

LEONOR SERRANO GONÇALVES HENRIQUES

**EXPLORING AFFECTIVE RESPONSES IN STRETCHING
EXERCISES**

Orientador: Professor Doutor Diogo dos Santos Teixeira

**Universidade Lusófona – Centro Universitário de Lisboa
Faculdade de Educação Física e Desporto
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Presidente: Prof.^a Doutora Eliana Cristina Veiga Carraça;

Arguente: Prof. Doutor António João Labisa da Silva Palmeira;

Orientador: Prof. Doutor Diogo dos Santos Teixeira

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Resumo Geral

Objetivo. O objetivo desta dissertação de mestrado consistiu em analisar as respostas afetivas em exercícios de alongamentos. Primeiramente, foi conduzida uma revisão sistemática da literatura (RSL) para explorar 1) a utilidade e viabilidade de *core affect* avaliado com a Feeling Scale (FS) e/ou Felt Arousal Scale (FAS); 2) o momento de aplicação das escalas; e 3) a sua aplicação e interpretação contextual. Em segundo lugar, foi realizado um estudo quasi-experimental para 1) comparar as respostas afetivas durante e imediatamente após exercícios de alongamentos em adultos aparentemente saudáveis, de forma a detetar a existência de um *affective rebound* e compreender o momento adequado para uma avaliação; 2) verificar a confiabilidade e a concordância das respostas afetivas através de um teste re-teste realizado com uma semana de intervalo.

Método. Para a RSL, uma pesquisa foi realizada entre janeiro e fevereiro de 2022 nas bases de dados PubMed, SportDISCUS, PsycINFO. Os estudos incluíram a FS e a FAS aplicada a atividades de alongamento, em adultos aparentemente saudáveis. A pesquisa dos artigos foi baseada no modelo PICO, de acordo com as recomendações do PRISMA. Um total de 141 títulos foram identificados e 12 estudos foram incluídos na revisão. Foi também realizado um estudo quasi-experimental com uma amostra de 34 participantes, experientes em exercício físico (32.8 ± 8.6 anos). As respostas afetivas foram medidas durante e imediatamente após 5 exercícios de alongamento estático. Os exercícios foram realizados em 3 intensidades diferentes: leve, moderada e vigorosa, respetivamente. Foi realizada uma ANCOVA de medidas repetidas, onde o sexo foi utilizado como co-variável. Para garantir a fiabilidade e a concordância, foi testado um coeficiente de correlação intraclass (ICC) de dois fatores de concordância absoluta e gráficos de Bland-Altman.

Resultados. A RSL demonstrou que ambas as escalas parecem ser viáveis de utilizar em exercícios com alongamentos, apesar de limitações associadas ao momento de medição, que limitam a interpretação do *core affect*. O segundo estudo demonstrou um *affective rebound* em todas as intensidades, particularmente notório na intensidade vigorosa, sugerindo que o *core affect* deve ser avaliado durante o exercício de alongamento. Em geral, a repetibilidade entre dias para as medidas de FS e FAS foi boa em todos os grupos musculares alongados. Os ICCs tenderam a ser superiores nas medições realizadas durante o alongamento em intensidade vigorosa.

Conclusão. A RSL demonstrou que a avaliação do *core affect* em atividades relacionadas ao alongamento carece de suporte metodológico, e que os resultados não puderam ser

interpretados adequadamente devido à heterogeneidade dos protocolos dos estudos incluídos. Os resultados do estudo quasi-experimental apresentaram evidências de que uma avaliação adequada deve ser realizada durante o alongamento, e que ambas as escalas representam uma abordagem viável e ecologicamente válida para medir o *core affect*. Concluindo, os resultados corroboram a confiabilidade dessas escalas psicométricas e dos métodos utilizados, sugerindo novas orientações quanto à aplicação das escalas durante os exercícios de alongamento.

Palavras-chave. *Core affect*, alongamento, feeling scale, felt arousal scale, exercício.

Abstract

Purpose. The purpose of the present study was to analyse the affective responses in stretching related activities. First, a systematic literature review (SLR) was conducted to explore 1) the utility and feasibility of core affect measured with FS and/or FAS; 2) the timing of application of these scales; and 3) its contextual applicability and interpretability. Secondly, a quasi-experimental study was conducted to 1) compare affective responses during and immediately after stretching exercises in apparently healthy adults, to detect a possible affective rebound and better understand the adequate timing for assessment; 2) to verify the reliability and agreement of the affective responses assessment through a test-retest performed 1 week apart.

Method. A search was conducted from January to February 2022 in the PubMed databases, SportDISCUS, PsycINFO. The studies included the feeling scale and the felt arousal scale applied to stretching activities in apparently healthy adults. The search for the articles was based on the PICO model according to the PRISMA recommendations. 141 titles were identified, and 12 relevant studies were included in the review. A quasi-experimental study was carried out with a sample of 34 trained participants (32.8 ± 8.6 years). Affective responses were performed during and immediately after 5 static stretching exercises. The exercises were performed at 3 different intensities: light, moderate, and vigorous, respectively. Repeated measures ANCOVA was performed, where sex was used as covariate. To ensure reliability and agreement, a two-way mixed effects absolute agreement Intraclass Correlation Coefficient (ICC) and Bland-Altman plots were developed.

Results. The SLR showed that both scales seem to be feasible to use in stretching exercises, despite limitations associated with the measurement timing, which limits the interpretation of core affect. In the second study, an affective rebound was observed in all intensities, suggesting that core affect should be assessed during the stretching exercise. In general, the inter-day repeatability for FS and FAS measurements was good across the stretched muscle groups. ICCs tended to be higher in measurements performed during the stretch at vigorous intensity.

Conclusion. The SLR demonstrated that the evaluation of core affect in stretching-related activities lacked methodological support, and the results of core affect could not be properly interpreted due to the heterogeneity of the study protocols. The results of the study performed presented evidence that measurements should be made during the stretch for an adequate assessment. The FS and FAS applied *during* the execution of a static stretch represent a feasible

and ecologically valid approach to measure core affect. Concluding, the results support the reliability of these psychometric scales and methods used, suggesting new guidelines regarding the application of the scales during the stretching exercises.

Keywords. Core affect, stretching, feeling scale, felt arousal scale, exercise.

Abbreviations and Acronyms

FS – Feeling Scale

FAS – Felt Arousal Scale

ICC – Intraclass Correlation Coefficient

LOA – Limits of Agreement

PA – Physical Activity

RCT – Randomized Controlled Trial

RSL – Revisão Sistemática da Literatura

SLR – Systematic Literature Review

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General Introduction

Physical inactivity impact in overall health

There is robust evidence that physical activity (PA) can reduce the risk of developing physical and psychological diseases (Arem et al., 2015; McKinney et al., 2016), and that people who are not sufficiently active have an increased risk of death from 20% to 30% compared to active people. This brings negative impacts on the economic, health and environment systems, as well as on the community well-being and quality of life (World Health Organization, 2020). Also, more than 80% of adolescents are not sufficiently active and the levels of inactivity increase as countries develop economically (World Health Organization, 2020). This number has been increasing during the last years, bringing severe health consequences - up to 5 million deaths per year could be averted if the global population was more active. To explain motivational aspects associated to exercise adherence, various social-cognitive psychological frameworks have been used. However, these frameworks, which are primarily based on cognitivist assumptions, often account for less than 25% of the diversity in PA behavior (Ekkekakis & Dafermos, 2012; Ekkekakis & Zenko, 2016; Rodrigues et al., 2021) leaving them short of the assistance required to combat this problem. The interest in understanding behavioral change in an individual and in a population has grown in recent years (Tuso, 2014). It is imperative to determine which variables influence the personal decision to begin and to maintain continued access to PA on a regular basis, so that public health initiatives aimed at promoting PA strategies can be met with success.

The hedonic theory

To create the most effective interventions to improve compliance with PA recommendations, exercise psychology researchers have been integrating hedonic constructs into existing models of behavior change (Evmenenko & Teixeira, 2020). The hedonic principle suggests that individuals choose to participate in pleasant behaviors (that lead to positive affective responses), and avoid those that are unpleasant (Higgins, 1997). A systematic review of 24 studies (Rhodes & Kates, 2015), demonstrated that affective responses to bouts of exercise are good correlates and reliable predictors of future PA engagement in the small to medium effect range, although this is not an universal finding (Unick et al., 2015). This suggests that affective responses, especially those during exercise, may be key constructs in behavior-change strategies for effective PA promotion (Chen et al., 2020; Rhodes & Kates, 2015).

Affective valence and perceived activation in exercise

Two of the most used measurements to assess basic valence affect and activation responses (e.g., pleasure vs. displeasure; calmness vs. tension) are the Feeling Scale (FS) (Hardy & Rejeski, 1989) and the Felt Arousal Scale (FAS) (Svebak & Murgatroyd, 1985) (Evmenenko & Teixeira, 2020).

When using the FS and FAS together repeatedly during an exercise session, it is feasible to plot the trajectory of the affective response in the two-dimensional "circumplex model" of affect (Ekkekakis et al., 2013; Ekkekakis et al., 2011). This model adds clear and specific theoretical postulates and provides a more secure foundation for measurement (Ekkekakis & Petruzzello, 2002). As shown in figure 1, the affective space is divided into four quadrants:

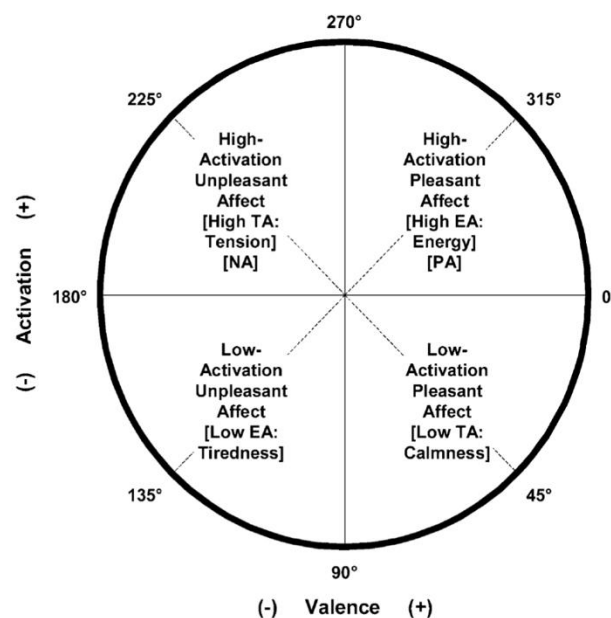


Figure 1 - The circumplex model of affect. Adapted from Ekkekakis and Petruzzello (2002).

TA: tense arousal; EA: energetic arousal; PA: positive activation; NA: negative activation.

Both scales can provide a snapshot of the nature and magnitude of affective changes that occur in response to various exercise stimuli across the entire affective domain (Ekkekakis & Petruzzello, 2002), helping exercise professionals create individualized behavioral-based exercise prescriptions by tracing affective responses to exercise across modalities and intensities. Thus, it is without surprise that the ACSM suggested measuring affective valence during cardiorespiratory and resistance exercise (ACSM, 2010) to facilitate regular exercise behavior, allowing one individual to choose a pleasant intensity and providing a pleasant experience (Evmenenko & Teixeira, 2020). According to research indications (Carraro et al., 2018; Cavarretta et al., 2018; Cavarretta et al., 2019; Decker & Ekkekakis, 2017; Ladwig et

al., 2017) measurements during exercise should be positioned mainly on the “high activation, pleasant affect” and “low activation, pleasant affect” quadrants of the circumplex model, so that the chosen intensities facilitate pleasure promotion, thought to lead to a regular and sustained exercise behavior. However, affective responses vary with exercise intensity, timing and training modality (Ekkekakis et al., 2011). An imposed exercise intensity can reduce perceived autonomy and control (Vazou-Ekkekakis & Ekkekakis, 2009), leading to reduced adherence, while an affect-regulated exercise approach can lead to a more pleasurable exercise experience and, consequently, more autonomy, control, and adherence. Previous findings suggest that both sedentary and active individuals can use affect to regulate their exercise intensity during aerobic exercise (Hamlyn-Williams et al., 2015; Parfitt, Alrumh, et al., 2012; Parfitt, Blisset, et al., 2012; Rose & Parfitt, 2008), and that self-selecting the intensity based on affect meets the recommendations for improving health and fitness (ACSM, 2021; Garber et al., 2011).

Affective responses may also vary with the moment of affect measurements. Timing matters when assessing the dynamics of affect during PA (Backhouse et al., 2007; Ekkekakis et al., 2005a; Ekkekakis et al., 2005b; Rose & Parfitt, 2007) as affective responses *following* exercise are less predictive of future behaviour than *during* exercise (Williams et al., 2008). However, this may vary with exercise modality. In resistance training, measuring affect *immediately after* the set does not differ from *during* the exercise, and it may be easier and safer to implement (i.e., security; ecological validity) (Stevens et al., 2020). This was demonstrated in a recent study by Andrade et al. (2022), where 33 experienced male exercisers (36.42 ± 7.72 years) completed FS and FAS at different time points (intra-set, post-set, and recall), at 3 different repetition maximum (%RM) (2x 15-17 repetitions at 60% RM; 3x 8-10 repetitions at 75% RM; 4x 5-6 at 90% RM), in 2 exercises (bench press and squat), and, generally, no differences emerged between different assessment time points and %RM. These findings suggest that in resistance training an "affective rebound" phenomenon may not even exist, and support the use of FS/FAS administered immediately after a set as a sufficient assessment to represent the trajectory of the affective response in resistance exercise, over a wide range of %RM and exercises (Andrade et al., 2022). Nonetheless, the affective rebound phenomenon was demonstrated in aerobic exercise (Ekkekakis et al., 2011). Moderate-intensity exercise (in some individuals) and high-intensity exercise (in almost all individuals) can cause a decrease in pleasure during an exercise bout, followed by a rapid and robust rebound during the first few seconds or minutes after the bout is concluded (Bixby et al., 2001; Hall et al., 2002; Landuyt et al., 2000; Parfitt et al., 2006). One such example is the study by

Schneider et al. (2009), who studied affective responses during 2 sessions of 30 min on a cycle ergometer (low and high intensity) in 124 participants. Both intensities led to post-exercise improvements, and when pre- and post-exercise responses were compared between the two intensities, they were not significantly different (both intensities led to post-exercise improvements), only the response trajectories during the bouts were significantly different. The intensity below the ventilatory threshold led to an increase in pleasure during exercise, while the intensity at the ventilatory threshold led to a significant decrease (M. Schneider et al., 2009).

Beyond aerobic and resistance training: the popularity of stretching activities

Recently, Evmenenko & Teixeira (2020) systematically reviewed 14 aerobic training studies, 5 resistance training studies, and 6 mixed activities studies in which FS and FAS scales were used and plotted to the circumplex model. One of the major limitations highlighted by the authors was that only a limited number of exercise modalities had been studied so far. Due to the different exercise protocols (e.g., group activities) and the variety of fitness modalities, a better understanding of the evidence in the use and usefulness of the FS and FAS scales in a broad range of modalities is relevant (Evmenenko & Teixeira, 2020). The popularity of stretching activities (e.g., Yoga, Pilates, Tai-Chi) have been growing globally, and different studies demonstrate their physical and psychological benefits in healthy population and in individuals with specific disorders (Campos et al., 2016). The level of flexibility is directly related to the quality of life (Farinatti, 2000), where minimal range of movement is needed to execute daily activities, and working within the limits of low resistance to movement, as they do not produce early fatigue (Dantas, 2008). Importantly, stretching-related interventions were shown to have good adherence patterns in previous trials (Chao et al., 2014; Yeh et al., 2009). DiaGiacomo and colleagues (2010), who analyzed the reasons for adherence with Tai Chi, found that experiencing the exercise as accessible and engaging and the low risk of low-moderate intensity were considered important aspects (DiGiacomo et al., 2010).

However, the dynamics of pleasure/displeasure has been studied mainly in aerobic and resistance training. Therefore, there is a need to explore and better understand the application of both scales in stretching exercises.

The importance of reliability in the use of affect scales to regulate exercise intensity - the case for stretching activities

Anyone who takes or uses measurements should have some understanding of measurement error. The reliability of the test refers to the reproducibility of the observed value when the measurement is repeated. These errors have a major impact on our attempts to

measure changes between repeated measurements (Hopkins, 2000). This is particularly important when the individual perception of pleasure differ between those individuals who experience a positive affective response from exercise, and those who do not (Arent et al., 2005; Bibeau et al., 2010; Ekkekakis et al., 2011). Acknowledging this variability is crucial and the belief that most individuals find exercise pleasant was one of the reasons that delayed the research of the affect-adherence relationship. The key was the shift from examining only pre- to post-exercise changes, to tracking the trajectory of affective change during and after the exercise bout (Ekkekakis et al., 2011). Therefore, it is important to examine both pre- to post-exercise changes as well as changes in affect during an exercise bout (Backhouse et al., 2007; K. L. Schneider et al., 2009; Unick et al., 2012).

The affective responses are also not uniform to the same repeated exercise stimulus. The perception of exercise is an active process, one where internal (e.g., ventilation, muscular strain) and external (e.g., environment, distractions) factors can interact to influence how one feels (Rejeski, 1985). The affective responses to exercise may become more positive over time as a participant becomes more familiar with the exercise stimulus, so we may want to assess affect at multiple time points or use that as a composite measure to predict future health behaviors, for instance. Conversely, participants may become bored with repetition of the exercise protocol, which could lead to negative shifts in affective response (Zajonc, 2001).

The reliability in affective response to *acute exercise* has been only scarcely examined. Landuyt et al. (2000) examined inter-individual variability in affective responses to moderate-intensity cycle ergometer exercise in 82 university students aged 19.9 ± 1.4 years and found a striking disparity when comparing group averages and individual affective responses *during* exercise measured at 5- minute intervals (Landuyt et al., 2000). Unick et al. (2015) examined the reliability in the affective responses to 3 treadmill exercise sessions of 30-min in duration, in 28 overweight/obese women. The authors found that all affective measures exhibited less than optimal agreement on the change from pre-exercise to post-exercise within an individual over the 3 sessions (ICCs=0.02-0.60), even after controlling for variations in heart rate. Only FS exhibited ‘good’ consistency when controlling for pre-exercise values (ICC=0.72). However, the mean FS score during exercise was highly consistent within an individual (ICC=0.83) (Unick et al., 2015). Overall, this suggests that individual affective responses must be considered in formulating conceptual models of exercise-affect relationship and deriving public health PA recommendations, and that it may not be as important for future research to investigate who experiences positive or negative changes in affect, but rather an additional focus of research should be on understanding which circumstances may facilitate

pleasurable versus unpleasurable exercise experiences within an individual (Unick et al., 2015). Elsangedy et al. (2018) took a different approach and evaluated the feasibility and reliability of the FS to self-regulate resistance training intensity. The authors found that the interclass correlation coefficient for the 4 experimental sessions ranged from 0.73 to 0.99 for %1RM and 0.77 to 0.99 for the weight lifted, with a coefficient of variation of approximately 7%, 4%, 2%, and 2% for FS descriptors of +5, +3, +1 and -1, respectively (Elsangedy et al., 2018). Again, the reliability in the affective response to acute exercise comes from a very limited number of exercise modalities, leaving uncovered a plethora of stretching activities that are highly popular, but are extremely challenging to objectively manipulate intensity. Usually, the perception of effort is given by numerical classification and/or verbal expressions, although each participant experiences a unique perception. Curiously, experimenters often resort to descriptive terms to convey the sensation, what the intensity should feel like during the stretching exercise (Jacobs & Sciascia, 2011), which aligns with entities of reference, like the ACSM, where it is recommended “holding a single flexibility exercise for 10–30 seconds to the point of tightness or slight discomfort” (ACSM, 2021). Thus, it is important to examine affective responses across different stretching exercises, whether these vary among muscle groups or with the stretching intensity, and whether they exhibit temporal stability. This would also allow to test the use of affect responses as a powerful tool to monitor the intensity of the stretching exercise.

This dissertation is organized into two chapters. The first chapter comprises the systematic review, aiming to analyse 1) the utility and feasibility of core affect in stretching-related activities, 2) the timing of application, and 3) its contextual applicability and interpretability. The second chapter contains a quasi-experimental study aiming to 1) compare affective responses during and immediately after stretching exercises in apparently healthy adults, to detect a possible affective rebound and better understand the adequate timing for assessment, and 2) to verify the reliability and agreement of the affective responses assessment.

Chapter 1 – Affective Valence and Activation in Stretching Activities: A Systematic Review*

* Manuscript currently in revision on an international peer review journal

Abstract

Affective responses have been considered a key determinant for exercise adherence. However, they have been mainly studied in aerobic and resistance exercises. Considering the importance of the affective assessment in stretching exercises, the aim of this review is to explore 1) the utility and feasibility of core affect measured with the feeling scale and/or felt arousal scale in stretching-related activities; 2) the timing of application of these scales; and 3) its contextual applicability and interpretability.

This systematic review was conducted through a search on PubMed, SPORTDiscus and PsycINFO, adding studies retrieved manually and following PRISMA guidelines. A total of 12 empirical studies published between 2003 and 2021 were analysed (n = 718).

Results seem to suggest that both scales seem to be feasible to use in stretching exercises, and in the most common contexts of practice, but core affect results cannot be properly interpreted due to studies protocols heterogeneity and absence of baseline guidelines for an adequate assessment. In sum, results indicate that core affect assessment in stretching-related activities lacks methodological support. Future studies should be designed to understand how, when, and how many times affective responses should be assessed during stretching activities to allow additional insights into its usefulness or feasibility.

Keywords: Core affect, stretching, feeling scale, felt arousal scale, exercise.

1. Introduction

There is irrefutable evidence of the effectiveness of regular PA in the primary and secondary prevention of several chronic diseases (e.g., cardiovascular disease, diabetes, cancer, hypertension, obesity, osteoporosis, depression, and anxiety) and premature death (Warburton et al., 2006; Warburton & Bredin, 2017). Still, 36.2% of adults in Europe aged 18 and over were not active enough in 2017 (Nikitara et al., 2021). This means they do not meet the global recommendations of at least 150 minutes of moderate-intensity, or 75 minutes vigorous-intensity PA per week, and if current trends continue, the 2025 global PA target (a 10% relative reduction in insufficient PA) will not be met (Guthold et al., 2018). Therefore, understanding how to successfully increase PA levels needs to be prioritized.

Several psychological frameworks in exercise psychology have been put forth to understand sustainable PA behaviours, including the social cognitive theory (Bandura, 1998), the theory of planned behaviour (Ajzen, 1991), and the transtheoretical model of behaviour change (Prochaska & Velicer, 1997), just to name a few. However, these have been criticized due to their heavy emphasis on cognitive and reasoned determination of behaviour, overlooking or rejecting the contribution of non-rational processes to decision making (Ekkekakis & Zenko, 2016; Rebar et al., 2016). Thus, during the last decade, affect, an umbrella term that reflects general valenced experiential responses (i.e., core/basic affect), emotions, and mood (Ekkekakis & Petruzzello, 2000), is increasingly represented as a central aspect of behaviour maintenance/change grounded on hedonic assumptions. It has been explored either as a reflective (e.g., affective judgments, like enjoyment) or automatic (e.g., affective association) process in several dual-process theoretical approaches related to exercise and/or health-related behaviours. These include the Affective-Reflective Theory (Brand & Ekkekakis, 2018) (ART), the Physical Activity Adoption and Maintenance model (Strobach et al., 2020) (PAAM), the Affective and Health Behaviour Framework (Williams & Evans, 2014) (AHBF), and the Theory of Effort Minimization in Physical Activity (Cheval & Boisgontier, 2021) (TEMPA), as examples. Particularly in the AHBF, the affective response (immediate affective response, e.g., during running; post-behaviour affective response, e.g., immediately after a workout) is considered a key determinant of a health behaviour. This affective response can be understood as core affect (i.e., an elementary non-reflective feeling consciously available), and has demonstrated a relevant predictive value for exercise adherence (Rhodes & Kates, 2015; Rodrigues et al., 2020; Williams, 2008). However, exercise prescription guidelines emitted by international entities fail to describe how to assess the individual affective states, judgments,

or associations, or how to adjust the exercises or session to promote a better affective response (e.g., ACSM).

Basic affective responses to exercise have been commonly assessed by the Feeling Scale (Hardy & Rejeski, 1989) and the Felt Arousal Scale (Svebak & Murgatroyd, 1985), depicting the affective valence (perceived pleasure/displeasure) and arousal (perceived activation), respectively, in an easy and reliable way (Evmenenko & Teixeira, 2020). Importantly, responses can be plotted to the circumplex model (Ekkekakis et al., 2011; Russell, 1980), enabling the tracing of affective responses to exercise in, for example, different exercise modalities, emerging as a powerful tool for exercise professionals to refine their prescriptions. However, affective responses to exercise have been mainly studied in aerobic and resistance exercise (Cavarretta et al., 2019; Evmenenko & Teixeira, 2020), with only scarce attempts performed in stretching activities (e.g., yoga, tai-chi, pilates), which have been gaining popularity worldwide (Thompson, 2022; Yeh et al., 2009; Yeh et al., 2008). This is important, not only because stretching activities have long been used in many physical exercise activities to increase range of motion around a joint (Opplert & Babault, 2018; Riebe et al., 2018), but also because they are usually employed and integrated in the warm-up or recovery stages, or even as the main component of several group fitness classes. Stretching exercises are directly related to improvements in self-rated sleep quality (Smith et al., 2007; Telles et al., 2012; Yoshihara et al., 2014), flexibility and dynamic balance, muscular endurance (Cruz-Ferreira et al., 2011), and cardiorespiratory fitness (Fernández-Rodríguez et al., 2019), and have shown improvements in self-esteem, health-related quality of life, and mood (Smith et al., 2007; Telles et al., 2012; Yoshihara et al., 2014), and reductions in perceived stress, anxiety, depression (Wang et al., 2010), and pain (Miyamoto et al., 2013). Stretching activities are considered to be secure, accessible, and engaging (DiGiacomo et al., 2010), likely contributing to promote good adherence rates in several activities (Chao et al., 2014; Yeh et al., 2009).

Bearing this in mind, understanding how to promote perceived pleasurable experiences in stretching activities is important, given that it may allow a better adjustment of the activities and expected outcomes, and support exercise engagement and adherence. For that, analysing known challenges regarding the use of the FS and FAS such as 1) the utility and feasibility of core affect in stretching-related activities, 2) the timing of application, and (3) its contextual applicability and interpretability, stand out as relevant and address a current gap of knowledge on the topic.

1.1 Method

The present review was written following the recommendations suggested by the PRISMA protocol (Page et al., 2021), and registered in PROSPERO with the number 42022329331.

1.1.1. Inclusion/exclusion criteria

The following inclusion criteria were adopted: (1) experimental and non-experimental studies; (2) written in English; (3) based on the feeling scale and felt arousal scale applied to PA settings both individually or in groups classes; (4) strictly with stretching activities isolated or as components of a class/activity; (5) sampling individuals of any age (young adults, adults, older adults); and (6) focusing on apparently healthy individuals. Exclusion criteria were as follows: (1) populations with mental health issues; (2) populations with cancer, diabetes, hypertension, cardiovascular disease, or diseases likely to alter the perception of pain or with chronic pain; (3) instrument validation studies; (4) grey literature; (5) systematic reviews. Level I study screening included a review of all titles and abstracts to check those against eligibility criteria. Full-text publications of any studies not eliminated at Level I were retrieved for complete review at Level II screening, which involved reading the full-text publication to determine that all eligibility criteria were met, and no exclusion criteria were applicable.

1.1.2. Research strategy

A wide search of scientific papers was conducted from January 2022, till February 2022, on the following databases: PubMed (host: MEDLINE): last search run February 2022, SportDISCUS (host: EBSCO) and PsycINFO (host: EBSCO), last search run February 2022. The search was carried out using the following entries: “physical activity”, “physical exercise”, “feeling scale”, “felt arousal scale”, “flexibility”, “stretching”. These keywords were searched for separately and in various combinations with the use of conjunctions such as “AND” and “OR” organized according to the PICOS strategy. Bibliographic references from related studies and other sources were also examined to include studies that potentially met the inclusion criteria (last search conducted in February 2022).

1.1.3. Data collection and data items

For general characterization (Table 1), the following main characteristics of the studies were extracted: (1) bibliographic information (authors, year of publication, country of research), (2) study design; (3) sample size; (4) sample characteristics; (5) FS/ FAS measures; (6) analysis; (7) outcomes.

1.1.4. Study risk of bias assessment

Methodological quality of the studies was assessed using Effective Public Health Practice Project (Thomas et al., 2004). This quality assessment tool for quantitative studies is adjusted for experimental and non-experimental studies. This instrument comprises 22 questions assessing the quality of a study according to the following dimensions: bias, study design, confounders, blinding, data collection methods, withdrawals and drop-outs, intervention integrity and analyses. The evaluation was made by two independent reviewers. The reviewers' results, when in disagreement, were compared, and the discrepancies were resolved by an external reviewer. All reviewers were debriefed and trained prior to the use of the quality checklist. Cohen's inter-rater agreement presented an almost perfect agreement ($k = .806$; (McHugh, 2012)).

1.2. Results

1.2.1. Study selection

During database search (see Figure 2), a total of 141 titles were identified. By analysing bibliographical references from other sources, 2 other potentially relevant studies were added. 3 records were excluded after the deduplication process. 140 records were screened, with 94 having been excluded for different motives after reading the titles of the papers. 46 papers had a careful read-through of the abstract, and after the screening, the selection was reduced to 27 papers. 19 papers were assessed for full text review and 7 studies were excluded as they did not analyse affective responses in stretching activities, making the total sample of 12 papers that underwent a thorough analysis.

These studies have been published or accepted for publication until February 2022. Table 1 and Table 2 represent a synthesis of the data extracted from the selected studies. The list is organized alphabetically by the main author's name.

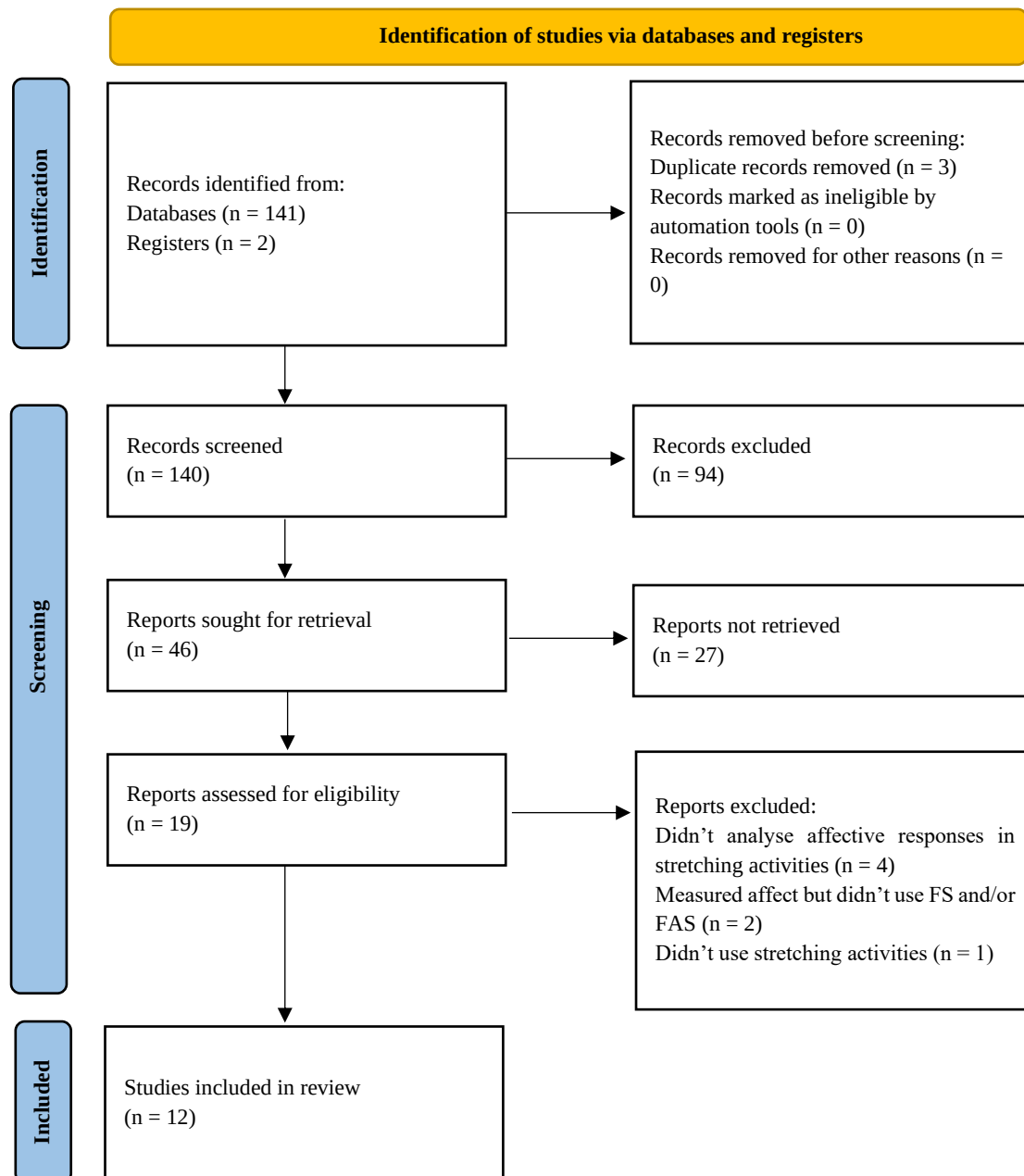


Figure 2 - Studies Chart Flow

Table 1 - General descriptive characteristics of the studies and main outcomes.

Author(s)	Location	Design	Size (%F)	Features (Age M±SD)	Intervention	Measures	Analysis	Outcomes	Quality
Barbosa et al., (2018)	Brazil	RCT	n=45 (0)	Control group (CG): (21.27±2.8) . Static stretching group (SSG): (23.07±3.5) . Dynamic stretching group (DSG): (21.47±3.0)	CG: no intervention. SSG: 3x 30" sets of hamstring self-stretching for each limb, mild discomfort; DSG: dynamic hip flexion with knee extension 3x 30" sets for each limb.	FS post-exercise.	Chi-squared test	Chi-squared test showed no statistically significant association between experimental groups and sensation during stretching.	Moderate
Beltrão et al., (2020)	Brazil	RCT	n=14 (0)	Untrained men (21.53±2.52)	Hamstrings stretch: 3x 60" with 30" rest intervals. 3x/ week, for 12 weeks. Low-intensity group (LIG): intensity between 1 and 2 of Verbal Numerical Scale. High- intensity group (HIG): intensity between 9 and 10 of Verbal Numerical Scale.	FS pre-intervention, 6 weeks, and 12 weeks.	Mann–Whitney U test. Friedman test.	The Mann–Whitney U test for affective responses showed no significant differences between the groups at preintervention, intermediate and final assessments. The Friedman test showed no differences in affective responses between moments for both LIG and HIG.	Strong
Chao et al., (2014)	Brazil	Quasi-experimental	n=16 (100)	Experienced practitioners (61.2±8.8)	Tai-Chi 3x/week for 7 weeks.	FS at 15', 30', and 45' assessed in each session (21 sessions).	Friedman test with Dunn's post hoc test.	There was a significant difference between responses at 15' and 30'; and between responses at 15' and 45'. There was no difference in responses between 30' and 45' min.	Weak
Edwards et al., (2018)	United States & Canada	Parallel group, randomized control experimental	n=63 (?)	Walking group (WG) (n = 21): (21.24±2.17); meditation group (MG) (n = 21): (21.29±2.10); stretching group (SG) (n = 21): (21.52±1.75)	SG: 10' of guided stretching. 10 upper and lower extremity stretches, each stretch was performed twice, for 20–30"; WG: 10' brisk walking; MG: 10' guided mindfulness meditation.	FS & FAS pre, during, post-exercise.	3 × 2 ANOVAs	SG and WG increased FS scores significantly. WG increased arousal significantly.	Weak
Follador et al., (2019)	Brazil	Ex post facto research design, that is,	n=70 (100)	Experienced practitioners.	60min classes 2x/week. 5' of warm-up exercises; 50' of specific techniques (Tai-chi, yoga, or	FS & FAS at baseline, 15', 30', 45', 60'.	ANOVA; Shapiro–Wilk test; Kruskal–Wallis test, followed by the Mann–	Affective responses were similar between groups. However, tai-chi results for mean arousal were significantly different	Weak

		a static group comparison		Tai-chi group (TCG) (68.65±8.04); Yoga group (YG) (70.04±6.65); Stretching group (SG) (69.47±5.50)	stretching); and 5' cooldown exercise.		Whitney post hoc test with a Bonferroni correction. Cohen's d	compared to the yoga and stretching groups.	
Lee et al., (2021)	South Korea	Quasi-experimental	n=16 (75)	University students (21.2±2.4)	2 Zumba sessions (low and moderate intensity; 45'): 10' warm-up, 30' Zumba program, 5' cooldown.	FS & FAS (pre-exercise, warm-up, and cooldown) using tailor-made applications on a smartwatch.	two-way repeated measures ANOVA. Pearson correlation coefficient between HR and feeling, and between HR and arousal for each exercise section.	FS revealed a significant interaction effect of exercise intensity and section. Post hoc tests indicated that in the low- intensity condition, pre-exercise FS scores were significantly lower than the FS scores measured during exercise and cooldown. However, no differences in FS were observed among the exercise sections. In the moderate-intensity condition, the FS scores of all the exercise sections were significantly higher than that of pre-exercise. The FS scores of reggaeton, cumbia, and cooldown were higher than those of the pre-exercise and warm-up, with no differences across sections.	Weak
McAuley et al., (2003b)	USA	RCT	n=174 (72)	Older, unfit, and overweight (65.5±5.35)	6-month (3xweek) of either: walking classes (WG) (n=85) (50-55% VO2peak) gradually increasing to (65% VO2peak);	FS following each exercise session (daily). FS post-	Latent growth curve analyses.	The average of the FS responses was higher in the STG than in the WG.	Moderate

					stretching & toning classes (STG) for 60' (n=89) (intensity undetermined)	exercise responses were averaged over the final (6 th) month		2	sized effect of exercise frequency on exercise affect was nonsignificant,	
McAuley et al., (2003a)	USA	Prospective study	n=174(71,8)	(65.5±5.35)	6-month exercise program + 18-month follow-up	FS following each exercise session (daily). FS post-exercise responses were averaged over the final (6 th) month	A (condition) by 2 (sex) repeated measures ANOVA.		Greater social support within the exercise setting was associated with more positive affective responses during the exercise program. The relationship between social support and affect was found to be significant.	Moderate
Melo et al., (2021)	Brazil	RCT	n=41(0)	No stretching (NS) (23.8±4.1); Comfort level stretching (CLS) (24.7±4.8); Mild discomfort level stretching (MDLS) (24.7±4.8); Pain level stretching (PLS) (22.8±2.1)	NS (n=10); CLS (n=11); MDLS (n=10); PLS n=10). 10 sessions of 3x 30'' sets of passive static stretching 3x/week.	FS post-exercise (48 h after the 10 th session)	One-way ANOVA was carried out to compare intergroup sensation of affective valence		Affective valence showed similar and higher positive responses for the PLS and MDLS compared to the CLS group after the static stretching protocol.	Strong
Reed et al., (2014)	USA	Quasi-experimental	n=45 Experimental group was 70% female and 30% male, and the control group was 50% male and	Experimental group: (28.55±10.91); Control group: (28.27±7.7)	Control group (CG): 50' yoga 2x week for 15 weeks. Experimental (placebo) (EG): 50' yoga 2x week for 15 weeks, with bracelet during class for 6 weeks (weeks 2 to 7)	FAS baseline (during pre-relaxation in week 1 & 2), acute placebo (Affect was measured during final relaxation in week 2), 6-week placebo (week 7), acute no-placebo (week 8), and 6-	2 x 5 (group x placebo phase) repeated measures ANOVA	Neither group reported significant FAS changes.	Weak	

			fema le,			week no- placebo (week 13).				
Sullivan et al., (2019)	USA	Quasi- experi- mental	n=33 (100)	(21±2)	3 sessions: stretch yoga (SYG) 1- hour; power yoga (PYG) 1-hour; and control (CG) 1-hour educational movie.	FS and FAS were administe red at 3 time points for each session: pre, during, post- session.	Repeated Measures General Linear Model (RM GLM)	There was a significant main effect for condition time as well as a significant condition × time interaction effect. The univariate tests revealed that the condition effect was present for both the FS.	Strong	
Vandoni et al., (2016)	Italy	Quasi- experi- mental	n=27 (37)	Men (22.5±2.0); Women (23.3±2.2)	2 group exercise training sessions at moderate and vigorous intensities.	FS & FAS immediat ely after the warm- up and immediat ely after the cooldown .	Repeated measures analysis of variance (ANOVA)	FS: a more positive affective response occurred during the moderate-intensity trial than during the vigorous-intensity trial. The changes in affective responses to exercise differed as a function of the exercise intensity trial. FAS: the changes in perceived activation during the exercise sessions were similar for the two exercise intensity trials. FAS increased (compared with 0-min values) at 15 min and 30 min, but not at 45 min and cooldown, for the two exercise intensity trials.	Strong	

1.2.2. Study characteristics

Table 1 and Table 2 summarizes the descriptive data collected from the 12 papers analysed. Most of the studies included convenience samples of active people, although occasionally sedentary or physically inactive individuals were also sampled (Beltrão et al., 2020; McAuley et al., 2003a; McAuley et al., 2003b). Edwards et al. (2018) did not provide information regarding the characteristics of the individuals. Participants met the inclusion criteria set, allowing for a wider coverage of possible PA contexts, and using the Feeling Scale and/or Felt Arousal Scale in stretching exercises. Collectively, the sample of this review consists of 718 apparently healthy exercisers. In general, exercise was performed in different settings (recreational PA, laboratory setting), different modes of exercise (yoga, tai-chi, stretching, conditioning, dancing, individual stretching exercises and group classes), and between different age groups (young adults, adults, older adults).

Table 2 - Summary of Samples' Characteristics.

Characteristics	Studies	Population (n = 718)
SAMPLE SIZE		
<30	4	73
30–50	4	164
50–100	2	133
>100	2	348
SEX		
Female only	3	119
Male only	3	100
Mixed genders	6	499
LOCATION		
North America	5	
South America	5	
Europe	1	
Asia	1	
MEAN AGE (YEARS)		
<25	7	239
25–64	2	61
≥65	2	418

1.2.3. Risk of bias in studies

Methodological quality of the studies was assessed using Effective Public Health Practice Project (Thomas et al., 2004). Score ranges were given corresponding quality levels: strong (4 studies); moderate (3 studies); weak (5 studies). Quality classification is presented in Table 1.

1.2.5. Results of individual studies

Exercise mode

Three studies included individual stretching exercises (Barbosa et al., 2018; Beltrão et al., 2020; Melo et al., 2021), and the rest (n=7) had stretching performed in group classes: yoga (Follador et al., 2019; Reed, 2014; Sullivan et al., 2019), tai-chi (Chao et al., 2014; Follador et al., 2019), and guided stretching classes (Edwards et al., 2018; McAuley et al., 2003b). Two studies included mainly aerobic exercise (Lee et al., 2021; Vandoni et al., 2016), and therefore only the session moments where stretching exercise was assessed (e.g., pre-exercise, warm-up, and cooldown) were used.

In the stretching classes/exercises, different approaches and types of contraction (i.e., static, dynamic, passive, active) were used: Follador et al. (2019) used 16 static stretching exercises in both the upper and lower extremities; Melo et al. (2021) included static passive stretching for the hamstring muscles; Beltrão et al. (2020) used static passive stretching exercise for the hamstrings; and Barbosa et al. (2018) divided the groups according to static or dynamic hamstring stretches. In other studies, the type of stretch was not described (Beltrão et al., 2020; Edwards et al., 2018; Lee et al., 2021; McAuley et al., 2003b; Vandoni et al., 2016).

Type of study

From all studies included in this review, only one was not an experimental study (McAuley et al., 2003a). This study was an 18-month follow-up of McAuley et al. (2003b). Five studies were randomized controlled trials (Barbosa et al., 2018; Beltrão et al., 2020; Edwards et al., 2018; McAuley et al., 2003b; Melo et al., 2021), six studies quasi-experimental (Chao et al., 2014; Follador et al., 2019; Lee et al., 2021; Reed, 2014; Sullivan et al., 2019; Vandoni et al., 2016). In those where a control/comparison group was included, groups were either divided by exercise mode (Barbosa et al., 2018; Edwards et al., 2018; Follador et al., 2019; McAuley et al., 2003a; McAuley et al., 2003b) or intensity (Beltrão et al., 2020; Melo et al., 2021). Reed (2014), had two conditions (placebo vs. no-placebo) performing the same activity (introductory Hatha yoga).

FS/FAS measurement procedures

Instructions and prior training of the participants on the use of FS/FAS were only described in four studies (Beltrão et al., 2020; Chao et al., 2014; Follador et al., 2019; Vandoni et al., 2016). Measurement timings differed across studies; five studies applied affective measurements only following exercise (Barbosa et al., 2018; Beltrão et al., 2020; McAuley et al., 2003a; McAuley et al., 2003b; Melo et al., 2021), and the remaining seven studies evaluated

the affective responses at baseline, during (the session, not during the stretch position), and post-session (Beltrão et al., 2020; Chao et al., 2014; Edwards et al., 2018; Follador et al., 2019; Lee et al., 2021; Reed, 2014; Sullivan et al., 2019; Vandoni et al., 2016). No apparent standardization regarding the moment or number of measurements in each protocol/session was detected.

Intensity Control

Intensity varied from light to moderate, and seven studies used different instruments to control intensity. Three studies objectively monitored intensity through heart rate: Lee et al. (2021) used a smartwatch; Edwards et al. (2018) and Vandoni et al. (2016) used a heart rate monitor throughout the exercise sessions. Six studies subjectively measured intensity: perceived exertion ratings (Borg, 1982) were used in four studies (Chao et al., 2014; Edwards et al., 2018; Follador et al., 2019; Vandoni et al., 2016); Melo et al. (2021) used the scale of perceived effort in flexibility (PERFLEX) (Dantas, 2008); and Beltrão et al. (2020) used the Verbal Numerical Scale (Ferreira-Valente et al., 2011). Barbosa et al. (2018) did not measure intensity, but asked subjects to perform the stretching exercises until a mild discomfort sensation was felt. Sullivan et al. (2019) designed the two yoga sessions differently, so that the power yoga session had a higher intensity and faster pace than the stretch yoga session. Three studies did not present data for intensity in their protocols (McAuley et al., 2003a; McAuley et al., 2003b; Reed, 2014).

Transitional affective states plotted on the circumplex model

Follador et al. (2019), Lee et al. (2021), Sullivan et al. (2019), and Vandoni et al. (2016) used both scales (FS and FAS) and plotted the affective responses to the circumplex model. The four studies registered scores in two quadrants: the low-activation pleasure (e.g., calmness, relaxation) and the high-activation pleasure (e.g., energy, vigor). Follador et al. (2019) had three intervention groups performing tai-chi, yoga, or stretching, and affective valence and arousal moved from the low-activation pleasure quadrant (baseline), to the high-activation pleasure quadrant. Lee et al. (2021) asked all participants to perform two Zumba sessions (low intensity and moderate intensity). Warm-up responses occurred in the low-activation pleasure quadrant for both intensities. Cooldown measures remained in the low-activation pleasure quadrant for the light intensity and rose to the high-activation pleasure quadrant for the moderate intensity session. Sullivan et al. (2019) performed three interventions with the same group of individuals (power yoga, stretch yoga and control). Stretch yoga and control sessions showed results only in the low-activation pleasure quadrant in all session moments (warm-up,

fundamental stage, cooldown). The power yoga session also had baseline and post-session responses in the low-activation pleasure quadrant, but measures during the fundamental stage occurred in the high-activation pleasure quadrant. In the study by Vandoni et al. (2016) the participants performed two group exercise sessions (moderate or vigorous intensity), but only the warm-up and cooldown measures were considered for this review. Warm-up affective responses were registered in the low-activation pleasure quadrant for both groups. Although the moderate intensity group kept the same results in the cooldown measures as in the warm-up, the vigorous intensity group increased to the high-activation pleasure quadrant.

1.3. Discussion

The purpose of this systematic review was to assess whether affective responses measured with FS and FAS in stretching activities are useful, feasible, reflect any methodological and procedural standardization, and applicable within a PA ecological context. There is enough literature at present to make basic recommendations for future research. Twelve studies met the review criteria, and their quality assessment classified four studies as weak, three as moderate, and five as strong. Overall, no issues related to the use and comprehensibility (by the exercisers) of FS and FAS were reported. Regarding the core affect assessment, the included studies did not depict an apparent standardization regarding the assessment moment (when to apply throughout the session), frequency (how many times), and timing (immediately after, sometime after or during the stretch position). Given the heterogeneity of the studies' protocols, several limitations emerge in the comprehension of affect in this mode of practice. Additionally, an apparent disregard of the conditions needed to effectively assess core affect (e.g., timing), highlights the need for future efforts in methodological guidelines and procedures development, which will allow a correct measure, interpretation, and use of the pleasure/displeasure responses in these activities.

As stated in literature, timing matters when assessing affect during aerobic and resistance exercise (Andrade et al., 2022; Cavarretta et al., 2019; Ekkekakis et al., 2011). According to the AHBF, the way one feels during behaviour is markedly different and often has an opposite valence to how one feels after the behaviour. Indeed, while there is great variation in how individuals respond affectively during PA (Ladwig et al., 2017), post-PA affect is known to improve almost universally. This phenomenon is known as the “affective rebound effect” (Cavarretta et al., 2019; Ekkekakis et al., 2005b; Ekkekakis et al., 2011) and has been reported in resistance training (Cavarretta et al., 2019; Emanuel et al., 2021), and particularly in aerobic exercise, where a high percentage (more than 95%) of participants

experience a positive affective response immediately after the cessation of exercise (Ekkekakis et al., 2011). It is also believed that this should be the case in stretching activities due to the discomfort caused by the intrinsic characteristics of the exercises (i.e., muscle under stretch), but no study or methodological consideration was found that addresses this issue. This gap in affect measure does not allow us to properly evaluate some of the study results nor give a more structured guidance to research efforts. For example, some of the included studies reported only post-exercise session measurements, while others, have measured during the session/segment of the stretching activity (but none while the muscle is stretched); in other cases, assessments were made prior and after the exercise session, thus excluding the affective panorama interpretation throughout the session, and other combinations of assessment moments and timings have emerged that may bias the results understanding. This poses a concern in the affective response to exercise assessment and interpretation, given that core affect can only be experienced *in vivo*, or in close proximity to the activity (Stevens et al., 2020; Zenko et al., 2016). Importantly, affect recall (i.e., affect assessment through the memory of previous feelings, and thus subjected to cognitive appraisal) does not reflect core affect emanated from exercise, thus precluding the in-session pleasure reading, stated in literature as a relevant predictor of PA intention and behaviour (Rhodes & Kates, 2015). Given the absence of methodological standardization in core affect assessment and the apparent heterogeneity of the approaches to this purpose, finding the best moment to assess the pleasure/displeasure responses in stretching activities should be a focus of interest in future studies.

Another relevant aspect concerns the frequency/number of assessments. The FS and FAS should be used at regular intervals, balancing the accurate representation of affect during the session (or segments of the sessions; or some specific exercise modes) without the burden of excessive assessments (Zenko & Ladwig, 2021), but allowing an accurate reading of the affective response. When in need, these series of results can be plotted in the circumplex model of affect, thus allowing a deeper understanding of the affective response fluctuations across the session/activities. This was carried out in four studies, and, in general, affective responses showed scores in the low-activation pleasant quadrant and the high-activation pleasant quadrant. The intensities in these cases were set to light or moderate intensity and were measured in distinct moments of the session (e.g., warm-up; cooldown) and timings (e.g., after, but not immediately after the stretch), which as mentioned previously, raises concerns regarding the core affect quality assessment.

In this line of thought, the balance of assessments may vary with the exercise mode, duration, intensity, among others. However, the reviewed studies presented a high

heterogeneity in the number of assessments, which ranged from one (Barbosa et al., 2018; McAuley et al., 2003a; McAuley et al., 2003b; Melo et al., 2021) to seven (Lee et al., 2021) during exercise sessions. Although the number of assessments can be set differently given each study aim and needs, overall, discrepancies in the number of assessments performed challenges comparison between studies and raises concerns on possible interpretation of the affective response. This problem may increase given that the protocols used in the included studies depicted stretching exercises on a wide variety of exercise settings, including individual stretches, group classes, warm-up, and cooldown sections. Also, various types of contraction (e.g., static, dynamic, passive, active) were used. With this in mind, methodological guidelines that may allow an adjusted number of assessments when aiming to understand the affective response in distinct stretching-related activities are another relevant topic in need of further exploration.

On another relevant note, no issues were reported regarding the use and comprehensibility of FS/FAS, which may point to its feasibility of application in this activity and usual exercise contexts (e.g., health club activities), aligning with what has been previously suggested in a related review in PA settings (Evmenenko & Teixeira, 2020). However, the correct application and understanding of the scales is an important aspect to consider. Duda (1998), Evmenenko & Teixeira (2020), and Zenko & Jones (2021) recommended researchers and participants to have prior training to achieve consistent application results. In the included studies, four studies reported some previous training of the participants (Beltrão et al., 2020; Chao et al., 2014; Lee et al., 2021; Vandoni et al., 2016), but no study reported training of the researchers. Given the specificity of both scales, as in general for all perceptual scales (Haile et al., 2015), prior training of their use and interpretation must be made for the professional and exerciser, thus ensuring the quality of the assessments. This may be particularly relevant in studies where other scales are used in proximity (e.g., RPE), thus precluding the participant to confuse, for example, effort with activation/arousal.

Overall, the evidence derived from studies on affective responses to stretching exercises partially supports the feasibility of the application of FS and FAS in real-life settings (e.g., gyms, studios, group classes), although caution is needed when interpreting the meaning and precision of the affective response.

1.3.1. Limitations

Although this review addresses a relevant and understudied aspect of affect assessment, some considerations should be made for adequate interpretation of results and

future efforts on the topic. These generally relate to the low number of studies that addressed this topic and the high heterogeneity of methods, activities, and intensities, which limits the interpretation and generalization of the results of this review. In fact, the lacking empirical evidence supporting how and when to assess core affect during stretching activities may explain the heterogeneity of the methods applied, and simply express an attempt by researchers to explore this topic. For example, no study was found that explored the affective rebound for this mode of practice, which should be reasonably expected to be present, and will probably reflect that the execution is less pleasant (or even unpleasant) when compared to the post-stretch. So, at this point, this review results cannot ascertain several aspects of the intended objective but highlight priorities for future research and efforts on the topic.

1.4 Conclusion

In conclusion, the results of the present review indicate that the assessment of core affect in stretching-related activities lack methodological support. The FS and FAS appear to be useful and feasible in this exercise mode and in the most common contexts of practice, but core affect results cannot be properly interpreted due to studies protocols heterogeneity and absence of baseline guidelines for an adequate assessment. Future studies should be designed to understand how, when, and how many times affective responses should be assessed during stretching activities to allow additional insight into its usefulness or feasibility.

1.5 References

- ACSM. (2010). *ACSM's guidelines for exercise testing and prescription* (8th ed.). Lippincott Williams & Wilkins.
- ACSM. (2021). *ACSM's guidelines for exercise testing and prescription*. (11th ed.). Lippincott Williams & Wilkins.
- Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes*, 50(2), 179-211.
- Andrade, A. J., Ekkekakis, P., Evmenenko, A., Monteiro, D., Rodrigues, F., Cid, L., & Teixeira, D. S. (2022, 2022/09/01/). Affective responses to resistance exercise: Toward a consensus on the timing of assessments. *Psychology of Sport and Exercise*, 62, 102223. <https://doi.org/https://doi.org/10.1016/j.psychsport.2022.102223>
- Arem, H., Moore, S. C., Patel, A., Hartge, P., Berrington de Gonzalez, A., Visvanathan, K., Campbell, P. T., Freedman, M., Weiderpass, E., Adami, H. O., Linet, M. S., Lee, I. M., & Matthews, C. E. (2015, Jun). Leisure time physical activity and mortality: a detailed pooled analysis of the dose-response relationship. *JAMA Intern Med*, 175(6), 959-967. <https://doi.org/10.1001/jamainternmed.2015.0533>
- Arent, S. M., Landers, D. M., Matt, K. S., & Etnier, J. L. (2005). Dose-response and mechanistic issues in the resistance training and affect relationship. *Journal of Sport and Exercise Psychology*, 27(1), 92-110.
- Backhouse, S. H., Ekkekakis, P., Bidle, S. J., Foskett, A., & Williams, C. (2007, Aug). Exercise makes people feel better but people are inactive: paradox or artifact? *J Sport Exerc Psychol*, 29(4), 498-517. <https://doi.org/10.1123/jsep.29.4.498>
- Bandura, A. (1998, 1998/07/01). Health promotion from the perspective of social cognitive theory. *Psychology & Health*, 13(4), 623-649. <https://doi.org/10.1080/08870449808407422>
- Barbosa, G. M., Figueirêdo Dantas, G. A., Silva, B. R., Souza, T. O., & Brito Vieira, W. H. (2018, 2018/10/01/). Static or dynamic stretching program does not change the acute responses of neuromuscular and functional performance in healthy subjects: a single-blind randomized controlled trial. *Revista Brasileira de Ciências do Esporte*, 40(4), 418-426. <https://doi.org/https://doi.org/10.1016/j.rbce.2018.06.002>
- Beltrão, N. B., Ximenes Santos, C., de Oliveira, V. M. A., Pirauá, A. L. T., Behm, D., Pitangui, A. C. R., & de Araújo, R. C. (2020, Sep 01). Effects of a 12-Week Chronic Stretch Training Program at Different Intensities on Joint and Muscle Mechanical Responses: A Randomized Clinical Trial. *J Sport Rehabil*, 29(7), 904-912. <https://doi.org/10.1123/jsr.2018-0443>
- Bibeu, W. S., Moore, J. B., Mitchell, N. G., Vargas-Tonsing, T., & Bartholomew, J. B. (2010). Effects of acute resistance training of different intensities and rest periods on anxiety and affect. *The Journal of Strength & Conditioning Research*, 24(8), 2184-2191.

- Bixby, W. R., Spalding, T. W., & Hatfield, B. D. (2001). Temporal dynamics and dimensional specificity of the affective response to exercise of varying intensity: differing pathways to a common outcome. *Journal of Sport and Exercise Psychology*, 23(3), 171-190.
- Borg, G. A. (1982). Psychophysical bases of perceived exertion. *Medicine & Science in Sports & Exercise*, 14(5), 377-381.
- Brand, R., & Ekkekakis, P. (2018). Affective-reflective theory of physical inactivity and exercise. *German Journal of Exercise and Sport Research*, 48(1), 48-58.
- Campos, R. R., Dias, J. M., Pereira, L. M., Obara, K., Barreto, M. S., Silva, M. F., Mazuquin, B. F., Christofaro, D. G., Fernandes, R. A., Iversen, M. D., & Cardoso, J. R. (2016, 2016 Jul-Aug). Effect of the Pilates method on physical conditioning of healthy subjects: a systematic review and meta-analysis. *J Sports Med Phys Fitness*, 56(7-8), 864-873. <https://www.ncbi.nlm.nih.gov/pubmed/26004043>
- Carraro, A., Paoli, A., & Gobbi, E. (2018, 2018/08/01). Affective response to acute resistance exercise: a comparison among machines and free weights. *Sport Sciences for Health*, 14(2), 283-288. <https://doi.org/10.1007/s11332-018-0427-4>
- Cavarretta, D., Hall, E., & Bixby, W. (2018, 06/08). The acute effects of resistance exercise on affect, anxiety, and mood – practical implications for designing resistance training programs. *International Review of Sport and Exercise Psychology*, 12. <https://doi.org/10.1080/1750984X.2018.1474941>
- Cavarretta, D. J., Hall, E. E., & Bixby, W. R. (2019). Affective Responses From Different Modalities of Resistance Exercise: Timing Matters! *Front Sports Act Living*, 1, 5. <https://doi.org/10.3389/fspor.2019.00005>
- Chao, C. H., Costa, E. C., Okano, A. H., De Brito Farias, T., Farias, L. F., Elsangedy, H. M., & Krinski, K. (2014, Jun). Rating of perceived exertion and affective responses during Tai Chi Chuan. *Percept Mot Skills*, 118(3), 926-939. <https://doi.org/10.2466/10.06.PMS.118k27w5>
- Chen, C., Finne, E., Kopp, A., & Jekauc, D. (2020). Can Positive Affective Variables Mediate Intervention Effects on Physical Activity? A Systematic Review and Meta-Analysis. *Frontiers in psychology*, 11, 587757-587757. <https://doi.org/10.3389/fpsyg.2020.587757>
- Cheval, B., & Boisgontier, M. P. (2021). The theory of effort minimization in physical activity. *Exercise and Sport Sciences Reviews*, 49(3), 168.
- Cruz-Ferreira, A., Fernandes, J., Laranjo, L., Bernardo, L. M., & Silva, A. (2011, Dec). A systematic review of the effects of pilates method of exercise in healthy people. *Arch Phys Med Rehabil*, 92(12), 2071-2081. <https://doi.org/10.1016/j.apmr.2011.06.018>
- Dantas, E. (2008, 09/20). Scale of perceived exertion in the flexibility (PERFLEX): a dimensionless tool to evaluate the intensity? *Fitness & Performance Journal*, 7, 289-294. <https://doi.org/10.3900/fpj.7.5.289.e>

- Decker, E. S., & Ekkekakis, P. (2017, 2017/01/01/). More efficient, perhaps, but at what price? Pleasure and enjoyment responses to high-intensity interval exercise in low-active women with obesity. *Psychology of Sport and Exercise*, 28, 1-10. <https://doi.org/https://doi.org/10.1016/j.psychsport.2016.09.005>
- DiGiacomo, M., Lam, P., Roberts, B. L., Lau, T. C., Song, R., & Davidson, P. M. (2010, Dec). Exploring the reasons for adherence to t'ai chi practice. *J Altern Complement Med*, 16(12), 1245-1246. <https://doi.org/10.1089/acm.2010.0510>
- Duda, J. (1998). *Advances in sport and exercise psychology measurement*. Fitness Information Technology.
- Edwards, M. K., Rhodes, R. E., Mann, J. R., & Loprinzi, P. D. (2018, 03 15). Effects of acute aerobic exercise or meditation on emotional regulation. *Physiol Behav*, 186, 16-24. <https://doi.org/10.1016/j.physbeh.2017.12.037>
- Ekkekakis, P., & Dafermos, M. (2012, 01/01). Exercise Is a Many-Splendored Thing, but for Some It Does Not Feel So Splendid: Staging a Resurgence of Hedonistic Ideas in the Quest to Understand Exercise Behavior. *The Oxford handbook of exercise psychology*, 295-333. <https://doi.org/10.1093/oxfordhb/9780195394313.013.0016>
- Ekkekakis, P., Hall, E., & Petruzzello, S. (2005a, 01 Sep. 2005). Some like It Vigorous: Measuring Individual Differences in the Preference for and Tolerance of Exercise Intensity. *Journal of Sport and Exercise Psychology*, 27(3), 350-374. <https://doi.org/10.1123/jsep.27.3.350>
- Ekkekakis, P., Hall, E. E., & Petruzzello, S. J. (2005b, May). Variation and homogeneity in affective responses to physical activity of varying intensities: an alternative perspective on dose-response based on evolutionary considerations. *J Sports Sci*, 23(5), 477-500. <https://doi.org/10.1080/02640410400021492>
- Ekkekakis, P., Hargreaves, E. A., & Parfitt, G. (2013, 2013/09/01/). Invited Guest Editorial: Envisioning the next fifty years of research on the exercise–affect relationship. *Psychology of Sport and Exercise*, 14(5), 751-758. <https://doi.org/https://doi.org/10.1016/j.psychsport.2013.04.007>
- Ekkekakis, P., Parfitt, G., & Petruzzello, S. J. (2011, Aug). The pleasure and displeasure people feel when they exercise at different intensities: decennial update and progress towards a tripartite rationale for exercise intensity prescription. *Sports Med*, 41(8), 641-671. <https://doi.org/10.2165/11590680-000000000-00000>
- Ekkekakis, P., & Petruzzello, S. J. (2000, 2000/10/01/). Analysis of the affect measurement conundrum in exercise psychology: I. Fundamental issues. *Psychology of Sport and Exercise*, 1(2), 71-88. [https://doi.org/https://doi.org/10.1016/S1469-0292\(00\)00010-8](https://doi.org/https://doi.org/10.1016/S1469-0292(00)00010-8)
- Ekkekakis, P., & Petruzzello, S. J. (2002, 2002/01/01/). Analysis of the affect measurement conundrum in exercise psychology: IV. A conceptual case for the affect circumplex. *Psychology of Sport and Exercise*, 3(1), 35-63. [https://doi.org/https://doi.org/10.1016/S1469-0292\(01\)00028-0](https://doi.org/https://doi.org/10.1016/S1469-0292(01)00028-0)

- Ekkekakis, P., & Zenko, Z. (2016). Chapter 18 - Escape From Cognitivism: Exercise as Hedonic Experience. In M. Raab, P. Wylleman, R. Seiler, A.-M. Elbe, & A. Hatzigeorgiadis (Eds.), *Sport and Exercise Psychology Research* (pp. 389-414). Academic Press. <https://doi.org/https://doi.org/10.1016/B978-0-12-803634-1.00018-2>
- Elsangedy, H. M., Machado, D. G. D. S., Krinski, K., Duarte DO Nascimento, P. H., DE Amorim Oliveira, G. T., Santos, T. M., Hargreaves, E. A., & Parfitt, G. (2018, 07). Let the Pleasure Guide Your Resistance Training Intensity. *Med Sci Sports Exerc*, 50(7), 1472-1479. <https://doi.org/10.1249/MSS.0000000000001573>
- Emanuel, A., Rozen Smukas, I., & Halperin, I. (2021, 01 01). How One Feels During Resistance Exercises: A Repetition-by-Repetition Analysis Across Exercises and Loads. *Int J Sports Physiol Perform*, 16(1), 135-144. <https://doi.org/10.1123/ijsp.2019-0733>
- Evmenenko, A., & Teixeira, D. S. (2020). The circumplex model of affect in physical activity contexts: a systematic review. *International Journal of Sport and Exercise Psychology*, 1-34. <https://doi.org/10.1080/1612197X.2020.1854818>
- Farinatti, P. d. T. V. (2000). Flexibilidade e esporte: uma revisão da literatura. *Rev Paul Educ Fís*, 14(1), 85-96.
- Fernández-Rodríguez, R., Álvarez-Bueno, C., Ferri-Morales, A., Torres-Costoso, A. I., Cavero-Redondo, I., & Martínez-Vizcaíno, V. (2019, Oct 23). Pilates Method Improves Cardiorespiratory Fitness: A Systematic Review and Meta-Analysis. *J Clin Med*, 8(11). <https://doi.org/10.3390/jcm8111761>
- Ferreira-Valente, M. A., Pais-Ribeiro, J. L., & Jensen, M. P. (2011, Oct). Validity of four pain intensity rating scales. *Pain*, 152(10), 2399-2404. <https://doi.org/10.1016/j.pain.2011.07.005>
- Follador, L., Alves, R. C., Ferreira, S. D. S., Silva, A. C., & Silva, S. G. D. (2019, Apr). Perceived Exertion and Affect From Tai Chi, Yoga, and Stretching Classes for Elderly Women. *Percept Mot Skills*, 126(2), 223-240. <https://doi.org/10.1177/0031512518823661>
- Garber, C., Blissmer, B., Deschenes, M., Franklin, B., Lamonte, M., Lee, I. M., Nieman, D., & Swain, D. (2011, 07/01). Quantity and Quality of Exercise for Developing and Maintaining Cardiorespiratory, Musculoskeletal, and Neuromotor Fitness in Apparently Healthy Adults: Guidance for Prescribing Exercise. *Medicine and science in sports and exercise*, 43, 1334-1359. <https://doi.org/10.1249/MSS.0b013e318213fefb>
- Guthold, R., Stevens, G. A., Riley, L. M., & Bull, F. C. (2018, 10). Worldwide trends in insufficient physical activity from 2001 to 2016: a pooled analysis of 358 population-based surveys with 1.9 million participants. *Lancet Glob Health*, 6(10), e1077-e1086. [https://doi.org/10.1016/S2214-109X\(18\)30357-7](https://doi.org/10.1016/S2214-109X(18)30357-7)
- Haile, L., Gallagher Jr, M., & Robertson, R. J. (2015). *Perceived exertion laboratory manual: From standard practice to contemporary application* [doi:10.1007/978-1-4939-1917-8]. Springer Science + Business Media. <https://doi.org/10.1007/978-1-4939-1917-8>

- Hall, E. E., Ekkekakis, P., & Petruzzello, S. J. (2002). The affective beneficence of vigorous exercise revisited. *British journal of health psychology*, 7(1), 47-66.
- Hamlyn-Williams, C. C., Tempest, G., Coombs, S., & Parfitt, G. (2015). Can previously sedentary females use the feeling scale to regulate exercise intensity in a gym environment? an observational study. *BMC Sports Sci Med Rehabil*, 7, 30. <https://doi.org/10.1186/s13102-015-0023-8>
- Hardy, C. J., & Rejeski, W. J. (1989). Not what, but how one feels: The measurement of affect during exercise. *Journal of Sport and Exercise Psychology*, 11(3), 304 – 317. <https://doi.org/https://doi.org/10.1123/jsep.11.3.304>
- Higgins, E. T. (1997, Dec). Beyond pleasure and pain. *Am Psychol*, 52(12), 1280-1300. <https://doi.org/10.1037//0003-066x.52.12.1280>
- Hopkins, W. G. (2000, Jul). Measures of reliability in sports medicine and science. *Sports Med*, 30(1), 1-15. <https://doi.org/10.2165/00007256-200030010-00001>
- Jacobs, C. A., & Sciascia, A. D. (2011). Factors that influence the efficacy of stretching programs for patients with hypomobility. *Sports health*, 3(6), 520-523.
- Ladwig, M. A., Hartman, M. E., & Ekkekakis, P. (2017). AFFECT-BASED EXERCISE PRESCRIPTION: An Idea Whose Time Has Come? *ACSM's Health & Fitness Journal*, 21(5). https://journals.lww.com/acsm-healthfitness/Fulltext/2017/09000/AFFECT_BASED_EXERCISE_PRESCRIPTION_An_Idea_Whose.6.aspx
- Landuyt, L., Ekkekakis, P., Hall, E., & Petruzzello, S. (2000, 09/01). Throwing the Mountains into the Lakes: On the Perils of Nomothetic Conceptions of the Exercise-Affect Relationship. *Journal of Sport and Exercise Psychology*, 22, 208-234. <https://doi.org/10.1123/jsep.22.3.208>
- Lee, J., Park, J., Kim, Y., & Woo, M. (2021, Oct). Affective Change With Variations in Zumba Fitness Intensity as Measured by a Smartwatch. *Percept Mot Skills*, 128(5), 2255-2278. <https://doi.org/10.1177/00315125211022700>
- McAuley, E., Jerome, G. J., Elavsky, S., Marquez, D. X., & Ramsey, S. N. (2003a, 2003/08/01/). Predicting long-term maintenance of physical activity in older adults. *Preventive Medicine*, 37(2), 110-118. [https://doi.org/https://doi.org/10.1016/S0091-7435\(03\)00089-6](https://doi.org/https://doi.org/10.1016/S0091-7435(03)00089-6)
- McAuley, E., Jerome, G. J., Marquez, D. X., Elavsky, S., & Blissmer, B. (2003b). Exercise self-efficacy in older adults: social, affective, and behavioral influences. *Ann Behav Med*, 25(1), 1-7. https://doi.org/10.1207/S15324796ABM2501_01
- McHugh, M. L. (2012). Interrater reliability: the kappa statistic. *Biochemia medica*, 22(3), 276-282. <https://pubmed.ncbi.nlm.nih.gov/23092060>
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3900052/>

- McKinney, J., Lithwick, D. J., Morrison, B. N., Nazzari, H., Isserow, S. H., H., B., & Krahn, A. D. (2016). The health benefits of physical activity and cardiorespiratory fitness. *British Columbia Medical Journal*, 58(3), 131–137.
- Melo, R. R. V., Cerqueira, M. S., Barbosa, G. M., Laurentino, A. L. B. A., Franca, I. M., Souza, T. O., & Brito Vieira, W. H. (2021). Static Stretching at Pain-Tolerated Intensity Is Not Necessary to Increase Knee Range of Motion in Amateur Soccer Players: a Randomized Trial. *Muscles, Ligaments and Tendons Journal* <https://doi.org/10.32098/mltj.03.2021.19>
- Miyamoto, G. C., Costa, L. O., & Cabral, C. M. (2013, 2013 Nov-Dec). Efficacy of the Pilates method for pain and disability in patients with chronic nonspecific low back pain: a systematic review with meta-analysis. *Braz J Phys Ther*, 17(6), 517-532. <https://doi.org/10.1590/S1413-35552012005000127>
- Nikitara, K., Odani, S., Demenagas, N., Rachiotis, G., Symvoulakis, E., & Vardavas, C. (2021). Prevalence and correlates of physical inactivity in adults across 28 European countries. *European Journal of Public Health*, 31(4), 840-845. <https://doi.org/10.1093/eurpub/ckab067>
- Opplert, J., & Babault, N. (2018, 02). Acute Effects of Dynamic Stretching on Muscle Flexibility and Performance: An Analysis of the Current Literature. *Sports Med*, 48(2), 299-325. <https://doi.org/10.1007/s40279-017-0797-9>
- Page, M. J., Moher, D., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., McGuinness, L. A., Stewart, L. A., Thomas, J., Tricco, A. C., Welch, V. A., Whiting, P., & McKenzie, J. E. (2021). PRISMA 2020 explanation and elaboration: updated guidance and exemplars for reporting systematic reviews. *BMJ*, 372, n160. <https://doi.org/10.1136/bmj.n160>
- Parfitt, G., Alrumh, A., & Rowlands, A. V. (2012, Nov). Affect-regulated exercise intensity: does training at an intensity that feels 'good' improve physical health? *J Sci Med Sport*, 15(6), 548-553. <https://doi.org/10.1016/j.jsams.2012.01.005>
- Parfitt, G., Blisset, A., Rose, E. A., & Eston, R. (2012, Jan). Physiological and perceptual responses to affect-regulated exercise in healthy young women. *Psychophysiology*, 49(1), 104-110. <https://doi.org/10.1111/j.1469-8986.2011.01287.x>
- Parfitt, G., Rose, E. A., & Burgess, W. M. (2006, Feb). The psychological and physiological responses of sedentary individuals to prescribed and preferred intensity exercise. *Br J Health Psychol*, 11(Pt 1), 39-53. <https://doi.org/10.1348/135910705X43606>
- Prochaska, J. O., & Velicer, W. F. (1997). The transtheoretical model of health behavior change. *American journal of health promotion*, 12(1), 38-48.
- Rebar, A. L., Dimmock, J. A., Jackson, B., Rhodes, R. E., Kates, A., Starling, J., & Vandelanotte, C. (2016, 2016/10/01). A systematic review of the effects of non-

- conscious regulatory processes in physical activity. *Health Psychology Review*, 10(4), 395-407. <https://doi.org/10.1080/17437199.2016.1183505>
- Reed, J. (2014, Sep 2014 2017-11-21). Effect of Placebo-Induced Changes in Expectancies on Self-Reported Affect Associated with Yoga Practice. *Journal of Sport Behavior*, 37(3), 268-285. <https://www.proquest.com/scholarly-journals/effect-placebo-induced-changes-expectancies-on/docview/1553181488/se-2?accountid=192066>
- Rejeski, W. J. (1985). Perceived exertion: An active or passive process? *Journal of Sport Psychology*, 7(4), 371-378.
- Rhodes, R. E., & Kates, A. (2015). Can the Affective Response to Exercise Predict Future Motives and Physical Activity Behavior? A Systematic Review of Published Evidence. *Annals of Behavioral Medicine*, 49(5), 715-731. <https://doi.org/10.1007/s12160-015-9704-5>
- Riebe, D., Ehrman, J., Liguori, G., Magal, M., & American College of Sports Medicine. (2018). *ACSM's guidelines for exercise testing and prescription* (W. Kluwer, Ed. 10th ed.).
- Rodrigues, F., Teixeira, D. S., Cid, L., & Monteiro, D. (2021, 09). Have you been exercising lately? Testing the role of past behavior on exercise adherence. *J Health Psychol*, 26(10), 1482-1493. <https://doi.org/10.1177/1359105319878243>
- Rodrigues, F., Teixeira, D. S., Neiva, H. P., Cid, L., & Monteiro, D. (2020). Understanding exercise adherence: the predictability of past experience and motivational determinants. *Brain Sciences*, 10(2), 98.
- Rose, E. A., & Parfitt, G. (2007, Jun). A quantitative analysis and qualitative explanation of the individual differences in affective responses to prescribed and self-selected exercise intensities. *J Sport Exerc Psychol*, 29(3), 281-309. <https://doi.org/10.1123/jsep.29.3.281>
- Rose, E. A., & Parfitt, G. (2008). Can the Feeling Scale Be Used to Regulate Exercise Intensity? *Medicine & Science in Sports & Exercise*, 40(10). https://journals.lww.com/acsm-msse/Fulltext/2008/10000/Can_the_Feeling_Scale_Be_Used_to_Regulate_Exercise.19.aspx
- Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology*, 39(6), 1161-1178. <https://doi.org/10.1037/h0077714>
- Schneider, K. L., Spring, B., & Pagoto, S. L. (2009). Exercise and energy intake in overweight, sedentary individuals. *Eating behaviors*, 10(1), 29-35. <https://doi.org/10.1016/j.eatbeh.2008.10.009>
- Schneider, M., Dunn, A., & Cooper, D. (2009, Dec). Affect, exercise, and physical activity among healthy adolescents. *J Sport Exerc Psychol*, 31(6), 706-723. <https://doi.org/10.1123/jsep.31.6.706>

- Smith, C., Hancock, H., Blake-Mortimer, J., & Eckert, K. (2007, Jun). A randomised comparative trial of yoga and relaxation to reduce stress and anxiety. *Complement Ther Med*, 15(2), 77-83. <https://doi.org/10.1016/j.ctim.2006.05.001>
- Stevens, C. J., Baldwin, A. S., Bryan, A. D., Conner, M., Rhodes, R. E., & Williams, D. M. (2020, 2020-December-01). Affective Determinants of Physical Activity: A Conceptual Framework and Narrative Review [Review]. *Frontiers in Psychology*, 11. <https://doi.org/10.3389/fpsyg.2020.568331>
- Strobach, T., Englert, C., Jekauc, D., & Pfeffer, I. (2020). Predicting adoption and maintenance of physical activity in the context of dual-process theories. *Performance Enhancement & Health*, 8(1), 100162.
- Sullivan, M., Carberry, A., Evans, E. S., Hall, E. E., & Nepocatych, S. (2019, 10). The effects of power and stretch yoga on affect and salivary cortisol in women. *J Health Psychol*, 24(12), 1658-1667. <https://doi.org/10.1177/1359105317694487>
- Svebak, S., & Murgatroyd, S. (1985). Metamotivational Dominance. A Multimethod validation of Reversal Theory constructs. *Journal of Personality and Social Psychology*. 48(1), 107 – 116. <https://doi.org/https://doi.org/10.1037/0022-3514.48.1.107>
- Telles, S., Singh, N., Yadav, A., & Balkrishna, A. (2012, 2012 Jul-Sep). Effect of yoga on different aspects of mental health. *Indian J Physiol Pharmacol*, 56(3), 245-254. <https://www.ncbi.nlm.nih.gov/pubmed/23734439>
- Thomas, B. H., Ciliska, D., Dobbins, M., & Micucci, S. (2004). A process for systematically reviewing the literature: providing the research evidence for public health nursing interventions. *Worldviews Evid Based Nurs*, 1(3), 176-184. <https://doi.org/10.1111/j.1524-475X.2004.04006.x>
- Thompson, W. R. (2022). Worldwide Survey of Fitness Trends for 2022. *ACSM's Health & Fitness Journal*, 26(1), 11-20. <https://doi.org/10.1249/fit.0000000000000732>
- Tuso, P. (2014). Behavior medicine specialist. *Perm J*, 18(4), 52-57. <https://doi.org/10.7812/TPP/14-035>
- Unick, J. L., Michael, J. C., & Jakicic, J. M. (2012, Sep 01). Affective responses to exercise in overweight women: Initial insight and possible influence on energy intake. *Psychol Sport Exerc*, 13(5), 528-532. <https://doi.org/10.1016/j.psychsport.2012.02.012>
- Unick, J. L., Strohacker, K., Papandonatos, G. D., Williams, D., O'Leary, K. C., Dorfman, L., Becofsky, K., & Wing, R. R. (2015, Oct). Examination of the Consistency in Affective Response to Acute Exercise in Overweight and Obese Women. *J Sport Exerc Psychol*, 37(5), 534-546. <https://doi.org/10.1123/jsep.2015-0104>
- Vandoni, M., Codrons, E., Marin, L., Correale, L., Bigliassi, M., & Buzzachera, C. F. (2016). Psychophysiological Responses to Group Exercise Training Sessions: Does Exercise Intensity Matter? *PLoS One*, 11(8), e0149997. <https://doi.org/10.1371/journal.pone.0149997>

- Vazou-Ekkekakis, S., & Ekkekakis, P. (2009). Affective consequences of imposing the intensity of physical activity: does the loss of perceived autonomy matter. *Hellenic Journal of Psychology*, 6(2), 125-144.
- Wang, C., Bannuru, R., Ramel, J., Kupelnick, B., Scott, T., & Schmid, C. H. (2010). Tai Chi on psychological well-being: systematic review and meta-analysis. *BMC complementary and alternative medicine*, 10, 23-23. <https://doi.org/10.1186/1472-6882-10-23>
- Warburton, D. E., Nicol, C. W., & Bredin, S. S. (2006). Health benefits of physical activity: the evidence. *Cmaj*, 174(6), 801-809.
- Warburton, D. E. R., & Bredin, S. S. D. (2017). Health benefits of physical activity: a systematic review of current systematic reviews. *Current Opinion in Cardiology*, 32(5). https://journals.lww.com/co-cardiology/Fulltext/2017/09000/Health_benefits_of_physical_activity_a_systematic.10.aspx
- Williams, D. M. (2008, Oct). Exercise, affect, and adherence: an integrated model and a case for self-paced exercise. *J Sport Exerc Psychol*, 30(5), 471-496. <https://doi.org/10.1123/jsep.30.5.471>
- Williams, D. M., Dunsiger, S., Ciccolo, J. T., Lewis, B. A., Albrecht, A. E., & Marcus, B. H. (2008, May). Acute Affective Response to a Moderate-intensity Exercise Stimulus Predicts Physical Activity Participation 6 and 12 Months Later. *Psychol Sport Exerc*, 9(3), 231-245. <https://doi.org/10.1016/j.psychsport.2007.04.002>
- Williams, D. M., & Evans, D. R. (2014). Current emotion research in health behavior science. *Emotion Review*, 6(3), 277-287.
- World Health Organization. (2020). *Physical activity*. Retrieved 16/3/2021 from <https://www.who.int/news-room/fact-sheets/detail/physical-activity>
- Yeh, G. Y., Wang, C., Wayne, P. M., & Phillips, R. (2009, 2009 May-Jun). Tai chi exercise for patients with cardiovascular conditions and risk factors: A SYSTEMATIC REVIEW. *J Cardiopulm Rehabil Prev*, 29(3), 152-160. <https://doi.org/10.1097/HCR.0b013e3181a33379>
- Yeh, G. Y., Wang, C., Wayne, P. M., & Phillips, R. S. (2008). The effect of tai chi exercise on blood pressure: a systematic review. *Prev Cardiol*, 11(2), 82-89. <https://doi.org/10.1111/j.1751-7141.2008.07565.x>
- Yoshihara, K., Hiramoto, T., Oka, T., Kubo, C., & Sudo, N. (2014, Jan 03). Effect of 12 weeks of yoga training on the somatization, psychological symptoms, and stress-related biomarkers of healthy women. *Biopsychosoc Med*, 8(1), 1. <https://doi.org/10.1186/1751-0759-8-1>
- Zajonc, R. B. (2001, 2001/12/01). Mere Exposure: A Gateway to the Subliminal. *Current Directions in Psychological Science*, 10(6), 224-228. <https://doi.org/10.1111/1467-8721.00154>

Zenko, Z., Ekkekakis, P., & Ariely, D. (2016, Apr). Can You Have Your Vigorous Exercise and Enjoy It Too? Ramping Intensity Down Increases Postexercise, Remembered, and Forecasted Pleasure. *J Sport Exerc Psychol*, 38(2), 149-159.
<https://doi.org/10.1123/jsep.2015-0286>

Zenko, Z., & Jones, L. (2021). *Essentials of exercise and sport psychology: An open access textbook*. Society for Transparency, Openness, and Replication in Kinesiology.
<https://doi.org/https://doi.org/10.51224/B1000>

Zenko, Z., & Ladwig, M. A. (2021). Affective responses to exercise: Measurement considerations for practicing professionals. *Essentials of exercise and sport psychology: An open access textbook*, 271-293.

Chapter 2 – Affective Responses to Stretching Exercises: Exploring the Timing of Assessments

Abstract

Affective responses during exercise have been identified as a major predictor of exercise adherence. However, core affect assessments have been mostly limited to aerobic and, more recently, to resistance exercises. Considering that stretching activities are also an important component in physical and psychological fitness, this quasi-experimental study was designed to 1) compare affective responses during and immediately after stretching exercises in apparently healthy adults and detect a possible affective rebound and better understand the adequate timing for assessment, and 2) to verify the reliability and agreement of the affective responses assessment through a test-retest performed 1 week apart. For that purpose, we applied and analyzed the Feeling Scale (FS) and Felt Arousal Scale (FAS) using Time (during and after stretching) x Intensity (light, moderate, and vigorous) x Stretched Muscle Group (quadriceps, hamstrings, glutes, latissimus dorsi, and triceps) repeated measures analysis of variance (ANCOVA) in 34 participants (21 males; aged 32.8 ± 8.6 years). Repeatability assessments of FS and FAS performed on different days were also performed using a two-way mixed effects absolute agreement Intraclass Correlation Coefficient (ICC) and Bland-Altman plots, respectively. An affective rebound was observed in all intensities. FS scores were higher following the stretching exercises, whereas FAS scores were lower, particularly in the vigorous stretching intensity. In general, the inter-day repeatability for FS and FAS measurements was good across the stretched muscle groups. ICCs tended to be higher when FS and FAS were measured during stretching exercises and when they were performed at vigorous intensity. FS and FAS applied *during* the execution of a static stretch represents a feasible and ecologically valid approach to measure core affect. These results suggest that an adequate assessment of core affect in stretching activities should be performed during the exercise.

Keywords: exercise; feeling scale; felt arousal scale; stretching; valence; affect.

2.1 Introduction

Regular PA comprises a variety of health benefits associated with a reduced risk of all-cause mortality and several chronic medical conditions (Warburton & Bredin, 2017). Despite the overwhelming evidence supporting the health benefits of PA, and international guidelines recommending 150min/week of moderate intensity aerobic activity or 75 min/week of vigorous intensity aerobic activity, a considerable part of the world population does not attain these recommendations (Riebe et al., 2018; World Health Organization, 2020). To lessen the actual barriers, initiatives should emphasize that health benefits can be obtained with lower levels of

PA and/or intensity (Segar et al., 2020; Warburton & Bredin, 2016). An exercise prescription that considers one individual characteristics and needs, such as the promotion of positive affect (i.e., ‘feeling good’ while exercising), has a great potential for eliciting behavioral change (Warburton & Bredin, 2017), and has shown to be able to predict PA behavior maintenance (Rhodes & Kates, 2015; Williams, 2008).

Core affect and exercise adherence

Grounded on hedonic assumptions, the study of core affect has been gaining popularity among exercise psychologists as a central aspect of behavior (Ekkekakis et al., 2011). It is defined as “*the most basic or elementary characteristic component of all valenced responses, positive or negative, pleasant or unpleasant, including, but not limited to, emotions and moods*” (p.478) (Ekkekakis et al., 2005b). Thus, core affect may represent the valence of a response based on a momentary experience, that is “*consciously accessible as a simple, nonreflective feeling that is an integral blend of hedonic (pleasure–displeasure) and arousal (sleepy–activated) values*” (p.147) (Russell, 2003).

Measuring affect may be of particular interest to help exercise professionals creating individualized behavioral-based prescriptions focused on the promotion of an individually adjusted affective response (Evmenenko & Teixeira, 2020). Two of the most commonly used scales for that purpose are the Feeling Scale (Hardy & Rejeski, 1989) (FS) and Felt Arousal Scale (Svebak & Murgatroyd, 1985) (FAS), used to assess affective valence (perceived pleasure/displeasure) and arousal (perceived activation), respectively. These scales can be plotted in a circumplex model, allowing for the understanding of the individual affective and activation experience during the session (Evmenenko & Teixeira, 2020; Russell, 1980). Both scales can capture the response to various exercise stimuli throughout the affective domain (Ekkekakis & Petruzzello, 2002), but have been mostly used in aerobic (Rhodes & Kates, 2015) and, more recently, in resistance training (Andrade et al., 2022; Cavarretta et al., 2019; Evmenenko & Teixeira, 2020).

Closing the gap of affective response assessment – the case of stretching exercise

Stretching activities are an important component of physical and psychological fitness (Behm et al., 2016; Riebe et al., 2018). Their benefits include improvements in flexibility, and muscular endurance, increased balance both in adults (Cruz-Ferreira et al., 2011) and older adults (Casonatto & Yamacita, 2020), and reduced pain (Miyamoto et al., 2013). Psychological benefits include reducing stress, anxiety, depression, and increased self-esteem (Wang et al.,

2010). Stretching activities can be used in different modalities (i.e., Yoga, Pilates, Tai-Chi, Stretching) integrated across different settings, such as group fitness classes in gyms and academies, but also as specific exercises to be included in exercise regimen. These activities are considered to have a low perceived barrier to participation, be secure, accessible, and engaging (Apostolopoulos et al., 2015; DiGiacomo et al., 2010). They also provide a qualitatively different exercise experience, focusing on relaxation, body awareness, and control, which may be perceived as less strenuous and more pleasurable (Hagins et al., 2007). Therefore, it is not surprising that stretching activities have thrive in popularity not only in fitness clubs, but also in the scientific community, as shown by the growing number of studies published in the last years (Wieland et al., 2021).

Current study

Affective responses have been scarcely addressed in stretching-related activities, as shown by a recent review on the topic (Henriques & Teixeira, in review). Overall, the included studies demonstrated that these activities are developed in a wide variety of exercise settings (i.e., individual stretches, group classes, warm-up, cooldown sections), with different types of manifestation (i.e., static, dynamic, passive, active), and high heterogeneity in the assessment's procedures, including the number and timing of the assessments. Given this context and variability, the authors concluded that the assessment of the affective response in stretching activities lacked methodological quality (i.e., assessment standardization) to adequately understand the response to pleasure/displeasure. One particularly relevant aspect to be explored is related to the fact that the way one feels *during* the stretch may be different and likely with an opposite valence to how one feels after the stretch, a phenomenon known as “affective rebound effect” (Ekkekakis et al., 2011). This has been supported in aerobic exercise (Ekkekakis et al., 2011), and to a lesser extent in resistance training (Andrade et al., 2022; Cavarretta et al., 2019). Given all the above, this effect might depend on the assessment timing, the intensity of the stretching, or even the stretched muscle group, but to the best of our knowledge, this has not yet been examined. This challenges the individualization of stretching activities based on hedonic motivation models aimed at encouraging sustainable practices.

Therefore, the aims of the present study were two-fold: 1) to compare affective responses during and immediately after stretching exercises in apparently healthy adults, to detect a possible affective rebound and better understand the adequate timing for assessment, and 2) to verify the reliability and agreement of the affective responses assessment through a test-retest performed 1 week apart. It is hypothesized that 1) an affective rebound will be

present in all intensities, depicted by an improved affective valence immediately after the stretch; 2) higher exercise intensities will present higher differences between moments (i.e., during vs. post stretch) in the affective valence; and 3) that the affective response assessment in the stretching protocol will present temporal stability and thus support the reliability of the scales and method used.

2.2 Methods

2.2.1. Participants

Considering the aims and hypothesis of the study, a 2 (time: intra, post-exercise) by 3 (intensity: light, moderate, vigorous) by 5 (exercises: quadriceps, hamstring, gluteus, latissimus dorsi, and triceps) repeated measures ANCOVA was needed (controlling variable: sex). To determine the adequacy of the sample size, a sensitivity analysis was performed with G*Power v.3.1.9.7 (Faul et al., 2009) using the following input parameters: alpha = .05, statistical power = .95, sample size of 34, correlation among measures = .7, and a nonsphericity correction = .7. The sensitivity analysis predicted a Cohen's $f = .13$ ("small" to "medium" effect) (Cohen, 1988). Given the absence of similar studies as defined by this study protocol (see method), two studies where passive stretching was performed and the FS and FAS was measured during the session (not *during the exercise*) and after the session (not *immediately after*, but a few minutes after) was used for effect size adequacy analysis (Edwards et al., 2018; Sullivan et al., 2019). Results indicated an $f = .26$ (FS) and $f = .16$ (FAS) (Sullivan et al., 2019), and a $f = .17$ (FS) and $f = .07$ (FAS) (Edwards et al., 2018), which aligns with the sensitivity analysis for the total sample. However, it is expected that the measurement *during* the exercise would reflect mechanical and physiological manifestations of the stretching with higher discomfort than the perceived during the session (e.g., in between exercises but throughout the session). Thus, a higher difference between moments is expected with this protocol, which further supports that an effect size of $f = .13$ is adjusted. All the remaining imputed values for sample size calculations are in line with similar studies and relatable outcomes (Andrade et al., 2022; Baldwin et al., 2016; Zenko et al., 2017).

A total of 34 (male = 21) individuals ($M_{\text{age}} = 32.8 \pm 8.6$ years; $M_{\text{BMI}} = 23.7 \pm 2.7 \text{ kg/m}^2$; $M_{\text{experience}} = 12.5 \pm 10.2$ years; $M_{\text{frequency}} = 3.7 \pm 1.5$ days) participated in this study. The recruitment was made in two localizations: in an university and in a health club, both in the Lisbon area. The inclusion criteria were as follows: volunteers aged 18 to 55 years, apparently healthy, free from injury or any contraindication to exercise, and physically active. Athletes and/or individuals engaged in professional activities involving the regular use of flexibility

(e.g., dancing; gymnasts) were excluded from this study. All participants read and signed an informed consent form prior to the experiment. This study was approved by the Faculdade de Educação Física e Desporto da Universidade Lusófona institutional review board and was developed in accordance with the Helsinki Declaration and its later amendments.

2.2.2. Procedures

Study Protocol

Participants took part in two experimental sessions (one week apart) and were instructed to avoid vigorous exercise for at least 48 hours prior to each session. In the beginning of the first session, participants completed a battery of sociodemographic and psychometric questionnaires and were briefed about the upcoming activities. The warm-up was performed on a cycle ergometer (light-to-moderate intensity; 5-7 minutes) and was followed by five static stretching exercises, focused on the majority of the large muscle groups (quadriceps, hamstring, gluteus, latissimus dorsi), but also including one minor group (triceps). The routine was performed at three different intensities: light, moderate, and vigorous, respectively. Depending on the intensity, participants were instructed to stretch until a light (beginning of the stretch feeling), mild (feeling tightness/moderate stretch), or high (vigorous stretch) discomfort was felt in the targeted muscle, and then hold the position for 25 seconds. A rest of 15 seconds was given between each routine of five exercises. The dominant side was selected for all participants. The FS and FAS were applied during the stretch (at second 12) and immediately after each stretch (at second 25). To analyze test-retest reliability, the whole procedure was repeated after a week (Unick et al., 2015).

In both sessions the warm-up was used to familiarize the participants with the assessment instruments. Scales were presented orally and visually (horizontally (FS) and vertically (FAS)) to better differentiate them. Following the recommendations by Duda (1998) and Evmenenko & Teixeira, (2020) on psychometric scales, 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 scales to provide anchoring examples for their answers. During the protocol, however, the researchers highlighted the importance of representing these feelings as experienced *in the present moment* (e.g., during the stretch). To standardize the experimental conditions and limit the influence of the researcher on perceptual and affective responses, participants received no encouragement. Data collection was carried out by two of the researchers. Both were trained on the

administration of psychometric instruments on a small independent sample prior to the beginning of the study, following the instructions provided by the developers of the instruments, as well as other relevant studies pertaining to psychometric assessments (Ekkekakis & Petruzzello, 2002; Russell et al., 1989).

2.2.3. Instruments

Feeling Scale and Felt Arousal Scale

The affective valence was measured with the Feeling Scale (Hardy & Rejeski, 1989). The FS is an 11-point scale ranging from -5 (“very bad”) to +5 (“very good”). The FS has been widely used to assess affective valence during exercise and has demonstrated satisfactory validity (Hardy & Rejeski, 1989) through correlations with other measures of affective valence (Evmenenko & Teixeira, 2020). Perceived activation was measured with the Felt Arousal Scale (Svebak & Murgatroyd, 1985). The FAS is a 6-point single-item rating scale, ranging from 1 (“low arousal”) to 6 (“high arousal”). The FAS has been used in exercise research in conjunction with the FS (Evmenenko & Teixeira, 2020) to assess the two dimensions of the circumplex model (i.e., perceived activation and affective valence, respectively) (Russell, 1980). Both scales were previously translated to Portuguese and were found to demonstrate acceptable validity (Brito et al., 2022).

2.2.4. Statistical Analyses

Descriptive statistics were calculated for all relevant variables, and the mean and standard deviation scores presented. Normality and homoscedasticity were evaluated through Shapiro-Wilk and Levene’s tests, respectively. For the first objective, a 2 (time: intra, post-exercise) by 3 (intensity: light, moderate, vigorous) by 5 (exercises: quadriceps, hamstring, gluteus, latissimus dorsi, and triceps) repeated measures ANCOVA was performed, where sex was used as covariate. If violations of sphericity were present, ANCOVA results based on Greenhouse-Geisser-adjusted scores of freedom were reported (indicated by the presence of decimal degrees). In case of significant ANCOVA main effects and interactions, a Bonferroni-adjusted (main effects) and a Fisher’s Least Significant Difference (LSD; interactions) post-hoc to analyze pairwise comparisons was developed. When needed, the uncorrected p values from the pairwise comparison multiplied by the number of comparisons, to allow the evaluation of the customary criterion of $p < .05$, was performed. Eta-squares (η^2_p) effect sizes were calculated for ANCOVA’s, and the rough benchmarks suggested by Cohen (1988) (“small” effect = .01, “medium” effect = .06, “large” effect = .14) were used for interpretation. When comparing means for one-sample differences between paired observations, the effect size

through Cohen's d was calculated (Cohen, 1988) using the formula presented in section 2.3.5 (p. 48), an following the “small” effect = .20, “medium” effect = .50, and “large” effect = .80 scores for interpretation.

As for the second objective, a test-retest was performed. To ensure reliability and agreement, a two-way mixed effects absolute agreement Intraclass Correlation Coefficient (ICC) and Bland-Altman plots, respectively, were performed (Berchtold, 2016; Koo & Li, 2016). The ICC was interpreted as: poor [$<.50$], moderate [$.50, .74$], good [$.75, .90$], and excellent $> .90$ (Koo & Li, 2016). The significance level was set at 5%. All analysis were performed using IBM SPSS v. 27.0. Bland-Altman plots were performed with ggplot2 package (Wickham et al., 2022).

2.3. Results

2.3.1. Affective Responses

A descriptive analysis revealed that there were no issues during screening or incoherent results for FS/FAS (no outliers or random scores). Global scores for these scales in all exercises and moments are presented in Tables 3 and 4, and in Figure 3a and 3b. Additionally, differences between intra (12'') and post-exercise (25'') measurements, in both weeks, were calculated, and the effect size for paired observation presented. The FS presented higher scores in the post-exercise assessments when compared to the intra-exercise. In general, the differences between moments increased across intensity, suggesting a detrimental effect of vigorous intensity on the FS scores (also detected on the Cohen's d results). As for the FAS, results were higher in the intra (12'') vs. post-exercise (25'') assessments. When considering it as an intensity manipulation check, the moments differences (and again Cohen's d results) showed an increasing pattern of activation, thus reflecting the intensity increase across conditions.

Table 3 - Global sample for the FS measurements for each muscle group stretched at different time points and intensities.

FS	Week 1		Δ	<i>d</i> intra-end	Week 2		Δ	<i>d</i> intra-end
	During (12")	Post (25")			During (12")	Post (25")		
	M±DP				M±DP			
Quadriceps								
Light	1.9±1.7	2.4±2.0	-0.5	-0.27	1.8±1.8	1.8±1.8	0	0
Moderate	2.4±1.9	2.9±1.9	-0.5	-0.26	2.0±1.7	2.4±1.6	-0.4	-0.24
Vigorous	0.8±2.4	2.5±1.8	-1.7	-0.8	0.6±2.6	2.1±1.8	-1.5	-0.67
Hamstrings								
Light	1.6±1.7	2.3±1.8	-0.7	-0.4	1.4±1.9	1.7±1.6	-0.3	-0.17
Moderate	1.8±2.0	2.6±1.7	-0.8	-0.43	1.0±2.4	1.9±1.9	-0.9	-0.42
Vigorous	-0.2±2.8	2.1±2.1	-2.3	-0.93	-0.5±2.7	2.1±1.9	-2.6	-1.11
Glutes								
Light	1.9±2.1	2.6±1.9	-0.7	-0.3	1.7±1.6	1.9±1.5	-0.2	-0.13
Moderate	2.1±2.0	2.6±1.8	-0.5	-0.26	1.9±2.0	2.4±1.8	-0.5	-0.26
Vigorous	1.0±2.3	2.4±1.8	-1.4	-0.68	0.9±2.4	2.3±1.8	-1.4	-0.66
Latissimus Dorsi								
Light	1,6±2,1	2.4±1.8	-0.8	-0.41	1.3±2.0	2.0±1.7	-0.7	-0.38
Moderate	1,6±2,4	2.5±1.9	-0.9	-0.42	0.9±2.1	2.1±1.6	-1.2	-0.64
Vigorous	-0,1±2.6	2.2±2.0	-2.3	-0.99	-0.3±2.7	1.8±2.0	-2.1	-0.88
Triceps								
Light	1.8±1.8	2.6±1.7	-0.8	-0.46	1.5±1.7	2.2±1.6	-0.7	-0.42
Moderate	1.4±2.2	2.4±1.8	-1	-0.5	1.2±2.1	2.1±1.6	-0.9	-0.48
Vigorous	0.4±2.7	2.4±2.2	-2	-0.81	0.3±2.4	2.2±1.9	-1.9	-0.88

Notes: Δ = differences; *d* intra-end = Cohen's *d*.

Table 4 - Global sample for the FAS measurements for each muscle group stretched at different time points and intensities.

FAS	Week 1		Δ	<i>d</i> intra-end	Week 2		Δ	<i>d</i> intra-end
	During (12")	Post (25")			During (12")	Post (25")		
	M±DP				M±DP			
Quadriceps								
Light	2.3±1.0	2.4±0.9	-0.1	-0.11	2.1±1.0	1.7±.9	0.4	0.42
Moderate	3.3±1.5	2.5±1.4	0.8	0.55	3.0±1.1	2.1±1.6	0.9	0.66
Vigorous	4.3±1.4	3.1±1.4	1.2	0.86	4.1±1.6	2.9±1.8	1.2	0.7
Hamstrings								
Light	2.8±1.7	1.9±1.1	0.3	0.13	2.4±1.0	2.0±1.0	0.4	0.4
Moderate	3.4±1.5	2.6±1.4	0.8	0.55	3.2±1.3	2.4±1.1	0.8	0.66
Vigorous	4.7±1.5	2.1±1.6	2.6	1.68	4.5±1.4	3.0±1.5	1.5	1.03
Glutes								
Light	2.6±1.2	1.9±1.1	0.7	0.61	2.1±1.0	1.7±0.9	0.4	0.42
Moderate	3.4±1.4	2.5±1.4	0.9	0.64	2.9±1.0	2.2±1.0	0.7	0.7
Vigorous	4.1±1.4	3.0±1.5	1.1	0.76	3.9±1.3	2.8±1.3	1.1	0.85
Latissimus Dorsi								
Light	3.0±1.4	2.1±1.2	1.1	0.84	2.5±1.1	2.0±1.0	0.5	0.48
Moderate	3.8±1.3	2.8±1.3	1	0.77	3.3±1.2	2.4±1.1	0.9	0.78
Vigorous	4.8±1.5	3.4±1.6	1.4	0.9	4.4±1.4	3.2±1.4	1.2	0.86
Triceps								
Light	2.9±1.3	2.3±1.2	0.6	0.48	2.2±0.8	1.8±0.8	0.4	0.5
Moderate	3.6±1.3	2.7±1.3	0.9	0.69	3.2±1.2	2.5±1.0	0.7	0.63
Vigorous	4.4±1.5	3.2±1.5	1.2	0.8	4.1±1.5	3.2±1.3	0.9	0.64

Notes: Δ = differences; *d* intra-end = Cohen's *d*.

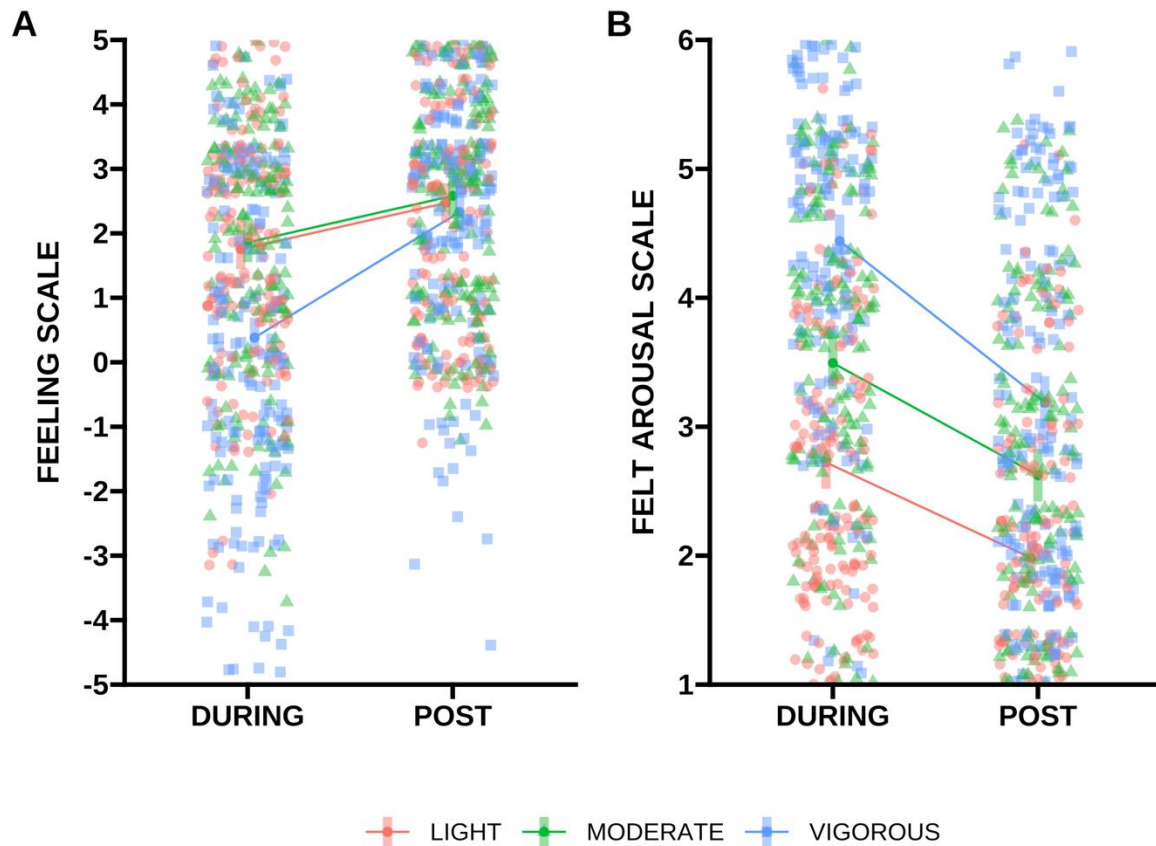


Figure 3 – FS (A) and FAS (B) scores during (12'') and following (25'') stretching exercises at different intensities.

The results for the repeated-measures ANCOVA for the FS and FAS scores in week 1 are presented in Table 5. A main effect of time was present for FS ($[F(1, 32) = 14.132, p = .001, \eta^2_p = .304]$). The examination of the marginal means showed for time 1 (intra exercise; 12'') a lower score (1.331, 95% CI, .809 to 1.853) when compared with time 2 (post-exercise; 25'') (2.461, 95% CI, 1.982 to 2.940). For FAS, the main effects of time ($[F(1, 32) = 14.247, p = .001, \eta^2_p = .308]$), intensity ($[F(2, 42.57) = 21.184, p < .001, \eta^2_p = .398]$), and exercise ($[F(4, 128) = 3.511, p = .009, \eta^2_p = .099]$) were significant. The marginal means showed for intra exercise (12'') a higher score (3.553, 95% CI, 3.147 to 3.959) compared to post-exercise (25'') (2.598, 95% CI, 2.204 to 2.992); for intensity a higher mean in vigorous intensity (3.815, 95% CI, 3.359 to 4.270) when compared to moderate (3.059, 95% CI, 2.640 to 3.477) and light (2.353, 95% CI, 2.028 to 2.678) intensities; and for exercise, significant differences emerged between exercise 1 (quadriceps) and exercise 2 (hamstring), 4 (latissimus dorsi) and 5 (triceps); exercise 2 (hamstring) and exercise 4 (latissimus dorsi); and exercise 3 (glutes), exercise 4 (latissimus dorsi) and exercise 5 (triceps), where marginal means were higher for latissimus dorsi (3.319, 95% CI, 2.916 to 3.721), when compared to triceps (3.196, 95% CI, 2.795 to

3.597), hamstrings (3.108, 95% CI, 2.715 to 3.500), glutes (2.907, 95% CI, 2.519 to 3.295) and quadriceps (2.848, 95% CI, 2.493 to 3.203). Additionally, one two-way interaction was present in FAS (intensity*exercise; $[F(8, 186,81) = 2.551, p = .022, \eta^2_p = .074]$). Post-hoc analysis showed that the FAS scores were different as intensity increased per exercise, and in all exercises (all $p < .001$); additionally, when looking at differences in the FAS scores in the exercises by intensity, differences emerged only in light (exercise 1 vs. 4 and 5) and vigorous (exercise 1 vs. 4; exercise 3 vs. 4) intensities. Finally, in general, sex as covariate did not present significant results. The only exception was with FS time*intensity ($p = .03$).

Table 5 - Repeated measures ANCOVA in week 1 for the FS and FAS

	Week 1					
	ε	df1	df2	F	p	η_p^2
Feeling Scale (FS)						
Main effect of time	1	1	32	14.132	0.001	0.304
Main effect of intensity	0.74	2	48.79	1.681	0.209	0.049
Main effect of exercise	0.642	4	84.86	1.667	0.196	0.048
Time * intensity	0.701	2	46.29	1.693	0.193	0.052
Time * exercise	0.869	4	132	1.4	0.252	0.041
Intensity * exercise	0.694	8	264	1.34	0.24	0.039
Time * Intensity * exercise	0.693	8	184.256	0.457	0.832	0.014
Felt Arousal Scale (FAS)						
Main effect of time	1	1	32	14.247	0.001	0.308
Main effect of intensity	0.667	2	42.57	21.184	<0.001	0.398
Main effect of exercise	0.848	4	128	3.511	0.009	0.099
Time * intensity	0.722	2	46.22	1.748	0.192	0.052
Time * exercise	0.96	4	128	1.339	0.259	0.04
Intensity * exercise	0.73	8	186.81	2.551	0.022	0.074
Time * intensity * exercise	0.723	8	256	0.57	0.802	0.018

Notes: ε = Greenhouse-Geisser epsilon indicating the severity of the violation of the assumption of sphericity; df_1 = degrees of freedom for the numerator of the F ratio; df_2 = degrees of freedom for the denominator (error) of the F ratio; F = value of the F ratio; p = probability of F; η_p^2 = partial eta-squared effect size.

2.3.1. ICC

The test-retest reliability results are presented in Tables 6 and 7. Overall, the inter-day repeatability for FS and FAS measurements can be classified as moderate to good across stretched muscle groups, as suggested by the ICCs results. Within each stretched muscle group, the ICCs tended to be higher as intensity increased. Additionally, for FS, the ICC for quadriceps stretching performed at light intensity was significantly different from those performed at moderate or vigorous intensities. As for the FAS, the ICCs for quadriceps, hamstrings, glutes, and triceps stretching at light intensities were significantly different from those performed at moderate and vigorous intensities. Regarding post-exercise ICCs, differences were detected for FAS in quadriceps, glutes, and triceps stretching performed at light intensities when comparing

with moderate (quadriceps and glutes) and vigorous intensities (quadriceps, glutes, and triceps). Light intensity for FS, but particularly FAS, presented the lower ICCs. Intra-exercise assessment depicted, on average, higher scores.

Table 6 - Inter-day repeatability statistics for FS measurements for each muscle group stretched at different time points and intensities.

FS	Week 1 vs. week 2 during stretch (12")			Week 1 vs. week 2 after stretch (25")		
	ICC	Lower 95%CI	Upper 95%CI	ICC	Lower 95%CI	Upper 95%CI
Quadriceps						
Light	.605	.201	.803	.66	.326	.829
Moderate	.825	.655	.913	.698	.397	.849
Vigorous	.882	.763	.941	.812	.625	.906
Hamstrings						
Light	.810	.619	.905	.807	.578	.908
Moderate	.827	.603	.919	.74	.43	.876
Vigorous	.862	.726	.931	.777	.551	.889
Glutes						
Light	.799	.6	.9	.707	.382	.857
Moderate	.81	.62	.905	.704	.407	.852
Vigorous	.896	.791	.948	.825	.651	.913
Latissimus Dorsi						
Light	.824	.651	.912	.785	.571	.893
Moderate	.801	.571	.904	.747	.498	.873
Vigorous	.844	.689	.922	.83	.659	.915
Triceps						
Light	.814	.63	.906	.79	.583	.895
Moderate	.888	.778	.944	.876	.753	.938
Vigorous	.892	.781	.947	.897	.795	.948

Notes: ICC = Intraclass correlation coefficient; CI = Confidence Intervals.

Table 7 - Inter-day repeatability statistics for FAS measurements for each muscle group stretched at different time points and intensities.

FAS	Week 1 vs. week 2 during stretch (12'')			Week 1 vs. week 2 after stretch (25'')		
	ICC	Lower 95%CI	Upper 95%CI	ICC	Lower 95%CI	Upper 95%CI
Quadriceps						
Light	.525	.053	.763	.269	-.493	.638
Moderate	.818	.627	.91	.832	.65	.918
Vigorous	.884	.77	.942	.886	.773	.943
Hamstrings						
Light	.7	.385	.852	.649	.29	.825
Moderate	.857	.717	.929	.681	.366	.84
Vigorous	.927	.854	.963	.817	.636	.908
Glutes						
Light	.422	-.106	.705	.581	.169	.79
Moderate	.804	.477	.915	.837	.667	.919
Vigorous	.894	.789	.947	.858	.718	.929
Latissimus Dorsi						
Light	.753	.436	.884	.749	.501	.874
Moderate	.86	.594	.941	.87	.667	.942
Vigorous	.874	.715	.941	.763	.528	.881
Triceps						
Light	.605	.03	.823	.657	.263	.835
Moderate	.843	.678	.923	.812	.627	.906
Vigorous	.905	.798	.954	.883	.766	.942

Notes: ICC = Intraclass correlation coefficient; CI = Confidence Intervals.

2.3.1. Repeatability

Finally, the test-retest agreement results through Bland-Altman plots can be seen in Tables 8 and 9, as for Figures 4 and 5. The mean bias in FS and FAS repeated measurements is small, the slopes are low, but the LOA are rather large, and some measurements do not fall within the 95% LOA for FS and FAS. This could be concerning in certain settings, as, for example, FS during quads stretching at light intensity can be scored as much as 4 below and 4 above the mean bias. However, proportional bias was not observed in repeated FS measurements and only occasionally observed in repeated FAS measurements (e.g., triceps stretching at light intensity and glutes stretching at moderate intensity), suggesting that differences increased as mean FAS scores increased. It is not evident that time of measurement or the stretched muscle group influence the agreement between the FS and FAS repeated measurements. However, proportional bias is evident in some repeated FAS measurements during and after stretching exercises performed at moderate intensity (Figure 5), but not in FS (Figure 4).

Table 8 - Bland-Altman resume table for inter-day FS measurements for each muscle group stretched at different time points and intensities.

FS	DURING					POST				
	Δ	95% Lower LOA	95% Upper LOA	Slope	p	Δ	95% Lower LOA	95% Upper LOA	Slope	p
Quadriceps										
Light	.12	-3.55	3.78	-.13	.57	.65	-3.12	4.41	.14	.48
Moderate	.41	-2.28	3.10	.1	.5	.52	-2.49	3.55	.04	.83
Vigorous	.12	-3.07	3.31	-.07	.57	.41	-2.36	3.19	-.05	.77
Hamstrings										
Light	.24	-2.63	2.92	-.14	.37	.59	-1.97	3.14	.12	.43
Moderate	.76	-2.29	3.81	-.21	.13	.73	-2.25	3.72	-.16	.33
Vigorous	.35	-3.44	4.14	.04	.76	.03	-3.42	3.36	.13	.43
Glutes										
Light	.20	-2.76	3.17	.3	.06	.71	-2.37	3.78	.31	.08
Moderate	.15	-3.06	3.35	-.004	.98	.21	-3.20	3.61	.004	.98
Vigorous	.06	-2.75	2.87	-.05	.67	.14	-2.59	2.88	-.03	.86
Latissimus Dorsi										
Light	.35	-2.69	3.40	.08	.61	.44	-2.42	3.30	.1	.53
Moderate	.76	-2.65	4.18	.19	.2	.41	-2.61	3.43	.22	.21
Vigorous	.24	-3.57	4.03	-.03	.86	.44	-2.50	3.38	.05	.75
Triceps										
Light	.29	-2.37	2.96	.05	.76	.36	-2.33	3.03	.07	.68
Moderate	.26	-2.39	2.92	.02	.87	.26	-2.01	2.54	.06	.64
Vigorous	.06	-3.11	3.23	.13	.26	.21	-2.24	2.66	.16	.15

Notes: Δ = difference between paired scores; LOA = Limits of agreement; Slope = beta value of the regression between mean and average values; p = p -value of the correlation between mean and average values.

Table 9 - Bland-Altman resume table for inter-day FAS measurements for each muscle group stretched at different time points and intensities.

FAS	DURING					POST				
	Δ	95% Lower LOA	95% Upper LOA	Slope	p	Δ	95% Lower LOA	95% Upper LOA	Slope	p
Quadriceps										
Light	.17	-2.05	2.41	-.01	.97	-.06	-2.47	2.35	.02	.95
Moderate	.35	-1.57	2.28	.3	.033	.35	-1.44	2.15	.27	.048
Vigorous	.17	-1.72	2.07	-.09	.45	.15	-1.53	1.83	.16	.17
Hamstrings										
Light	.44	-1.67	2.55	.25	.17	-.06	-2.21	2.09	.1	.63
Moderate	.18	-1.72	2.07	.18	.16	.24	-2.23	2.69	.35	.08
Vigorous	.18	-1.30	1.66	.07	.48	.26	-2.06	2.59	.07	.66
Glutes										
Light	.5	-2.11	3.11	.27	.3	.21	-1.89	2.30	.3	.18
Moderate	.53	-1.16	2.21	.4	.002	.29	-1.41	2.00	.37	.005
Vigorous	.21	-1.38	1.79	.07	.52	.24	-1.70	2.17	.21	.11
Latissimus Dorsi										
Light	.53	-1.47	2.53	.27	.09	.18	-1.72	2.07	.25	.16
Moderate	.5	-1.04	2.04	.09	.45	.41	-1.05	1.86	.23	.04
Vigorous	.41	-1.34	2.16	.09	.46	.21	-2.38	2.79	.19	.28
Triceps										
Light	.74	-1.33	2.79	.51	.006	.5	-1.45	2.45	.43	.002
Moderate	.32	-1.46	2.11	.09	.52	.24	-1.57	2.04	.29	.052
Vigorous	.33	-1.32	1.98	.006	.95	-.03	-1.86	1.80	.13	.3

Notes: Δ = difference between paired scores; LOA = Limits of agreement; Slope = beta value of the regression between mean and average values; p = p-value of the correlation between mean and average values.

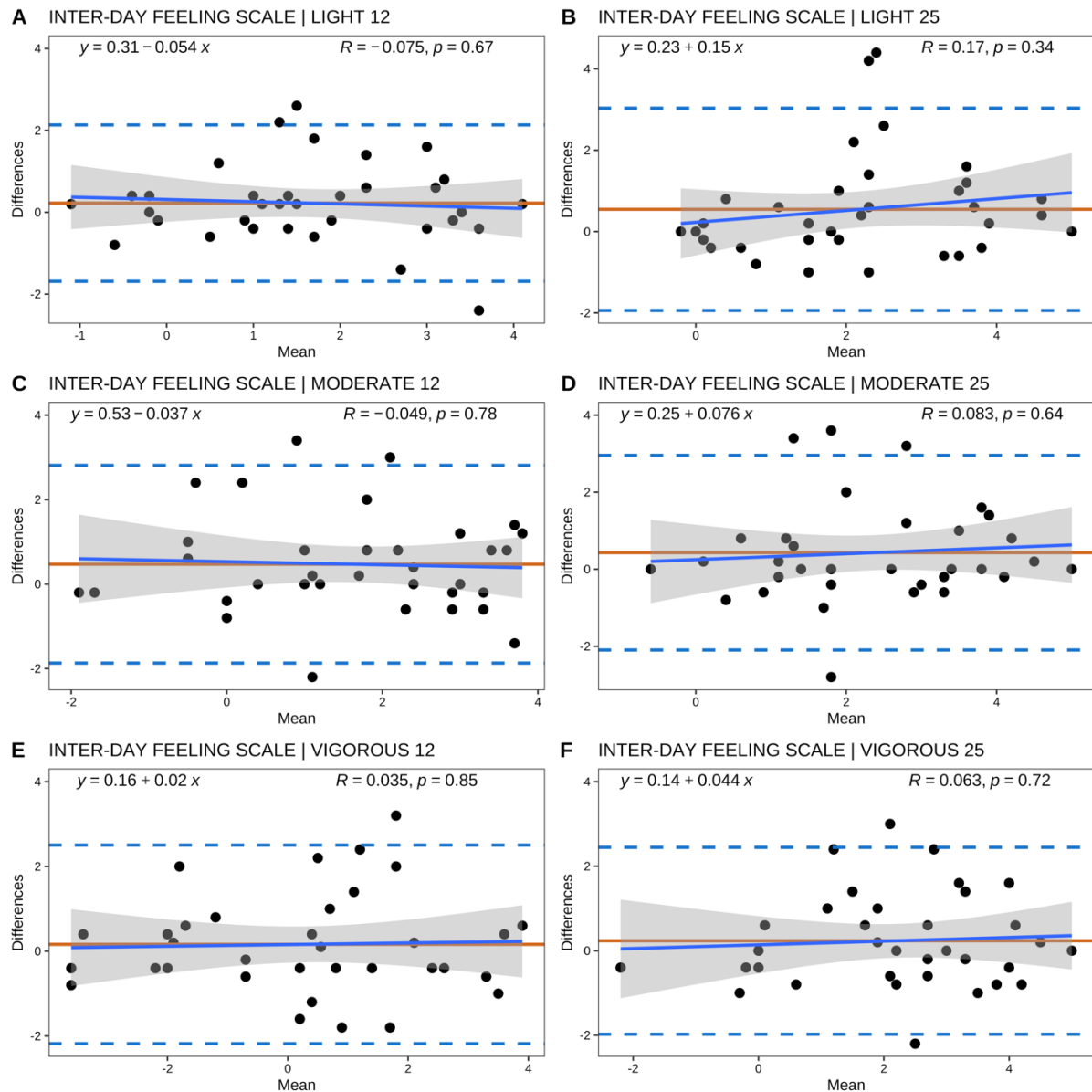


Figure 4 - Bland-Altman plots for inter-day FS measurements during and after stretching exercises performed at different intensities.

The solid orange line shows the mean bias for each comparison. Dashed lines represent the limits of agreement (95% confidence interval) around the mean bias (± 1.96 standard deviation [SD]). Solid blue line shows the linear relationship between the mean and difference, with shaded gray showing the 95% confidence interval for this relationship. Pearson's correlation (r) and p value are reported for the correlation between the mean and the difference.

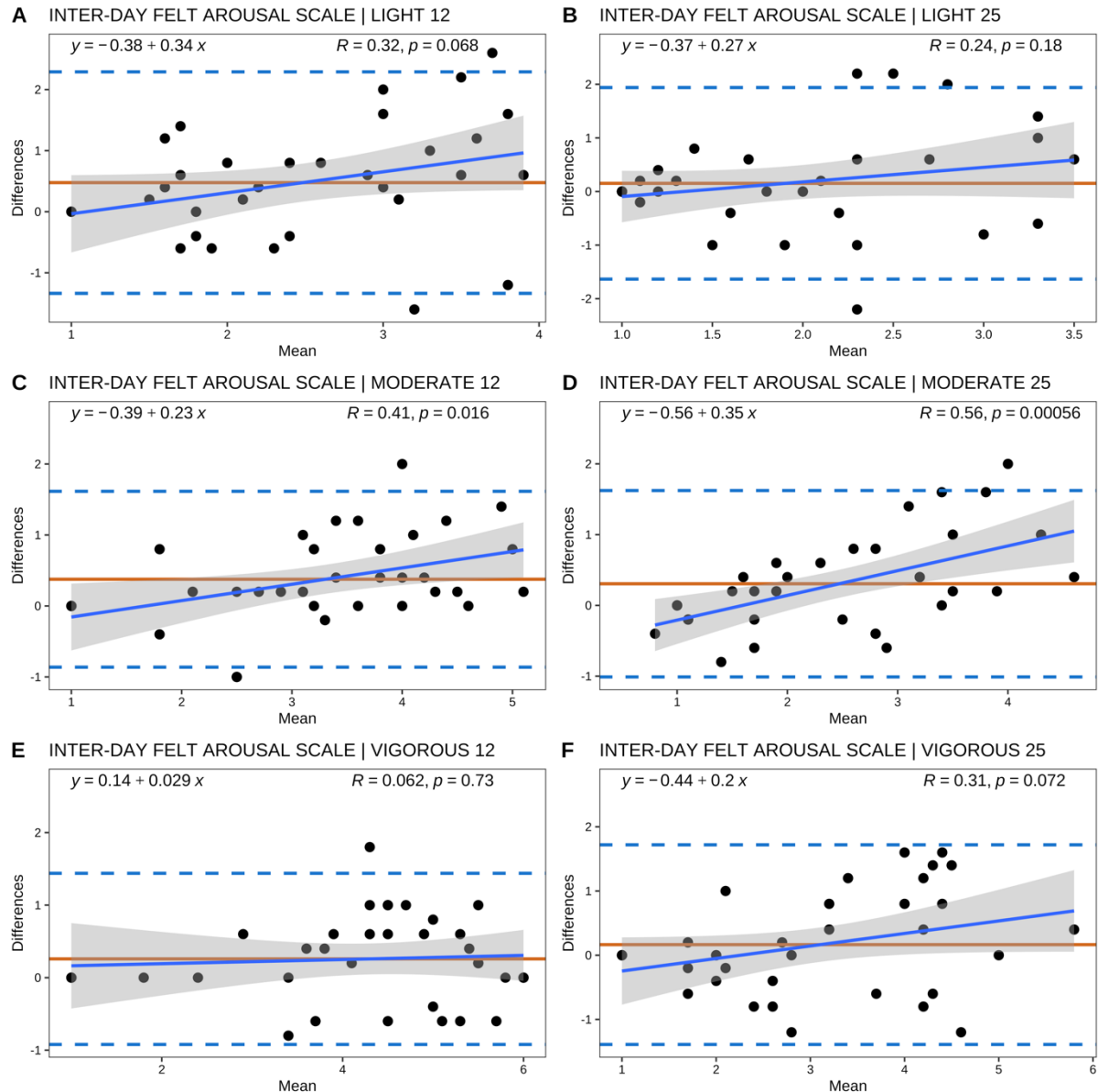


Figure 5 - Bland-Altman plots for inter-day FAS measurements during and after stretching exercises performed at different intensities.

The solid orange line shows the mean bias for each comparison. Dashed lines represent the limits of agreement (95% confidence interval) around the mean bias (± 1.96 standard deviation [SD]). Solid blue line shows the linear relationship between the mean and difference, with shaded gray showing the 95% confidence interval for this relationship. Pearson's correlation (r) and p value are reported for the correlation between the mean and the difference.

2.4. Discussion

The purpose of this study was to 1) compare affective responses during and immediately after stretching exercises in apparently healthy adults, and 2) to verify the reliability and agreement of the affective responses through a test-retest made with 1 week apart. An affective rebound was present in all intensities, although more pronounced in the vigorous stretching intensity, highlighting the importance of how one feels during the stretch when aiming to understand the affective response in this mode of exercise. Additionally, reliability and agreement results support temporal stability and the method used, thus reinforcing previously presented recommendations for the use of the FS and FAS, as for their adequacy in affective responses assessments. In sum, the defined hypotheses were supported, and implications will be discussed herein.

The timing of assessment

The difference of how one feels during the exercise and after their termination can be substantially different. This has led to recent efforts to better understand how this difference should be interpreted, as to how it can be assessed during exercise (Bastos et al., 2022; Ekkekakis et al., 2011; Evmenenko & Teixeira, 2020; Henriques & Teixeira, in review). Although this difference (affective rebound) is relatively clear in aerobic exercise (Ekkekakis et al., 2011), and more recently studied and clarified in resistance exercise (Andrade et al., 2022), it has not been explored in stretching activities. This has been highlighted in a review on the topic (Henriques & Teixeira, in review), where no apparent methodological standardization regarding *when* to assess the affective response in this mode of exercise was present. As such, much confusion can arise when trying to interpret the affective response and its usefulness in the well-known outcomes of adherence and well-being.

The present results suggest that a rebound effect is evident during static stretching exercises in distinct intensities and multiple muscle groups, confirming our first hypothesis. This effect had a higher magnitude in vigorous intensity stretching, possibly due to a greater discomfort caused by the intrinsic characteristics of the stretching exercises (e.g., mechanoreceptors). Previous recommendations indicated that to preserve the contribution of interoceptive and homeostatic disturbances of the affective state, assessments of core affective valence and perceived activation (e.g., feeling good or bad, pleasure or displeasure) should be made with relatively low contribution from reflective thought and relevant cognitive appraisals, and conducted as temporarily close to the activity as possible (Ekkekakis et al., 2011; Hardy & Rejeski, 1989). Present results confirm these indications.

These results also warn to past interpretations made regarding the affective response in stretching activities. As shown in a review on this purpose (Henriques & Teixeira, in review), previous attempts have used different assessment timings. Present study results now suggest that the scores obtained in different moments of the exercise/session may be assessing other perceptions rather than core affect. Thus, this work highlights that the timing of the assessment is crucial, and it seems reasonable to assume that a measurement obtained during the stretch would reflect core affect more accurately when compared to a retrospective measurement taken after the stretch, even if it is made immediately after the exercise.

Intensity and the affective response

The results highlight the importance of intensity when trying to promote better affective responses, an issue that has already been proposed and discussed in other exercise modes (Andrade et al., 2022; Ekkekakis et al., 2011; Stevens et al., 2020; Teixeira et al., 2022). As reported, an increase in intensity tend to depict an improvement in pleasurable feelings up until a point where a variability emerges and pleasure starts do decrease or even cease, in a rhythm and magnitude dependent of individual characteristics (Ekkekakis et al., 2011; Ladwig et al., 2017). Although this is hypothesized to happen also in stretching activities, no previous exploration on the topic was found.

As seen in the results, and when considering intra-exercise assessments, light and moderate intensities presented better affective responses when compared to vigorous intensity, aligning with previous theoretical assumptions. Moreover, the differences between moments (intra vs. post-exercise) were greater for both FS and FAS as intensity increased, thus partially supporting the study second hypothesis that suggested that higher exercise intensities would present higher differences between moments in the affective valence. To be noted is the fact that the main effect for intensity in the FS ANCOVA-RM analysis was not significant. When looking to the descriptive data representation (Table 3 and Figure 3a), it is possible to observe that the FS scores of light and moderate intensities, both intra and post-exercise, were very similar, something that did not occur in the FAS scores. A post-hoc between paired observations (not presented in the results) showed that the FS scores between the light and moderate intensities did not differ statistically, but both differed significantly from the vigorous intensity. This would suggest that these two initial intensities, probably, would not significantly influence the affective response of the participants, and could be more freely used by professionals concerned with affect-related behavioral aspects when prescribing this exercise mode.

Also relevant to the intensity-affect relation are the FAS scores. As seen, they depict the expected dose-response relation. As intensity increases, so does the perceived activation, and this relation is sustained in both moments of the protocol application (week 1 and 2). When looking at the sample characteristics and inclusion criteria, it is possible to see that all participants had previous exercise experience and were accustomed to distinct degrees of stretching. This was a key point to this protocol implementation, as it allowed the explanation of how to experience the physical strain and local stretching to match the intended intensity. As theorized, the FAS results highlight this understanding, and in addition to aid as an exercise intensity control, they can be further explored by exercise and related professionals to better understand and advise during practice the perceived intensity (at least in experienced exercisers).

Test-retest reliability and agreement

It is important that the feeling and arousal scales show high consistency across time points and intensities, allowing exercise professionals to create and evaluate the efficacy of behavioral-based prescriptions focused on the promotion of an individually adjusted affective response. In aerobic exercise, self-selecting an intensity to promote an affective state through the FS has been shown reliable across trials (Hamlyn-Williams et al., 2015; Rose & Parfitt, 2008), but this remains unexplored in stretching activities.

The study results indicate that the inter-day ICC at different intensities was, in general, moderate to good, with a tendency for higher reliability during vigorous intensity stretching. Some issues were detected for FS and FAS in some intra-exercise assessments at light intensity. Corroborating the FS ANCOVA-RM main effects for intensity, the light and moderate intensities seem to not differentiate on the affective valence scores, although some differences towards a dose-response pattern (e.g., the moderate intensity showing better feeling scores than light intensity) emerged, and the same type of pattern of response appears for FAS. This may suggest that at this intensity (e.g., light) described to the participants as the beginning of the muscle stretch feeling there may not be sufficient stimulus for some of the participants to experience more relevant effects on affective valence and/or arousal (e.g., interindividual differences in muscle stiffness), thus justifying a higher variability on both the FS and FAS results. Additionally, there were also higher ICC average scores in the intra vs. post-exercise assessment, which reinforces the reliability of the method and scales used in the now suggested adequate timing for assessment of core affect (e.g., intra-exercise).

To further support the reliability analysis and respective interpretation, an agreement analysis was performed (Berchtold, 2016), which showed that the affective valence responses (FS) were highly variable between individuals as given by the high SD and %CI, particularly at light and moderate stretching intensities, and some LOA were rather large. In these cases, the affective responses were scored as much as 4 below and 4 above the mean bias, and the SD of FS during stretching was consistently higher than the mean value. Nonetheless, the majority of the measurement points are within the LOA, and as recommended by Giavarina (2015), the LOA range interpretation should be defined based on “analytical, biological or clinical goals”, thus helping defining the usefulness of the instruments/methods to be tested. Without any similar study to use as reference, some comparisons can be made with a similar protocol and scales used in a resistance exercise recent research (Andrade et al., 2022), where the SD of the FS was also considerably superior to the mean score, thus ensuring that the large LOA obtained may be adequate for this purpose.

The test-retest results are partially expected, and results must be put in perspective for adequate interpretation. It is well supported that individuals differ on the intensity of exercise they prefer and tolerate (Ekkekakis et al., 2005a; Hall et al., 2014; Teixeira et al., 2022), and depict at some point when doing a given intensity an interindividual response on the affective response, which reflects for some a decrease in pleasure, and for others the opposite response (Evmenenko & Teixeira, 2020; Ladwig et al., 2017). Additionally, given that the exercise intensity was defined through an indication of the individually local discomfort felt during the stretch, it is expected that some minor variations should exist in the degree of stretch between the sessions and among participants, an issue that future study designs could try to address. Furthermore, and despite intended, not all individuals performed the two days evaluations at approximately the same hour. It is reasonable to expect that, given previous exploration on the topic, the ability to stretch could receive minor influences of the circadian rhythm variation (Gifford, 1987). Globally, these factors could help explain part of the variability of the FS and FAS scores obtained. Nonetheless, in general, agreement results tend to support the reliability of the scales and methods and seem in line with the variation expected in affective valence and arousal responses across time and intensity, and thus help to partially confirm the third hypothesis which postulated that the affective response assessments would present temporal stability.

2.4.5. Limitations and future directions

Although the present study pushed forward the understanding of affective responses measurement in stretching activities, some limitations and future research efforts must be presented. Regarding the sample characteristics, it must be noted that only apparently healthy and experienced exercisers were enrolled. This warrant caution when extrapolating results for other populations. For example, limitations related to musculoskeletal pain may mask or alter the interpretation of the FS/FAS scores, and exercise in(experience) may present a higher magnitude of the dose-effect relation with lower intensities, something this study could not ascertain.

Another issue that could deserve some attention relates to this study design. First, an objectively measured stretching intensity through, for example, goniometry, could be used for assessing and monitoring the respective range of motion for a given intensity, thus ensuring that the intended intensities are being experienced. Additionally, a cross-over design could be potentially relevant. In this study, the intensities started always from light to moderate to vigorous. Doubts can be raised if an inverted intensity approach would depict the same results. Moreover, the order of exercises, the type of muscles (larger muscle groups vs. smaller muscle groups), and type of stretching (static vs. dynamic; active vs. passive; individually performed vs. in a group class), need to be considered in future efforts on the topic.

On a final possible limitation, it is noteworthy that although trained and acquainted with the stretching techniques used, participants may have controlled the intensity applied during vigorous stretching, as mean values only seldom reached negative values. This may suggest that most of the participants remained in their “comfort zone” during vigorous intensity stretching. Although it is not common to see very low FS and very high FAS scores simultaneously (for a review, see (Ekkekakis et al., 2011; Evmenenko & Teixeira, 2020), in addition to a more objectively applied intensity, the addition of an assessment on the degree or proximity to the maximal effort on the task may help shed some light on this issue.

2.5. Conclusion

In conclusion, the timing of assessment in stretching activities matters. Present results suggest that an affective rebound was observed in all intensities, although its magnitude was superior in vigorous intensity stretching exercises. For adequate assessment of core affect, measurements must be made during the stretch. Results also supported the scales and method reliability.

2.6 References

- Andrade, A. J., Ekkekakis, P., Evmenenko, A., Monteiro, D., Rodrigues, F., Cid, L., & Teixeira, D. S. (2022, 2022/09/01/). Affective responses to resistance exercise: Toward a consensus on the timing of assessments. *Psychology of Sport and Exercise*, 62, 102223. <https://doi.org/https://doi.org/10.1016/j.psychsport.2022.102223>
- Apostolopoulos, N., Metsios, G. S., Flouris, A. D., Koutedakis, Y., & Wyon, M. A. (2015). The relevance of stretch intensity and position-a systematic review. *Front Psychol*, 6, 1128. <https://doi.org/10.3389/fpsyg.2015.01128>
- Bastos, V., Andrade, A. J., Rodrigues, F., Monteiro, D., Cid, L., & Teixeira, D. S. (2022, 2022/08/03). Set to fail: Affective dynamics in a resistance training program designed to reach muscle concentric failure [<https://doi.org/10.1111/sms.14222>]. *Scandinavian Journal of Medicine & Science in Sports*, n/a(n/a). <https://doi.org/https://doi.org/10.1111/sms.14222>
- Behm, D. G., Blazevich, A. J., Kay, A. D., & McHugh, M. (2016, Jan). Acute effects of muscle stretching on physical performance, range of motion, and injury incidence in healthy active individuals: a systematic review. *Appl Physiol Nutr Metab*, 41(1), 1-11. <https://doi.org/10.1139/apnm-2015-0235>
- Berchtold, A. (2016, 2016/01/01). Test–retest: Agreement or reliability? *Methodological Innovations*, 9, 2059799116672875. <https://doi.org/10.1177/2059799116672875>
- Brito, H., Teixeira, D., & Araújo, D. (2022, 08/20). Translation and Construct Validity of the Feeling Scale and the Felt Arousal Scale in Portuguese Recreational Exercisers. *Cuadernos de Psicología del Deporte*, 22(3), 103-113. <https://doi.org/10.6018/cpd.514061>
- Casonatto, J., & Yamacita, C. M. (2020, Jan). Pilates exercise and postural balance in older adults: A systematic review and meta-analysis of randomized controlled trials. *Complement Ther Med*, 48, 102232. <https://doi.org/10.1016/j.ctim.2019.102232>
- Cavarretta, D. J., Hall, E. E., & Bixby, W. R. (2019). Affective Responses From Different Modalities of Resistance Exercise: Timing Matters! *Front Sports Act Living*, 1, 5. <https://doi.org/10.3389/fspor.2019.00005>
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associate.
- Cruz-Ferreira, A., Fernandes, J., Laranjo, L., Bernardo, L. M., & Silva, A. (2011, Dec). A systematic review of the effects of pilates method of exercise in healthy people. *Arch Phys Med Rehabil*, 92(12), 2071-2081. <https://doi.org/10.1016/j.apmr.2011.06.018>
- DiGiacomo, M., Lam, P., Roberts, B. L., Lau, T. C., Song, R., & Davidson, P. M. (2010, Dec). Exploring the reasons for adherence to t'ai chi practice. *J Altern Complement Med*, 16(12), 1245-1246. <https://doi.org/10.1089/acm.2010.0510>
- Duda, J. (1998). *Advances in sport and exercise psychology measurement*. Fitness Information Technology.

- Edwards, M. K., Rhodes, R. E., Mann, J. R., & Loprinzi, P. D. (2018, 03 15). Effects of acute aerobic exercise or meditation on emotional regulation. *Physiol Behav*, 186, 16-24. <https://doi.org/10.1016/j.physbeh.2017.12.037>
- Ekkekakis, P., Hall, E., & Petruzzello, S. (2005a, 01 Sep. 2005). Some like It Vigorous: Measuring Individual Differences in the Preference for and Tolerance of Exercise Intensity. *Journal of Sport and Exercise Psychology*, 27(3), 350-374. <https://doi.org/10.1123/jsep.27.3.350>
- Ekkekakis, P., Hall, E. E., & Petruzzello, S. J. (2005b, May). Variation and homogeneity in affective responses to physical activity of varying intensities: an alternative perspective on dose-response based on evolutionary considerations. *J Sports Sci*, 23(5), 477-500. <https://doi.org/10.1080/02640410400021492>
- Ekkekakis, P., Parfitt, G., & Petruzzello, S. J. (2011, Aug). The pleasure and displeasure people feel when they exercise at different intensities: decennial update and progress towards a tripartite rationale for exercise intensity prescription. *Sports Med*, 41(8), 641-671. <https://doi.org/10.2165/11590680-000000000-00000>
- Ekkekakis, P., & Petruzzello, S. J. (2002, 2002/01/01/). Analysis of the affect measurement conundrum in exercise psychology: IV. A conceptual case for the affect circumplex. *Psychology of Sport and Exercise*, 3(1), 35-63. [https://doi.org/https://doi.org/10.1016/S1469-0292\(01\)00028-0](https://doi.org/https://doi.org/10.1016/S1469-0292(01)00028-0)
- Evmenenko, A., & Teixeira, D. S. (2020). The circumplex model of affect in physical activity contexts: a systematic review. *International Journal of Sport and Exercise Psychology*, 1-34. <https://doi.org/10.1080/1612197X.2020.1854818>
- Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G* Power 3.1: Tests for correlation and regression analyses. *Behavior research methods*, 41(4), 1149-1160.
- Giavarina, D. (2015). Understanding bland altman analysis. *Biochemia medica*, 25(2), 141-151.
- Gifford, L. S. (1987, 1987/01/01/). Circadian Variation in Human Flexibility and Grip Strength. *Australian Journal of Physiotherapy*, 33(1), 3-9. [https://doi.org/https://doi.org/10.1016/S0004-9514\(14\)60579-1](https://doi.org/https://doi.org/10.1016/S0004-9514(14)60579-1)
- Hagins, M., Moore, W., & Rundle, A. (2007, Nov 30). Does practicing hatha yoga satisfy recommendations for intensity of physical activity which improves and maintains health and cardiovascular fitness? *BMC Complement Altern Med*, 7, 40. <https://doi.org/10.1186/1472-6882-7-40>
- Hall, E. E., Petruzzello, S. J., Ekkekakis, P., Miller, P. C., & Bixby, W. R. (2014). Role of self-reported individual differences in preference for and tolerance of exercise intensity in fitness testing performance. *The Journal of Strength & Conditioning Research*, 28(9), 2443-2451.

- Hamlyn-Williams, C. C., Tempest, G., Coombs, S., & Parfitt, G. (2015). Can previously sedentary females use the feeling scale to regulate exercise intensity in a gym environment? an observational study. *BMC Sports Sci Med Rehabil*, 7, 30. <https://doi.org/10.1186/s13102-015-0023-8>
- Hardy, C. J., & Rejeski, W. J. (1989). Not what, but how one feels: The measurement of affect during exercise. *Journal of Sport and Exercise Psychology*, 11(3), 304 – 317. <https://doi.org/https://doi.org/10.1123/jsep.11.3.304>
- Henriques, L., & Teixeira, D. (in review). Affective Valence and Activation in Stretching Activities: a Systematic Review. *Perceptual and Motor Skills*.
- Koo, T. K., & Li, M. Y. (2016, Jun). A Guideline of Selecting and Reporting Intraclass Correlation Coefficients for Reliability Research. *J Chiropr Med*, 15(2), 155-163. <https://doi.org/10.1016/j.jcm.2016.02.012>
- Ladwig, M. A., Hartman, M. E., & Ekkekakis, P. (2017). AFFECT-BASED EXERCISE PRESCRIPTION: An Idea Whose Time Has Come? *ACSM's Health & Fitness Journal*, 21(5). https://journals.lww.com/acsm-healthfitness/Fulltext/2017/09000/AFFECT_BASED_EXERCISE_PRESCRIPTION_An_Idea_Whose.6.aspx
- Miyamoto, G. C., Costa, L. O., & Cabral, C. M. (2013, 2013 Nov-Dec). Efficacy of the Pilates method for pain and disability in patients with chronic nonspecific low back pain: a systematic review with meta-analysis. *Braz J Phys Ther*, 17(6), 517-532. <https://doi.org/10.1590/S1413-35552012005000127>
- Rhodes, R. E., & Kates, A. (2015). Can the Affective Response to Exercise Predict Future Motives and Physical Activity Behavior? A Systematic Review of Published Evidence. *Annals of Behavioral Medicine*, 49(5), 715-731. <https://doi.org/10.1007/s12160-015-9704-5>
- Riebe, D., Ehrman, J., Liguori, G., Magal, M., & American College of Sports Medicine. (2018). *ACSM's guidelines for exercise testing and prescription* (W. Kluwer, Ed. 10th ed.).
- Rose, E. A., & Parfitt, G. (2008). Can the Feeling Scale Be Used to Regulate Exercise Intensity? *Medicine & Science in Sports & Exercise*, 40(10). https://journals.lww.com/acsm-msse/Fulltext/2008/10000/Can_the_Feeling_Scale_Be_Used_to_Regulate_Exercise.19.aspx
- Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology*, 39(6), 1161-1178. <https://doi.org/10.1037/h0077714>
- Russell, J. A. (2003, Jan). Core affect and the psychological construction of emotion. *Psychol Rev*, 110(1), 145-172. <https://doi.org/10.1037/0033-295x.110.1.145>
- Russell, J. A., Weiss, A., & Mendelsohn, G. A. (1989). Affect Grid: A single-item scale of pleasure and arousal. *Journal of Personality and Social Psychology*, 57(3), 493-502. <https://doi.org/10.1037/0022-3514.57.3.493>

- Segar, M. L., Marques, M. M., Palmeira, A. L., & Okely, A. D. (2020, 11 04). Everything counts in sending the right message: science-based messaging implications from the 2020 WHO guidelines on physical activity and sedentary behaviour. *Int J Behav Nutr Phys Act*, 17(1), 135. <https://doi.org/10.1186/s12966-020-01048-w>
- Stevens, C. J., Baldwin, A. S., Bryan, A. D., Conner, M., Rhodes, R. E., & Williams, D. M. (2020, 2020-December-01). Affective Determinants of Physical Activity: A Conceptual Framework and Narrative Review [Review]. *Frontiers in Psychology*, 11. <https://doi.org/10.3389/fpsyg.2020.568331>
- Sullivan, M., Carberry, A., Evans, E. S., Hall, E. E., & Nepocatych, S. (2019, 10). The effects of power and stretch yoga on affect and salivary cortisol in women. *J Health Psychol*, 24(12), 1658-1667. <https://doi.org/10.1177/1359105317694487>
- Svebak, S., & Murgatroyd, S. (1985). Metamotivational Dominance. A Multimethod validation of Reversal Theory constructs. *Journal of Personality and Social Psychology*. 48(1), 107 – 116. <https://doi.org/https://doi.org/10.1037/0022-3514.48.1.107>
- Teixeira, D. S., Rodrigues, F., Cid, L., & Monteiro, D. (2022). Enjoyment as a Predictor of Exercise Habit, Intention to Continue Exercising, and Exercise Frequency: The Intensity Traits Discrepancy Moderation Role. *Front Psychol*, 13, 780059. <https://doi.org/10.3389/fpsyg.2022.780059>
- Unick, J. L., Strohacker, K., Papandonatos, G. D., Williams, D., O'Leary, K. C., Dorfman, L., Becofsky, K., & Wing, R. R. (2015, Oct). Examination of the Consistency in Affective Response to Acute Exercise in Overweight and Obese Women. *J Sport Exerc Psychol*, 37(5), 534-546. <https://doi.org/10.1123/jsep.2015-0104>
- Wang, C., Bannuru, R., Ramel, J., Kupelnick, B., Scott, T., & Schmid, C. H. (2010). Tai Chi on psychological well-being: systematic review and meta-analysis. *BMC complementary and alternative medicine*, 10, 23-23. <https://doi.org/10.1186/1472-6882-10-23>
- Warburton, D. E. R., & Bredin, S. S. D. (2016, 2016/04/01/). Reflections on Physical Activity and Health: What Should We Recommend? *Canadian Journal of Cardiology*, 32(4), 495-504. <https://doi.org/https://doi.org/10.1016/j.cjca.2016.01.024>
- Warburton, D. E. R., & Bredin, S. S. D. (2017). Health benefits of physical activity: a systematic review of current systematic reviews. *Current Opinion in Cardiology*, 32(5). https://journals.lww.com/co-cardiology/Fulltext/2017/09000/Health_benefits_of_physical_activity_a_systematic.10.aspx
- Wickham, H., Chang, W., Henry, L., Pedersen, T. L., Takahashi, K., Wilke, C., Woo, K., Yutani, H., Dunnington, D., & RStudio. (2022). *ggplot2: Create Elegant Data Visualisations Using the Grammar of Graphics*. In (Version 3.3.6)
- Wieland, L. S., Cramer, H., Lauche, R., Verstappen, A., Parker, E. A., & Pilkington, K. (2021, 2021/08/01/). Evidence on yoga for health: A bibliometric analysis of systematic

reviews. *Complementary Therapies in Medicine*, 60, 102746.
<https://doi.org/https://doi.org/10.1016/j.ctim.2021.102746>

Williams, D. M. (2008, Oct). Exercise, affect, and adherence: an integrated model and a case for self-paced exercise. *J Sport Exerc Psychol*, 30(5), 471-496.
<https://doi.org/10.1123/jsep.30.5.471>

World Health Organization. (2020). *Physical activity*. Retrieved 16/3/2021 from
<https://www.who.int/news-room/fact-sheets/detail/physical-activity>

General Discussion

The study of core affect has been gaining popularity among exercise psychologists as a central aspect of behavior maintenance/change (Ekkekakis & Petruzzello, 2000). It is suggested that affective responses, especially those during exercise, may be key constructs in behavior-change strategies for effective PA promotion (Chen et al., 2020; Rhodes & Kates, 2015). Researchers have made progress in identifying different and relevant aspects related with affective responses like the exercise intensity dose-response, the individual differences that moderate this relationship, and the role of cognitive and interoceptive factors (i.e., mechanoreceptors, baroreceptors, thermoreceptors) (Ekkekakis, 2003; Ekkekakis et al., 2005; Ekkekakis & Lind, 2006), after addressing several significant conceptual and methodological challenges (Ekkekakis et al., 2020). In the process, it has become clear that the exercise-effect relationship involves more than just the "feel-better" effect. This effect is less prevalent and robust than previously thought, otherwise most people were to be active (Ekkekakis et al., 2020). Despite that the health benefits of regular PA are well established, more than a quarter of the adult population in the world is not sufficiently active (World Health Organization, 2020). In Portugal, recent data suggests that 73% of the populations never exercises or play sport (Eurobarometer, 2022), which leads to an annual estimated cost of approximately 900 million euros (Serviço Nacional de Saúde, 2017).

Our starting point in this dissertation were early research findings on the affective responses that accompany bouts of exercise. One major limitation highlighted by several authors was that only a limited number of exercise modalities had been studied so far (Evmenenko & Teixeira, 2020). Due to the different exercise protocols (e.g., group activities) and the variety of fitness modalities, a better understanding of the evidence in the use and usefulness of the FS and FAS scales in a broad range of modalities remains relevant (Evmenenko & Teixeira, 2020). Attending to the popularity of stretching activities such as Yoga, Pilates, Tai-Chi and Stretching, we critically revised methodological elements that characterized the available research, and eventually added important considerations to the assessment, timing, intensity, and the need to appreciate individual variability when measuring affect during and immediately after stretching exercises. In the following paragraphs, we will critically contextualize our contributions to this field of research and explore future directions.

1. Assessment of Affect

One of the advantages of single-item measures is their ability to be employed repeatedly throughout a session without overloading the individual. The use of the single-item Rating of Perceived Exertion (Borg, 1982) is one good example. Despite the usefulness and feasibility of FS and FAS that this work demonstrated, there are other instruments to measure the affective response that should be considered as well. The Affect Grid (Russell et al., 1989) is a 9 by 9 grid, with the horizontal dimension representing valence and the vertical dimension representing the degree of perceived activation. However, as a limitation, this measure has been used in only a few studies. The Self-Assessment Manikin (Lang et al., 1980), is a computer-based interactive graphical instrument for the assessment of pleasure, arousal, and dominance. The SAM is widely used in psychophysiological research, and it has been proposed for cross-cultural study because it uses generally recognizable cues and representations rather than linguistic descriptors (Morris, 1995). Overall, the FS and the FAS have a more conventional rating-scale format which may prove more practical for a wider range of individuals (Ekkekakis & Petruzzello, 2000); the trajectory of the affective responses can be plotted to the circumplex model; and emerging studies have made use of technology that allow participants to answer the FS and the FAS to bouts of PA in real time and in their natural living environments, through the use of ecological momentary assessment (Stevens et al., 2020).

2. Timing of Measurements

The present results recommend that FS and FAS should be applied during stretching exercises. Although previous guidelines emphasise the importance of measuring affective responses as close to the activity as possible (Ekkekakis et al., 2011; Hardy & Rejeski, 1989), one of the main issues detected in the systematic review developed for this dissertation was that the measurements were performed only before and/or after the stretch. Other important issue was the high heterogeneity in the methodological procedures among studies (i.e., when, and how many times should the measurements be performed). The present findings brought clarity to the procedures, as the reliability and agreement of the affective responses were demonstrated and it can be suggested that one measurement *during* the stretch may be sufficient to measure core affect when there is prior training from the intervenients (i.e., researcher and practitioner). This adds new recommendations to the existing literature in aerobic (Ekkekakis et al., 2011) and resistance modes of exercise (Andrade et al., 2022).

3. Standardization of Exercise Intensity

The findings of the quasi-experimental study suggest that affect may be a useful tool to control muscular stretching intensity, just like it has been shown in aerobic exercise (Hamlyn-Williams et al., 2015; Rose & Parfitt, 2008). As affect is suggested to be related with adherence (Landuyt et al., 2000; Williams et al., 2008), one aspect to be taken into consideration by exercise professionals is the refinement of the intensity into a more pleasant response that may potentially increase adherence rates (Rose & Parfitt, 2008). It seems that a light or moderate intensity will not significantly influence the affective response of the participants, but a vigorous intensity is related with a less positive response, as suggested by FS scores.

4. Individual Variability

One consequence of examining the link between exercise and affect with the assumption of a generalized “feel better” effect, was the use of a general linear model analysis, where variance for subject variations within the group were treated as statistical errors (Ekkekakis et al., 2020). Nonetheless, studies utilizing repeated measurement analysis began to show a pattern of individual heterogeneity in response trajectories (Backhouse et al., 2007; Landuyt et al., 2000), where at some point from a given intensity a decrease in pleasure can happen for some and the opposite response for others, in a rhythm and magnitude dependent on individual characteristics (Ekkekakis et al., 2011; Evmenenko & Teixeira, 2020; Ladwig et al., 2017). The use of only pre- to post-evaluation protocols may have induced researchers to ignore this variability, raising some misconceptions. This was shown in a study by Landuyt (2000), where the average did not represent the response pattern of an individual. Although the mean ratings of affective valence remained stable during exercise, almost half of the individuals experienced progressive improvement, while the other half experienced progressive deterioration. Thus, it was initially thought that the exercise stimulus had no impact on affective valence.

Our findings confirm the prevalence of high inter-individual variability as suggested by the high SD and moderate %CI, particularly at light and moderate intensities. Future studies should direct efforts to uncover the behavioral/physiological bases of this variability.

Although current international guidelines (ACSM, 2021) suggest exercisers to find the variables that lead to a positive affective response, they do not specify the procedures to do so (which instruments to use; when and how often should be assessed; or the type of exercise).

The second study concretely supports the resolution of this limitation as its findings add important information regarding the procedures in the of affective responses in stretching exercises. This may be useful for exercise professionals to adjust and refine their exercise prescription and be helpful to create successful public health initiatives aimed at promoting PA strategies for sustained behavioral modifications. As affective responses to PA are determinant of future PA, understanding how to perform these measurements is key to promote a sustainable exercise practice.

General Conclusion

Behavioural modifications continue to be one of the main obstacles when it comes to increase PA levels. The study of affective responses may complement other current behavioural change models, allowing the creation of more effective sustainable exercise adherence strategies and consequently their application may be helpful to increase PA levels and promote public health. This dissertation showed that although the assessment of core affect in stretching-related activities lack methodological support, the FS and FAS appear to be feasible and reliable in this exercise mode. It was also shown that the timing of assessment in stretching activities matters and an affective rebound was observed in all intensities, although its magnitude was superior in vigorous stretching exercises.

References

- ACSM. (2021). *ACSM's guidelines for exercise testing and prescription*. (11th ed.). Lippincott Williams & Wilkins.
- Andrade, A. J., Ekkekakis, P., Evmenenko, A., Monteiro, D., Rodrigues, F., Cid, L., & Teixeira, D. S. (2022, 2022/09/01/). Affective responses to resistance exercise: Toward a consensus on the timing of assessments. *Psychology of Sport and Exercise*, 62, 102223. <https://doi.org/https://doi.org/10.1016/j.psychsport.2022.102223>
- Backhouse, S. H., Ekkekakis, P., Bidle, S. J., Foskett, A., & Williams, C. (2007, Aug). Exercise makes people feel better but people are inactive: paradox or artifact? *J Sport Exerc Psychol*, 29(4), 498-517. <https://doi.org/10.1123/jsep.29.4.498>
- Borg, G. A. (1982). Psychophysical bases of perceived exertion. *Medicine & Science in Sports & Exercise*, 14(5), 377–381.
- Chen, C., Finne, E., Kopp, A., & Jekauc, D. (2020). Can Positive Affective Variables Mediate Intervention Effects on Physical Activity? A Systematic Review and Meta-Analysis. *Frontiers in psychology*, 11, 587757-587757. <https://doi.org/10.3389/fpsyg.2020.587757>
- Ekkekakis, P. (2003, Mar). Pleasure and displeasure from the body: Perspectives from exercise. *Cogn Emot*, 17(2), 213-239. <https://doi.org/10.1080/02699930302292>
- Ekkekakis, P., Hall, E. E., & Petruzzello, S. J. (2005, May). Variation and homogeneity in affective responses to physical activity of varying intensities: an alternative perspective on dose-response based on evolutionary considerations. *J Sports Sci*, 23(5), 477-500. <https://doi.org/10.1080/02640410400021492>
- Ekkekakis, P., Hartman, M. E., & Ladwig, M. A. (2020). Affective Responses to Exercise. In *Handbook of Sport Psychology* (pp. 231-253). <https://doi.org/https://doi.org/10.1002/9781119568124.ch12>
- Ekkekakis, P., & Lind, E. (2006, Apr). Exercise does not feel the same when you are overweight: the impact of self-selected and imposed intensity on affect and exertion. *Int J Obes (Lond)*, 30(4), 652-660. <https://doi.org/10.1038/sj.ijo.0803052>
- Ekkekakis, P., Parfitt, G., & Petruzzello, S. J. (2011, Aug). The pleasure and displeasure people feel when they exercise at different intensities: decennial update and progress towards a tripartite rationale for exercise intensity prescription. *Sports Med*, 41(8), 641-671. <https://doi.org/10.2165/11590680-000000000-00000>
- Ekkekakis, P., & Petruzzello, S. J. (2000, 2000/10/01/). Analysis of the affect measurement conundrum in exercise psychology: I. Fundamental issues. *Psychology of Sport and Exercise*, 1(2), 71-88. [https://doi.org/https://doi.org/10.1016/S1469-0292\(00\)00010-8](https://doi.org/https://doi.org/10.1016/S1469-0292(00)00010-8)
- Eurobarometer. (2022). *Eurobarómetro Desporto e Atividade Física 2022*. Directorate-General for Communication. Retrieved 02/11/2022 from

- Evmenenko, A., & Teixeira, D. S. (2020). The circumplex model of affect in physical activity contexts: a systematic review. *International Journal of Sport and Exercise Psychology*, 1-34. <https://doi.org/10.1080/1612197X.2020.1854818>
- Hamlyn-Williams, C. C., Tempest, G., Coombs, S., & Parfitt, G. (2015). Can previously sedentary females use the feeling scale to regulate exercise intensity in a gym environment? an observational study. *BMC Sports Sci Med Rehabil*, 7, 30. <https://doi.org/10.1186/s13102-015-0023-8>
- Hardy, C. J., & Rejeski, W. J. (1989). Not what, but how one feels: The measurement of affect during exercise. *Journal of Sport and Exercise Psychology*, 11(3), 304 – 317. <https://doi.org/https://doi.org/10.1123/jsep.11.3.304>
- Ladwig, M. A., Hartman, M. E., & Ekkekakis, P. (2017). AFFECT-BASED EXERCISE PRESCRIPTION: An Idea Whose Time Has Come? *ACSM's Health & Fitness Journal*, 21(5). https://journals.lww.com/acsm-healthfitness/Fulltext/2017/09000/AFFECT_BASED_EXERCISE_PRESCRIPTION_An_Idea_Whose.6.aspx
- Landuyt, L., Ekkekakis, P., Hall, E., & Petruzzello, S. (2000, 09/01). Throwing the Mountains into the Lakes: On the Perils of Nomothetic Conceptions of the Exercise-Affect Relationship. *Journal of Sport and Exercise Psychology*, 22, 208-234. <https://doi.org/10.1123/jsep.22.3.208>
- Lang, P., Sidowski, J., Johnson, J., & Williams, T. (1980). *Technology in mental health care delivery systems*.
- Morris, J. D. (1995). Observations: SAM: the Self-Assessment Manikin; an efficient cross-cultural measurement of emotional response. *Journal of advertising research*, 35(6), 63-68.
- Rhodes, R. E., & Kates, A. (2015). Can the Affective Response to Exercise Predict Future Motives and Physical Activity Behavior? A Systematic Review of Published Evidence. *Annals of Behavioral Medicine*, 49(5), 715-731. <https://doi.org/10.1007/s12160-015-9704-5>
- Rose, E. A., & Parfitt, G. (2008). Can the Feeling Scale Be Used to Regulate Exercise Intensity? *Medicine & Science in Sports & Exercise*, 40(10). https://journals.lww.com/acsm-msse/Fulltext/2008/10000/Can_the_Feeling_Scale_Be_Used_to_Regulate_Exercise.19.aspx
- Russell, J. A., Weiss, A., & Mendelsohn, G. A. (1989). Affect Grid: A single-item scale of pleasure and arousal. *Journal of Personality and Social Psychology*, 57(3), 493-502. <https://doi.org/10.1037/0022-3514.57.3.493>
- Serviço Nacional de Saúde. (2017). *O custo da inatividade física*. Retrieved 16/3/2021 from <https://www.sns.gov.pt/noticias/2017/02/13/prevencao-do-sedentarismo/>

- Stevens, C. J., Baldwin, A. S., Bryan, A. D., Conner, M., Rhodes, R. E., & Williams, D. M. (2020, 2020-December-01). Affective Determinants of Physical Activity: A Conceptual Framework and Narrative Review [Review]. *Frontiers in Psychology*, 11. <https://doi.org/10.3389/fpsyg.2020.568331>
- Williams, D. M., Dunsiger, S., Ciccolo, J. T., Lewis, B. A., Albrecht, A. E., & Marcus, B. H. (2008, May). Acute Affective Response to a Moderate-intensity Exercise Stimulus Predicts Physical Activity Participation 6 and 12 Months Later. *Psychol Sport Exerc*, 9(3), 231-245. <https://doi.org/10.1016/j.psychsport.2007.04.002>
- World Health Organization. (2020). *Physical activity*. Retrieved 16/3/2021 from <https://www.who.int/news-room/fact-sheets/detail/physical-activity>

Attachments

CARTA EXPLICATIVA DO ESTUDO AOS PARTICIPANTES E CONSENTIMENTO INFORMADO

A Faculdade de Educação Física e Desporto da Universidade Lusófona gostaria de o convidar a participar num estudo que terá como objetivo analisar a resposta afetiva no treino de flexibilidade. A informação recolhida neste estudo poderá, no futuro, ajudar no desenho de estratégias eficientes que contribuam para a saúde e bem-estar das populações. Para participar neste estudo deverá ser praticante regular de exercício físico e não ter limitações de saúde associadas à sua prática. Atletas ou praticantes de treinos diários orientados para alongamento/flexibilidade não são adequados para este estudo.

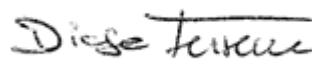
O estudo consistirá na realização de alguns exercícios de flexibilidade, num estúdio de aulas de grupo. A duração de cada sessão (2 no total) será, aproximadamente, de 20 min. Não se antecipam problemas ou desvantagens pessoais com a participação no estudo. Poderá existir algum desconforto físico ou dores musculares pós-atividade como resultado dos exercícios realizados, expectáveis como resultado normal de um processo de treino muscular.

Este estudo seguirá as recomendações de diversas entidades internacionais e de autores de referência para garantir a realização de uma intervenção segura e com o menor risco possível. No entanto, existe sempre na prática desportiva o risco de lesão. Se sentir que o presente estudo pode colocar em risco a sua saúde, por favor dê indicação aos investigadores sobre essa situação e sinta-se livre de não participar no estudo.

Se decidir participar no estudo, poderá abandonar o mesmo em qualquer momento sem ter que fornecer qualquer tipo de explicação. Todo o material recolhido será codificado e tratado de forma anónima e confidencial.

Os resultados do estudo serão apresentados apenas para divulgação científica, nunca sendo os participantes identificados de forma individual.

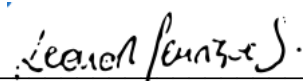
Caso surja alguma dúvida, ou necessite de informação adicional, por favor contacte pessoalmente ou através do email o responsável do estudo:



Professor Doutor Diogo S. Teixeira

(diogo.teixeira@ulusofona.pt)

A mestrandia:



(Leonor Henriques)

DECLARAÇÃO DE CONSENTIMENTO INFORMADO

Reconheço que os procedimentos de investigação descritos na carta anexa me foram explicados e que todas as minhas questões foram esclarecidas de forma satisfatória. Compreendo igualmente que a participação no estudo não acarreta qualquer tipo de potenciais desvantagens para além das enunciadas na carta explicativa.

Fui informado que tenho o direito a recusar participar e que a minha recusa em o fazer não terá consequências para mim. Compreendo que tenho o direito de colocar agora e durante o desenvolvimento do estudo, qualquer questão relacionada com o mesmo. Compreendo que sou livre de, a qualquer momento, abandonar o estudo sem ter de fornecer qualquer explicação.

Assim, declaro que aceito participar nesta investigação, com a salvaguarda da confidencialidade e anonimato e sem prejuízo pessoal de cariz ético ou moral.

Profissional do Exercício responsável pelo estudo:



(Professor Doutor Diogo S. Teixeira)

O Participante:

_____, ____ de _____ de 2021

1. ESCALA DE SENSAÇÃO (PRAZER/DESPRAZER: FEELINGS SCALE)

ESCOLHA O NÚMERO QUE MELHOR REFLETE COMO SE ESTÁ A SENTIR NESTE MOMENTO?

?

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MUITO MAL		MAL	RELATIVAMENTE MAL	NEUTRO	RELATIVAMENTE BEM	BEM		BEM	MUITO BEM	

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2. ESCALA DE ATIVAÇÃO (ELTAROUSAL SCALE)

QUANTO ATIVADO ESTÁ NESTE MOMENTO?

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?	POUCO ATIVADO	1	RELAXAMENTO; ABORRECIDO; CALMO
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