scarce and much needed. Given existing limitations and theoretical suggestions, a RT program was developed and applied to recreational exercisers in a quasi-experimental design aiming to (1) explore the affective response dynamic through an assessment after the last set of each exercise; and (2) analyze possible differences of preference and tolerance profiles in affective variables (core affect and enjoyment). For that purpose, 43 participants (21 male and 22 female; $M_{age} = 34.69 \pm 6.71$ years; $M_{experience} = 8.32 \pm 4.54$ years; $M_{BMI} = 24.26 \pm 2.64\,kg/m^2$) accepted to participate in this study. Descriptive statistics, correlational, and group comparisons analyses were performed to provide evidence for proposed objectives. The present study showed that measures of affective valence/arousal applied immediately after a set represents a feasible and ecologically valid approach to tap core affect. Results presented evidence that recreationally trained exercisers in a common RT program would need a minimum of one measurement to assess the affective response. However, additional assessments could refine the understanding of exercise pleasurable experience. Results also suggest that exercisers with distinct profiles of preference/tolerance depicted differentiated patterns for the affective response, possibly justifying a distinct approach when promoting affective regulation.

KEYWORDS
activation, affect, pleasure, preference, resistance exercise, tolerance

1 | INTRODUCTION

Despite the ever-increasing evidence of the benefits of physical activity and exercise and the hazardous consequences of sedentary behaviors,[1] a considerable part of the world population is not physically active.[2] Resistance Training (RT) is one form of exercise that presents relevant contributions to the public health, but in need of further research efforts and advancements.[3] The benefits of RT are vast and currently supported by a large body of evidence of its worth in health and well-being, playing a vital role in sarcopenia and osteoporosis prevention, and a reduction in all-cause mortality in both healthy and clinical populations.[1,3,4]

This form of exercise is typically performed in health clubs and gyms.[5] Although providing RT activities for the general and clinical populations, these facilities have struggled to keep exercisers enrolled, and behavioral change techniques have been proposed to address that issue.[1,6,7] Moreover, among the most common forms of exercising, RT is one of the least explored when aiming to create conditions for exercise persistence.[8,9] Thus, the current study sought to explore this issue grounded in the affective response to exercise and related theoretical assumptions.[1,10]

1.1 | A dual-process approach to exercise adherence—the role of affect

Grounded in hedonic assumptions, evidence suggests that people tend to engage in activities they consider pleasurable and enjoyable, while trying to avoid pain and displeasure. This suggests that the dynamic between positive and negative affect can influence current behavior, the beliefs regarding a given activity, the intentions to continue, and other relatable outcomes (habit, frequency, well-being).[11-13] In fact, the study of affect (labeled recently as 'affectivism') has been revitalized in recent years and proposed to be a relevant line of reasoning in psychological research, able to enrich the understanding of current behavior models, as well as to promote and develop new behavior engagement strategies.[14]

These assumptions have been on the basis of several dual-process theoretical approaches related to exercise and/or health-related behaviors. These sustain that behavior is the result of two distinct processes: an automatic, implicit, and fast processing (i.e., type-I), and a reflective, explicit, and slower process (i.e., type-II). For example, the Affective-Reflective Theory[15] (ART), the Physical Activity Adoption and Maintenance model[16] (PAAM), the Affective and Health Behavior Framework[17] (AHBF), and the Theory of Effort Minimization in Physical Activity[18] (TEMPA), represent recent attempts to explore behavior grounded in the dual-process framework. In all, affect represents a central aspect of behavior maintenance/change and has been explored either as a reflective (e.g., affective judgments, like enjoyment) or automatic (e.g., affective association) process.

Particularly in the AHBF, the affective response (immediate affective response, e.g., during running; post-behavior affective response, e.g., immediately after a workout) is considered a key determinant of health behavior. This affective response can be understood as an assessment of core affect (i.e., an elementary non-reflective feeling consciously available), and has demonstrated a relevant predictive value for exercise adherence.[6,12,13]

1.2 | Intensity as a relevant exercise control variable in affective dynamics

Exercise intensity has been shown to have a direct association with pleasurable experiences. Increases in exercise intensity are generally associated with a better affective response up until a point where it starts to undermine or negatively influence that response.[10,15] However, the inversion point of the pleasure–displeasure response depicts a considerable inter-individual variability.[19,20] Given that exercise prescription guidelines emitted by the international entities do not adequately address how to *operationally* achieve or promote an adjusted affective response (e.g., how to assess the individual affective states, judgments, or associations; how to adjust the exercises or session to promote a better affective response), understanding how to address this variability represents a relevant contribution to the gap of the affective relation with exercise adherence.[19,21]

An approach to this gap can be made through an exercise prescription aligned with two traits proposed to reflect the individual predisposition to experience affective responses related to exercise intensity, namely the preference and tolerance traits.[22] Preference is considered a predisposition to select a particular level of exercise intensity, and tolerance the ability to continue exercising at an imposed level of intensity even when the activity is unpleasant/uncomfortable.[22,23] Although experimental evidence is still lacking in the gym and health club domain, it can be hypothesized that knowing the individual preference for and tolerance of exercise intensity, and aligning the exercise prescription with those characteristics, may be a promoter of a better affective response and, consequently, impact positively exercise behavior. Recent observational studies have supported this assumption, showing that an agreement between the training and these two traits depicts a better exercise frequency, intention to continue, and habit formation for exercising.[21,23]

Another possibility to address the current gap of affect regulation knowledge is through affect assessment *during* exercise (e.g., affective response as postulated by the AHBF). This has been suggested to be made[1,24] with the Feeling Scale[25] (FS) and Felt Arousal Scale[26] (FAS), thus presenting the affective valence (perceived pleasure/displeasure) and arousal (perceived activation), respectively. For core affect assessment purposes, both scales can be plotted in a circumplex model to understand the affective fluctuations of an individual in a specific moment, exercise, or, taken globally, the session.[20] These affective dimensions are also proposed to be effective in capturing the response to exercise intensity and may be of particular interest when considering prescribing/supervising exercise activities focused on the promotion of an individually adjusted affective response.[20] Both scales have been used extensively in the exercise context research, both individually and conjunctly.[27,28] However, this assessment has been made more extensively in aerobic activities, leaving RT and other modes of practice lagging in contextual applications.[20,27]

1.3 | Current study

Given the role of affective responses in exercise behavior, understanding how to promote perceived pleasurable experiences during RT can be relevant for exercise adherence. Some of the current challenges for this purpose relate to the admeasurement of affect during and/or after RT for the general population. For example, in a recent systematic review, the authors pinpointed three major limitations regarding the use of the FS and FAS in RT and respective plotting in the circumplex model: (1) the non-standardization of the timing of application, (2) its applicability in a real-life training context, and (3) the relevance to consider inter-individual variability.[20] All these limitations remain vastly unexplored but crucial for the intended affect regulation and to the application of the proposed behavioral theories and strategies for exercise adherence.[1]

Additionally, suggestions for individual or tailor-made exercise promotion/prescription could benefit beforehand of an additional understanding of how someone will "feel" exercise intensity. It is hypothesized that the affective response should be perceived differently according to preference for and tolerance of exercise intensity,[29,30] but, to our knowledge, no study has explored this hypothesis in the RT setting.

Given previous limitations and suggestions, a RT program will be developed and applied to healthy exercisers in a quasi-experimental design aiming to: (1) explore the affective response dynamics in RT through an assessment after the last set of each exercise; and (2) analyze distinct profiles of preference for and tolerance of exercise intensity on core affect and enjoyment. The exercise session will be structured following general exercise recommendations for RT, and intensity of effort controlled using the Repetition in Reserve scale[31] (RIR; see method section). This will allow selecting the load for the defined exercises, while equalizing the intensity for all participants.

Considering the first objective of this study, the current evidence for affective response assessment, albeit preliminary for RT, suggests the application of the FS and FAS immediately after the end of a set, thus effectively assessing pleasure and activation without a significant contribution of an affective rebound effect.[8,32,33] This procedure seems to address the two previously identified limitations regarding the time for assessment and its feasibility in a real-life setting. Moreover, considering that no specific recommendations exist regarding the number of assessments for a RT session, a continuous application of the FS/FAS will develop a first insight of the affective dynamics in this exercise mode, thus allowing to make an exploration to the needed affective valence and activation assessments. As stated by Zenko and Ladwig,[34] these scales should be used at regular intervals, achieving an adequate balance between an accurate representation of how the exerciser feels during the session, and limiting the burden of excessive assessments. This is proposed to be dependent on several variables (e.g., exercise mode, objectives, experience), but can probably be reduced given some circumstances, like exercise plan intensity homogeneity, and adaptation to exercise regimen.

As for the second objective and considering the hypothesis regarding the differences of affective responses according to exercise intensity traits, the FS and FAS scores plotted in a circumplex model should depict in exercisers with higher preference and/or tolerance a transition to a more positively activated position in the respective quadrant (vertically to higher arousal and horizontally to feeling good; energy and vigor).[10] Although not directly, this aim reduces previously stated limitations which focused on plotting affective responses considering only global scores (i.e., sample mean scores), by testing responses in distinct intensity preference and tolerance profiles (i.e., sub-group of relatable individuals).

2 | METHOD

2.1 | Participants

A priori sample size calculations were developed with G*Power v.3.1 Faul et al.[35] to ensure adequate statistical power. The more restrictive analysis (a repeated measures

ANOVA for the three time-points of enjoyment assessment) indicated a minimum of 43 participants. This result was obtained through the definition of several conservative values and estimations: anticipated effect size of $f = 0.25$, statistical power $1-\beta = 0.95$, correlation among repeated measures = 0.50, and $\alpha = 0.05$, following previous studies and authors suggestions.[36,37]

A total of 48 participants were recruited for this study. After data collection, five participants were excluded as they did not meet RIR repetition range; (see study protocol). Consequently, 43 participants (male = 21; female = 22; $M_{age} = 34.69 \pm 6.71$ years; $M_{experience} = 8.32 \pm 4.54$ years; $M_{BMI} = 24.26 \pm 2.64\,kg/m^2$) were considered for analysis. The recruitment was made by convenience in two health clubs in the Lisbon area, considering the following inclusion criteria: volunteers aged between 20–45 years old; apparently healthy; free of injury or any other contraindication for exercise; and, at least, 3 months of continuous RT participation experience (with a minimum of one training session per week). An informed consent form was read and signed by all the participants before the experiment. This study was approved by the ethical review board of the Faculty of Physical Education and Sport of the Lusófona University and was developed in accordance with the Helsinki Declaration and its later amendments.

2.2 | Instruments

2.2.1 | Preference for and tolerance of the intensity of exercise

Preference (item example: "Low-intensity exercise is boring") and tolerance of exercise intensity (item example: "Feeling tired during exercise is my signal to slow down or stop") were measured using the Preference for and Tolerance of the Intensity of Exercise Questionnaire Portuguese version[23] (PRETIE-Q-PT). The questionnaire comprises five items for each construct accompanied by a 5-point bipolar Likert scale anchored from 1 ("I totally disagree") to 5 ("I totally agree"). The scores are obtained through the sum of the items per construct where five is the minimum score and 25 is the highest. This questionnaire was previously validated in a sample of health club exercisers and exhibited good psychometric properties.[23] In present study, both scales presented acceptable internal consistency (Cronbach's alpha; preference $\alpha = 0.76$; tolerance $\alpha = 0.69$).

To analyze profiles of preference for and tolerance of exercise intensity, the global sample was split into four profiles for each trait score: (light intensity: 5–9; light- to moderate-intensity: 10–14; moderate- to vigorous-intensity: 15–19; vigorous intensity: 20–25). Given that none of the exercisers depicted light intensity traits, only the remaining three profiles were considered. Afterwards, a total of six groups were created considering the preference for (three groups) and the tolerance of (three groups) exercise intensity (more information in Table 3).

2.2.2 | Affective valence and activation

The Feeling Scale[25,38] (FS) was used to measure the affective valence of the participants. This 11-point scale, ranging from −5 ("Very bad") to +5 ("Very good"), has been broadly used in the literature to assess affective valence during exercise.

Perceived activation was measured with Felt Arousal Scale[26,38] (FAS). The FAS is a 6-point single-item bipolar rating scale, ranging from 1 to 6 with verbal anchors of (1) "Low arousal" and (6) "High arousal".

The FS and FAS have been shown to possess satisfactory validity and reliability in the exercise context and have been used in conjunction to plot affective dynamics in a circumplex model of affect[39] (i.e., perceived activation and affective valence, respectively).[20,38] The circumplex model of affect is crossed by the FS and FAS and divided into four quadrants: (1) high-activation displeasure (e.g., tension; distress), (2) high-activation pleasure (e.g., energy, vigor), (3) low-activation pleasure (e.g., calmness, relaxation) and (4) low-activation displeasure (e.g., boredom, fatigue), respectively.[40]

In the present study, the scale's scores were analyzed in 8 (all moments) and 6 (RT) moments (named RT FS and RT FAS).

2.2.3 | Physical activity enjoyment

The Physical Activity Enjoyment Scale Portuguese version[41] was used to measure the level of exercise enjoyment. This questionnaire includes eight items related to "how do you feel at the moment about the exercise you have been doing?" that are answered using a 7-point bipolar scale ranging from 1 ("Totally disagree") to 7 ("Totally agree"). The scale presents excellent internal consistency in all three moments of assessment in the present study (start $\alpha = 0.93$; end $\alpha = 0.91$; 24 h after $\alpha = 0.94$).

2.2.4 | Repetition in reserve

The RIR[31] based on the ratings of a perceived exertion scale was used to measure how close to concentric failure the participants were in their last repetition. The answers can be rated in a 10 points scale (1–10), where each point represents an estimation of the number of repetitions to muscle failure (e.g., rating 5–6 represents 4 to 6 repetitions remaining; rating 8 represent 2 repetitions remaining). The present scale has been used in several related studies validly and reliably (e.g., Ormsbee et al.[42]).

2.3 | Procedures

2.3.1 | Study protocol

Study participants took part in two experimental sessions. The main objective of the first session was to familiarize the participants with the psychometric scales used in the present study, namely: FS, FAS, and RIR. The session started with a briefing about the upcoming activities before completing the socio-demographic and psychometric questionnaires. This was followed by a general warm-up on a treadmill (low to moderate-intensity; 5–7 min), one set of 12 repetitions in six resistance training exercises, and a brief cool-down back on the treadmill (low intensity; 2 min). The six resistance training exercises chosen for the present study were: the lat pulldown, back squat, bar chest press, deadlift, dumbbell shoulder press, and the leg extension, in that order. The exercise cadence was defined at 2:2 with a rest interval of 90 s between sets and 3 min between exercises. This exercise selection follows the ACSM[1] guidelines for RT, which is exercises for large muscle groups and mostly multi-joint movements. The FS and the FAS were applied immediately after the termination of the warm-up, after each resistance exercise, and 5 min after cool-down. The data were not used for the statistical analysis of this study but merely for scale familiarization, as suggested in previous studies.[20,43] The session exercises load and repetitions in reserve were determined by the RIR scale to adjust the effort and exercise intensity of the following session.

The second and main session followed the same exercise structure but with three sets for each resistance training exercise. The FS and the FAS were applied after the termination of the warm-up, immediately after the third set of each exercise, following Andrade et al.[8] suggestions, and 5 min after the cool-down. The RIR scale was used after every set to better adjust the load for the third and final set, with the objective of approaching concentric failure. This allowed for an equalization of the resistance exercise intensity for all participants, particularly in the set (third set) that precedes the application of the FS and FAS. Participants were expected to reach concentric failure near the 12th repetition, but a range of 8–14 repetitions was deemed acceptable for study inclusion due to the expected inter-subject variability.[44] This would ensure that exercises would be performed at ~70% of 1RM, following international guidelines[1,45] related to the threshold between moderate- and vigorous-intensity of load. Assessment of enjoyment was applied at the start, at the end, and approximately 24 h after.

In both sessions, during warm-up, researchers explained how and when the measures of affective valence and perceived activation would be administered, to familiarize the participants with these assessment instruments, highlighting the importance that the ratings of affective valence and perceived activation should represent these feelings as experienced *in the present moment* (e.g., immediately after the set). The instruments were presented horizontally (FS) and vertically (FAS) to better differentiate them for the participants and, simultaneously, align the scales with their respective position on the circumplex model of affect. The standardized instructions and item stems were described to the participants and several examples were chosen to illustrate what these scales intended to assess. The participants were then asked to recall exercise-related activities, which they have experienced, for the extreme items of both bipolar scales (i.e., the FS and the FAS) to provide anchoring examples for their answers, but the emphasis was given to the importance of answering during the workout what they felt *in the present moment*. To standardize the experimental conditions, no encouragement was provided to the participants.

Three researchers conducted the data collection. Prior to the beginning of the present study, data from a small independent sample was collected for their training on the application of the psychometric instruments. This followed the recommendations of the developers of the instruments, as well as other relevant studies related to psychometric assessments (e.g., Duda[43]).

2.3.2 | Data analysis

The statistical analyses were conducted using IBM SPSS version 25.0. Descriptive statistics and correlational analyses were conducted for all studied variables. Normality and homoscedasticity were verified with the Shapiro–Wilk ($n < 50$) and Levene's tests. For all tests, the significance level to reject the null hypothesis was set at 5%.

First, global sample analysis procedures were developed. For differences in the dependent variables (FS, FAS, and enjoyment), a repeated measures ANOVA testing was conducted. The assumption of sphericity was examined using Mauchly's test. When this assumption was not met, the Greenhouse–Geisser adjusted values and degrees of freedom were reported.[46] The repeated measures analyses were followed by Bonferroni-adjusted post hoc tests to analyze pairwise comparisons. The η_p^2 effect size was calculated and the assumed reference values were as follows:

"small" effect = 0.01, "medium" effect = 0.06, and "large" effect = 0.14.[47]

After global sample analysis, the focus was given to understand FS and FAS responses across (1) profiles (e.g., light- to moderate-intensity vs. moderate- to vigorous-intensity vs. vigorous intensity) and (2) all six exercises. This was done considering three profiles for preference and three profiles for tolerance. Descriptive analysis of the profiles depicted small sample sizes, and adjusted procedures were selected for hypothesis testing. Thus, to understand if there were differences between profiles in each trait, a Kruskal–Wallis test was performed. For comparison and identification of possible differences in each profile of RT FS and RT FAS, the Friedman test was used. Both these tests are non-parametric and adjusted for small samples testing (Ho[46]). Finally, pairwise comparisons for the two non-parametric analyses were developed, whenever $p<0.05$ (Kruskal–Wallis: Dunn's post hoc; Friedman: Wilcoxon test). A Bonferroni correction (i.e., alpha level/number of tests) was applied in these cases to account for type I errors due to multiple comparisons (Ho[46]).

3 | RESULTS

The descriptive statistics and correlational analysis results are presented in Table 1. As observed, the study's participants had a mean age of 34.69 years (SD = 6.71), were experienced exercisers (M = 8.32 years; SD = 4.54) and presented a normal body mass index (BMI: M = 24.26 kg/m^2; SD = 2.64).

The exercise-intensity preference (M = 18.30; SD = 3.79) and tolerance (M = 16.63; SD = 3.46) mean scores were above scale midpoint (minimum 5; medium 15; maximum 25). Preference for and tolerance of exercise intensity presented positive associations with activation ($r = 0.31$, $p<0.05$; $r = 0.41$, $p<0.01$, respectively), activation during RT ($r = 0.39$, $p<0.01$; $r = 0.45$, $p<0.01$, respectively) and training volume ($r = 0.38$, $p<0.01$; $r = 0.52$, $p<0.01$, respectively). The preference for exercise intensity also depicted a positive association with FS ($r = 0.34$, $p<0.05$).

Regarding core affect, both affective valence (M = 2.86; SD = 1.13) and activation (M = 4.42; SD = 0.53) presented relatively high mean scores (global scores are depicted in Table 1 and Figure 1); the mean scores for the RT affective valence (M = 2.85; SD = 1.49) and activation during RT (M = 5.01; SD = 0.85) presented a similar pattern. In the correlation analysis, FS presented positive associations with pre-exercise enjoyment ($r = 0.44$, $p<0.01$) and 24 h after exercise enjoyment ($r = 0.44$, $p<0.01$). The same trend of results occurred with affective valence during RT ($r = 0.42$, $p<0.01$; $r = 0.40$, $p<0.01$, respectively). For activation, a positive association appeared with post-exercise

TABLE 1 Global sample descriptive and correlational analysis of the intensity traits, affective variables, and training volume.

	M	SD
Age (years)	34.69	6.71
BMI (kg/m^2)	24.26	2.64
Experience (years)	8.32	4.54

	M	SD	1	2	3	4	5	6	7	8	9
1. Preference (5–25)	18.30	3.79	1								
2. Tolerance (5–25)	16.63	3.46	0.71**	1							
3. FS (5–5)	2.86	1.13	0.34*	0.22	1						
4. FAS (1–6)	4.42	0.53	0.31*	0.41**	0.23	1					
5. RT FS (-5–5)	2.85	1.49	0.19	0.17	0.91**	0.19	1				
6. RT FAS (1–6)	5.01	0.85	0.40**	0.45**	0.20	0.72**	0.01	1			
7. Pre enjoyment (8–56)	43.70	7.39	−0.02	0.06	0.44**	0.14	0.42**	−0.02	1		
8. Post enjoyment (8–56)	46.28	6.51	0.04	0.03	0.22	0.34*	0.15	0.17	0.81**	1	
9. 24 h enjoyment (8–56)	43.00	7.74	0.01	0.05	0.44**	0.26	0.40**	0.08	0.94**	0.79**	1
10. Training volume (sets × reps × load)	2 759 750.2	881 062.8	0.38*	0.52**	0.17	0.22	0.19	0.35*	−0.20	−0.16	−0.14

Abbreviations: FAS, Felt arousal scale; FS, Feeling scale; *M*, mean; RT FAS, RT felt arousal scale; RT FS, RT feeling scale; RT, resistance training; SD, standard deviation.

*$p<0.05$; **$p<0.01$.

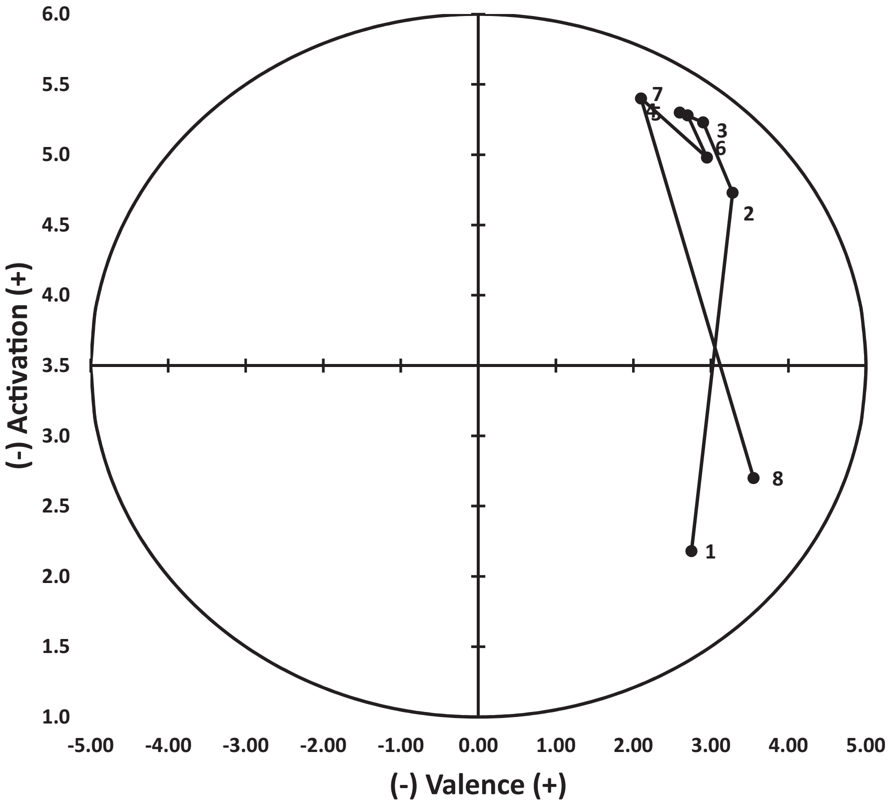

FIGURE 1 Global sample circumplex model in all measured moments.

enjoyment ($r = 0.34$, $p < 0.05$), and for activation during RT a positive association with exercise volume was detected ($r = 0.35$, $p < 0.05$).

As for the enjoyment scores, all three assessments (pre-exercise: $M = 43.70$; SD = 7.39; post-exercise: $M = 46.28$; SD = 6.51; 24 h after exercise: $M = 43.00$; SD = 7.74) presented values above scale midpoint.

Given study purposes, the next set of results relate to the affective valence and activation scores and possible differences across resistance exercises in the global sample. As seen in Table 2, no differences in affective valence emerged according to moment comparisons. Regarding activation, moment 1 presented significant differences with moments 2, 3, 4, and 6 (all $p < 0.001$); moment 3 with moment 5 ($p = 0.042$); and moment 4 with moment 5 ($p = 0.029$). Enjoyment in the three collected moments were also tested in the global sample. Results indicated differences between moments [$F(2, 84) = 15.648$, $p < 0.001$; $\eta_p^2 = 0.27$]. In a Bonferroni-adjusted pairwise comparison, post-exercise enjoyment was significantly different from the pre-exercise (mean difference = −2.581, $p = 0.001$) and 24 h exercise session (mean difference = 3.279, $p < 0.001$).

For testing differences according to preference for and tolerance of exercise intensity, profiles for descriptive analysis and comparisons were developed (see Table 3). Differences were detected in preference for and tolerance of exercise intensity, and training volume. Preference (in preference profiles) and tolerance (in tolerance profiles) were significantly different, aligning with the proposed profiling of the traits for this study. Exercise volume was significantly different in the preference (moderate- to vigorous-intensity vs. vigorous) and tolerance (light- to moderate-intensity vs. vigorous) intensity profiles. All pairwise comparisons were significant when considering the Bonferroni corrected value ($p = 0.017$; all pairwise <0.001).

Following the previous testing, analysis of possible differences in affective valence and activation across RT exercises in each profile showed, in general, no differences between assessments. Exceptions occur in the preference and tolerance moderate- to vigorous-intensity profiles for activation, where all $p < 0.002$ (Bonferroni corrected $p = 0.003$) (Table 4).

When plotting the six profiles and the eight assessment points in a circumplex model, it is possible to observe that the affective response starts in the low activation/pleasure quadrant (warm-up), throughout the session shift to the high activation/pleasure quadrant (main session), and at the end again in the low activation/pleasure quadrant (cool-down). Additionally, it is possible to observe across preference and tolerance profiles, that the affective dynamics tend to shift vertically to higher activation and horizontally to a better feeling state. These results suggest an increase in the affective response as exercisers present higher preference and tolerance profiles (Figure 2A [preference] and Figure 2B [tolerance]).

TABLE 2 Global sample repeated measures ANOVA for the FS and FAS in the six resistance exercises.

M (SD)	Lat pulldown	Back squat	Bar chest press	Deadlift	Dumbbell shoulder press	Leg extension	*F*	df1, df2	*p*	η^2_p	Pairwise comparisons
RT FS	3.3 (0.12)	2.95 (0.28)	2.58 (0.31)	2.7 (0.28)	2.91 (0.28)	2.14 (0.38)	3.575[a]	3.728, 156.586[a]	0.010[a]	0.078[a]	[b]
RT FAS	4.63 (0.12)	5.19 (0.13)	5.28 (0.12)	5.23 (0.12)	4.93 (0.14)	5.28 (0.15)	9.23	5, 210	<0.001	0.180	1≠2, 3, 4, 6; 3≠5; 4≠5
Enjoyment	Pre		Post		24 h		15.648	2, 84	<0.001	0.27	1≠2; 2≠3
	43.70 (7.39)		46.28 (6.51)		43.00 (7.74)						

Abbreviations: df1, degrees of freedom of the six conditions; df2, degrees of freedom of error; F, test results; *M*, mean; *p*, significance; RT FAS, resistance training felt arousal scale; RT FS, resistance training feeling scale; SD, standard deviation; η^2_p, partial eta-square.

[a]Greenhouse–Geisser adjustment.

[b]No differences detected.

4 | DISCUSSION

The present study aimed to explore the affective response dynamics in a RT program while addressing some previously reported concerns in the literature for this purpose. Additionally, the current study analyzed how distinct profiles of two intensity traits would depict core affect responses and enjoyment.

To address the issues regarding timing and the number of assessment moments, six applications of the FS and FAS were performed, all after the last set of the RT exercises. The protocol implementation (both regarding training and application) seems to align with Andrade et al.[8] suggestions of its contextual feasibility. No issues were detected during data collection nor did incoherent results appear for FS/FAS (no outliers or random scores). For the global sample, mean scores in affective valence and activation during RT posits the exercisers in the high activation/high pleasure quadrant (or positively activated quadrant; Figure 1), and enjoyment scores suggest positive benefits from the exercise protocol and no negative impact on the 24 h assessment after exercise. These results bring a first approach to the affective response and remembered affect (i.e., enjoyment) understanding in RT, when set to reach (or approximate) muscle concentric failure. Given that this intensity effort control method is based on the individual capacity to perform an exercise with a given load, and that the load was adjusted throughout the sets, approaching concentric failure would suggest an equalization of exercise intensity (~70% RM) for that given range of repetitions.[48] Consequently, training close to muscle failure in the general conditions proposed by this study protocol does not seem to negatively impact the sensation of pleasure, and thus, is not expected, although hypothetical at this point, to negatively affect exercise adherence and relatable outcomes. This has been proposed previously for affective valence and with this range of RM%,[49] but more studies are needed to adequately evaluate this result given that a wide array of training methodological variables can be used (e.g., distinct training loads, cadence, single vs. multi-joint exercises).

Still on the study's first aim, affective valence and activation scores throughout the RT session presented apparently distinct results. The affective valence presented no differences between exercises, but some differences emerged with activation scores (greatest difference between moments = 0.65). Two reasons may explain why arousal depicted some differences. First, the lat pulldown (as the first exercise) depicted the lowest activation score during RT and is the one that presents more pairwise differences. Probably, this could represent a perceptual imprecision of the transitional change from the aerobic activity (positive deactivated quadrant) and

TABLE 3 Descriptive and Kruskal–Wallis analysis of the intensity-traits, FS, FAS, enjoyment, and training volume for the six profiles.

	Light-to-moderate		Moderate-to-vigorous		Vigorous					
	10–14 ($n = 9$)		15–19 ($n = 17$)		20–25 ($n = 17$)					
Preference	*M*	SD	*M*	SD	*M*	SD	χ^2	df	*p*	Pairwise comparisons[a,b]
Preference (5–25)	12.89	1.05	17.47	1.5	22.00	1.77	36.74	2	<0.001	1≠2, 3; 2≠3
Tolerance (5–25)	13.44	2.83	15.76	2.54	19.18	2.77	17.98	2	<0.001	1≠3; 2≠3
FS (-5–5)	2.46	1.27	2.58	1.08	3.35	0.99	4.59	2	0.101	[c]
FAS (1–6)	4.21	0.57	4.43	0.62	4.53	0.41	1.22	2	0.544	[c]
RT FS (-5–5)	2.87	1.78	2.35	1.46	3.32	1.28	3.88	2	0.113	[c]
RT FAS (1–6)	4.52	1.33	5.01	0.72	5.26	0.53	2.05	2	0.495	[c]
Pre enjoyment (8–56)	44.56	7.38	42.29	8.07	44.65	6.88	0.71	2	0.701	[c]
Post enjoyment (8–56)	45.78	5.43	46.24	6.54	46.59	7.32	0.28	2	0.868	[c]
24 h enjoyment (8–56)	43.11	6.58	42.76	8.18	43.18	8.29	0.05	2	0.978	[c]
Training volume (sets × reps × load)	2 566 801	1 079 402	2 451 028	751 891	3 170 621	766 971	8.03	2	0.018	2≠3
	Light-to-moderate		Moderate-to-vigorous		Vigorous					
Tolerance	10–14 ($n = 13$)		15–19 ($n = 22$)		20–25 ($n = 8$)		χ^2	df	*p*	Pairwise comparisons[a,b]
Preference (5–25)	15.69	3.17	18.36	3.33	22.38	2.00	16.13	2	<0.001	1≠3; 2≠3
Tolerance (5–25)	12.54	1.45	17.18	1.26	21.75	1.28	35.38	2	<0.001	1≠2, 3; 2≠3
FS (−5–5)	2.67	1.15	2.79	1.21	3.34	0.81	1.80	2	0.407	[c]
FAS (1–6)	4.23	0.58	4.45	0.52	4.64	0.43	2.52	2	0.284	[c]
RT FS (−5–5)	2.78	1.62	2.63	1.50	3.54	1.18	2.15	2	0.342	[c]
RT FAS (1–6)	4.50	1.14	5.18	0.61	5.35	0.49	4.44	2	0.109	[c]
Pre enjoyment (8–56)	41.54	6.70	44.32	7.91	45.50	6.99	1.93	2	0.381	[c]
Post enjoyment (8–56)	45.31	4.35	46.27	7.23	47.88	7.79	1.49	2	0.475	[c]
24 h enjoyment (8–56)	40.62	6.09	43.91	8.05	44.38	9.30	3.11	2	0.211	[c]
Training volume (sets × reps × load)	2 212 894	439 094	2 835 821	993 972	3 439 193	511 865	8.03	2	0.005	1≠3

Abbreviations: df, degrees of freedom; FAS, Felt arousal scale; FS, Feeling scale; *M*, mean; *n*, sample size; *p*, significance; RT FAS, RT felt arousal scale; RT FS, RT feeling scale; RT, resistance training; SD, standard deviation; χ^2, chi-squared.

[a]Dunn's post hoc.

[b]Bonferroni correction.

[c]No differences detected.

TABLE 4 Friedman test for affective valence and activation in the six resistance exercises in each trait profile.

	Mean rank	Lat pulldown	Back squat	Bar chest press	Deadlift	Dumbbell shoulder press	Leg extension	χ^2	df	*p*	Pairwise comparisons[a,b]
Preference											
Light-to-moderate ($n = 9$)	RT FS	3.94	3.28	3.56	3.50	3.28	3.44	1.01	5	0.963	[c]
	RT FAS	2.28	4.28	4.39	3.33	3.39	3.33	10.37	5	0.065	[c]
Moderate-to-vigorous ($n = 17$)	RT FS	2.94	2.71	1.82	1.94	2.94	1.76	14.45	5	0.013	[c]
	RT FAS	2.21	3.47	3.91	4.15	2.71	4.56	29.23	5	<0.001	1≠6; 5≠1, 4, 6
Vigorous ($n = 17$)	RT FS	4.15	3.59	3.71	3.41	3.47	2.68	8.65	5	0.124	[c]
	RT FAS	4.82	5.35	5.35	5.41	5.18	5.47	14.05	5	0.015	[c]
Tolerance											
Light-to-moderate ($n = 13$)	RT FS	3.00	3.08	1.85	2.46	2.62	2.08	7.12	5	0.212	[c]
	RT FAS	4.38	4.85	5.15	4.92	4.54	4.77	13.91	5	0.016	[c]
Moderate-to-vigorous ($n = 22$)	RT FS	3.18	2.64	2.41	2.64	2.73	2.18	6.81	5	0.236	[c]
	RT FAS	4.73	5.23	5.27	5.36	5.09	5.41	19.30	5	0.002	1≠4
Vigorous ($n = 8$)	RT FS	4.13	3.63	4.25	3.25	3.88	2.13	14.43	5	0.013	[c]
	RT FAS	4.75	5.63	5.50	5.38	5.13	5.75	17.50	5	0.004	[c]

Abbreviations: df, degrees of freedom; *p*, significance; RT FAS, resistance training felt arousal scale; RT FS, resistance training feeling scale; χ^2, chi-squared.

[a]Wilcoxon test.

[b]Bonferroni correction.

[c]No differences detected.

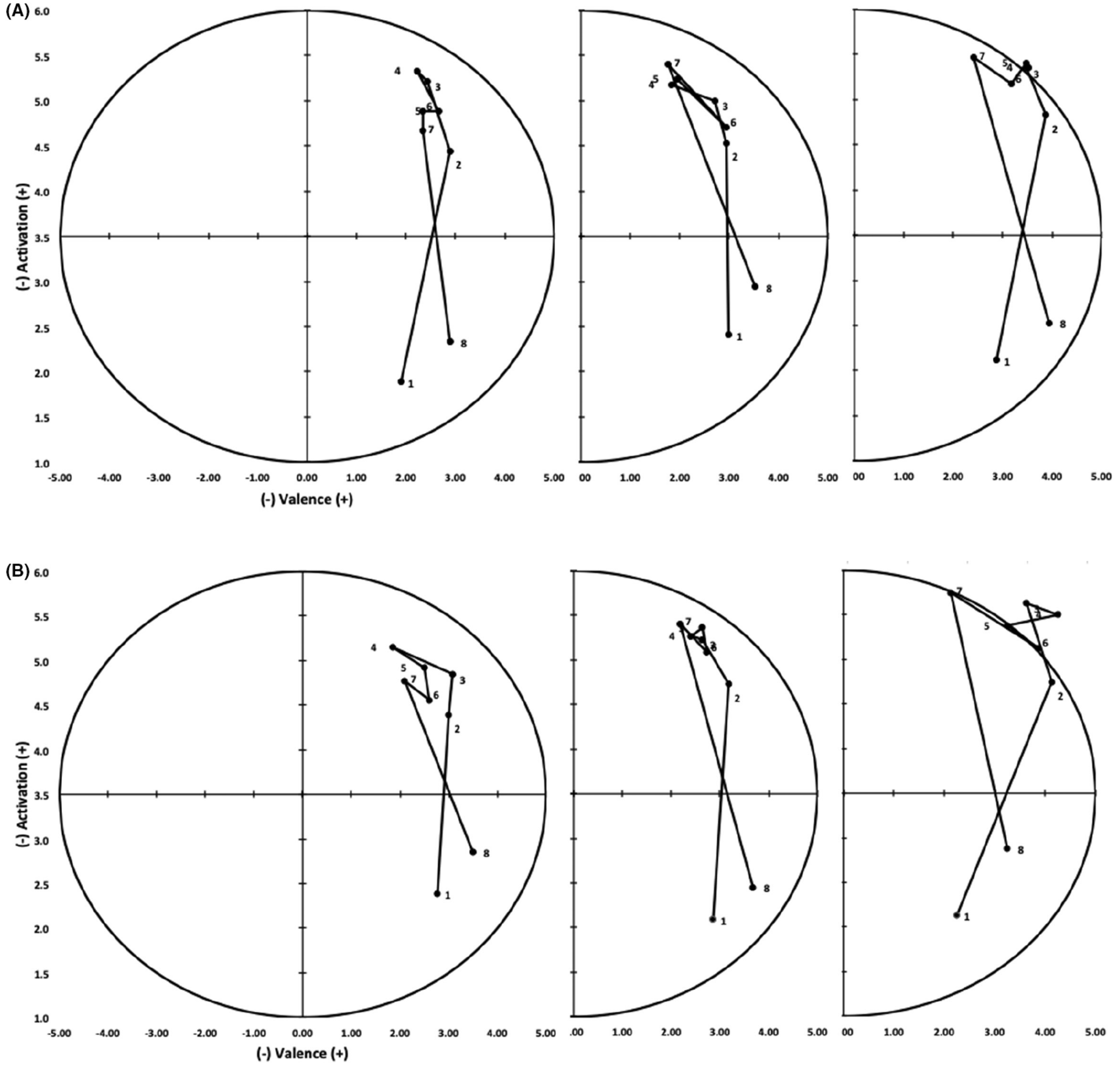

FIGURE 2 (A) Circumplex model by preference groups (from left to right: light- to moderate-intensity, moderate- to-vigorous-intensity, and vigorous-intensity). (B) Circumplex model by tolerance groups (from left to right: light- to moderate-intensity, moderate- to vigorous-intensity, and vigorous-intensity).

this first exercise (positively activated quadrant), given that the remaining RT exercises depicted more homogenous responses. Additionally, Carraro et al.[9] showed in a RT program that exercisers depicted lower activation scores in weight machines when compared to free weight, a variable that this study cannot adequately confirm due to the selected exercises (two exercises in machines vs. four with free weights), but which seems to align with data of Table 2 (global) and particularly Table 4 (profiles). On a second note, regarding affective valence and activation scores during RT, the dumbbell shoulder press also depicted two pairwise comparison differences, which may be related to the fact that, despite being a multi-joint exercise, it is the one with the smallest muscle groups activated during sets. Several studies have hypothesized that smaller muscle groups could depict different affect valence and activation scores when compared to large muscle groups,[9,32,50] but research is not yet clear on that matter. Thus, although some differences emerged between exercises, in general, results tend to suggest that for this protocol, fewer assessments would suffice to capture de affective response during RT.

Regarding the intensity traits profile analysis defined as the second aim of this study, results indicate that no differences emerged in the affective valence and activation scores during RT, and between all assessments of enjoyment (Table 3). Additionally, a comparison between the six RT exercises in each profile presented the same trend of results as those in the global sample (Tables 2 and 4). Once again, activation depicted some pairwise differences relatable with moment one assessment, but only in moderate- to vigorous-intensity in preference/tolerance profiles, thus providing preliminary evidence that for this RT program and method of assessment defined, a lesser number of measures are needed for affective responses understanding. Thus, considering results of the global and profiles samples assessment, and based on other recommendations for affective responses evaluation,[20,34] current results tend to suggest that one assessment would be adequate for a RT like this study protocol. However, given the limited evidence in this mode of practice, and knowing that several close variables can influence the affective response, caution must be made when using different exercises, planning variables (e.g., rest time, cadence), and populations (e.g., beginners, pain disorders), as more measuring moments may be needed for an accurate affective representation of the session/exercises.

Interestingly, as seen in Figure 2A,B (and mean scores in Table 3), the FS/FAS scores plotted depict a transition to a more positively activated position in the respective quadrant (vertically to higher arousal and horizontally to feeling good). Although the results of per trait profiles comparisons depicted non-significant results, it is important to consider that it is in the combined effect of the FS and FAS that a closer look to core affect can be made. The trend in mean scores configured in the circumplex model does suggest that exercisers showing higher preference or tolerance experience a better affective response. This has already been partially explored in a high-intensity exercise protocol, where exercisers with higher preference showed a more pleasant response than a lower-intensity preference group, even when the perceptions for exertion were similar.[29] Additionally, some studies have reported that small differences in affective valence and activation scores may be relevant to explain the lower levels of physical activity of some people, and that a difference of one unit on the FS may impact considerably the amount of future quantity of physical activity.[13,51] This may suggest that for low fitness individuals (or novice/beginners), intensity profiling and affective response assessments may be even more relevant to adequately promote a pleasurable feeling while exercising. Thus, core affective responses change as depicted across intensity traits profiles should be considered relevant for exercise prescription that aims to target positive affective experiences.

4.1 | Limitations and future directions

Although this quasi-experimental study brings novelty and addresses a relevant gap in hedonic assumptions for exercise promotion, some limitations must be reported. First, sample size, their characteristics, and study protocol must be considered when trying to extrapolate for other similar situations. As stated previously, several factors may influence affective response during exercise. This study aligns with several others that have been trying to better understand a method for adequate assessment of these questions in this exercise mode, but several confounding variables (e.g., experience; exercise selection; age) may still emerge that warrant caution when interpreting the results. However, and grounded in current evidence, some directions now seem clearer (e.g., timing for assessment; applicant and exerciser previous training for FS/FAS interpretation and application) and should be a concern by researchers that aim to advance this field of study.

The intensity traits now explored have received some attention in recent years but are still lacking experimental research and evidence, as for methodological orientations, particularly for leisure physical activity purposes. In the present study, preference and tolerance were treated independently, but recent evidence[23] proposes the creation of profiles that can encompass a different conceptualization than those proposed here (e.g., high preference – low tolerance; high preference – high tolerance; traits agreement). For this purpose, advancements must be made to test experimentally and with larger samples some of these possible traits combinations, as preliminary evidence does suggest their relevant role in exercise behavior.[21]

5 | PERSPECTIVE

For exercise adherence, professionals should also focus on developing positive affective responses. In the exercise domain, that purpose can be achieved through an individual approach to exercise intensity prescription and supervision, thus aligning with current behavioral frameworks and strategies. Additionally, this approach can help to expand the predictive value of several other theoretical models, thus targeting contemporary methods for the understanding of human behavior.[14] Particularly relevant is the ease of application and respective exercise counseling/prescription adjustments that can emerge from the present study instruments. These target relevant gaps for the professional's practice and address a commonly used expression of physical exercise (i.e., resistance exercise), thus allowing their use in a very large sample of recreational exercisers.

6 | CONCLUSION

Concluding, the present study showed that in a RT session developed to approach concentric failure, the FS and FAS applied immediately after the final set in each RT exercise represents a feasible and ecologically valid approach to tap core affect. Results presented evidence that recreationally trained exercisers enrolled in a common RT program would need a minimum of one measurement to assess the affective response of the session. Finally, results also suggest that exercisers with distinct profiles of preference or tolerance depict a differentiated pattern for affective valence and activation responses, possibly justifying a distinct approach when aiming to promote affective regulation.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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