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Stephanie Jeckel · Gorden Sudeck
Institute of Sport Science, Eberhard-Karls University Tübingen, Tübingen, Germany

Sport activities in daily routine

Situational associations between individual goals, activity characteristics, and affective well-being

Introduction

Various meta-analyses have documented the acute positive effects of sport activities on affective well-being (e. g., Reed & Ones, 2006), and these positive effects have proved to be predictors of future activity (Kwan & Bryan, 2010; Bryan, Hutchison, Seals, & Allen, 2007; Ekkekakis, Hall, & Petruzzello, 2005; Carels, Berger, & Darby, 2006). However, the research has increasingly drawn attention to the fact that some people feel unwell after engaging in sport activities and that there exists a substantial interindividual variability regarding the acute effects of sport activities on affective well-being (e. g., Backhouse, Ekkekakis, Biddle, Foskett, & Williams, 2007; Bixby, Spalding, & Hatfield, 2001; Ekkekakis, Parfitt, & Petruzzello, 2011; Sudeck & Conzelmann, 2014; Van Landuyt, Ekkekakis, Hall, & Petruzzello, 2000; Welch, Hully, Ferguson, & Beauchamp, 2007). Therefore, it is important to identify the factors influencing acute changes in affective well-being to gain a clearer understanding of the heterogeneity of affective responses to sport activities (Rose & Parfitt, 2007, 2010). To this end, Sudeck, Schmid, and Conzelmann (2016) have discussed the relevance of within-person differences in affective responses to sport activities. While many studies measure affective responses to sport activities during a single session (e. g., Kwan & Bryan, 2010; Williams, Dunsinger, Jennings, & Marcus, 2012), intraindividual consistency in affective responses over multiple sessions is rarely taken into account. Unick et al. (2015) observed that even for multiple, standardized ergometer sessions and pre/post recording of affective well-being there are substantial within-person differences in the acute effects of sport activities on affective well-being. In particular, not much is known about the factors that determine the within-person situational heterogeneity of affective reactions to sport activities.

The article *The Big Picture of Individual Differences in Physical Activity Behavior Change: A Transdisciplinary Approach* (Bryan et al., 2011) considers the contributions of various influencing factors: a) the characteristics of sport activities (e. g., activity dose), b) physiological reaction to activity (e. g., heart rate or HR), c) subjective experiences (e. g., situational perceived exertion), and d) motivation to exercise (e. g., specific goals). Therefore, when sport activities are part of a daily routine, the manifestation of these factors can be distinguished in different situations. Sport activity in general refers to structured physical activities during leisure time with increased energy expenditures. The term includes more than merely traditional sports, which are often associated with competition and performance, and is neutral relating to underlying behavioral motives (Fuchs, 2001). In this study, a broader range of sport activities is intended, one that includes activities performed for their own sake (fun, enjoyment) or for personal (performance), social (socializing), or health (physical fitness, well-being) reasons (Fuchs, Klaperski, Gerber, & Seelig, 2015). Considering the research deficit, this paper addresses the question of to what extent situational associations in daily routines exist between goals for sport activities, activity characteristics, and affective well-being. The answer to this question can improve understanding of the heterogeneity of affective reactions to sport activities in real-life situations and can therefore be useful for recommendations for the regulation of affective well-being through sport activities and individual behavior change.

Associations between sport activities and affective well-being in real-life situations

Studies capturing affective responses to sport activities not in laboratory settings but in real-life situations are comparatively rare (Liao, Shonkoff, & Dunton, 2015). The studies that do examine real-life situations mostly consider physical activity in general and in terms of basic affect dimensions (Schimmack & Grob, 2000; Wilhelm & Schoebi, 2007) and show that for valence and energetic arousal there are consistent positive effects. Yet, regarding feelings of calmness, the study results are rather inconsistent. When comparing daily physical activity and sport activities undertaken on a daily basis, Jeckel and Sudeck (2016) observed that for sport activities positive effects with high effect sizes on calmness, valence, and energetic arousal. Therefore, sport activities undertaken daily showed rather good potential for positive effects on the three basic affect dimensions. Beyond that, not much is known about the specific activity characteristics that codetermine the potential to regulate one's well-being in real-life situations.

Activity dose is considered an important factor. It is a function of the intensity and duration of a sport activity (McArdle, Katch, & Katch, 2001), and conclusions about sport activity dose and affective change based on either intensity or duration alone may be misleading (He, 1998). In their meta-analysis, Reed and Ones (2006) point out that low[1] and moderate activity doses are positively associated with positive-activated affect after sport activities. In contrast, high and very high activity doses result in at least temporary reductions in positive-activated affect and in greater interindividual heterogeneity. However, many of the studies producing these results were conducted in laboratory settings.

Various studies have shown different effects on affective well-being after sport activities based on the chosen intensity. Studies employing dual-mode theory (DMT; Ekkekakis, 2009) have shown somewhat consistently that most people feel well and activated in activities with moderate intensity (55 to < 70% of the maximum heart rate HR_{max}; Norton, Norton, & Sadgrove, 2010). Yet this effect changes as the intensity exceeds a certain threshold. Therefore, individually heterogeneous well-being occurs with vigorous intensities (70 to < 90% HR_{max}), ranging from pleasant conditions to great discomfort (e. g., Ekkekakis & Acevedo, 2006; Ekkekakis et al., 2011; Schlicht & Reicherz, 2012). However, the results of the meta-analysis by Reed and Ones (2006), which summarizes the results of 158 studies, indicate that, in sum, the effects of low intensity activity (<55% of the HR_{max}) were greater than the effects of moderate and high-intensity activities.

Regarding associations between affective well-being and subjective indicators of intensity in terms of perceived exertion, the findings are less distinct. Sudeck et al. (2016) found no within-person associations between perceived exertion (rate of perceived exertion; RPE) and affective well-being during sport activities when looking at individuals engaging in multiple sport activities. However, there are between-person associations. People who feel they generally get overexerted when engaging in sport activity report more negative well-being on average. In contrast, Guérin, Fortier, and Sweet (2013) analyzed the affective well-being of active women before, immediately after, and three hours after moderate to vigorous physical activity and found positive associations between perceived exertion and positive affect when analyzing close to daily routine. Yet, reliable statements are not possible regarding situational associations between perceived exertion and affect. It seems more likely that other individual factors codetermine these situational associations.

The role of individual goals for sport activities for affective well-being

Individual goals may be a relevant personal factor in the heterogeneity of affective responses to sport activities. One main hypothesis of DMT (Ekkekakis, 2009) is that the variability of affective responses to vigorous intensities particularly depends on cognitive factors in terms of individual goals. It is well established that people engage in sport activities for different reasons (e. g., Lehnert, Sudeck, & Conzelmann, 2011). Explicit motives and goals reflect what people want to accomplish with their intended sport activity. Therefore, this refers to the *goal contents* (Austin & Vancouver, 1996) and contains a high cognitive portion (Heckhausen & Heckhausen, 2006). Furthermore, the consideration of Vallerand's (2007) hierarchical model of motivation and the differentiation of the motives into situational, contextual, and global levels calls attention to a situation-specific view of goals. This may lead to situation-specific associations with affective well-being, as a given outcome should correspond to the level of the goal that produced it.

In their study of active women, Guérin et al. (2013) examined in daily routine the influence of situational motivation for moderate to vigorous physical activity on affective well-being after the activity. They found that intrinsic motivation is positively associated with positive affect immediately after the physical activity. In terms of specific goal contents, there have been relatively few findings to date. Referring to the above-mentioned study (Jeckel & Sudeck, 2016) that found increased calmness to be associated with sport activities compared to daily physical activity, the authors assume that a specific recovery intention distracts from problems and therefore promotes a feeling of calmness. This argument is in line with recovery theories (e. g., Allmer, 1996) that point out the importance of individual intentions of recovery actions in order to gain benefits in affective well-being.

Other studies show that intentional factors are also associated with activity characteristics (e. g., intensity). Duncan, Hall, Wilson, and Jenny (2010) assessed cross-sectional data of 1054 participants via self-report measures relating to their sport activities and behavioral regulation in exercise. The results showed that introjected regulation is positively associated with intensity. The study does not analyze situational associations. Referring to the reported study results, it would be conceivable that specific situational goals also codetermine activity characteristics. For instance, we assume that participants with the specific goal of distracting themselves from acute stress or occupational problems undertake sport activities with greater intensity. However, the current state of research does not permit established knowledge for situation-specific associations.

Research questions

One result of the described research is a stronger focus on intraindividual differences (Unick et al., 2015). The acute effects of sport activity on affective well-being can differ within persons for the same sport activity in laboratory settings. We assume that variations in daily routine may be even greater, and therefore influ-

[1] The categories for the activity doses are as follows (Reed & Ones, 2006): low ≙ 10–30 min of low intensity to 7–20 min of moderate intensity; moderate ≙ 30–40 min of moderate intensity to 20–30 min of high intensity; high ≙ 60–90 min of moderate intensity to 40–60 min of high intensity; very high ≙ 180–1400 min of moderate to 300 min of high intensity.

Abstract · Zusammenfassung

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S. Jeckel · G. Sudeck

Sport activities in daily routine. Situational associations between individual goals, activity characteristics, and affective well-being

Abstract

During the last few years, research interest on interindividual differences in acute affective reactions on sport activities has increased. Moreover, current studies show that besides interindividual differences, substantial intraindividual variations exist. Therefore, we assume that the potential of regulating affective well-being through sport activities varies situationally. This ambulatory assessment study analyzes affective reactions on sport activities in daily routine to identify possible factors for situational variability of changes in affective well-being. First, situational differences in affective well-being (valence, calmness, energetic arousal), goals for sport activities (e.g., regulation of body weight, activation), and activity characteristics (e.g., activity dose, perceived exertion) were analyzed. Second, associations between these parameters and activity characteristics were dissected. Third, associations with affective well-being after sport activities are identified. For 7 days, 25 women and 21 men (M_{age} = 32 years) participated. Activity characteristics were captured objectively (accelerometer, electrocardiogramm). Affective well-being, situational goals, and perceived exertion were gathered via smartphone. Multilevel analyses confirmed situational heterogeneity of affective well-being (e.g., intraclass-coefficient $ICC_{valence}$ = 0.48), situational goals (e.g., $ICC_{activation}$ = 0.59), and activity characteristics (e.g., $ICC_{activity\ dose}$ = 0.21). Furthermore, we observed that higher feelings of calmness and stronger situational goals for body weight and activation are followed by a higher activity dose. This higher activity dose comes along with higher energetic arousal after sport activities, whereas higher perceived exertion is followed by lower feelings of calmness. Study results confirm intraindividual variation of affective well-being, specific goals, and activity characteristics. They emphasize the relevance of situational characteristics for the regulation of affective well-being through sport activities.

Keywords

Ambulatory assessment · Sport activity · Affective well-being · Situational intentions · Physical Exercise

Sportaktivitäten im alltäglichen Handlungsverlauf. Situative Assoziationen zwischen individuellen Zielen, Aktivitätsgestaltung und affektivem Befinden

Zusammenfassung

In den letzten Jahren zeigt sich ein verstärktes Forschungsinteresse an interindividuellen Unterschieden in den akuten affektiven Reaktionen auf Sportaktivitäten. Aktuelle Studien zeigen neben interindividuellen Unterschieden zudem substanzielle intraindividuelle Variationen. Eine Annahme ist daher, dass das befindensregulative Potenzial sportlicher Aktivitäten situativ variiert. Die vorliegende ambulante Assessment-Studie analysiert affektive Reaktionen auf Sportaktivitäten im alltäglichen Handlungsverlauf, um mögliche Einflussfaktoren für situativ variable Befindensveränderungen zu identifizieren. Erstens wird gefragt, welche situativen Unterschiede im affektiven Befinden (Valenz, Ruhe, positive Aktivierung), in individuellen Zielen (z. B. Gewichtsregulation, Aktivierung) sowie bei Aktivitätsparametern (z. B. Aktivitätsdosis, wahrgenommene Anstrengung) bestehen. Zweitens wird geprüft, welche Assoziationen diese Merkmale mit der Gestaltung der Aktivitätsparameter aufweisen. Weitergehend werden drittens Zusammenhänge mit dem affektiven Befinden nach Sportaktivitäten ermittelt. An der Studie nahmen 46 Freizeitsportler (25 Frauen; M_{Alter} = 32) über sieben Tage teil. Aktivitätsparameter wurden objektiv erfasst (Akzelerometrie, Elektrokardiogramm). Affektives Befinden, situative Ziele und wahrgenommene Anstrengung wurden Smartphone-basiert erfragt. Die Ergebnisse mehrebenenanalytischer Regressionsmodelle bestätigten die situative Heterogenität des affektiven Befindens (z. B. Intraclass-Koeffizient ICC_{Valenz} = 0.48), der situativen Ziele (z. B. $ICC_{Aktivierung}$ = 0.59) sowie der Aktivitätsparameter (z. B. $ICC_{Aktivitätsdosis}$ = 0.21). Weiter konnte z. B. beobachtet werden, dass höherem Ruheempfinden und stärker ausgeprägten Zielen zur Gewichtsregulation und Aktivierung eine höhere Aktivitätsdosis folgte. Diese höhere Aktivitätsdosis ging mit einer höheren positiven Aktivierung nach Sportaktivitäten einher. Hingegen fiel bei höherer wahrgenommener Anstrengung das Ruheempfinden nach Sportaktivitäten geringer aus. Die Ergebnisse zeigen, dass affektives Befinden, spezifische Ziele vor der Sportaktivität sowie die Aktivitätsgestaltung intraindividuell variieren. Sie unterstreichen die Bedeutung situativer Merkmale, wenn es um befindensregulatives Potenzial sportlicher Aktivität geht.

Schlüsselwörter

Ambulantes Assessment · Sportliche Aktivität · Affektives Befinden · Situative Intentionen · Aktivitätsdosis

encing factors should be identified close to everyday life, in order to be externally valid. To analyze this complex relationship between situational goals, activity characteristics, and affective well-being, the current study includes multiple sport activities per person, based on the recommendation of Unick et al. (2015). Moreover, real-life situations are required to analyze the relevance of individual and situational goals for sport activities and affective well-being in daily sports routines. This can only occur with a study that examines participants' daily life (see the position paper by Kanning, Ebner-Priemer, & Schlicht, 2013). Therefore, a seven-day ambulant assessment study was undertaken to capture situational information from everyday life relating to affective well-being before and after sport activities, situational goals for sport activities, and activity characteristics.

On this methodological basis, the following specific research questions are posed:

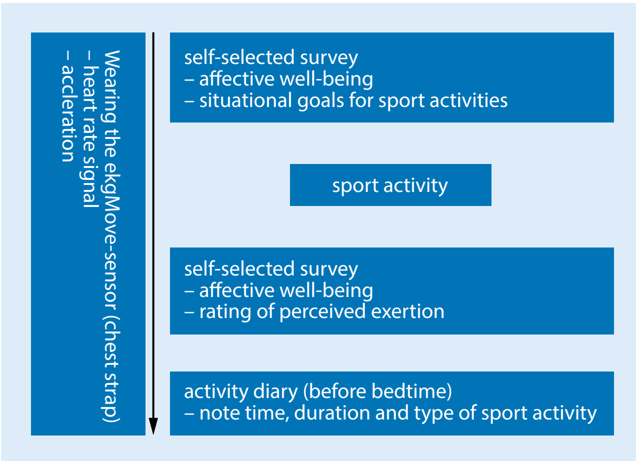

Fig. 1 ◂ Overview of the participants' daily schedule for study days with sport activities

Q1. Research Question 1 considers in a basic analysis the intraindividual variance in people's situational goals for sport activity, activity characteristics (intensity, activity dose, perceived exertion), and affective well-being across multiple sessions of sport activity in participants' daily routines.

Q2. Research Question 2 analyzes associations between situational goals for sport activities, pre-activity affective well-being, and the activity characteristics (intensity, activity dose, perceived exertion). The potential of situational goals and their associations with activity characteristics is explored. Therefore, the existing knowledge of a cross-sectional study that shows introjected regulation is associated with greater intensities could be complemented on a situational level. Moreover, pre-activity affective well-being might be related to the manifestation of activity characteristics.

Q3. Research Question 3 examines associations between activity characteristics, situational goals for sport activities, and affective well-being after sport activities. Existing studies, which are mainly laboratory studies, show positive associations for moderate intensity, negative associations for vigorous intensity, positive associations for low and moderate activity dose, and negative associations for high and very high activity dose. Initial studies indicate that for perceived exertion, associations on between-person level are negative but are positive on within-person level and for intrinsic motivation.

The aim of this study is to assess the transferability of the existing knowledge on situational associations in daily routines and, if applicable, to extend the knowledge.

Methods

Participants

The sample consisted of 25 women and 21 men between 21 and 59 years old (M_{age}= 32 years; SD_{age}= 10.2). Among them were 31 employees (67%), 9 university students working part-time (20%), and 6 university students (13%). A screening questionnaire was used to select suitable participants. It contained the screening regarding the stage model of exercise behavior (the modified and shortened version of the "Stadien Flussdiagramm" by Fuchs (2001)) and sociodemographic data (age, gender, employment status). An inclusion criterion was that participants be young adults or middle-aged adults (older than 18 but not yet retired) and engage in sport activities sporadically or regularly (at least once a week). Individuals were excluded if they were competitive athletes or were enrolled in sports sciences with fixed sport classes. These criteria were chosen because activity-related behavior should not be influenced by a commitment to a competitive team or course requirements.

Design and procedure

Participants were recruited through the individual addresses of the study assistants within the university as well as their private environment. People who met the inclusion and exclusion criteria and who were interested in participating were invited to come to the study office. They usually came to the study office on Fridays and there received written information about the study goals and procedure. According to the declaration of Helsinki, participation was voluntary and participants could withdraw for no reason without incurring any personal disadvantage. After receiving the information, participants gave their written informed consent. Participants did not receive financial compensation or any other reward. For further characterization of the sample, information on sport activity habits (self-report habit index, SRHI; Verplanken & Orbell, 2003) was gathered via questionnaire. Subsequently, the study equipment was handed out, and the study assistants explained and demonstrated its usage. The equipment consisted of a smartphone (including power cable), a printed two-sided activity diary, and a chest strap with an accelerometer and a one-channel electrocardiogram (ECG) with a corresponding charging station. Participants were instructed to take off the accelerometer when sleeping, swimming, or taking a shower. More data (body size and body weight) relevant in analyzing the objective physical activity data later were assessed objectively.[2]

The ambulant assessment study lasted seven days, usually beginning on a Monday morning with putting on the chest strap. The study ended the following Sunday evening at 10:30 p.m. so that data was collected for six days and 15 h. If participants were involved in sport activities on a given day, they had to answer questionnaires on the smartphone prior to the sport activity and immediately afterward. Questions on their situational

[2] The study design and procedure is part of a more extensive ambulant assessment study that contains several processes and analyses relating to different research questions (see also Jeckel & Sudeck, 2016).

goals (SGs) for the sport activity, their affective well-being, and their perceived exertion were included in these questionnaires (for detailed information on the questionnaires used, see the section on measures). Participants were instructed to answer these questions as close in time to the sport activity as possible. Every evening, participants noted in their activity diary if and for how long they had engaged in any sport activity that day. An overview of the participants' daily schedule for study days with sport activity can be found in **Fig. 1**. After the end of the study, participants were invited to the study office to return the study equipment. If any technical problems occurred during the study, participants were able to contact the study assistants and, if necessary, study equipment could be replaced so that participants could continue without any data loss.

All captured data were stored on the smartphone and the combination of ECG and activity sensor data were downloaded to a server by the study assistants. All data were pseudonymized so that data sources of each person were gathered based on a code number. Therefore, it was not possible to draw conclusions about individual participants during the analysis.

Measures

Affective well-being

The current affective state was assessed via smartphone (HTC Touch Diamond T5353) using the software MyExperience (Movisens GmbH, Karlsruhe, Germany). The German short version (Wilhelm & Schoebi, 2007) of the Multidimensional Mood Questionnaire (MDBQ) (Steyer, Schwenkmezger, Notz, & Eid, 1997) was installed on the smartphone. The short version contains two binary pairs of adjectives for valence (VA; *unwell–well*; *discontent–content*), calmness (CA; *tense–relaxed*; *agitated–calm*), and energetic arousal (EA; *tired–awake*; *without energy–full of energy*). The scale was developed and validated especially for assessing affective states in daily life routines. Participants selected either the questionnaire "before sport" or "after sport" and rated their momentary affective state by continuing the sentence "At this moment, I feel …" on a seven-point scale (0–6), so that higher scores indicated higher values for valence, calmness, and energetic arousal. Wilhelm and Schoebi (2007) investigated homogeneity at the between-person and within-person levels. The level-specific reliability coefficients for the between-person level were 0.92 for valence and 0.90 for calmness and energetic arousal. The reliability coefficients for the within-person level were 0.70 for valence and calmness and 0.77 for energetic arousal. Based on this, both reliabilities resulted in satisfactory internal consistencies.

Situational goals

Nine items of the Bernese Motive and Goal Inventory in Leisure and Health Sports (BMZI; Lehnert et al., 2011) were used. It is a reliable and valid instrument that is usually suitable for screening multidimensional motive profiles. We classified the nine items into the original dimensions of the BMZI as follows: health *(… to counteract physical discomfort; … especially because of health reasons)*, body weight *(… to regulate weight)*, distraction/stress regulation *(… to settle my thoughts; … to distract from other problems; … to release anger and petulance; … to release stress)*, and activation *(… especially for enjoyment of body movement; … to replenish energy)*. After selecting the "before sport" questionnaire on the smartphone, participants had to rate the answers for the sentence "At this moment, I am doing sports because …" for each of the nine items on a five-point scale, with answers ranging from *1 = not true at all* to 5 = *completely true*. The mean value of each dimension was used for the statistical analysis when more than one item represented the dimension. Inter-item correlations revealed satisfactory to good internal consistencies for these dimensions (health: $r = 0.46$; distraction/stress regulation: $r = 0.39$–0.71; activation: $r = 0.33$).

Activity characteristics

Sport activity in general was assessed using a paper and pencil activity documentation form that was conceptualized in reference to the questionnaire to assess physical and sport activities (BSA-F; Fuchs et al., 2015). At the end of every day, participants recorded whether they engaged in any sport activity. They received a definition of sport activity (according to the definition of sport activity used in the BSA-F; Fuchs et al., 2015) at the beginning of the study, which was included on the activity diary, to distinguish it from any other daily physical activity. Additionally, the diary contained information on the kind of activity, duration, and time of day. On that basis, we ensured that participants only named sport activities they undertook during their leisure time. Participants named endurance activities (54%), strength and fitness training (e. g., back pain prevention program; 20%), combined endurance and strength training (e. g., Tae Bo; 15%), and team sports (11%). The self-reports were compared to the objectively assessed data of the accelerometer and the heart rate monitor. In doing so, there was no evidence of information that could not be associated with the objective activity data.

The HR and the energy expenditure were collected by a triaxial accelerometer with an ECG sensor (ekgMove, Movisens GmbH, Karlsruhe, Germany) attached to the chest with a strap. Data was stored in one-minute intervals for the relevant time of the sport activities. For the further analyses, HR and metabolic equivalent (MET) were used as medians of the one-minute intervals of the period of sport activities. This measure was used because it is more resistant to statistical outliers than the mean value. As HR represents an age-dependent variable (e. g., Gellish et al., 2007), absolute values cannot be compared for statements on intensity. For that reason, we initially estimated the HR_{max} for each participant based on a validated formula by Gellish et al. (2007). Subsequently, we translated the absolute HR values into a percentage of a person's HR_{max} (% HR_{max}). The captured energy expenditure was calculated in relation to the energy expenditure at rest and converted into METs (for more information, see Anastasopoulou, Tansella, Stumpp, Shammas, & Hey, 2012). In analyzing the research questions, these activity data represent the physiological response as *intensity* (% HR_{max}) and the objective load as *activity dose* (METh) of the sport activi-

Table 1 Distribution of the sport activities of our study sample into the different categories of exercise and physical activity intensity following Norton et al. (2010)

Intensity category	% HR_{max}		MET (median)		Perceived Exertion	
Light	<55% HR_{max}	6.2%	<3 METs	28.8%	RPE: 1–2	8.2%
Moderate	55 < 70% HR_{max}	53.4%	3 < 6 METs	29.5%	RPE: 3–4	35.1%
Vigorous	70 < 90% HR_{max}	39.7%	6 < 9 METs	23.3%	RPE: 5–6	40.3%
High	≥90% HR_{max}	0.7%	≥9 METs	18.5%	RPE: ≥7	16.4%

% HR_{max} percentage of a person's maximum heart rate, *MET* metabolic equivalent as median, *RPE* rating of perceived exertion

ties. For the latter, we calculated the product of intensity (as median MET value of a specific sport activity) and duration. For example, if a person had the median MET value of 4.6 for 70 min of jogging, the activity dose (in METh) was calculated as follows: (4.6 MET × 70 min) / 60 = 5.4 METh.

Moreover, as a *subjective measure of exertion* we collected data using the Rating Scale of Perceived Exertion (RPE). It is used to subjectively quantify an individual's perception of the physical demands of an activity. Answers were given using the Borg CR10 scale (Borg, 1998), with ratings 0 (not at all), 0.5 (very, very light), 1 (very light), 1.5, 2 (light), 2.5, 3 (moderate), 4, 5 (intense), 6, 7 (very intense), 8, 9, and 10 (extremely strong). Therefore, in the "after sports activity" questionnaire on the smartphone, participants answered the question "How exhausting was the sport activity overall?" The CR10 scales have shown reliability and validity for healthy, clinical, and athletic adult populations (Chen, Fan, & Moe, 2002). For descriptive purposes, the activity characteristics are classified according to Norton and colleagues (2010; see **Table 1**).

Data analyses

The analyses for the three research questions were based on multilevel modeling procedures using the statistical program HLM 7.0 (Raudenbush, Bryk, Cheong, Congdon, & du Toit, 2011), which makes it possible to consider the hierarchical structure of the data. The multiple measures of affective well-being, SGs, and characteristics of sport activities define the lower level of the hierarchy (level 1). These components were nested within the subjects who define the higher level of the hierarchy (level 2). A total of 46 participants engaged in 133 sport activities. The number of participants in our sample is close to the recommended number of 50 level 2 units for estimations with fixed effects (Nezlek, Schröder-Abé, & Schütz, 2006). This number of level 2 units is more important for making precise and adequate estimations than a higher number of level 1 units—which is certainly low with 3 units on average in our study (Niall, Stadler, & Laurenceau, 2012). According to Raudenbush and Bryk (2002), the values of our intraclass-coefficients (ICCs) (as displayed in **Table 2**) imply a calculation via multilevel analyses that considers the nested data structure and between-person differences. Using HLM makes it possible to have different numbers of measurements per person (Hoffman & Rovine, 2007). We used restricted maximum likelihood estimations for the multilevel analyses. The α level of the tests was set to $p < 0.05$.

To answer research question Q1, an estimate of the intraclass coefficients was used. For activity characteristics (%HR_{max}, METh, RPE), affective well-being after sport activities (VA, CA, EA), and the SGs for sport activities, an unconditional model without any predictor variables was tested to separate the variance into within- and between-subject sources.

To analyze the associations between affective well-being before sport activities (VA_{pre}, CA_{pre}, EA_{pre}) and the activity characteristics (%HR_{max}, METh, RPE) (research question Q2a), separate models were used for each parameter of the sport activities. We analyzed research question Q2b in the same way but replaced affective well-being before sport with the SGs for sport activities in our model.

For research question Q3a, we analyzed the associations of the activity characteristics (%HR_{max}, METh, RPE) and affective well-being after the sport activities (VA_{post}, CA_{post}, EA_{post}). For research question Q3b, SGs before sport activities were used instead of the activity characteristics. For research questions Q3a and Q3b, separate models were used for each subscale of affective well-being.

Additionally, for questions Q3a/b, we analyzed whether VA_{post}, CA_{post}, or EA_{post} varied as a function of the level 2 predictor, the average level of each affective subscale (MEAN_AWB[3]). The following equations for the hierarchical equations of Q3a are meant as an example (the variables can be replaced as described above for the equations of the models for the other research questions):

$$\text{Level 1}: Y_{ij} = \beta_{0j} + \beta_{1j} * (\%\,HR_{max\,ij}) + \beta_{2j} * (METh_{ij}) + \beta_{3j} * (RPE_{ij}) + r_{ij} \quad (1)$$

$$\text{Level 2}: \beta_{0j} = \gamma_{00} + \gamma_{01} * (MEANAWB_j) + u_{0j} \quad (2)$$

$$\text{Level 2}: \beta_{1j} = \gamma_{10} \quad (3)$$

$$\text{Level 2}: \beta_{2j} = \gamma_{20} \quad (4)$$

$$Level 2: \beta_{3j} = \gamma_{30} \quad (5)$$

Level 1 represents within-subject effects. In Eqs. 1 the subject's response for one of the three basic affect dimensions (VA_{post}, CA_{post}, EA_{post}; Y_{ij}) is represented. The dependent variable Y_{ij} is defined as

[3] We did not control for time of day, as previous analyses (Jeckel & Sudeck, 2016) showed no significance for time of day for acute effects of sport activities on affective well-being. The average levels of the level 2 predictor MEAN_AWB are based on 644 data points for each affective subscale (valence, calmness, energetic arousal). They were calculated for each person using surveys on affective well-being (morning, noon, evening, before going to bed) throughout one week (for detailed information, see Jeckel & Sudeck, 2016).

Table 2 Descriptive parameters of the basic affect dimensions (valence, calmness, energetic arousal) before and after sport, the situational goals, activity characteristics, and corresponding intraclass coefficients (ICC)

	Minimum	Maximum	Mean	SD	ICC
Affective well-being before and after sport activities					
VA_{pre}	1.00	6.00	4.07	1.09	0.48
VA_{post}	2.00	6.00	5.10	0.79	0.41
CA_{pre}	1.50	6.00	3.89	1.18	0.43
CA_{post}	2.00	6.00	4.49	0.98	0.57
EA_{pre}	1.00	6.00	3.81	1.11	0.42
EA_{post}	1.50	6.00	4.33	0.97	0.35
Situational goals for sport activities					
SG_{health}	1.00	5.00	3.34	1.04	0.62
$SG_{bodyweight}$	1.00	5.00	2.95	1.34	0.80
$SG_{distraction/stress\ regulation}$	1.00	5.00	2.93	0.98	0.40
$SG_{activation}$	1.00	5.00	3.84	0.85	0.59
Activity characteristics					
Intensity (HR in bpm)	71.63	169.70	126.47	18.64	0.40
Intensity (% HR_{max})	40.69	90.36	68.90	9.53	0.32
Activity Dose (METh)	0.64	13.96	5.41	3.09	0.21
Perceived Exertion (RPE)	1.50	8.00	4.63	1.63	0.55

VA_{pre} valence before sport activities, *CA_{pre}* calmness before sport activities, *EA_{pre}* energetic arousal before sport activities, *VA_{post}* valence after sport activities, *CA_{post}* calmness after sport activities, *EA_{post}* energetic arousal after sport activities, *SG* situational goal. For detailed information on the units of measures, see the section on measures

the average intercept of a basic affect dimension across all subjects (β_{0j}) and the level 1 predictors of the activity characteristics (β_{1j} * $\%HR_{max}$), (β_{2j}*METh), and (β_{3j} * RPE). The affective subscale variables valence, calmness, and energetic arousal (VA, CA, EA), the variables of the activity characteristics ($\%HR_{max}$, METh, RPE), and the variables of the SGs were centered on the grand mean (Snijders & Bosker, 1999). The random error value for the level 1 model is given by r_{ij}.

Level 2 represents between-person effects. Eqs. 2, 3, 4, and 5 include the fixed effects (γ) as the average intercepts and slopes of all participants, the average of the participants' mean of the affective subscale (MEAN_AWB), and the random effect (u_{0j}) (Eq. 2). The level 2 predictor MEAN_AWB was centered on the grand mean. All models are calculated as random intercept only models with a fixed slope at level 2. The number of observations for each person suggests using economical modeling so that random slopes are shelved due to the data structure.

Considering the hierarchical structure of the model, an adaptation of degrees of freedom was made for the effect size estimation (Snijders & Bosker, 2011). Eq. 6 was used to calculate the $N_{\text{effective}}$ of the models:

$$N_{\text{effective}} = Nn/(1 + [n - 1] * \rho_I) \quad (6)$$

Nn indicates the number of measurement points, and *n* represents the average number of measurement points per person. ρ_I is the ICC of the dependent variable (intensity, activity dose, perceived exertion/VA_{post}, CA_{post}, EA_{post}). The effect size *r* was calculated using the *t*-values of the regression models and the corresponding adapted effective degrees of freedom. For interpretation, the effect size *r* was transformed into effect size *d* and conventionally classified according to Cohen (1988).

Results

Descriptive analyses

The 46 participants recruited for the study completed 161 sport activities over the seven study days. We had to exclude five sport activities where the activity type was swimming, and another ten occasions when participants did not wear the accelerometer on the chest-strap for unknown reasons. For the remaining 146 sport activities, participants forgot to answer the pre- and post-sport activity questionnaires 13 times. Therefore, for our analyses, we were able to take complete data of 133 sport activities of 46 people into account. On average, participants engaged in sport activities approximately three times per week. The average duration of one sport activity was 68 min (*SD* = 43.9). The average time between before- and after-sport surveys was 84 min. The screening relating to the stage model of exercise behavior revealed that most of the 46 participants could be classified in the stage of habituation ($n = 27$ or 60%). Another 17 participants could be assigned to the stage of implementation (38%), and one person was in the fluctuation stage (2%). Considering the habit criterion based on the self-report habit index, the sample could be divided according the cut-off value established by Gardener, de Brujn, and Lally (2011) consistently into participants with the habit (SRHI ≥ 3.3; $n = 21$ or 46%) and without the habit (SRHI < 3.3; $n = 25$ or 54%) of engaging in sport activities. Beyond that, most participants showed normal weight (18 ≥ BMI ≤ 25; $n = 40$; 87%). One participant was underweight (BMI < 18; 2%); four participants were overweight (25 > BMI ≤ 30; 8%); and one participant was obese (BMI > 30; 2%) (referring to Pate et al., 1995).

A classification of the activity characteristics ($\%HR_{max}$, MET, RPE) into descriptive intensity categories is shown in

Table 3 Associations between affective well-being and situational goals before sport activities and activity characteristics

	Intensity (% HR_{max})		Activity Dose (METh)		Perceived Exertion (RPE)	
	B	*p*	B	*p*	B	*P*
Intercept	69.430	<0.001**	5.414	<0.001**	4.613	<0.001**
VA_{pre}	0.535	0.539	−0.198	0.674	−0.155	0.419
CA_{pre}	−0.269	0.729	0.811	0.006*	−0.326	0.026*
EA_{pre}	−0.321	0.694	−0.220	0.553	0.299	0.033*
Intercept	69.550	<0.001**	5.492	<0.001**	4.615	<0.001**
SG_{health}	−2.232	0.008*	−0.422	0.161	0.065	0.708
$SG_{bodyweight}$	0.722	0.286	0.584	0.021*	0.033	0.814
$SG_{distraction/stress\ regulation}$	0.216	0.799	−0.132	0.699	0.184	0.266
$SG_{activation}$	0.832	0.485	1.322	0.001*	−0.075	0.726

VA_{pre} valence before sport activities, CA_{pre} calmness before sport activities, EA_{pre} energetic arousal before sport activities, *SG* situational goal
*p <0.05; **p <0.001

Table 1.[4] An overview of the descriptive parameters of the three basic affective dimensions (before and after sport activities), the SGs for sport activities, and the activity characteristics (%HR_{max}, METh, RPE) can be found in Table 2.[5]

Situation-specific within-person heterogeneity

For valence, calmness, and energetic arousal (after sport activities), the ICCs imply that for the affective states after sport activity, 69%, 43%, and 65% refer to within-person differences (see Table 2). For the SGs for sport activities, the ICCs show a wide range, indicating that between 20% ($SG_{bodyweight}$) and 60% ($SG_{distraction/stress\ regulation}$) refer to within-person differences. The ICCs for the activity characteristics show that for intensity, activity dose, and perceived exertion, 68%, 79%, and 45% refer to within-person differences.

Associations between pre-activity affective well-being, situational goals, and activity characteristics

For intensity, Table 3 shows a negative within-person effect of the SG health (p = 0.008). For situations when participants rated the goal of health higher by one unit, the intensity was lower by 2% of the HR_{max}. The effect size is medium, with d = 0.58. There are no associations between affective well-being and the intensity of the sport activity.

For activity dose, there are positive within-person effects of calmness (p = 0.006) and the SGs body weight (p = 0.021) and activation (p = 0.001). When participants rate the goal of activation higher by one unit, the activity dose is higher by 1.3 METh. Effect sizes are all medium, with d = 0.56 for calmness, d = 0.47 for body weight, and d = 0.66 for activation.

For perceived exertion, there is a negative within-person effect of calmness (p = 0.026) and a positive effect of energetic arousal (p = 0.033), each with medium effect sizes (d = 0.56 for calmness; d = 0.54 for energetic arousal).

Associations between activity characteristics, situational goals, and affective well-being after sport activities

Table 4 shows no within-person effects of activity characteristics or SGs for sport activities on affective valence after sport activities. For feelings of calmness after sport activities, there is a negative within-person effect of perceived exertion (p = 0.033) and a positive within-person effect of the SG of activation (p = 0.022). Effect sizes are medium, with d = 0.54 for perceived exertion and d = 0.58 for activation.

For energetic arousal, there is a positive within-person effect of activity dose (p = 0.005) and a negative within-person effect of perceived exertion (p = 0.035). The effect sizes are medium, with d = 0.64 for activity dose and d = 0.48 for perceived exertion.

For these analyses, we controlled for between-person effects of the mean level of affective subscales on the effects of affective well-being after sport activities. As shown in Table 4, the average levels of valence, calmness, and energetic arousal refer to affective valence, calmness, and energetic arousal after sport activities (p < 0.001) as it was expected.

Discussion

In the current ambulant assessment study, situational analyses of affective reactions after sport activities were conducted in daily life, considering specific goals and the different characteristics of different sport activities. The aim was to enhance the current state of research regarding the associations between SGs, activity characteristics, and affective well-being after real-life sport activities. Therefore, we captured activity-related data using a combination of objective characteristics (accelerometer, ECG) and subjective estimation (rating scale) in real-life situations. Affective well-being and the SGs for sport activities were gathered via smartphone. In doing this, we followed the current recommendations for methodological quality standards for the analyses of associations between physical activity and affective well-being

[4] The number of sport activities in the intensity category "light" differs among the three intensity categories. A possible explanation is that some types of activities cannot adequately be captured by accelerometers and are therefore allocated as "light," even though people find them to be quite exhausting. For example, a combination of strength training and stretching had an RPE value of 5 (≙ vigorous), but the MET value was, on average, 1.5 (≙ light).

[5] According to the definition of a sport activity (Fuchs, 2003), the range of intensities is from light to high. There are lower values of the objective activity characteristics, as some activities contain, for example, a combination of strength training and stretching, which comprise lower HR and MET values, on average.

Table 4 Associations between activity characteristics, situational goals, and affective well-being after sport activities

	VA_{post}		CA_{post}		EA_{post}	
	B	*p*	B	*p*	B	*p*
Intercept	5.113	<0.001**	4.486	<0.001**	4.291	<0.001**
Mean_AWB	0.526	<0.001**	0.594	<0.001**	0.492	<0.001**
Intensity (% HR_{max})	0.004	0.516	−0.006	0.523	−0.010	0.270
Activity Dose (METh)	0.012	0.645	0.021	0.486	0.061	0.005*
Perceived Exertion (RPE)	−0.017	0.640	−0.104	0.033*	−0.109	0.035*
Intercept	5.166	<0.001**	4.523	<0.001**	4.349	<0.001**
Mean_AWB	0.623	<0.001**	0.592	<0.001**	0.526	<0.001**
SG_{health}	−0.059	0.275	−0.029	0.714	0.102	0.233
$SG_{bodyweight}$	0.059	0.189	0.006	0.923	0.056	0.323
$SG_{distraction/stress\ regulation}$	0.006	0.938	−0.054	0.552	−0.014	0.855
$SG_{activation}$	0.040	0.656	0.245	0.022*	0.179	0.073

VA_{post} valence after sport activities, *CA_{post}* calmness after sport activities, *EA_{post}* energetic arousal after sport activities, *SG* situational goals
* $p < 0.05$; ** $p < 0.001$

in daily life (Kanning et al., 2013; Liao et al., 2015).

Situation-specific within-person heterogeneity

Our study results show that for differences in affective well-being after sport activities, within-person variance predominates for valence (59%) and energetic arousal (65%). It is less distinct for calmness (43%). This confirms the results of Unick et al. (2015), that is, that even within persons there is heterogeneity in affective well-being after sport activities. Moreover, we analyzed other parameters situationally. It can be stated that SGs for sport activities vary situationally within-person as well, so that a person does not have the same goals for sport activities in general. However, the results also imply that depending on the goals, more or less situational variability can be expected. For rather extrinsically motivated health aspects, the between-person variance prevails, as the SGs *body weight* (80%) and *health* (62%) show. Therefore, participants who engage in sport activities for health reasons, to counteract physical discomfort, or to regulate their weight clarified these goals as less situationally varying. For rather intrinsic goals, such as to replenish energy or doing sports especially for enjoyment of body movement ($SG_{activation}$), between-person variance (59%) predominates. The strongest within-person variance exists for the situational goal *distraction/stress regulation* (60%). The reasons to engage in sport activities to settle one's thoughts, to distract from other problems, to release anger and petulance or stress are more situationally variable. This result confirms the hypotheses of Allmer (1996), who characterizes recovery intentions as situationally specific.

Furthermore, analyses revealed situationally variable manifestations for the three assessed parameters of sport activities. There is a great within-person variance for intensity (68%) and activity dose (79%). The result for perceived exertion is interesting, as the within-person variance is less distinct (45%). One reason for the divergent results between the objective and subjective data may be the fact that the RPE was only captured as a post-measurement after the sport activities and not during the activity. Against this, the objective characteristics (intensity, activity dose) have been assessed for the whole time of the sport activity, which may also be a source of the variation.

To sum up the results of research question 1, it can be stated that affective well-being after sport activities is not the only element that varies within persons; a within-person heterogeneity for activity characteristics and situational goals could also be identified.

Associations between pre-activity affective well-being, situational goals, and activity characteristics

To explain the situationally varying activity characteristics, in research question 2 we analyzed associations between affective well-being and SGs for sport activities and characteristics of sport activities. Affective well-being shows two patterns of relationships with the activity characteristics that occur depending on the related affect dimension. On one hand, more calm and relaxed feelings before sport activities go along with lower perceived exertion, although these more relaxed feelings are associated with a greater activity dose. This coherence cannot be explained by longer durations of sport activities (results not reported). Therefore, greater temporary opportunities for sport activities in less stressful situations cannot be established as a reason. Rather, the results indicate that in stressful conditions, relatively lower activity doses are realized and are perceived as more exerting. A further association exists for feelings of greater energetic arousal before sport activities, as there is a greater possibility to perceive the subsequent sport activity as more exerting. There are no positive associations with the objectively captured activity characteristics; therefore, the association needs to be interpreted on a level of the subjective experiences. Moreover, alternative explanations need to be discussed according to the methodological problems in the assessment of the activity for different activity types, which are addressed below. The reported results can enhance the findings of Lawton, Conner, and McEachan (2009), who stated that intentions are a significant predictor of physical activity behavior but not of affective well-being.

The current study results concerning the SGs confirm the importance of cognitive factors for activity characteristics. Therefore, our findings show that two motivational situations are associated with higher activity doses. On one hand, this applies to the SG *body weight*, which is based on a rather introjected motivation mode (Lehnert et al., 2011). For this subjective pattern of argumentation, it seems reasonable that the intended regulation of body weight may be successful with a higher energy expenditure, which in turn requires higher activity doses. On the other hand, the SG *activation* is considered as rather intrinsic (Lehnert et al., 2011), which may be associated with higher activity dose because the sport activity itself holds more appeal and is pursued longer and more intensively. For *body weight* in particular, attention should be paid to the fact that people indicate this goal as relatively stable and important across situations (see ICCs). Our results support the conclusion that it is not only a situational association but also an association on the contextual level in terms of Vallerand's hierarchic model. This complies with the results of Duncan et al. (2010), who found positive associations between introjection and the intensity of sport activities in a cross-sectional survey. Moreover, health-oriented goals situationally go along with reduced intensity of the sport activity. Self-selected intensities may be an issue and are recommended to be moderate for people engaging in health and recreational sport activities. Likewise, activity guidelines in health-oriented sport activity programs can be relevant, as they typically suggest moderate (or less intensive) loads, which are also established by the instructors. Certainly, a precise interpretation of our results is restricted because the activity type becomes important for the manifestation of the activity dose, as endurance activities can be represented better by accelerometers in terms of their actual intensity than weight training. The detected associations between individual goals and activity characteristics are all based on medium effect sizes so that substantial associations can be resumed. However, this is only applicable for the objective parameters activity dose and intensity.

A further leverage point for future studies is provided by Guérin and Fortier (2012), who analyzed the interaction between situational motivation and intensity (as RPE) of sport activities and a change in positive affect following the sport activity of running. Hierarchical regression analyses revealed a significant interaction effect between perceived exertion and introjection. At low levels of introjection, the influence of perceived exertion on the change in positive affect was considerable, with higher RPEs being associated with greater increases in positive affect.

All in all, for research question 2, our results indicate that some cognitive and affective variables before the activities are associated with the manifestation of activity characteristics that need, for example, to be considered for individually tailored activity recommendations.

Associations between situational goals, activity characteristics, and affective well-being after sport activities

For research question 3, the analysis of the associations between the activity characteristics, the SGs for sport activities and affective well-being after sport activities show that affective valence after sport activities is neither associated with activity characteristics nor with cognitive factors. This is remarkable because research on affective reactions—for example, on the basis of DMT—frequently focusses on the valence dimension (e. g., Ekkekakis et al., 2011). To what extent the MDBQ research procedure is relevant is hard to estimate. On one hand, it captures somewhat different affect adjectives with the adjective pairs *well–unwell* and *content–discontent* than the commonly used Feeling Scale (*good–bad*; Hardy & Rejeski, 1989). On the other hand, other studies that also used the bipolar MDBQ questionnaire showed generally positive effects of sport activity on affective valence (e. g., Sudeck & Conzelmann, 2014; Kanning, 2013). In our study, associations with post-activity affect occurred especially if energetic arousal was focused on as a basic dimension, that is, either relating to energetic arousal or calmness (whose antipole is negative activation).

The assumption that a recovery intention is relevant for the subsequent affect could only be partially proved by this study, namely in terms of energetic arousal. The study showed a positive association between the goal *activation* and post-activity energetic arousal. This confirms the situationally analyzed results of Guérin et al. (2013), in fact that intrinsic motives go along with positive affective well-being after sport activities. Moreover, the goal *activation* has the greatest intrinsic amount of motivation (Lehnert et al., 2011). To replenish energy or engage in sport activities especially for enjoyment of body movement are therefore goals with high intrinsic motivation and thus promote positive affective well-being. At the same time, this goal was less stable across different within-person situations than e. g. the goal *body weight*. For *activation* the between-person variance prevails (59%). Therefore, in order to precisely interpret these findings, interindividual and intraindividual differences need to be taken into account. The direct analysis of trait goals (e. g., by inclusion of the original BMZI items) and state goals (as assessed in this study) is missing here, especially in light of the low number of level 1 units. This limitation needs to be taken into account in the interpretation, and future studies should overcome it. There was no confirmation that recovery intentions such as *distraction/stress regulation* are associated with the post-activity affect of calmness (Jeckel & Sudeck, 2016). Accordingly, there is no association per se between specific recovery intentions and the post-activity affect. The relationship seems to be more complex, and therefore a closer look at the activity type or the specific aspects of distraction (e. g., to reduce negative affect, to settle one's thoughts) would be worthwhile.

The analysis of possible associations between activity characteristics and post-activity affective well-being showed divergent results for subjectively and objectively gathered activity parameters. For perceived exertion, the results showed that participants who experienced the sport activity as exhausting felt less calm and less relaxed as well as less awake and less activated after the sport activity. In contrast, the objectively assessed parameter activity dose was positively associated with energetic arousal after sport activities. Participants with a higher activity dose felt more awake and activated afterwards. These findings were determined under control of the mean affective well-being of each individual, so that situational affective well-being after sport activities can be interpreted by referring to a participant's general affective well-being for the time of the study. A consistent classification of our findings into the few existing study results proves difficult. Neither positive associations between perceived exertion and positive affect (Guérin et al., 2013) nor inverse associations between activity dose and positive activated affect after a sport activity can be confirmed (Reed & Ones, 2006). Therefore, it must be considered that the amount of vigorous to high activity, which is the span where negative associations occur the most in other studies, is less in the context of daily life (see ◘ **Table 1**). A further possible explanation for the positive associations between the objectively captured activity dose and energetic arousal can be the phenomenon described by Ekkekakis et al. (2011), namely that because of the self-selected intensities by a cognitive appraisal, a sense of autonomy and control emerges that affects the energetic arousal positively. Moreover, the mean affective well-being was used as a control variable, which was not realized continuously in other studies. Furthermore, existing studies on that topic were often conducted in laboratory settings, so that findings can be substantially caused by the context of daily life (e. g., Ekkekakis & Backhouse, 2009; Schlicht & Reicherz, 2012).

A further contextual reason for the divergent results of the associations of the subjectively and objectively captured activity characteristics with post-activity affective well-being might be the possible interindividual differences in the subjective appraisal of activity loads. So, perceived exertion (RPE) has the greatest stability across situations in the appraisals by individual (ICC = 0.55). One needs to be mindful of the personal traits relating to tolerance for and preferences regarding exercise intensities, which can be interindividually distinct (Ekkekakis, Hall, & Petruzzello, 2005a) and generally may influence the perceived exertion. However, the low ICCs of the objective parameters could reflect actual differences in the activity characteristics, which do not reasonably occur in the same way for perceived exertion. This can have contextual reasons, such as the divergent duration of activities within persons or the different activity types of different intensities within persons. The methodological limitations must also be discussed, as they can also be a reason for the divergence between RPE and objective activity characteristics. Strength training in particular cannot be captured by accelerometers or the relative HR_{max} as good as cyclical endurance activities (e. g., Gabrys et al., 2015). The descriptive information on the activity characteristics suggests that these methodological argumentations should be addressed in the discussion. It is therefore apparent that particularly for the intensity captured by the MET estimations, there are clearly more activities with light intensities compared to the physiological reaction (HR) and subjective ratings (RPE). Moreover, *high* intensities are least captured by relative $HR_{max,}$ which can also be augmented by strength exercise. This kind of sport activity can hardly reach such high intensities in the medium trend because of the rest intervals between the exercise series.

Taken together, affective well-being after sport activities in daily routines is associated with the intrinsic motivated goal activation, which is less stable—or most varying—across situations within persons. Moreover, the objectively assessed activity characteristics and the subjective parameters show divergent result patterns according the association with affective well-being after sport activities. This needs to be considered for activity recommendations as well.

Strengths and limitations

When reviewing the study results, further strengths and limitations must be considered. We already stated that we realized high methodological standards for the assessment of activity characteristics, affective well-being, and SGs as the main constructs (Kanning et al., 2013; Liao et al., 2015). By studying participants' daily routines, we were able to capture and analyze data from real-life situations and therefore carry out situation-specific analyses that were not influenced by certain laboratory conditions. The literature (e. g., Liao et al., 2015) critically states that studies are often conducted only with students and only last one or two days. The current study included an extended group of people with a larger age range and diverse professional careers, which may result in SGs that are more different than those of a sample of university students. Moreover, the study lasted seven days in order to reduce the impact of the specifics of a certain study day and according to the recommendation of Unick et al. (2015) to ensure that more than one sport activity per person was included in our analyses. Additional value lies in the stepwise analysis that proved the existing heterogeneity of affective well-being after sport activities not only between persons but also within persons and that proved the relevance of the heterogeneity of SGs and activity characteristics as influencing factors.

As post-activity assessment time is an important consideration, participants were instructed to answer the questions on the smartphone as soon as possible after the sport activities. Reed and Ones (2006) stated in their meta-analysis that the greatest increase in positive effects is seen within five minutes after a sport activity (e. g., Ekkekakis, Hall, Van Landuyt, & Petruzzello, 2000) and lowers thereafter, though the effects remain significantly elevated above baseline for 20–30 min (e. g., Bixby et al., 2001). In our sample, the difference between pre-post activity measurement points and the duration of the sport activities was on average 16 min. Hence, the margin is within the above-stated post-activity assessment time by Reed and Ones (2006). Nevertheless, future studies should capture the end of a sport activity more exactly, so that the post-activity assessment time can be captured more precisely.

Another limitation of the current study is the rather active sample. Our study results might be related to the sample's characteristics and therefore cannot be extrapolated to inactive people, but it was beneficial for our analyses that participants on average engaged in three sport activities per week. The more precise statements about situation-specific influencing factors for heterogeneity in affective well-being after sport activities are, the more situations can be included in the analyses. Moreover, the total number of recruited participants constitutes a further limitation, as the number of measurement points per person is below the suggested quantity. For this reason, more differentiated analyses, especially of within-person associations, could not be conducted in this study. Certainly, the power of our analyses is therefore restricted, which must be considered when interpreting the results. As a consequence, future studies analyzing situational associations should use a larger sample size and more sport activities per person. A further limitation is that participants might have changed their activity behavior due to the use of the study equipment. Although all participants were instructed to follow their regular daily routine, a possible reactivity cannot be ruled out. The main focus of our study remains on quantitative aspects of physical activity. In order to meet the possible variety of sports activities, further studies should take the activity type and participants' environment (e. g., social factors) into account.

Practical implications

Despite these limitations, the results of this explorative study can extend our knowledge of the heterogeneity of affective responses to sport activities because the study examined real-life situations. Three main implications can be drawn and will be summarized and illustrated below. First, as situational goals that affect people's accomplishment of expectations are associated with the manifestation of activity characteristics, our results reveal implications for fitness- and health-oriented sport activities. If a person with the goal of regulating body weight receives a recommendation of low activity doses (according to health-oriented activity guidelines), the instructors should be aware that this might be in conflict with his or her individual goals and expectations for ideally structured sport activities. Second, our study results underline the relevance of recommendations for persons whose goal is to regulate well-being. The recovery behavior in general can be characterized as individually varying (Allmer, 1996). This is especially true for the recovery intention of distraction and stress-regulation. As a consequence, for motive-based physical activity recommendations, the situational level of motivation should be considered, especially for people with recovery intentions (e. g., by self-observation within a first period of counseling). Third, the results emphasize the relevance of people being aware of their (situationally varying) goals and their ability to choose and adjust sport activities and activity characteristics thereupon (see Sudeck & Pfeifer, 2016 for detailed information on control competence). This includes instructors, participants, and people engaging in sport activities for themselves knowing how to deal with the above-mentioned possible differences between subjective ratings of perceived exertion (CR10, Borg, 1998) and objectively captured data for specific sport activities (e. g., strength training). Also, to meet the postulated control competence, the ACSM position stand (Garber et al., 2011) suggests using the feeling scale, which is a measure of affective valence (Hardy & Rejeski, 1989), as a secondary method for individuals seeking to self-regulate exercise intensity.

Conclusion

This predominantly explorative study gives further evidence that a situation-specific focus in determining the effect of sport activities in daily life is worth analyzing. The stepwise analysis of the current study indicates that the analysis of situation-specific interactions between the identified influencing factors seems to be promising for further research. The high SG *activation* was followed, on the one hand, by higher activity dose of the sport activity. On the other hand, participants felt more awake and activated if the activity dose was higher. Additionally, the SG *activation* is directly followed by a greater feeling of calmness. The results indicate interactions between some SGs and the activity dose. Moreover, it might be possible that, for example, there is an association between the specific recovery intention (distraction) and calmness but only for specific activity characteristics (high intensity). These kinds of research questions have been put aside due to the current sample size and the events per person. However, they can be relevant components of future research to achieve scientific optimization of individualized activity recommendations.

Corresponding address

S. Jeckel
Institute of Sport Science, Eberhard-Karls University Tübingen
Tübingen, Germany
stephanie.jeckel@uni-tuebingen.de

Compliance with ethical guidelines

Conflict of interest. S. Jeckel and G. Sudeck state that there are no conflicts of interest.

All procedures performed in the study involving human participants were in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

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