AUTOMATIC AFFECTIVE PROCESSES TOWARD DIFFERENT TYPES OF EXERCISE AND PHYSICAL ACTIVITY IN ADULTS AND CHILDREN

Automatic affective processes toward different types of exercise and physical activity in adults and children

by

Julia Limmeroth

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1. Advisor & Supervisor

Prof. Dr. Norbert Hagemann[1]

2. Advisor

Prof. Dr. Ralf Brand[2, 3]

1. Institute of Sports and Sports Science, University of Kassel, Germany
2. Sport and Exercise Psychology, University of Potsdam, Germany
3. Affiliate Professor at the Department of Kinesiology, Iowa State University, USA

“Zwei Seelen wohnen, ach! in meiner Brust”

[Two souls live in me alas, irreconcilable with one another]

(von Goethe, 1997, p. 37).

Table of Contents

List of Figures

List of Tables

List of Abbreviations

AAE	Automatic Evaluations of Exercise
AAP	Automatic Affective Process(-es)
AMP	Affect Misattribution Procedure
ART	Affective-Reflective Theory of Physical Inactivity and Exercise
BIAT	Brief Implicit Association Task
CON	Control
EP	Evaluative Priming
EXE	Exercise
FIT	Fitness
GNAT	Go/No-go Association Test
IAT	Implicit Association Task
MTB	Mountain Biking
Neg	Negative
PA	Physical Activity
Pos	Positive
PRI	Prime
RT	Reaction Time
RUN	Running
SCT	Social Cognitive Theory
SDT	Self-determination Theory
ST-IAT	Single-Category/Target Implicit Association Task
TPB	Theory of Planned Behavior
WHO	World Health Organization

List of Publications

Publication 1

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Publication 3

Limmeroth, J., & Raboldt, M. (2022). “I do what I like”: 8- to 10-year-old children’s physical activity behavior is already interrelated with their automatic affective processes. *Journal of Sport and Exercise Psychology, 44(2)*, 138-147. https://doi.org/10.1123/jsep.2021-0251

Preface

> "Both in explaining the past and in predicting the future, we focus on the causal role of skill and neglect the role of luck. We are therefore prone to an illusion of control. We focus on what we know and neglect what we do not know, which makes us overly confident in our beliefs" (Kahneman, 2013, p. 259).

This thesis entitled *"Automatic affective processes toward different types of exercise and physical activity in adults and children"* summarizes my dissertation. The dissertation was written cumulatively at the Faculty of Social Science at the University of Kassel and consists of three publications. I conducted the associated research at the Institute of Sport and Sport Science at the University of Kassel. The thesis includes a framework to underline the relationship between the three publications. First, the conceptual and theoretical considerations are elaborated which led to the publications. Second, the publications are briefly described and summarized and finally, methodical and theoretical implications are presented and discussed. The idea for the topic of this dissertation was based on the observation that my own experience with exercise and physical activity seemed to be very different from the experience of many other people: Exercising makes myself and numerous other people feel good but research over the past 20 years has demonstrated that the experience of pleasure while exercising or being physically active represents a myth for many people (Ekkekakis & Dafermos, 2012).

Outline of the research program: Automatic affective processes toward different types of exercise and physical activity in adults and children

Chapter 1

"Physical activity arguably offers more opportunities for pleasure than do most other health-related behaviors (compared to brushing, flossing, buckling up, and seeing the doctor, for example), we, ironically, have learned very little about intrinsic reinforcements (e.g., enjoyment of physical activity) for continued participation"

(Dishman, 2003, p. 46).

1. Outline of the research program

Although most people know that it would be good for them or for their health to be physically active enough, a large percentage fail to reach the minimum amount for physical activity (PA) recommended by the WHO (2010; 2020). Hence, physical inactivity is one of "the biggest public health problems of the 21st century" (Blair, 2009, p. 1). In this context, research over the past 20 years has shown that it is inaccurate to claim that exercise or being physically active automatically makes people feel better (Ekkekakis & Zenko, 2016). Rather this effect is conditional: many types and amounts of exercise make a lot of people of Western society (e.g., overweight or obese people or people, who are chronically sedentary) feel worse rather than better (Ekkekakis et al., 2011). According to this, many studies demonstrate that affective reactions to exercise are clearly related to the amount of exercise and can reliably predict them (Rhodes et al., 2009; Rodrigues, Faustino, et al., 2021; Tavares et al., 2021). Furthermore, higher levels of PA are associated with more positive affective states (Hyde et al., 2011), affective responses to PA predict future PA behavior (Kwan & Bryan, 2010; Lee et al., 2018), and in general, affect plays a central role for individuals' PA levels (Kiviniemi et al., 2007). Therefore, the central question is, why so many individuals feel uncomfortable while exercising and further, is this perhaps fundamental to why so many people fail to be sufficiently physically active?

In addition, by all indications, the failure of achieving the recommended amount of PA is not due to lack of interest. Perhaps the mere thought of exercising and being physically active creates feelings of unpleasantness and discomfort for these people. In that regard, research in the area of automaticity and affect is gaining importance to explain exercise and PA motivation and maintenance (Ekkekakis & Dafermos, 2012; Ekkekakis et al., 2020; Rhodes et al., 2019; Rhodes & Kates, 2015; Rhodes & Sui, 2021). A relatively new theoretical framework to explain exercise and PA behavior is based on dual-process approaches (e.g., Evans & Stanovich, 2013; Gawronski & Bodenhausen, 2006; Strack & Deutsch, 2004). In this sense, decisions and behavior are not solely driven by rational choices. Besides reflective processes (type-2), automatic affective processes (AAP; type-1), influence the behavioral motivation.

This thesis uses the Affective–Reflective theory of physical inactivity and exercise (ART; Brand & Ekkekakis, 2018) as its theoretical framework. As a default-intervention theory, it was developed to explain the motivational processes underlying the initiation of exercise- or PA-related behaviors. Thereby, ART emphasizes the role of an automatic affective reaction for and as part of exercise- and PA-related decision-making. The ART provides theoretical assumptions about the processing of affective experiences with exercise and PA. In detail, suggesting that reminders of exercise or PA (type-1 process) can directly impact exercise- and PA related decisions. This affective reaction then creates the foundation for a more reflective

motivational process (type-2 process). Negative feelings that are automatically activated by the thought of exercise (PA) can, in contrast, act as a restraining force that leads an individual to remain physically inactive (Ekkekakis & Brand, 2021).

For exercise psychology, research on the AAP toward exercise (PA) still represents a relatively new and innovative approach. Although people know that it would be good and rational for them to be sufficiently physically active, so many individuals fail to meet the recommended minimum amount of PA. According to this, a further question is, why a lot of individuals do not (like) exercising or being physically active. For these purposes, I want to provide additional explanation, and further, I want to clarify, "how, for whom and in which situations" (Chevance et al., 2019, p. 271) AAP are associated with PA behavior.

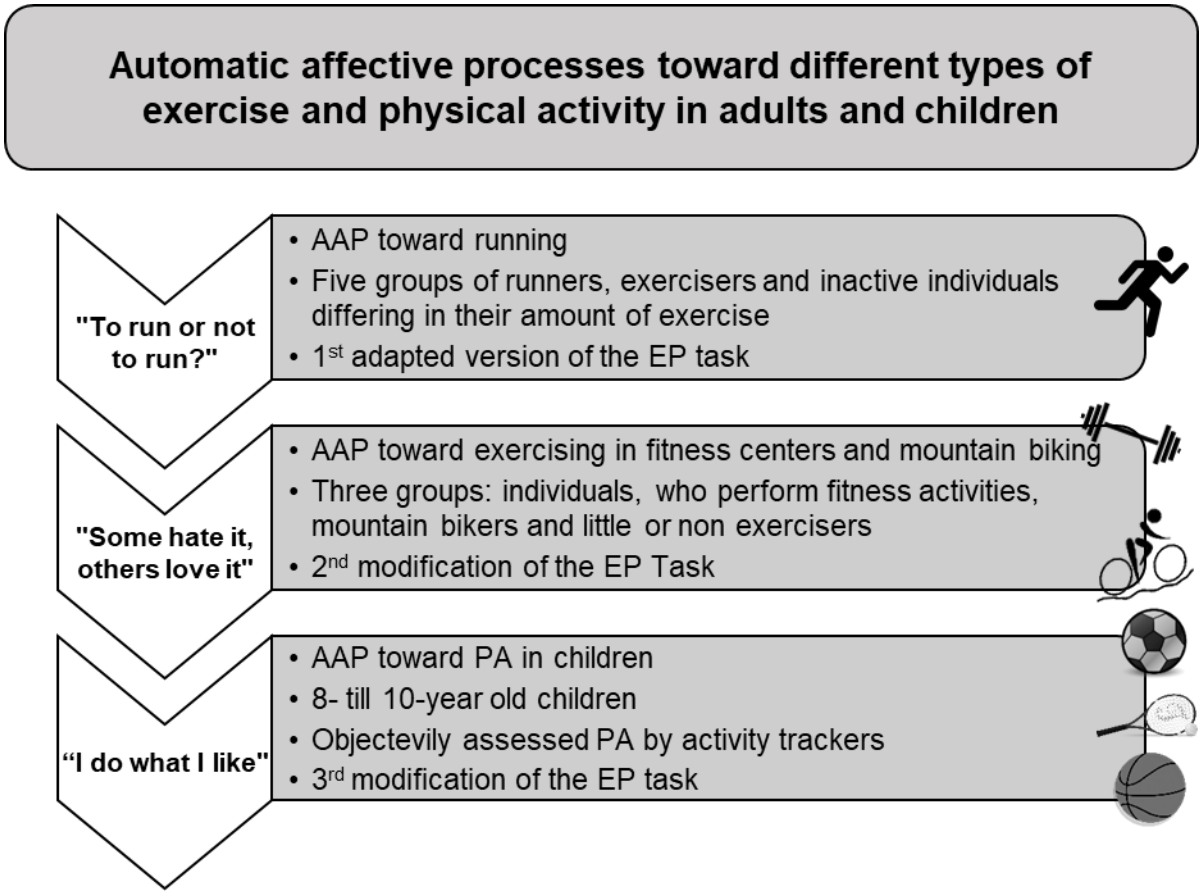
Based on the theoretical assumptions of ART by Brand and Ekkekakis (2018), my dissertation aims to investigate automatic affective reactions to exercise-/PA-related stimuli in different active and non-active individuals, referring to different types of exercise and different ages (children and adults), including their impact on exercising / PA. In this synopsis, I will first describe general and widespread assumptions about exercise motivation and reasons for physical inactivity (Chapter 2), to then describe in detail dual-process approaches (Chapter 3) and to introduce the central premises of the ART (Chapter 3.1). Here, I focus mainly on the ART's automatic affective (type-1) process (Chapter 3.2). In this context, previous research has already explored AAP with exercise (PA) and their role in exercise (PA) decisions (e.g., Schinkoeth & Antoniewicz, 2017). They are most commonly assessed by indirect tests, especially by the Implicit Association Task (IAT; Greenwald et al., 1998) and its variants (e.g., the Single-Category/Target IAT (ST-IAT); Karpinski & Steinman, 2006). In Chapter 4 I present the Evaluative Priming (EP; Fazio et al., 1986) task, with which I assessed the AAP toward exercise and PA.

Chapter 5 introduces the idea, to investigate in AAP toward different types of exercise. In my first publication, I focus on establishing a modified EP task to assess AAP toward running while differentiating between individuals with different exercise amounts and runners or no runners. This publication can be found in Chapter 5.1. Chapter 5.2 presents my second publication. In this publication I slightly changed the EP procedure and adapted it to the contexts of exercising in fitness centers and mountain biking. After addressing these differences in the manifestations of the AAP towards different types of exercise, I turned to the question of whether the AAP to PA is already related to the PA level in childhood. In addition, the EP task had to be adapted to the younger sample of children (Chapter 6). In Chapter 6.1, I described more in detail physical (in-)activity in children and hence, my third publication focusses on PA behavior in children and their AAP toward PA and is presented in Chapter 6.2. For these young participants I again modified the EP task. Therefore, I changed the target stimuli from words into smileys. Furthermore, the PA behavior was objectively measured by

an electronic device. The order of publications in the dissertation, entitled “Automatic affective processes toward different types of exercise and physical activity in adults and children” are shown in Figure 1.

Figure 1

The order of all three publications as part of this dissertation



In Chapter 7 I provided a general discussion of the methodological approach and the core findings of the conducted studies. Then, I will conclude with the general findings and further give methodical and theoretical implications for future research. This thesis ends with an overall summary (Chapter 8).

Physical inactivity, exercise motivation and promotion: searching for a new pathway

Chapter 2

"Why we do what we do is a perennial question that intrigues psychologists and others who are empowered to influence others (e.g., teachers and coaches). Encouraging others to act, think and behave a certain way is the responsibility of many people, however, motivating others can be quite challenging"

(Mallett et al., 2007, p. 601).

2. Physical inactivity, exercise motivation and promotion

According to Caspersen et al. (1985, p. 126), PA can be defined as “any bodily movement produced by skeletal muscles that results in energy expenditure”, whereas exercising forms a subcategory of PA. Nevertheless, exercising and PA are two distinct behaviors that of course are interrelated but might be uniquely influenced by distinct motivational variables (Biddle, 2011). According to the latest published WHO guidelines (2020) and several huge global studies (e.g., Guthold et al., 2018; Hallal et al., 2012), the majority of the Western world’s population does not achieve the recommended (minimum) amount of PA. Therefore, physical inactivity is a leading risk factor for non-communicable diseases and in contrast, maintaining a physically active lifestyle goes along with a lower risk of cardiovascular disease or diabetes (Lee et al., 2012). In general, cardiorespiratory and musculoskeletal fitness, cognition function, and academic achievement, pro-social behaviors, and overall mental health benefits of daily moderate or higher intensity PA are not only well-established for adults but also for children and adolescents (Álvarez-Bueno et al., 2017; Biddle et al., 2019; Maynou et al., 2021; Poitras et al., 2016).

The explanations for this huge public health challenge of physical inactivity especially in Western society is multifaceted, very complex and relates to many different research disciplines (Bryan et al., 2011). Many influencing factors like the built environment lie outside the research area of exercise psychology (Tcymbal et al., 2020). Focusing on the contributions of the field of exercise psychology, many researchers have made efforts to first identify psychological factors that support or hinder PA behavior and, to then develop interventions that promote PA behavior (including exercise behavior). Their theoretical assumptions were primarily grounded on cognitive factors (Rhodes et al., 2019). Thereby, the social cognitive framework was considered as the dominant explanatory basis (Ekkekakis & Zenko, 2016). For an overview of exercise psychological frameworks of PA behavior change see Table 1. Furthermore, interventions based, for example, on social-cognitive theories, that target children’s and adolescents’ PA behavior, also often fail in increasing PA (e.g., Klos et al., 2020; Rhodes & Dickau, 2012).

At present, no intervention approach based on any constructs of different psychological theories, including those with social cognitive or humanistic frameworks, has been reliably shown to increase the amount of exercise or PA in a meaningful and sustainable manner (Ekkekakis & Brand, 2021; Rhodes et al., 2021). The Lancet Physical Activity Series Working Group emphasize that “the traditional public health approach based on evidence and exhortation has - to some extent - been unsuccessful so far” (Hallal et al., 2012, p. 254) and the promotion of exercise and PA remains one of the greatest public health challenges of the 21st century (De Souto Barreto, 2013; Guthold et al., 2018; Silva et al., 2020).

Table 1

Four key theoretical frameworks of physical activity behavior change

	Framework	Popular theories	Key statements
(1)	Social cognitive	Theory of planned behavior (TPB; Ajzen, 1991); Social Cognitive Theory (SCT; Bandura, 1986)	"The framework is based on the premise that people form, and subsequently act upon, expectancies of behavioural events and outcomes. [...] Valued outcomes and expectancies that carry the most weight of importance are considered critical to subsequent action, which gave rise to the terms expectancy value or reasoned action approaches within theories that employ the social cognitive framework" (p. 101).
(2)	Humanistic / organismic	Self-determination theory (SDT; Deci & Ryan, 1985)	"Contrary to behaviourism, these perspectives propose that humans have inherent needs and that behaviour is not merely a response to reinforcement or punishment. Rather, human action is thought to be motivated by an innate drive to grow, develop, and realize one's potential—a concept often referred to as self-actualization" (p. 102).
(3)	Dual process	Affective-Reflective theory of physical inactivity and exercise (ART; Brand & Ekkekakis, 2018)	"Dual process frameworks are the mapping of individual level behavioural determinants onto one of two different types of influence – reflective processes [...], and non-conscious or automatic processes [...]. Dual process frameworks put forth that reflective processes include the conventional social-cognitive approach variables (e.g., intentions, values, expectations), and non-conscious processes include the comparatively less understood and less tested determinants of physical activity such as habits, automatic evaluations, automatic self-schemas, and automatic motivation" (p. 103).
(4)	Socioecological	Field theory (Lewin, 1951); Ecological Psychology (Barker, 1968)	"[It] is based on this premise that behaviour is the result of direct, indirect and interactive influences from factors of multiple levels that span from the individual to environment and social policy. [...] Behaviour is a function of persons and their environments [...] [and] both discriminable at the level of the individual, but also by environmental settings" (p. 104).

Note. Examples of popular theories and common key statements are presented following Rhodes et al. (2019): "Theories of physical activity behaviour change: A history and synthesis of approaches".

The approaches and frameworks mentioned above only marginally focus on affective processes and their importance for regulating PA or exercise behavior (Ekkekakis & Brand, 2021; Rhodes et al., 2019). However, increasing evidence is now emerging on the importance of considering the role of affect, emotion, and feelings for exercise and PA behavior (Ekkekakis & Brand, 2019; Rhodes & Kates, 2015). Dual-process approaches are based on these critical assumptions, and researchers have included affects and intuition into their theoretical models to extend the explanation of physical inactivity and also to develop new interventional approaches (Brand & Cheval, 2019; Rhodes et al., 2019; Zenko et al., 2021).

A post-cognitivist perspective: dual-process approaches in the context of exercise and physical (in-)activity

Chapter 3

"Bounded rationality is simply the idea that the choices people make are determined not only by some consistent overall goal and the properties of the external world, but also by the knowledge that decision makers do and don't have of the world, their ability or inability to evoke that knowledge when it is relevant, to work out the consequences of their actions, to conjure up possible courses of action, to cope with uncertainty [...] and to adjudicate among their many competing wants"

(Simon, 2000, p. 25).

3. A post-cognitivist perspective: dual-process approaches

The idea, that human's rationality is bounded can be traced back first to assumptions by Simon (1955, 1959) and thereupon taken up by Kahneman and Tversky (1979) in the development of their concept of prospect theory. Based on these fundamental considerations, dual-process models also present rationality as bounded. Dual-process theories presume that both automatic processes (type-1) and deliberate processes (type-2) are involved in the decision making process and influence behavior (Evans & Stanovich, 2013). In contrast to dual-system approaches (e.g., Strack & Deutsch, 2004), dual-process theories assume that it is not a matter of competition for control of behavior, but rather that both processes interact, which is theorized as default-interventionist (e.g., Gawronski & Bodenhausen, 2006). In the context of exercise psychology, dual-process theorizing is becoming increasingly important (Ekkekakis & Brand, 2021). Among others, Ekkekakis and Zenko (2016) and Zenko et al. (2021) argue for a post-cognitivist perspective on physical inactivity, exercise motivation and its promotion, due to the idea of bounded rationality. They further indicate that this theorizing will likely reflect dual-process approaches.

Authors have used a larger number of various terms to differentiate between those different pathways (e.g., impulsive/reactive versus reasoned/reflective, Strack & Deutsch, 2004). In Table 2 typical clusters of attributes, which are frequently associated with dual-process approaches are presented (adapted from Evans & Stanovich, 2013). In line with Evans and Stanovich (2013), in this dissertation the terms "type-1" and "type-2" processes will be used. The type-1 process is defined by its autonomy: "The execution of Type 1 processes is mandatory when their triggering stimuli are encountered, and they are not dependent on input from high-level control systems" (Stanovich & Toplak, 2012, p. 8). In contrast, what defines the type-2 process is its rationalization or cognitive decoupling that allows hypothetical reasoning (Pennycook et al., 2015). Thus, type-1 processes are expected to result in the default behavioral response except for when the effortful, more deliberate, and controlled type-2 process overwrites it (Evans & Stanovich, 2013). Further, it is theorized that the type-2 process is influenced by the type-1 process, which can often result in heuristic or cognitive bias in decision making (Kahneman, 2013). Applied to the context of physical (in-)activity or exercise, dual-process theorizing proposes that especially for a person who is rather physically inactive, the type-1 process will usually support the physically inactive behavior. Only if the more effortful type-2 process, needing more cognitive resources, overrides the type-1 process or the type -1 process, they will start with PA (Brand & Cheval, 2019).

Table 2

Clusters of attributes frequently associated with dual process and dual system theories of higher cognition

Type 1 process (intuitive)	Type 2 process (reflective)
Defining features	
Does not require working memory	*Requires working memory*
Autonomous	*Cognitive decoupling; mental simulation*
Typical correlates	
Fast	Slow
High capacity	Capacity limited
Parallel	Serial
Nonconscious	Conscious
Biased responses	Normative responses
Contextualized	Abstract
Automatic	Controlled
Associative	Rule-based
Experience-based decision making	Consequential decision making
Independent of cognitive ability	Correlated with cognitive ability
System 1 (old mind)	System 2 (new mind)
Evolved early	Evolved late
Similar to animal cognition	Distinctively human
Implicit knowledge	Explicit knowledge
Basic emotions	Complex emotions

Note. The clusters are taken from Evans and Stanovich (2013, p. 225): "Dual-process theories of higher cognition: advancing the debate". Italicized attributes are the proposed defining characteristics in the current article. The authors propose two systems include the features attributed to type-1 and type-2 processing but those systems may also include the additional features (attributes) named.

According to Rhodes and Nigg (2011), PA should be categorized as a unique behavior, also compared to other health behaviors. Therefore, they argue for a need to develop unique theories in the context of PA and exercise. Efforts have recently been made to develop such specific theories to establish dual-process theorizing in the context of exercise and PA (e.g., Brand & Ekkekakis, 2018; Conroy & Berry, 2017):

> "A crucial step in the transition of exercise psychology to the postcognitivist era [...] [remains in] the need to develop physical activity- and exercise-specific theoretical models, recognizing the unique features and challenges of these particular behaviors" (Ekkekakis & Zenko, 2016, p. 404).

3.*1 A definition of (core) affect*

In the past, the terms mood, emotion and affect were often used interchangeably, both within and outside of the research context. Of course, the definitions cannot be completely precise and transitions between those concepts are fluid. They make up a “fuzzy set” (Smith & Lazarus, 1990, p. 611), which makes it very difficult to define them independently. Nevertheless, for research approaches it must be clear what to measure. For this purpose, this chapter attempts to distinguish these concepts and to formulate a working definition of (core) affect and the meaning of affect with reference to the model of “affect heuristic” (Finucane et al., 2000; Slovic et al., 2007).

Mood

Frijda (2009) defines mood as "the appropriate designation for affective states that are about nothing specific or about everything-about the world in general" (p. 258). According to Morris (1992), a mood is usually temporally remote from its cause. Due to this, it is not always easy to identify the cause of a mood. Furthermore, several distinguishing factors for moods are used. For example, compared to emotions (described next), moods generally last longer, are diffuse and more global instead of specific (Ekkekakis, 2012).

Emotion

Russell and Barrett (1999) defined a "prototypical emotional episode [as a] complex set of interrelated sub-events concerned with a specific object" (p. 806). According to Ekkekakis (2012), a prototypical emotional episode is accompanied by (1) core affect (described next), (2) obvious behavioral actions congruent with the corresponding emotion (e.g., a smile), (3) attention focused on the evoked stimulus, (4) cognitive appraisal of the stimulus, (5) allocation of the origin of the stimulus, (6) the experience of the certain emotion, and (7) neural and endocrine changes consistent with the emotion. Importantly, the cognitive appraisal of emotions involved in the transaction between person and object is considered as its defining element. Three examples of emotions are anger, happiness or pride (Ekkekakis, 2012). To qualify something as an emotion and to differentiate between emotions and core affect, Russell (2003) gives an example for the emotion -pride-: "Pride can be thought of as feeling good about oneself. The 'feeling good' is core affect and the 'about oneself' is an additional (cognitive) component" (p. 148).

Core Affect:

Russell and Feldman Barrett (2009) define core affect as a “neuro-physiological state consciously accessible as a simple, primitive, nonreflective feeling most evident in mood and

emotion but always available to consciousness (p. 104).” Core affect includes a dimension of pleasure and displeasure (valence) as well as a dimension of arousal (activation) (Ekkekakis, 2012). On the one hand, core affect can be a part of emotions and moods, but it can also occur isolated. According to Russell (2003), "pride can be thought of as feeling good about oneself. The 'feeling good' is core affect and the 'about oneself' is an additional (cognitive) component" (p. 148). Importantly, affect can be interpreted as a motivational concept, for example for exercise motivation (e.g., Brand & Ekkekakis, 2018; Cheval et al., 2018; Conroy & Berry, 2017; Strobach, et al., 2020; Williams & Evans, 2014).

Affect heuristic

Besides the aspect of being a motivational driver, affect, within the affect heuristic, works as a facilitator for information integration in judgement and decision making and represents an internal guide for reasons and for weighing priorities (Finucane et al., 2003). A basic idea behind the affect heuristic is that “representations of objects and events in people’s minds are tagged to varying degrees with affect. In the process of making a judgment or decision, people consult or refer to an ‘‘affect pool’’ containing all the positive and negative tags consciously or unconsciously associated with the representations” (Slovic et al., 2007, p. 1335).

> “Using an overall, readily available affective impression can be far easier—more efficient—than weighing the pros and cons or retrieving from memory many relevant examples, especially when the required judgment or decision is complex or mental resources are limited. This characterization of a mental short-cut leads to labeling the use of affect a ‘‘heuristic’’ (Slovic et al, 2007, p. 1336).

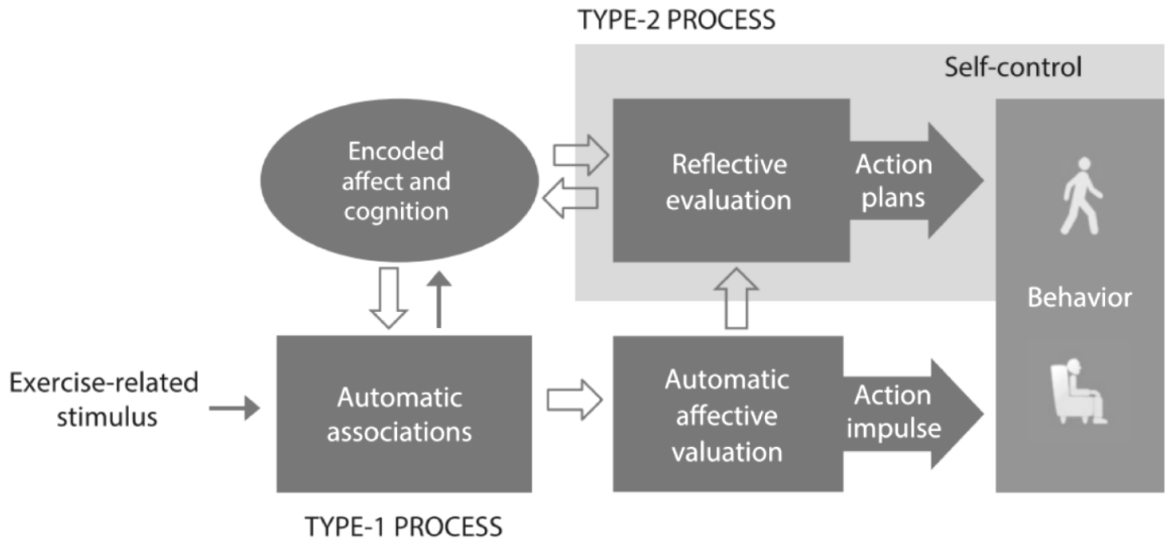
3.2 The Affective-Reflective Theory of physical inactivity and exercise (ART)

The ART (Brand & Ekkekakis, 2018) relates to the conceptual assumption of affect heuristic (Finucane et al., 2000; Slovic et al., 2007) and to the somatic marker hypothesis (Damasio, 1994, 1996). It can be categorized as a default intervention theory. The ART is a dual-process theory for explaining and promoting physical (in-)activity and exercise, involving two independent mental processes. The type 1 process can be characterized as automatic, inherently affective and default and the type 2 process, as reflective, deliberative, controlled, and needing cognitive effort. As shown in Figure 2, an (external or internal) exercise-related stimulus evokes the type 1 process. First, automatic associations with exercise as well as

associations linked to the present state are automatically[1] activated. Second, they result in an automatic affective valuation, a positive or negative *gut feeling*, which directly leads to a corresponding action impulse (Brand & Ekkekakis, 2018; Ekkekakis & Brand, 2021). According to Lewin's (1951) idea of driving and restraining forces, a positive affective valuation, a pleasant "gut feeling", may drive a person, who is currently physically inactive, to become (more) physically active or start exercising. Instead, a negatively valenced automatic valuation of exercise, an unpleasant "gut feeling", may act as a restraining force. Hence, the individual would maintain in the present state of physical inactivity. As shown in Figure 2, the automatic affective valuation forms the basis for rational reasoning and reflective evaluations of exercise and PA (type 2 process). Type-2 processing results in action plans (e.g., the intention to start going to the fitness center). Importantly, action plans can themselves represent a driving or restraining force. Especially, if self-control[2] resources are depleted, the type 1 process can thus directly influence exercise / PA behavioral decisions. In contrast, if enough self-control resources are available, the rational action plan (type-2) can possibly override the (type-1) automatic action impulse (Brand & Ekkekakis, 2018; Hofmann et al., 2009).

Figure 2

The Affective-Reflective theory of physical inactivity and exercise (ART)



Note. The illustration is based on Brand and Ekkekakis (2018, p. 56): "Affective–Reflective Theory of physical inactivity and exercise."

[1] According to Bargh (1994) the extent to which a process or a behavior is unintentional, occurs outside of awareness, is uncontrollable and is efficient in its use of attentional resources defines the degree to which the process or the behavior can be assumed to be more or less automatic.
[2] Here, self-control is treated as strategies to override conflicts.

The main focus of my dissertation is the automatic type-1 process[3]. For this, I will use the term automatic affective processes (AAP) in this dissertation, which results finally in the action impulse. AAP provide new insights for the explanation of physically (in-)active behavior and exercise motivation and participation. It forms a different approach compared to the traditional social cognitive one. The ART presents a theoretical explanation for the phenomena of why people do not engage in PA or exercise even though they know it would be good/healthy for them (Brand & Ekkekakis, 2018; Ekkekakis & Brand, 2021). Therefore, investigating AAP toward exercise and PA contribute to a better understanding of the motivational processes behind exercise / PA decisions and behavior. In the following chapters the state of research about AAP toward exercise and PA is shortly summarized (Chapter 3.2) and indirect measurement techniques to assess AAP, especially, the EP, are described more in detail (Chapter 4).

3.3 Automatic affective processes toward physical activity and exercise: a short overview of the state of research

Regarding AAP toward PA and exercise, two studies that systematically summarize the state of research must be mentioned: the systematic review by Schinkoeth and Antoniewicz (2017) and the systematic review and correlational meta-analyses by Chevance et al. (2019). It is important to note that AAP is also termed differently, for example automatic or implicit evaluations, implicit or non-conscious processes or automatic affective attitudes etc. (e.g., Conroy & Berry, 2017; Hagger, 2016; Phipps et al., 2021; Rebar, Dimmock, et al., 2016). In general, indirect tests were used to assess those processes (see also Chapter 4).

According to Schinkoeth and Antoniewicz (2017)[4], results about the link between AAP and exercise or PA variables were revealed in small to large effect-sizes. Individuals with positive AAP toward exercise / PA were more physically active or showed a greater amount of exercise or vice versa, individuals with a higher amount of exercise / PA showed more positive AAP (e.g., Bluemke et al., 2010; Chevance et al., 2016). Furthermore, several relations between AAP and exercise- / PA-related variables could be identified. One of the first explorations about AAP showed that visual attention to exercise cues is influenced by AAP (Calitri et al., 2009): the more extreme, positive or negative, individuals' AAP toward exercise was the greater their attentional bias to exercise words ("U-shaped relation"). In turn, Antoniewicz and Brand (2014) demonstrated that reflective evaluations of exercise were not significantly correlated with AAP, neither in fitness center exercisers nor in the comparison group. Brand and Schweizer (2015) showed that AAP influence situated decisions between

[3] Nevertheless, I also consider the reflective type-2 process.
[4] They included 19 records in total (one was a multi-study report of two separate studies) in their review.

exercise and behavioral alternatives. The more positive AAP are, the more likely individuals were to decide in favor of exercise activities facing behavioral alternatives. Additionally, it was shown that the tendency to decide for or against exercise predicts the habitual amount of exercise per week. Nevertheless, there are also some ambiguities:

1. There exist controversial findings regarding relations between AAP and exercise-related variables
2. and, an immense heterogeneity regarding the applied indirect test methods used to assess AAP toward PA and exercise must be assumed (e.g., Brand & Gutmann, 2020; Schinkoeth & Antoniewicz, 2017; Zenko & Ekkekakis, 2019b).

Chevance et al. (2019)[5] summarized that there exists a small, significant, and positive correlation between AAP and PA in adults. Importantly, they found that the association between AAP and PA was not significantly influenced neither by participants' age or other characteristics, the study design or objective, nor by measures of AAP or PA. According to Chevance et al. (2019), there remain several unresolved research questions: which other various variables interact with AAP, how they develop, how they change over time, and in which specific situations or for which specific behavior AAP are effectively important (e.g., Friese, Hofmann, & Schmitt, 2008; Muschalik et al., 2018; Oliver & Kemps, 2018). Hence, future research should focus on the specific conditions, situations and contexts under which AAP are or are not related with the corresponding exercise or PA behavior. Furthermore, if simple heuristics exist, developed through positive or negative experiences with PA and exercise in the past, it must be clarified how and when they influence our actual and future PA and exercise behavior, and under which conditions (Chevance et al., 2019). Therefore, it is also of great interest if AAP already evolve during childhood and are related to a child's PA or exercise behavior (e.g., Dunham et al., 2008).

[5] They included a total of 26 independent studies and 55 effect sizes.

The dissertation program: Indirect measures in the context of physical activity and exercise (AAP and EP)

Chapter 4

"Automatic attitude activation is itself a mediating mechanism that plays a role in many significant cognitive and social processes. The extent to which an individual's attitude is capable of automatic activation determines both the power that the attitude exerts on the individual's information processing, judgements, and behaviour and the functional value of possessing the attitude"

(Fazio, 2001, p. 127).

4. The dissertation program

In this chapter the dissertation program focusing also on the methodological approach of all publications is presented. The AAP has always been at the center of consideration and reflective processes were assessed additionally via several questionnaires. According to ART (Brand & Ekkekakis, 2018), the affective valuation is the result of a (re-) activation of mental associations (e.g., *exercise* and *pleasure*) and somato-affective connections (e.g., perceived exertion) formed through an individual's past exercise experiences. The automatic valuation of exercise has an affective quality in contrast to automatic association. This affective quality refers to core affective feelings of pleasure or displeasure that arise directly from the body. First of all, EP tasks neither directly measure core affect, nor assess directly the affective valuation, but based on theoretical assumptions, could possibly evoke it. Thus, the (pre-)activation by the prime is from affective characteristic, also works at the threshold or even below consciousness, and results in more than the mere association, an unconsciously evoked priming-effect. Therefore, as I already mentioned before, in this dissertation, I will use the term AAP refer to what is assessed by the EP procedure. Within the framework of this dissertation, AAP related to exercise or PA stimuli are the central focus of attention. The aim is to investigate AAP in different active and non-active individuals, referring to different types of exercise and different ages (children and adults). Their impact on exercising / PA is included as well as their relation to reflective processes.

4.1 The main measuring tool: the Evaluative Priming Task

Several indirect measuring methods were used to assess AAP toward exercise and PA (for an overview, see Brand & Gutmann, 2020). The most popular and also vigorously discussed method, the IAT (Greenwald et al., 1998) and its variants like the ST-IAT (Karpinski & Steinman, 2006) or the Brief IAT (BIAT; Sriram & Greenwald, 2009), have been used in quite a few studies (e.g., Antoniewicz & Brand, 2016a; Chevance et al., 2016; Sala et al., 2016). In addition to the IAT and other test procedures like the Affect Misattribution Procedure (AMP; Payne et al., 2005) or the Go/No-go Association Test (GNAT; Nosek & Banaji, 2001), the EP[6] task, developed by Fazio et al. (1986), can also be recognized as an indirect measure to assess AAP. Only a few studies in the context of exercise psychology have used the EP procedure so far (e.g., Bluemke et al., 2010; Brand & Schweizer, 2015; Eves et al., 2007). The EP relies on the theoretical assumption, that behavior can automatically be activated (compare with Bargh, 1994). Due to this, the EP is based on the idea that automatic activation of valence

[6] Importantly, instead of *Evaluative Priming*, it has also been referred to as *Affective Priming* by others like Hermans et al. (1994) or Murphy and Zajonc (1993).

can occur, following the appearance of a prime stimulus (Bargh & Chartrand, 1999). A significant advantage of the EP over the classical IAT is that it facilitates calculating separate (priming) scores for different kinds of associations (Wittenbrink, 2007).

The EP tasks (see also Figure 3, 4 and 5) are computer and reaction time based and involve two task-features. Participants are briefly presented with a prime stimulus (e.g., a word, a picture, etc.). The first feature consists in the instruction to neglect the primary presented prime stimulus. Then, in the standard version of the task, participants have to quickly identify whether the target (word) is positive or negative by pressing one of two response keys (Gawronski & De Houwer, 2014) . This forms the second feature of the EP task.

Based on the original EP procedure by Fazio et al. (1986) and the version adapted to the context of PA and exercise by Bluemke et al. (2010), the EP procedures for the three conducted studies were modified slightly and gradually. During each trial, a randomly chosen prime–target combination was presented. The elicited valence could subsequently lead to either response facilitation or response inhibition. In the case of response facilitation, the target stimulus is subjectively classified as valence congruent with the previous prime presentations. The contrary effect is seen in valence-incongruent trials. In general, primes activate the associated positive or negative valence within a few hundred milliseconds. For the calculation, the mean response latencies of the various prime/target combinations can be used. Therefore, the priming effect is evaluated by reaction times (RT) and calculated as follows: $[(\mathbf{RT}_{\text{Negative Target | Exercise or PA Prime}}) - (\mathbf{RT}_{\text{Negative Target | Control Prime}})] - [(\mathbf{RT}_{\text{Positive Target | Exercise or PA Prime}}) - (\mathbf{RT}_{\text{Positive Target | Control Prime}})]$.

4.2 The Evaluative Priming procedure within the framework of this dissertation

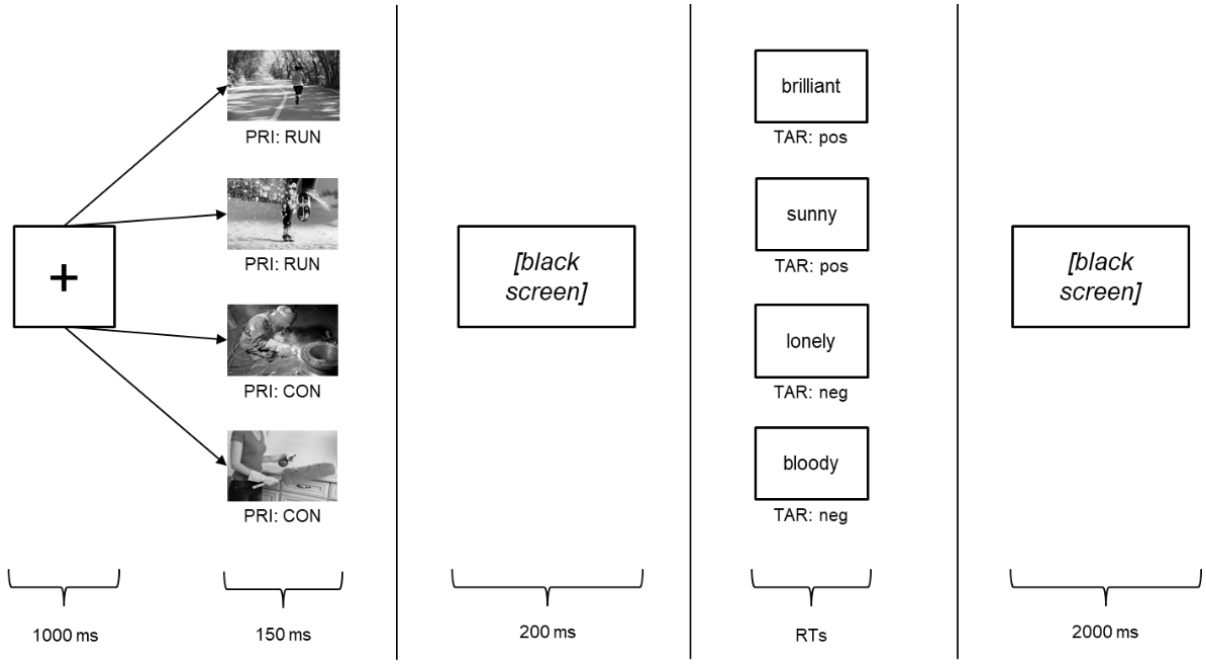
For this dissertation, the EP task was used adapted to the corresponding methodological approach for each study. The general methodology is based on the original EP task by Fazio et al. (1986), whereby the application to an exercise and PA context relates in detail to the approach by Bluemke et al. (2010). The aim of the first publication was to elaborate the specificity of AAP to understand how the amount of exercise and a specific type of exercise (e.g., running) result in differences in AAP toward running (additionally reflective processes were measured). For this purpose, the first modification is then shown in Figure 3 by focusing on the prime stimulus. The prime was now displayed in form of a picture and also presented a little longer, for 150 ms (Limmeroth & Hagemann, 2020) instead of 100 ms (Bluemke et al., 2010), but this can still be classified as subliminal[7] (Elgendi et al., 2018). Pictures were chosen as primes because scientific evidence supports the hypothesis that

[7] When an individual reacts to stimuli below the threshold of perception, subliminal priming occurs (if the stimulus occurs quickly, approx. in less than 500 ms).

pictures, in contrast to words, show advantages in access to a semantic network containing affective information (De Houwer & Hermans, 1994; Kensinger & Schacter, 2006). The target words, adjectives, were also exchanged and were taken from the previously validated Berlin Affective Word List (Vo et al., 2009)[8]. All adjectives had between 4 and 6 letters, with a similar valenced amplitude to the positive or negative (M_{pos} = 1.98, SD = 0.17; M_{neg} = −1.79, SD = 0.17)[9]. In addition to valence, the arousal level of the adjectives was considered (M_{pos} = 2.62, SD = 0.19; M_{neg} = 3.36, SD = 0.22)[10].

Figure 3

First modification of the Evaluative Priming Procedure



Note. Duration of each feature in milliseconds are shown. The figure is taken from Limmeroth and Hagemann (2020, p. 362): “To run or not to run? Automatic evaluations and reflective attitudes toward exercise”. Target words were originally presented in German. RT indicates reaction time; PRI = prime; TAR = target; RUN = running; CON = control; pos = positive; neg = negative.

The second study focused on elaborating on the specificity of AAP regarding different types of exercise: exercising in fitness centers and mountain biking. The corresponding modification of the EP task concerns exclusively the content of the primes, the presented pictures (Figure 4). First, pictures that represent the context of exercising in fitness centers,

[8] In the original approach, neutral adjectives were also used, but they will not be considered further in this overview (compare with the complete study design by Limmeroth and Hagemann (2020, p. 362)).
[9] The affective valence was originally rated on a 7-point scale ranging from −3 = very negative to 0 = neutral) to +3 = very positive (Vo et al., 2009).
[10] Arousal was rated on a 5-point scale ranging from 1 = low arousal to 5 = high arousal (Vo et al., 2009).

mountain biking and for various other types of exercise were used. Second, the control primes were once again adjusted for one context, namely *working on the computer*.

Figure 4

Example prime-pictures concerning to the second modification

FIT MTB EXE CON

Note. Pictures are taken from Limmeroth & Braun (2022): ""Some hate it, others love it": To the formation of automatic and reflective affective processes toward mountain biking and exercising in fitness centers". PRI = prime; TAR = target; FIT = exercising in fitness centers; MTB = mountain biking; EXE = exercising; CON = control.

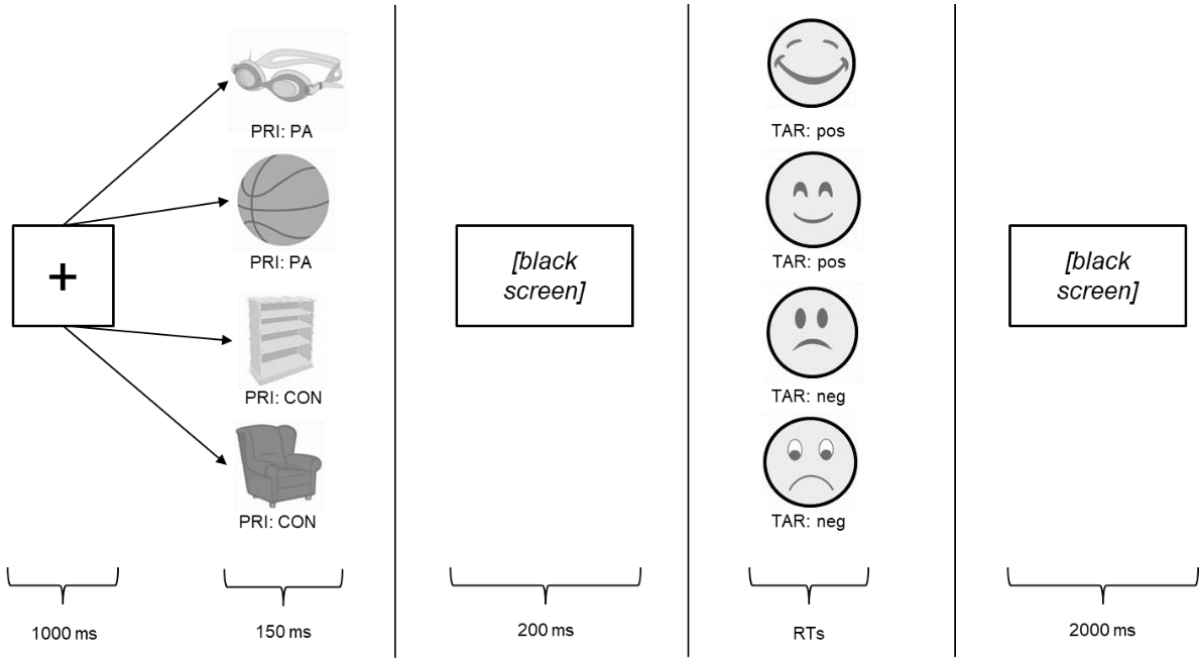
The last publication investigated in children's AAP. While the effect of AAP on PA in adults is well documented, for children, evidence is still lacking. Therefore, the type-1 process is under study and we modified the task for the needs of children. The third and last modification concerns both prime and target (Figure 5). In this approach, PA-related pictures (a bike, a rope, a basketball, etc.) representing moderate as well as high-intensity PA behavior were used as PA primes. As neutral, control primes, pictures representing furniture (a couch, a chair, a table, etc.) were shown. By completely avoiding the use of words as primes or targets in the EP procedure, the EP seems to be more suitable for children. As targets, positively and negatively valenced emoticons were used. A detailed description of each procedure can be found in the original studies included in this dissertation.

In general, priming effects correlate relatively well with real-life behaviors and attitudinal components, such as prejudices (e.g., Degner et al., 2007; Spalding & Hardin, 1999; Spruyt et al., 2007). However, there exist controversial results that show that correlations between priming effects and criterion variables are sometimes small or even absent, which in part seems to be related to the on-average-limited reliability (e.g., De Houwer et al., 2009; Gawronski & De Houwer, 2014; Zenko & Ekkekakis, 2019b). The often found relatively low reliability of these EP tests can probably be attributed to the fact that the relevant category, that should be examined, is usually not named explicitly (Olson & Fazio, 2003).

> "There is accordingly little control over whether or how participants process and categorize the prime stimuli, and this lack of control probably results in a large amount of error variance [...]. Hence, if a prime stimulus is presented, this will activate not only the corresponding concept node but all other nodes with which it is connected" (De Houwer et al., 2009, p. 359).

Figure 5

Third modification of the Evaluative Priming Procedure concerning prime and target



Note. Duration of each feature in milliseconds are shown. The figure is adapted from Limmeroth & Raboldt (2022): ""I do what I like": 8- to 10-year-old children's physical activity behavior is already interrelated with their automatic affective processes". PA-related pictures and furniture were presented as primes and emoticons as targets. PRI = prime; TAR = target; PA: physical activity; CON = control; pos = positive; neg = negative.

Despite these legitimate problems that may arise in connection with EP tasks, and which must of course be taken into account, there exist several advantages using an EP procedure compared also to other reaction-time-based procedures. Therefore, it is of crucial importance, that the indirect measurement method is always adapted to the design of the corresponding study and its objectives. According to Gawronski and De Houwer (2014), the EP task, might be a good predictor of behavior that involves the resolution of response conflicts (e.g., to stay seated vs. to go out for a walk). To conclude, the aim of this chapter is to show that the methodological approach regarding the assessment of AAP is central and at the same time diverse. Every measurement method comes with its particular advantages and

disadvantages, such as mentioned above. Therefore, the choice of an appropriate indirect test to assess - not to directly measure - AAP is crucial and should be reflected in the respective research question.

4.3 Overview of the dissertation project

As shown in the previous chapters, research interest on dual process theories continues to increase and more attention is being paid to the affective experience with regard to exercise and PA. Both the automatic and the reflexive process are considered, although there is still some need for research regarding the relationship between AAP and exercise or PA behavior:

- Which other variables interact with AAP?
- How do they develop?
- How do they change over time?
- In which specific situations or for which specific behavior are AAP effectively important?
- For whom are AAP related? To PA or exercise?

Hence, within the framework of this dissertation the focus lies on specific conditions, situations and contexts under which AAP are or are not related with the corresponding exercise or PA behavior and for whom they are related to PA and exercise. This results in three central research questions for this dissertation:

- Do people who exercise at a different amount (or not at all) and run or don't run differ in their AAP's towards running?
- Do people, who exercise in fitness-centers provide more positive AAP toward fitness activities than mountain bikers and less or non-exercisers and does this also apply to for mountain biking?
- Are AAP not only interrelated with adults PA level but also with children's PA behavior?

In Table 3 an overview of all three publications is presented regarding the purpose, research question, design and method and the main result of each study.

Table 3

Overview of the dissertation program

Publication	Journal	Purpose	Research question	Design & Method	Main result
1st Publication: To run or not to run? Automatic evaluations and reflective attitudes toward exercise	Journal of Sport and Exercise Psychology	Elaboration on the specificity of AAP in order to understand how the amount of exercise and a specific type of exercise (e.g., running) result in differences in AAP toward running.	Do people who exercise at a different amount (or not at all) and run or don't run differ in their AAP's towards running?	- quasi-experimental design - *N* = 95 participants (26 ± 5.06 years; 46% female) divided into five groups - calculation of a priming effect score - one-way analysis of variance with "group" as the between-subject factor and priming (automatic evaluations) as the dependent variable	The highly active runner group differed significantly from the inactive group and from the active exerciser group. AAP differ not only because of the amounts of performed exercise but also because of the preferred type of exercise.
2nd Publication: "Some hate it, others love it": To the formation of automatic and reflective affective processes toward mountain biking and exercising in fitness centers	German Journal of Exercise and Sport Research	Elaboration of the specificity of AAP regarding different types of exercise: exercising in fitness centers and mountain biking	Do people, who exercise in fitness-centers provide more positive AAP toward fitness activities than mountain bikers and less or non-exercisers and does this also apply to for mountain biking?	- quasi-experimental setting. - *N* = 60 participants (30.87 years ±7.53; 33% female) divided into three groups. - calculation of a priming effect score - one-way analysis of variance with "group" as between-subject factor and AAP toward exercising in fitness-centers (1), mountain biking (2) and various types of exercise (3) as dependent variable	AAP toward exercising in fitness centers are distinctive for the preference for this type of exercise. For mountain biking this is only shown on a descriptive level. The importance of choosing an adequate measurement technique to assess AAP toward different types of exercise is highlighted.
3rd Publication: "I do what I like": 8- to 10-year-old children's physical activity behavior is already interrelated with their automatic affective processes	Journal of Sport and Exercise Psychology	While the effect of AAP on PA in adults is well documented, for children, evidence is still lacking, which is why the type-1 process is under study here.	Are AAP not only interrelated with adults PA level but also with children's PA behavior?	- prospective design - AAP are assessed by an EP procedure - objectively measured PA for one week - N = 48 children (8.71 ± 0.71 years; 65% girls) - a linear regression model is calculated with AAP toward PA as predictor for PA behavior	PA-related AAP are associated with children's PA behavior, as has previously been found in adults. The importance of fostering positive affective experiences associated with PA during childhood is underlined.

Note. All three publications as part of this dissertation program entitled "*Automatic affective processes toward different types of exercise and physical activity in adults and children"* are presented.

Automatic and reflective affective processes regarding different types of exercise

Chapter 5

“Due to the wide variety of physical activity choices currently available, it is possible that individual differences [...] may exist that drive an individual’s preference to adopt (and adhere) a specific physical activity mode [compared to other activities]”

(Box et al., 2019, p. 3).

5. Automatic and reflective processes regarding different exercise settings

There are numerous studies examining the relation between AAP and PA or exercise in adults. To summarize, there is a small, significant, and positive correlation (Chevance et al., 2019). According to ART (Brand & Ekkekakis, 2018), AAP (type-1 processes) form the basis for type-2 processing, which manifests in rational reasoning and reflective (affective) processes. While type-1 processing results in an action impulse that can represent a driving or restraining force for exercise or PA; type-2 processing results in action plans (e.g., behavioral goals), which in their own right can represent a driving or restraining force for exercise or PA. On the basis of the theoretical understanding of the ART, the automatic (type-1) and the reflective (type-2) processes can interact with one another. So far, it remains unclear how this interaction takes place or whether both processes can also independently explain PA or exercise behavior. Within this chapter 5, publication 1 and publication 2 as part of this dissertation are presented.

5.1 Derivation of the first publication

Importantly, not only the amount of performed exercise results in variation in AAP, but also preferred exercise settings or types of exercise (e.g., Antoniewicz & Brand, 2014). Therefore, Strack and Deutsch (2004) argued that relatively stable AAP are grounded in recurrent experiences occurring in specific behavioral domains. This suggests that the more specifically adapted the exercise stimuli are, the more likely they are to actually represent the AAP. Frequent positive experiences with a specific type of exercise should result in more positive AAP toward that setting, “which in turn might influence behavioral choices and setting preferences” (Antoniewicz & Brand, 2014, p. 7).

Therefore, the main aim of the first publication is to understand if people who exercise at a different amount (or not at all) and run or don't run differ in their AAP’s towards running? To answer this question an Evaluative Priming Task is used to assess specific AAP toward running in people, who differ in their performed amount of exercise and if they run or do not run. In addition, reflective processes are considered too.

To run or not to run? Automatic evaluations and reflective attitudes toward exercise

5.2 *Publication 1*

Abstract Using an Evaluative Priming procedure, this study tested whether automatic evaluations of running differ among groups based on their amount of exercise and whether they were runners or not. Ninety-five participants (26 ± 5.06 years; 46% female) were divided into five groups: an inactive group, active exercisers, highly active exercisers, active runners, and highly active runners. A priming effect score was calculated based on the concept of response facilitation or inhibition: the reaction is faster when the target and prime are valence congruent and becomes slower if they are incongruent. The highly active runner group differed significantly from the inactive group ($p < .01$) and from the active exerciser group ($p < .05$). Furthermore, reflective evaluations were measured via questionnaires. The results show that priming effect scores can detect automatic evaluations of running, and they differ not only because of the amounts of physical exercise but also because of their preferred type of exercise.

Keywords: affective-reflective theory, dual-process, evaluative priming, physical inactivity

This chapter was published as Limmeroth, J., & Hagemann, N. (2020). To run or not to run? Automatic evaluations and reflective attitudes toward exercise. *Journal of Sport and Exercise Psychology*, *42*(5), 358-367. https://doi.org/org/10.1123/jsep.2019-0284.

It is presented within this dissertation in form of the final manuscript “as accepted for publication in *Journal of Sport & Exercise Psychology*, ©Human Kinetics”.

5.2.1 Introduction

In wealthier countries, physical activity (PA) guidelines are rarely reached, and the transition toward a more sedentary lifestyle is ongoing (Guthold et al., 2018). People differ significantly in terms of their exercise behavior: some people exercise very regularly several times per week; others fail to meet the minimum standards (World-Health-Organisation, 2010). Given these aspects, physical inactivity was identified as the fourth leading risk factor for noncommunicable diseases (Hallal et al., 2012) and characterized as one of the largest public health problems of the 21st century (Ekkekakis et al., 2011). Exercise psychologists have focused primarily on cognitive factors for over a decade to explain why some people participate regularly in sports and exercise, while others do not (Rhodes et al., 2019). The social cognitive or humanistic framework is considered a dominant framework and includes popular theories such as the theory of planned behavior (Ajzen, 1985) or the self-determination theory (Deci & Ryan, 1985). On the one hand, they deal with people's reflections on their thoughts and feelings and differentiate between them because of their capacity and willingness to make rational decisions to achieve desired goals (McEwan et al., 2016). One the other hand, they classify human behavioral action as being "motivated by an innate drive to grow, develop, and realize one's potential" (Rhodes et al., 2019, p. 3). These approaches only marginally focus on affective processes and their importance for regulating PA or exercise behavior (Conroy & Berry, 2017). Alternative approaches (e.g., emphasizing the role of affects, emotions, and feelings) perceive human action as partially intuitive and impulsive, and have been largely neglected in the current research landscape (Ekkekakis, 2017; Ekkekakis & Zenko, 2016).

Dual Process Models as Theoretical Framework

One of the most understudied frameworks—the dual-process approach—is based on these critical assumptions, and researchers have included affects and intuition into their theoretical model (Brand & Cheval, 2019; Rhodes et al., 2019). However, recent evidence referring to a dual-process approach has shown that these impulsive processes play an important role in explaining variations in human behavior (Evans & Stanovich, 2013). Dual-process theories distinguish between reflective and automatic processing of information. The deliberate consideration of available information characterizes reflective processes (Type II), and the resulting reflective evaluations may be cognitive or affective. Contrary to this perspective, automatic processes (Type I) represent the affective, spontaneous, and often nonconscious response to a stimulus or a current event. The reaction has its origin in the (learned) mental associations between a goal concept (e.g., exercise) and affective attributes (e.g., pleasurable). Importantly, the mental representation of one's own affective core response to the stimulus or event is the foundation for this reaction (Ekkekakis et al., 2013).

Automatic Evaluations and the Affective-Reflective Theory of Physical Inactivity and Exercise

Automatic evaluations of exercise (AEE)-related stimuli could possibly explain why some people are physically active and others are not (Schinkoeth & Antoniewicz, 2017). A recently developed model based on a dual-process perspective is the affective–reflective theory (ART) of physical inactivity and exercise (Brand & Ekkekakis, 2018). This model deals directly with physical inactivity and exercise and the resulting physical sensations. The basic idea behind this theory is grounded in Lewin's force-field analysis (1951). This theory is regarded as a simple conceptual framework accounting for driving and restraining forces. On the one hand, a person can be pushed toward a positively valenced region (situation) or, on the other hand, repulsed by a (in her or his eyes) negatively valenced region. ART suggests that momentary affective responses to a situation can -for some people- act as such a restraining force holding them back in the present situation, for example, by remaining seated instead of going out to exercise (Brand & Ekkekakis, 2018). A closer look at the theory reveals that the starting point is composed of an exercise-related stimulus connected with one's current state of physical (in-)activity, which triggers a first-step automatic association related to the concept of exercise (Brand & Ekkekakis, 2018). Based on those associations, a somatic core affect is generated, a process the authors call "automatic affective valuation" (Brand & Ekkekakis, 2018, p. 7). This automatic affective valuation leads to specific action impulses that can influence the individual to change his or her actual behavior or to maintain the present state: some people automatically associate something positive or pleasurable with this specific exercise-related stimulus, whereas others experience something negative or nonpleasurable. Therefore, in terms of the theory, AEE (Type I processes) are associated with approaching or avoiding bodily sensations linked to this behavior (Schinkoeth & Antoniewicz, 2017).

As a default-intervention theory, ART proposes that the automatic affective valuation forms the basis for controlled, reflective evaluations (Type II processes). They are built on propositional information (directly and automatically encoded affect and cognition from the automatic associations) and are possibly interconnected with future automatic associations. The controlled reflective response can result in an action plan (Brand & Ekkekakis, 2018). This action plan can be concordant or not concordant to the previously explained action impulse. In this context, self-control resources play an essential role because the resulting behavior depends on it in a decisive manner. The fewer self-control resources that are available, the greater the influence of AEE/Type I processes will be (Englert & Rummel, 2016; Schinkoeth & Antoniewicz, 2017). Whether Type I or Type II processes dominate the behavioral action will depend, for example, on interindividual differences in self-regulatory skills or on the time available in a certain situation (Friese, Hofmann, & Schmitt, 2008). ART proposes that AEE and reflective–affective evaluations should be interpreted as an interaction through reciprocal feedback. These loops vary among individuals.

Indirect Measurements and Exercise Behavior

It is important to focus on the implicit character of automatic evaluations in selecting an appropriate indirect measuring method (for an overview, see Brand & Gutman, 2020). The most popular and also vigorously discussed method is the implicit association test (IAT) and its variants (Greenwald et al., 1998), which have been used in several studies (Antoniewicz & Brand, 2016a; Chevance et al., 2016). In addition to the IAT and other tests, the Evaluative Priming task (EP; Fazio et al., 1986) has also been established to assess automatic processes. Some studies (Bluemke et al., 2010; Eves et al., 2007) already rely on the theoretical assumptions of the EP, which propose that behavior can automatically be activated (Bargh & Chartrand, 1999). The EP is based on the idea that automatic activation of valence occurs following the supra- or subliminal appearance of a prime stimulus. A significant advantage of the EP over the classical IAT is that it facilitates calculating separate (priming) scores for different kinds of associations (Gawronski & De Houwer, 2014). In general, according to Bargh (1994), the reactions are regarded as automatic in three aspects: they are unintentional, occur outside of awareness, and are uncontrollable. Only efficacy in the use of attentional resources can be considered to be critical.

Several studies have suggested that a relationship between AEE and exercise behavior itself exists (amount, duration, frequency, preferred type of exercise, and the activity level). Berry et al. (2011), using the IAT, examined the differences in AEE in 53 undergraduate university students with different exercise self-schemas (exercisers and nonexercisers) and different activity levels: AEE were more positive in the most active group than in those with a lower exercise level, and the AEE of “exerciser schematics” were more positive than in “nonexerciser schematics.” Another study investigated the relationship between AEE and the frequency and duration of the exercise behavior (Bluemke et al., 2010). They used an EP procedure with exercise-specific or generic verbs as prime stimuli and positive or negative exercise-specific or generic words as target stimuli. Both exercise groups held significantly more positive AEE than the participants who did not exercise. AEE predicted selfreported frequencies and overall amounts of exercise, as well as durations of exercise sessions.

Brand and Schweizer (2015) also used the same EP task. They showed that AEE were not associated with reflective evaluations, but significantly predicted situated decisions to exercise (in addition to reflective evaluations). The more positive the AEE and reflective evaluations, the more likely the participants would decide in favor of exercising, despite behavioral alternatives. In addition, Antoniewicz and Brand (2014) suggested that the preferred exercise setting (type of exercise) is relevant for AEE. They used the subliminal affect misattribution procedure, showing fitness-center stimuli to differentiate among highly active exercisers. They revealed that the specific exercise setting was more relevant than the amount of physical exercise: fitness-center exercisers hold more positive AEE by exercising in fitness

centers than a similar physically active comparison group (other preferred exercise setting). The same observation could be made for the reflective–affective evaluations: they were more positive for fitness-center exercisers than in the comparison group, while only nonsignificant correlations between AEE and reflective–affective evaluations were found in both groups.

Moreover, it is still unclear how AEE or PA evolves during childhood and develops during adulthood (Chevance et al., 2019). It remains of interest to determine which factors interact with automatic processes, how they develop, and how they change over time, and to understand in which specific situations or for which specific behavior AEE are important (Conroy & Berry, 2017; Chevance et al., 2019).

The Present Study

Furthermore, there is still a lack of evidence for dual-process theories, especially regarding the interaction of automatic and reflective evaluations of exercise. Therefore, it remains unclear how explicit processes moderate the interaction between implicit associations and exercise behavior or interact directly with them (Chevance et al., 2019). First, the present study aimed to provide evidence for the existence of AEE representing a dimension different from reflective evaluations. The hypothesis was that the reflective and automatic system independently contribute to predicting self-reported amounts of exercise. It was assumed that the study should contribute to the idea that people who exercise more experience more positive AEE than people who exercise less or are physically inactive.

Second, our approach is based on previous work showing that not only is the amount of exercise important for AEE, but also the preferred type of exercise (e.g., Antoniewicz & Brand, 2014). Strack and Deutsch (2004) argued that relatively stable automatic evaluations are grounded in recurrent experiences occurring in specific behavioral domains. Referring to ART (Brand & Ekkekakis, 2018), frequent positive experiences with a specific type of exercise should result in more positive AEE, “which in turn might influence behavioral choices and setting preferences” (Antoniewicz & Brand, 2014, p. 7). In our view, the added value of our study lies in our explicit focus on the specificity of running instead of more general approaches focusing on PA or exercise. We propose that the amount of exercise, as well as the specific type of exercise -running- will result in differences in AEE and in the reflective–affective evaluations.

5.2.2 Method

Participants

Potential participants were recruited from various settings such as running clubs, the university campus, the medical field, and different city center halls. We sought people differing

in the amount of exercise and in their preferred type of exercise, focusing on individuals who run and those who do not. To answer our research question, we needed one inactive group, groups differing in their amount of exercise, and groups of those who run or do not run. “Exercise groups” should exercise to the same extent, as should their equivalent “running group,” but should not run. Therefore, in a quasi-experimental design, the participants were divided into five groups as follows: an inactive group, active exercisers (who do not run), highly active exercisers (who do not run), active runners, and highly active runners. The participants who should be part of the active groups must exercise for >75 min and maximally for 299 min/week. More active participants form the highly active groups (US Department of Health and Human Services, 2018). All active participants are further divided into runners or exercisers. The participants who do not regularly exercise (exercising less than 75 min/week, according to the World Health Organization guidelines) were included in the inactive group. In total, 104 individuals were recruited and participated voluntarily. Finally, the data from 95 participants were analyzed. All participants were working or studying full time. A further description of the sample is presented in Table 4. We focused primarily on the exercise amount, but also collected data on general PA.

Power analysis

For our power analysis, we focused on our main variable: the AEE. In line especially with Antoniewicz and Brand (2014), we began our power analysis for an analysis of variance with the assumption of a medium-to-large effect size (d > 0.74) for a main effect of AEE with five groups as an independent variable. In keeping with the aforementioned study, we set the test power at 0.80, with a Type I error rate of α = .05 for two-sided testing. The power analysis revealed that 95 respondents are required. Anticipating that some data would be missing or unable to be used, we aimed to obtain data from at least 100 participants.

Procedure

Prestudy. In an independent prestudy using a subsample of active and inactive physical education students (n = 22), we pretested our stimuli set. The participants rated each of the 136 initial images on a horizontal visual analog scale (ranging from 0 to 100). For the scales, we used the following anchors: (a) pleasant/unpleasant, (b) activating/deactivating, and (c) exercise/no exercise. The running pictures had to reach a value of 75 to be considered (M= 81.23, SD = 10.91), and the control pictures had to fall below a value of 40 (M= 37.75, SD = 12.34). The running pictures had an average valence of 63.06 (SD = 22.56), and the control pictures of 55.03 (SD = 25.32). For the “arousal” category, the mean for the running pictures was 58.19 (SD = 19.32), and for the control pictures, it was 52.34 (SD = 24.57). In the end, the running pictures with the highest tendencies in favor of exercise were used for the experimental

(exercise) category, and for the control category, the control pictures with the lowest ratings for exercise were used. Finally, we chose 100 pictures for our EP procedure.

Main study. Potential participants were invited to the experimental setting. A quasi-experimental design was conducted using two different measurement methods: a computer-based EP task and different reflective questionnaires (see "Measures" section). After receiving general information about the procedure, the EP task had to be completed. Additionally, the participants filled out a questionnaire which measures exercise and sport activity (BSA-F; Fuchs et al., 2015), followed by questions about their reflective–affective and cognitive attitude toward exercise and running (Brand, 2006). Finally, they indicated their situated decisions related to running (adapted Situated Decisions to Exercise Questionnaire [SDEQ]; Brand & Schweizer, 2015). Ethical approval was obtained from the local ethics committee of the University of Kassel. Moreover, all procedures met the ethical requirements defined by the Declaration of Helsinki and its later amendments.

Measures

EP Task. Our study used the EP method, following the recommendation of Fazio and Olson (2003), who proposed that this method be used to assess automatic evaluations and the prediction of related behaviors (Eves et al., 2007). Based on Fazio et al.'s (1986) idea, the participants were instructed to perform a task with two features. The priming procedure is computer based: while participants are working on a series of prime–target combinations, they must also neglect the subjective positive or negative prime stimulus presented. This is the first feature of the priming procedure. Subsequently, the valence of a following positive or negative target stimulus must be identified correctly as quickly as possible by pressing a response key. That is the second feature of the priming procedure. Targets remain on the screen until the participant indicates their perceived valence by pressing one of two response keys (for positive and negative valence, respectively). A cross, presented for 1,000 ms at the center of the screen, indicates the beginning of each trial and activates the participant's attention to the following prime presentation. The prime presentation is presented for 150 ms (e.g., Bluemke et al., 2010; Fazio, 2007), followed by a black screen for 200 ms and the presentation of the target stimulus. A blank screen lasting for 2,000 ms marks the end of each trial, the break between two trials (Figure 6).

During each trial, a randomly chosen prime–target combination was presented. The elicited valence could subsequently lead to either response facilitation or response inhibition. In the case of response facilitation, the target stimulus is subjectively classified as valence congruent with the previous prime presentations. The contrary effect is seen in valence-incongruent trials. In general, primes activate the associated positive or negative valence within a few hundred milliseconds. As previously mentioned, Fazio and Olson (2003) described

that priming effects are usually interpreted as spreading activation within a participant's semantic network. The elicited valence is used for inferring the evaluation of primes. If the prime stimuli with a similar concept generate equal valence across multiple trials, the specific evaluation of the underlying concept can be calculated by the amount of facilitation and inhibition on congruent and incongruent target trials. As for the calculation, the mean response latencies of the various prime-target combinations can be used (Antoniewicz & Brand, 2016b; Brand & Schweizer, 2015). The priming effect is evaluated by reaction times (RT) and calculated as follows (e.g., Bluemke et al., 2010): $[(\mathbf{RT}_{\text{Negative Target | Running Prime}}) - (\mathbf{RT}_{\text{Negative Target | Control Prime}})] - [(\mathbf{RT}_{\text{Positive Target | Running Prime}}) - (\mathbf{RT}_{\text{Positive Target | Control Prime}})]$. If answers toward positive adjectives after showing running primes were facilitated, the resulting priming effect should be greater, and if answers toward negative adjectives were inhibited, the resulting priming effect should be more pronounced.

One hundred running-related and control pictures (concept of "work") were used for the first feature of the priming procedure. For the categorization task of positive and negative stimuli (second feature of the priming procedure), we chose 20 positive, 20 negative, and 10 neutral adjectives as target stimuli. The neutral stimuli serve as "fillers" to keep attention high during all trials. During the data analyses, we also controlled the sorting of these neutral trials toward the positive or negative category, but did not use them for further calculation. The adjectives (see Appendix: Chapter 5.2.7) were taken from the previously validated Berlin Affective Word List (Vo et al., 2009).

All chosen words had between four and six letters (M = 5.36, SD = 0.80). The positive words had an average valence of M = 1.98 (SD = 0.17), negative ones of M = −1.79 (SD = 0.17), and neutral ones of M = -0.08 (SD = 0.27). Emotional valence was originally rated on a 7-point scale ranging from -3 (very negative) to 0 (neutral) to +3 (very positive). Referring to the level of arousal, positive adjectives have an average of M = 2.62 (SD = 0.19), negative adjectives of M= 3.36 (SD = 0.22), and neutral ones of M = 2.95 (SD = 0.14). Arousal was rated on a 5-point scale ranging from 1 (low arousal) to 5 (high arousal).

The participants performed in 100 trials. For half of the trials, the left key was linked with a "positive valence" and the right key with a "negative valence," represented at the bottom of the screen with a positive or negative smiley face. After 50 trials, the keys were switched. The response keys were marked visually for the participants: the one on the left side of the keyboard was "CTRL," and the one on the right side was ",". The experiment took place in quiet rooms, always using the same computer (Fujitsu Life-book E782 with a 15.6" monitor, a resolution of 1280 × 1024 pixels and a refresh rate of 75 Hz; Fujitsu Technology Solutions GmbH, Munich, Germany), and the EP task lasted approximately 12 min. Cronbach's alpha was relatively low, with α = .58.

Questionnaires. The full BSA questionnaire was used primarily to obtain the exercise amount, but also to receive further information about PA during leisure time and at work per week (Fuchs et al., 2015). The BSA questionnaire distinguishes between activities with slightly increased energy expenditure, which we perform to fulfill our daily tasks (PA in leisure time and at work), and voluntary exercise activity. To assess the participants' reflective evaluations of exercise and running (as an output of the reflective system), we used the attitude questionnaire, which is an already published scale with established psychometric properties (Brand, 2006). This instrument is composed of four items related to one's cognitive attitude and four items addressing the participant's affective attitude toward exercising. We also modified it for a running context. Both components provide a description by means of semantic differentials, which must be evaluated on scales between 1 and 9; for example, "Imagine: 'When I think of running, I feel': not relaxed/extremely relaxed; not satisfied/extremely satisfied; not happy/extremely happy; not well/extremely well." The mean score of each category was calculated.

Additionally, they answered the SEDQ (Brand & Schweizer, 2015) in a version adapted to a specific type of exercise: running. The SDEQ is a measure of peoples' tendencies to decide in favor of exercise in situations in which they face behavioral alternatives: for example, "You're leaving work and you are just about to go out for a run. Now you hear that your colleagues plan to go out for a drink. They invite you. Do you go running or not?" The participants answered these questions on a 5-point scale, with the anchors labeled by *all means/definitely yes* (1) and by *no means/definitely no* (5). We first calculated Cronbach's alpha, which showed low correlations for Items 4 and 5 (both < .2). We decided not to include them in further analyses. Therefore, our final score for the situated decisions was composed of six items (Cronbach's α = .83).

Data analyses

The means and *SD*s were calculated as indicators of the descriptive statistics, and we began by testing bivariate relationships with Pearson's product-moment correlations. To facilitate the interpretation of latency outcomes, we prepared the latency measure in line with common recommendations. Trials with response latencies <250 ms and reactions that were 99% likely to fall outside the "normal response time" were considered outliers, and thus, were eliminated from the analyses (6.23% of the correct experimental trials). Participants with error rates >20% were also excluded.

The priming effects were directly expressed in measured milliseconds and subjected to one-way analysis of variance with "group" as the between-subject factor and priming (automatic evaluations) as the dependent variable. In a further step, the reflective variables were analyzed in separate analyses of variance. An alpha level of $p < .05$ was set throughout

all analyses to indicate significant characteristics. All analyses were carried out using SPSS (version 25.0; IBM Corp., Armonk, NY) for Windows. The thresholds for the interpretation of effect-size statistics followed Cohen's guidelines for *r* and *d*.

5.2.3 Results

As seen in Figure 7, the groups differed significantly in their priming effect; $F(4, 90) = 3.83$, $p = .01$; $d = 0.82$ (inactive: $M = -14.87$, ($SD = 85.16$); active exercisers: $M = -1.42$, ($SD = 62.07$); active runners: $M = 40.68$, ($SD = 58.34$); highly active exercisers: $M = 25.55$, ($SD = 58.02$); highly active runners: $M = 62.67$, ($SD = 85.73$)). The post-hoc analysis (via Bonferroni correction) revealed a significant difference between the inactive group and the highly active runner's group ($p < .01$). A comparison between the active exercise group and the highly active runner's group also showed a significant group difference ($p < .05$).

Overall, the participants identified target valence on average after $M = 803.33$ ms ($SD = 112.49$). The participants made few errors in the Evaluative Priming procedure (4.52% of trials, respectively). In general, the participants reacted faster with positive targets ($M = 751.66$; $SD = 105.29$) than with negative targets ($M = 854.99$; $SD = 126.01$): $t(94) = 17.50$, $p < .001$, $d = 1.80$. The mean reaction times after control ($M = 804.20$; $SD = 112.85$) and running primes ($M = 802.45$; $SD = 117.29$) were similar: $t(94) = 0.35$, $p = .73$, $d = .04$. The groups showed no significant differences in their general reaction times: $F(4, 90) = 0.91$, $p = .46$, $d = 0.40$. Data on reaction times and calculated priming effect were distributed normally.

It must be assumed that the reflective evaluations "the affective and cognitive attitudes to exercise and running" were not distributed normally. These evaluations were analyzed using the nonparametric Kruskal–Wallis procedure and the Welch procedure. The affective–reflective evaluations of exercise differed significantly between the five groups: $\chi^2(4) = 37.46$, $p < .001$, $d = 1.54$ (inactive: $M = 4.97$ ($SD = 1.71$); active exercisers: $M = 7.68$ ($SD = 1.06$); active runners: $M = 7.87$ ($SD = 0.84$); highly active exercisers: $M = 7.80$ ($SD = 1.14$); highly active runners: $M = 7.84$ ($SD = .91$)). The affective reflective evaluations of running also showed significant group differences: $\chi^2(4) = 42.3$, $p < .001$, $d = 1.72$ (inactive: $M = 3.69$, $SD = 1.51$; active exercisers: $M = 4.98$, $SD = 2.02$; active runners: $M = 7.33$, $SD = 1.08$; highly active exercisers: $M = 4.50$, $SD = 2.12$; highly active runners: $M = 7.21$, $SD = 1.64$). The cognitive component of exercise revealed almost no differences between these five groups: $\chi^2(4) = 8.37$, $p = .08$, $d = 0.45$ (inactive: $M = 8.00$, $SD = 0.74$; active exercisers: $M = 8.41$, $SD = 0.74$; active runners: $M = 8.58$, $SD = 0.59$; highly active exercisers: $M = 8.55$, $SD = 0.65$; highly active runners: $M = 8.00$, $SD = 1.15$). Moreover, no significant group differences could be detected in the cognitive component of running: $\chi^2(4) = 4.98$, $p = .29$, $d = 0.21$ (inactive: $M = 6.83$, $SD = 1.22$; active exercisers: $M = 7.16$, $SD = 1.29$; active runners: $M = 7.59$, $SD = 1.07$;

highly active exercisers: *M* = 7.05, *SD* = 1.54; highly active runners: *M* = 7.50, *SD* = 1.04). Z-transformed reflective and automatic evaluations as well as the situated decisions are presented in Figure 8.

Post-hoc analyses (via Bonferroni correction) showed for the affective component of running that the highly active runner group differed significantly from the inactive group, active exercisers and highly active exerciser groups ($p < .001$). In addition, the active runners differed significantly from these three groups ($p < .01$). According to the affective component of exercise, all four active groups showed significant differences from the inactive group ($p < .01$).

The situated decisions in favor of running differed significantly among all groups: $F(4,90) = 11.2$; $p < .01$; $d = 1.48$. It was found that highly active runners (*M* = 12.9, *SD* = 3.84) had the highest tendency to decide in favor of running if they were confronted with other options (the lower the score, the higher the tendency to decide in favor of running). Active runners (*M* = 15.79, *SD* = 3.47) showed the second highest tendency, followed by highly active exercisers (*M* = 17.25, *SD* = 6.05), active exercisers (*M* = 19.04, *SD* = 4.51), and inactive participants (*M* = 21.68, *SD* = 4.28). Moreover, the groups differed significantly in their situated decisions related to running. Post hoc analyses, using the Bonferroni procedure, revealed that the results can be explained by the significant differences between the inactive and the highly active runner group ($p < .001$), the active runner group ($p = .002$), and the highly active exercisers ($p = .04$). Highly active runners differed significantly from active exercisers ($p < .001$) and highly active exercisers ($p = .049$). No significant differences were found between both running groups. Situated decisions were normally distributed in this sample. Additionally, Pearson's correlation between all mentioned variables are shown in Table 5, and we added a regression model to the Supplementary Material (available online: Chapter 5.2.8). This model uses the priming effect as the dependent variable and Group (runner or not) × PA (continuous measure) as predictors.

5.2.4 Discussion

The primary aim of the present study was to provide further evidence for the relationship between AEE and exercise. Our findings add to the existing knowledge in several ways. First, we expanded the findings of Bluemke et al. (2010) on the correlation between overall exercise amount and automatic evaluations. Second, based on Antoniewicz and Brand (2014), we highlighted the importance of the specific, preferred type of exercise. Overall, for any rating level, higher affective priming effects correlated with higher scores of reported exercises. Thus, the stronger the activation of positive targets relative to negative targets following exercise primes (i.e., the bigger the exercise-specific EP effect) and compared with control conditions, the more the person exercised (Bluemke et al., 2010). We found significant group differences regarding the priming effect measured by the EP task (Eves et al., 2007).

Therefore, the amount of exercise, as well as the specific exercise context, account for differences in automatic evaluations of running.

According to the features of automaticity (Bargh, 1994), the reactions can be seen as (post consciously) automatic. Exercise-related stimuli trigger automatic associations, resulting in an automatic affective valuation of exercise (Type I process; Brand & Ekkekakis, 2018). The priming effect can be interpreted as partly driven by AEE. Importantly, we only found significant group differences between inactive participants and active exercisers compared with the highly active runner group. We take this as a strong indicator of our hypothesis that both aspects (the preferred type of exercise and the amount of exercise) play a crucial role in forming AEE.

In line with past research, we also found that positive AEE can help to discriminate exercisers from nonexercisers (Bluemke et al., 2010; Conroy et al., 2010). Our findings go beyond the existing evidence, as they show that AEE can be used to differentiate not only because of the amount of exercise, but also because of self-assessment of a specific type of exercise. Running is special because it is composed of many different exercise types (e.g., a person also runs in a soccer game). Furthermore, all types of exercise can be assigned to the whole concept of exercise. Therefore, it is also possible for a person who exercises but does not run to have positive AEE toward running. In this case, running is memorized as part of the whole associative network of exercising. Nevertheless, the AEE should be more positive or stronger if the specific exercise type (running) is performed regularly, as found in our data.

We used a sample of exercisers—varying in their weekly exercise amount—and nonexercisers. The exercisers not only differed based on their exercise amount, but also based on whether they ran. We expected that runners exercising to a greater degree would have several (more) positive past experiences while running and would therefore exhibit the most clearly pronounced AEE. Our aim was to maximize the magnitude and discriminability of AEE regarding their specificity to a unique type of exercise (running) and to show the importance of repetition of a specific behavior, for example, the amount of exercise (Conroy & Berry, 2017).

Focusing on the reflective evaluations, only both affective attitude components and the more distal exercise-related situated decisions differed among the five groups, whereas the cognitive attitude components did not. Importantly, the priming effect did not significantly correlate with the cognitive or the affective attitude components, although it was close to the significance level in terms of the affective attitude component of exercise. Our findings are in line with the assumption that the reflective and automatic processes can independently contribute to exercise behavior (e.g., Brand & Schweizer, 2015). However, further research is needed to define how they are interconnected. The ART, for example, proposes that Type I and Type II processes are interconnected through reciprocal feedback (Brand & Ekkekakis, 2018). However, it remains unclear how this relationship is constructed. Thus, it is of further interest to understand how and why AEE occasionally differ within a person (Schinkoeth &

Antoniewicz, 2017). We suggest that this could also vary between exercisers and nonexercisers. For example, if a person's action plan is to participate in exercise, but their AEE remain negative, this will lead to a contradictory state of restraining and driving forces (Brand & Ekkekakis, 2018; Lewin, 1951). Therefore, cognitive resources play a crucial role in the potential influence of the reflective system on action impulses and the behavior itself. For example, the importance of automatic associations will differ among individuals who vary in their capacity for self-regulation: those with a higher capacity would rely less on their automatic processes guiding their behavior than those with lower self-regulation (Chevance et al., 2019). It will be important for future research to carry out studies that focus on the specific conditions under which implicit associations are or are not associated with exercise behavior and to control for self-control in the form of strategies that override conflicts (Englert & Rummel, 2016).

Furthermore, it is important to differentiate among different forms of questioning for the reflective system. Our results underline that the affective attitude component is much more useful in differentiating among individuals who differ in their PA than their cognitive component. Moreover, it helps to differentiate among participants with different exercise amounts and preferred types of exercise. This finding corroborates existing research on the role of affective and cognitive attitudes toward exercising (Brand, 2006). In our study, we found no correlation between situated decisions and AEE, which is contrary to the findings of Brand and Schweizer (2015). However, we can vouch for the strong relationship between the SDEQ and reflective evaluations, especially for the more specific affective component of running. Therefore, the attitudes questionnaire and the SDEQ share a variance for methodological reasons, which may lead to these correlations in general (Hyde et al., 2012). For the cognitive and affective components of exercise and running, we had to deal with some statistical outliers. Four participants, who exercise and/or run regularly, rated low. In terms of their other answers and the structure of the questionnaire (order of the questions), we do not believe they misunderstood the rating of this question. Therefore, we decided to keep them in the data and deal with these statistical outliers instead (see Figure 8).

One limitation of our study, as in previous research, is the use of indirect measurement techniques to draw conclusions about automatic processes, and the reliability of the test. For our test, we also had to deal with a relatively low Cronbach's alpha of .58. We should emphasize that we need to improve the ratability of these indirect measurements (e.g., Chevance et al., 2019; Zenko & Ekkekakis, 2019a). One methodological challenge we faced was that it was simply impossible to ask the participants about their associations with something. By asking them, the process loses its automatic, implicit, and unconscious character. Therefore, we cannot be completely sure whether the underlying unconscious processes are what we were expecting of them (Gawronski & De Houwer, 2014) and if we were really testing what we expected to test (Zenko & Ekkekakis, 2019b). Nevertheless, we

believe that the EP task is strongly connected to our theoretical assumptions and a sensible indirect test of our hypothesis. The reasons for this assumption are its widespread activation processes (Fazio & Olson, 2003) and previous research using the EP task, which has provided insights into the mechanisms underlying attitude-behavior relations (for an overview, see Fazio, 2007). It is important to understand that the associative network itself remains a black box. However, we know from neuroscience that some neural brain regions are always activated when a person is thinking, for example, about exercise, and that other regions are activated when the person feels pleasure or displeasure (Cheval et al., 2018). If both reactions happen simultaneously, they fire together and, from that point on, are interconnected and, therefore, form a so-called associative network, which is the foundation of our hypothesis (De Houwer, et al., 2009). Evidence suggests that the EP effect shows some of the characteristics of automaticity (Fazio, 2007); reactions can be regarded as *unintentional*, occur *outside of awareness*, and are u*ncontrollable* (Bargh, 1994).

Furthermore, we would like to highlight that our test measures reaction times and that we interpret them as an automatic process because of our underlying theoretical framework. Nevertheless, this remains a challenging and controversial question about which we need further knowledge to clarify the interaction and potential influence of these associations (Calanchini & Sherman, 2013; Zenko & Ekkekakis, 2019a). Furthermore, testing standardization should be achieved in the future (Zenko & Ekkekakis, 2019b) but will most likely vary in terms of the specific underlying processes related to each particular measure (Znanewitz et al., 2018).

Our test may also be criticized for using a neutral category. We suggest that using neutral words maintains concentration and makes the test more challenging for participants. However, it is possible that the neutral targets involving a weak association somehow distracted the participants from the central task (Fazio et al., 1986). Indeed, as we found a relatively stable group priming effect, we can assume that the test itself worked. Nevertheless, we also found rather high *SD*s and had to exclude several outliers because of extensive reaction times that could no longer be categorized as automatic. We suppose that these outliers in particular were raised by the neutral category. We would recommend that future studies exclude a neutral category.

Additionally, we only focused on exercise behavior, although, of course, our so-called inactive group is not entirely physically inactive because members also go out for a walk, cycle to work, do gardening, and so forth. These behaviors are also important for a healthy lifestyle. Nevertheless, we hypothesize that they do not play an important role in forming AEE. Regardless of these limitations, we show that positive AEE related to a specific exercise context such as running can be detected in exercisers and runners, but not in the inactive group. Therefore, we assume that AEE differ according to an individual's preferred type of

exercise and the exercise amount. Repeated positive automatic experiences in terms of a specific situation could serve as an adherence factor for regular exercising. Specific associations appear to be related to the general context of exercise. According to our research, AEE play an important role in qualitative and quantitative behavioral regulation for frequent exercisers. A future challenge would be to obtain further insights and to better understand AEE and their importance for exercise behavior (Ekkekakis & Brand, 2019; Rhodes et al., 2019). If simple heuristics developed through experiences form the basis of automatic processes, we must clarify how specific they are and how generalizable they could be (Chevance et al., 2019).

We should especially focus on affective experiences during exercise and interpret them as a history of pleasant/unpleasant affective experiences forming nonconscious AEE and its impact on future exercising behavior. Dual-process theories, such as ART (Brand & Ekkekakis, 2018) or the model of Conroy and Berry (2017), postulate that exercise behavior is always shaped by the interaction of implicit (Type I) and explicit (Type II) processes. These interactions may be moderated by a multitude of other situational and dispositional variables, such as self-regulatory resources and/or depleted cognitive resources (Schinkoeth & Antoniewicz, 2017). Overall, our study contributes to a better understanding of the role of affective experiences and automatic processes in facilitating (or impeding) exercise behavior, emphasizing their importance, as called for by certain researchers (Ekkekakis & Brand, 2019; Hagger, 2016; Rebar, 2017).

It would be necessary in future studies to determine whether the findings obtained from our study can be generalized to other types of exercise and to other populations. Additionally, researchers might benefit from including potential moderators to clarify the relationship between reflective and automatic evaluations and the behavior itself (Friese, Hofmann, & Schmitt, 2008). Emphasizing increased effort on multivariate statistical analyses could also be helpful, first, to test the interconnection of Type I and Type II processes and, second, to prove ART is a theoretical background model. In general, future studies should include automatic evaluations as part of their theoretical considerations to promote a more physically active lifestyle (Rhodes et al., 2019) and to investigate behavioral change techniques and theories to better understand the origins of AEE, how they could be modified, and whether these modifications lead to lasting behavioral changes (Chevance et al., 2019).

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5.2.6 References

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5.2.7 Appendix

Adjectives (used in German and traduced to English)

Positive Adjectives. gratis - for free; sauber - clean; schlau - clever; stark - strong; tapfer - brave; froh - glad; heiter - bright; nett - kind; weise - wise; human - human; toll - great; loyal - loyal; lieb - nice; mutig - curageous; treu - faithful; vital - vital; warm - warm; genial - brilliant; sonnig - sunny; super - fantastic

Negative Adjectives. leblos - inanimate; einsam - lonely; elend - miserable; brutal - violent; krank - ill; mies - lousy; unfair - unfair; gemein - mean; pleite - broke; allein - alone; blutig - bloody; trist - dull; taub - deaf; gierig - greedy; irre - insane; labil - labile; stur - stubburn; muffig - musty; mutlos - discouraged; zornig - angry

Neutral Adjectives. anonym - anonymous; listig - artful; albern - silly; ehelos - celibate; forsch - brisk; massiv - massive; salzig - salty; scharf - spicy; fromm - devout; simpel – simple

5.2.8 Supplementary material: Regression model

In addition to our quasi-experimental design, searching for participants who fit our research design in terms of the five groups, we run a regression model with exercise time (continuous measure) and runner vs. no runner (dummy variable) as independent variables and the priming effect as dependent variable, which could lead to more between-person sensitivity and power to test our hypotheses. Multiple regression revealed that “exercise time” (β = .17) and “runner vs. no runner” (β = .26) accounted for 13% of the variance in the priming effect, F (2, 94) = 7.09, p < .01. “Runner vs. no runner” was the only significant predictor in this model.

5.2.9 Tables

Table 4

Description of the sample

group	*n*	age	gender	BMI	exercise amount	PA[a] in leisure time	PA[ab] at work
		M (*SD*) in years	%	*M* (*SD*)	*M* (*SD*) in min per week	*M* (*SD*) in min per week	*M* (*SD*) Likert-scale
inactive	22	26.86 (6.51)	68 %	25.27 (5.02)	7.05 (18.81)	346.76 (419.66)	3.95 (1.53)
active exercisers	23	26.09 (4.98)	57 %	24.18 (2.50)	188.32 (58.86)	213.11 (252.58)	2.91 (1.91)
active runners	14	27.85 (5.27)	50 %	23.03 (1.50)	220.89 (34.99)	308.09 (209.35)	3.00 (1.71)
highly active exercisers	16	25.93 (4.13)	37 %	24.10 (2.63)	422,27 (73.72)	145.84 (155.22)	3.38 (1.82)
highly active runners	20	25.55 (3.94)	15 %	23.86 (1.96)	457.56 (150.56)	217.79 (177.25)	3.35 (1.46)
all	95	26.38 (5.01)	46 %	24.18 (3.14)	247.22 (188.67)	247.54 (275.06)	3.34 (1.70)

Note. Data from nine participants were excluded from analysis because of misunderstanding the task (error rate from more than 20 % (*n*=2); reaction time was 2.58 standard deviation higher than the mean reaction time (*n*=2); incomplete data set (*n*=2); lack of motivation (*n*=2); insufficient language knowledge (*n*=1)).

[a]PA: physical activity. [b]A sum of 9 is the highest possible result, which represent high physical activity at work; e.g. "Your job or your education includes...: (a) sedentary behavior, (b) moderate physical activity, (c) intensive physical activity (-non-; -something-; -rather more-; -a lot-)."

Table 5

Pearson's correlation between eight variables.

Variable	*M (SD)*	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1: exercise amount	247.22 (188.67)	--						
2: running amount	34.91 (58.31)	.49**	--					
3: adapted SDEQ	23.4 (6.6)	-.51**	-52**	--				
4: cognitive attitude_exercise	8.28 (0.84)	.05	-.04	-.16	--			
5: cognitive attitude_running	7.2 (1.25)	.06	.16	-.41**	.41**	--		
6: affective attitude_exercise	7.13 (1.68)	.53**	.23*	-.40**	.27**	.28**	--	
7: affective attitude_running	5.42 (2.24)	.36**	.57**	-.62**	.22*	.43**	.54**	--
8: priming-effect[a]	19.7 (76.6)	.29**	.13	-.17	-.15	.01	.20	.15

Note. N = 95. Pearson's correlation coefficients (r) and descriptive statistics for all main study variables.

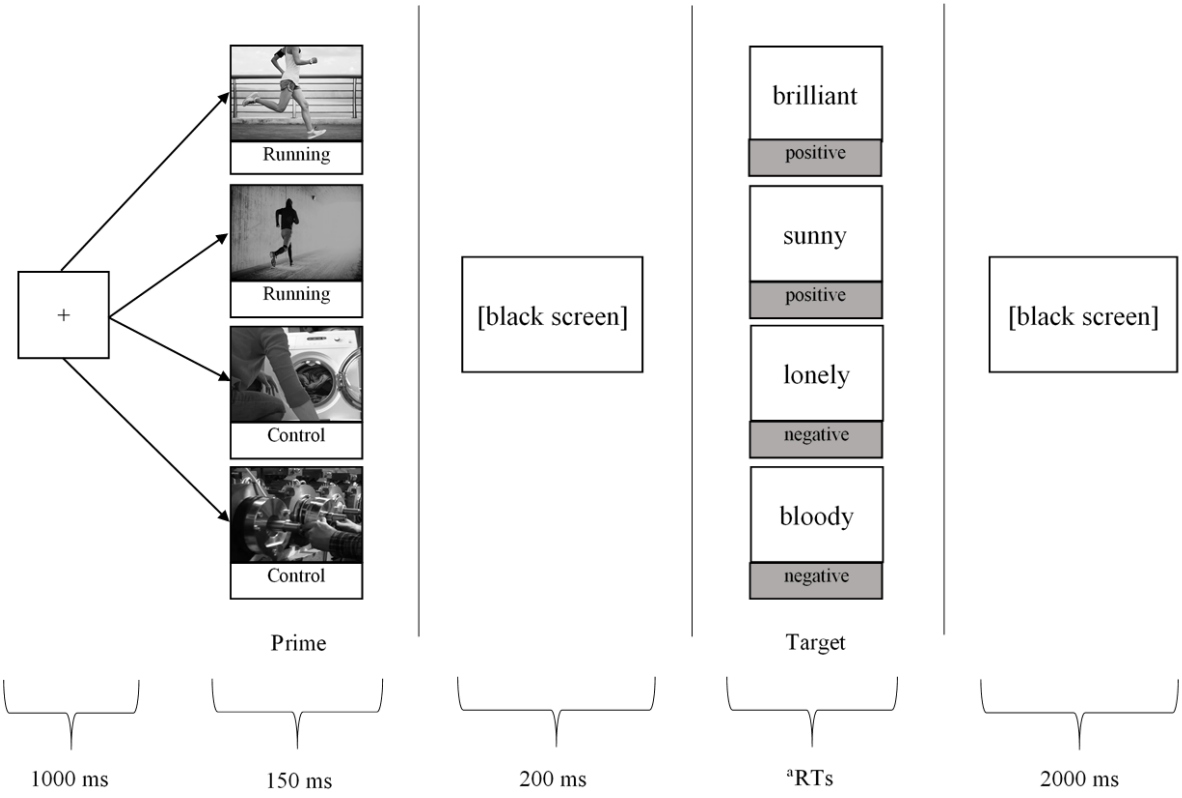
[a]Priming-effect: assessing au*tomatic evaluations towards running.*

*$p < .05$ **$p < .01$.

5.2.10 Figures Captions

Figure 6

The evaluative priming procedure with duration of each feature in milliseconds



Note Target-words were originally presented in German.

[a]RTs = reaction time.

Figure 7

Priming effect means (+SE) separated for each group

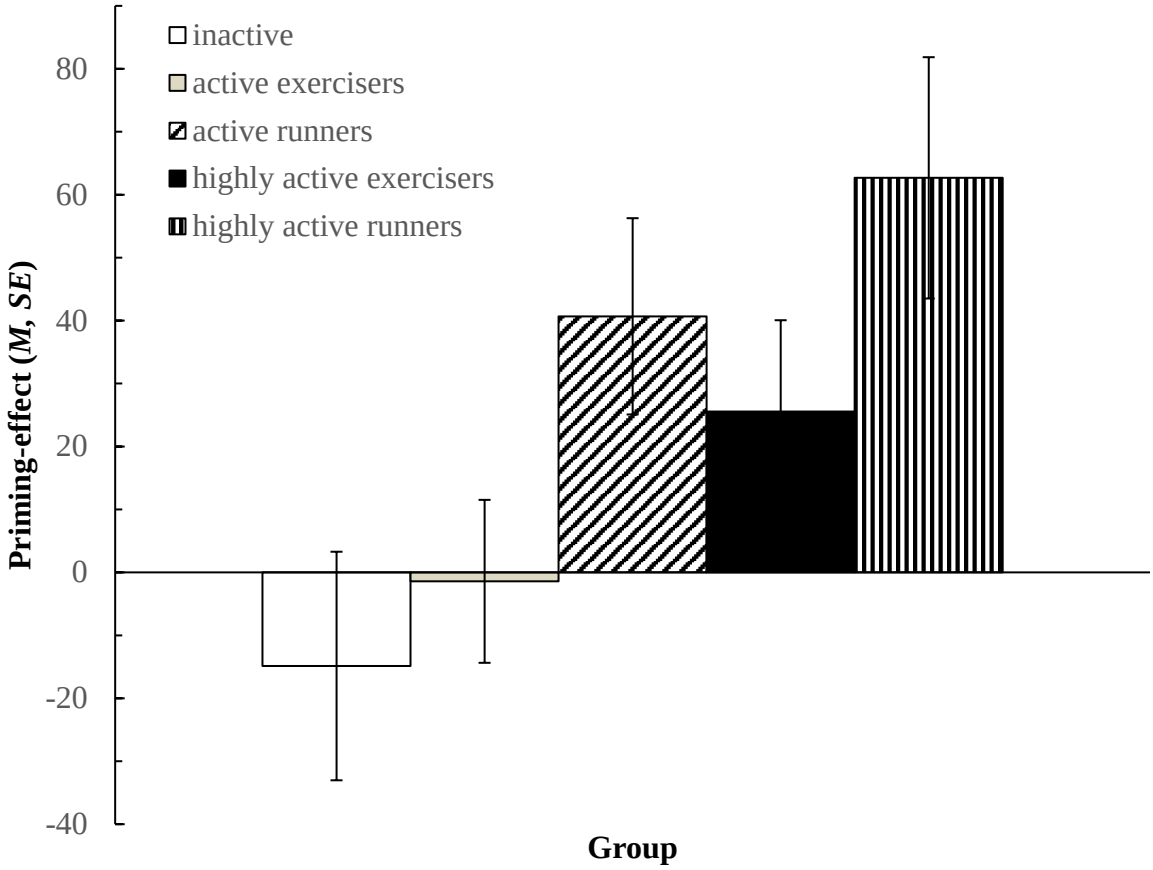
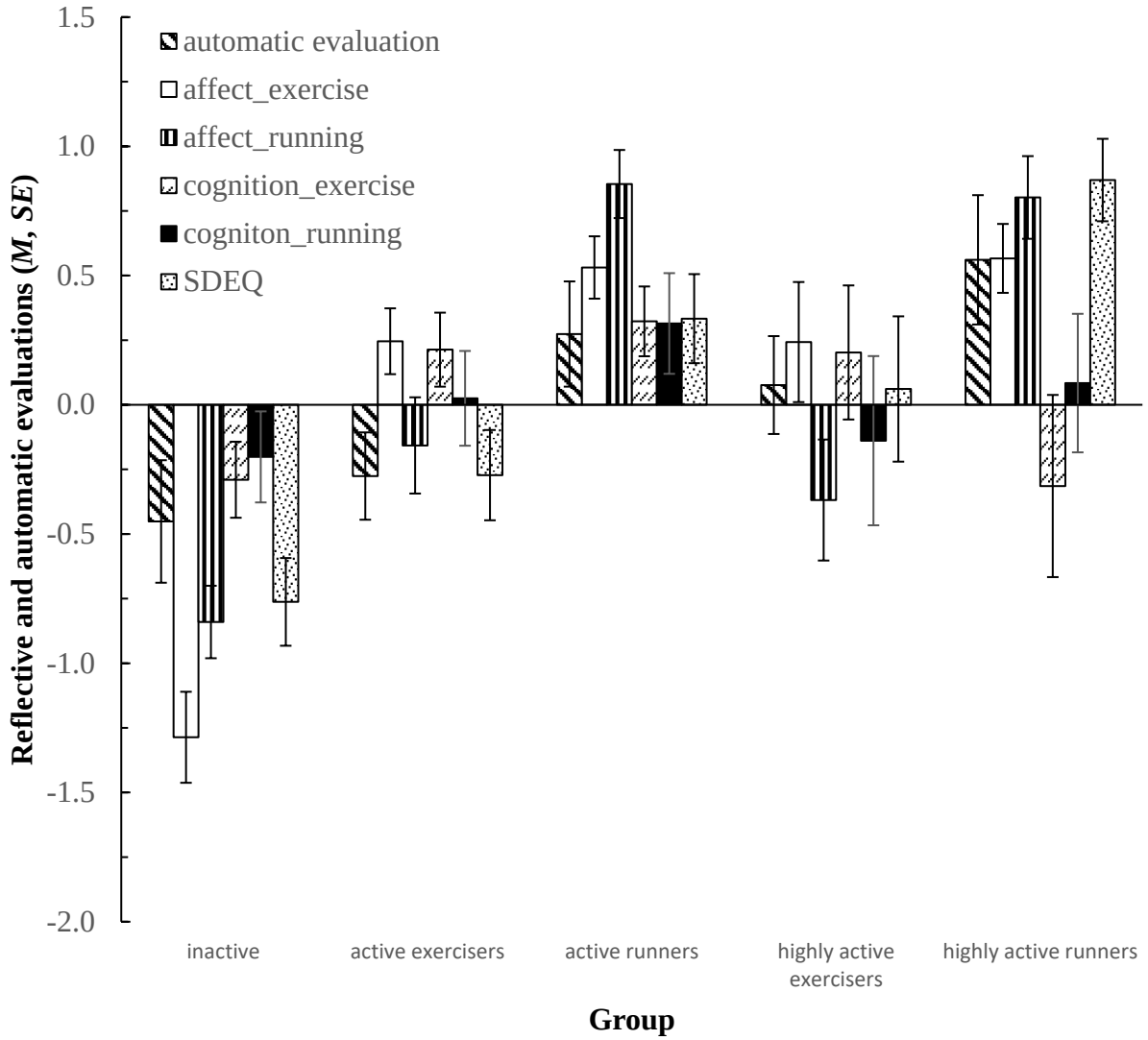


Figure 8

Z-transformed means (+*SE*) of the reflective and automatic evaluations as well as for the Situated Decisions are presented



Note Cognitive and affective component towards running and exercise & the Situated Decisions[1] are depicted.

[1]The Situated Decisions variable converted negative values into positive values. This means that a higher value lead to a greater tendency in deciding to favor running.

5.3 Derivation of the second publication

Building on previous results by Antoniewicz and Brand (2014) and others (e.g., Berry et al., 2011; Bluemke et al., 2010; Eves et al., 2007), the objective of the first publication was to test if AAP correlate with the amount of performed exercise but also if individuals differ in their AAP because of their preferred type of exercise (i.e. running). Furthermore, it should be established that an EP test modified to the context of running, can assess AAP. The applied EP task is grounded in the idea of a basic procedure of sequential priming (Fazio et al., 1986) and, within this study especially based on the methodological approach by Bluemke et al. (2010) and Brand and Schweizer (2015).

First, we expanded the findings of Bluemke et al. (2010) on the correlation between overall exercise amount and AAP and the findings by Antoniewicz and Brand (2014), regarding the importance of the specific, preferred type of exercise. Second, our results suggest that that the reflective processes and AAP can independently contribute to exercise (i.e. running) behavior. In contrast to Brand and Schweizer (2015), the situated decisions between running and behavioral alternatives were not significantly correlated with AAP toward running, which, from our perspective, should also be due to the very cognitive and action plan-based intention formation listed in the questionnaire. Regarding the EP task, on the one hand we assume that the adapted EP task was successfully deployed to assess AAP toward running. Especially the adaptation of the primes in form of pictures instead of words seems to be a more promising approach, also because of its more affective nature. On the other hand, EP's ratability must be further improved, especially with regard to its relatively low Cronbach's α = .58, which is a general problem of indirect, reaction based, measurement methods (Zenko & Ekkekakis, 2019a).

Overall, the results of the study provide additional directions for future research. In addition to the improvement and adaptation of the EP task, relevant questions arise regarding the importance of the preferred type of exercise to the formation of AAP, especially when controlling for the amount of performed exercise. Furthermore, based on the assumption of the ART (Brand & Ekkekakis, 2018), exercise behavior is always shaped by the interaction of automatic (affective) and reflective processes. In turn, these interactions seem to be specific determined by numerous situational, contextual and dispositional factors (Chevance et al., 2019; Schinkoeth & Antoniewicz, 2017). Therefore, the second publication focuses on the elaboration of the specificity of AAP regarding different types of exercise: exercising in fitness centers and mountain biking.

“Some hate it, others love it”: To the formation of automatic and reflective affective processes toward mountain biking and exercising in fitness centers

5.4 Publication 2

Abstract Based on a dual process approach, this study was conducted to test whether automatic affective processes toward exercise are not only interrelated with the amount of exercise but also distinctive for different types of exercise. In a quasi-experimental setting, N = 60 participants (30.87 years ±7.53; 33% female) completed an Evaluative Priming task to assess automatic affective processes toward exercising in fitness centers, mountain biking and exercise in general and completed a questionnaire about their exercise behavior and their reflective affective processes toward each type of exercise. The results showed that the automatic affective processes toward exercising in fitness centers differed significantly among the three groups (d = 0.74). Those who regularly exercise in fitness centers (n = 21) provided the most positive automatic affective processes, followed by mountain bikers (n = 16) and those engaging in little or no exercise (n = 23). Automatic affective processes toward mountain biking were nonsignificant between groups (p = .30; d = 0.42). All reflective affective processes assessed via questionnaire resulted in significant differences between the three groups, always in favor of those who often perform the respective exercise. Our results show that automatic affective processes toward exercising in fitness centers are distinctive for the preference for this type of exercise. Furthermore, they underline the importance of choosing an adequate measurement technique to assess automatic affective processes toward exercise, especially if these processes should be indicative for the preference of different types of exercise.

Keywords: dual-process; automatic processes; evaluative priming (EP); exercise setting; affect

This chapter was published as Limmeroth, J., & Braun, C. (2022). “Some hate it, others love it”: To the formation of automatic and reflective affective processes toward mountain biking and exercising in fitness centers. *German Journal of Exercise and Sport Research*. https://doi.org/10.1007/s12662-022-00803-4.

5.4.1 Introduction

People who exercise frequently engage in different types of exercise, such as popular forms like running, working out, bicycling, etc. (Dai et al., 2015). However, the majority of the western world’s population do not exercise enough according to the recommendations made by the WHO (Guthold et al., 2018; World Health Organization, 2020). In this sense, Ekkekakis and Zenko (2016) suppose, “exercise can make [only] some people feel better, given certain conditions (p. 408).” Furthermore, not all types of exercise performed in different exercise settings are equally attractive to every exerciser and therefore do not always provide positive affective experiences (Rhodes et al., 2009). Some people’s favorite activity is exercising in a gym such as weightlifting or cardio whereas others cannot even imagine going to a gym (e.g., Calogiuri & Elliott, 2017). The latter group of people instantly have unpleasant feelings when imagining exercising in fitness center rooms or hold negative opinions of weightlifting on machines, whereas, for example, Rodrigues, Teixeira, et al. (2021) assume that people who regularly exercise within the fitness context also show greater positive affect toward the activity itself.

Overall, multivariate factors influence whether people exercise or not as well as which type of exercise or exercise setting they choose. Some type of exercise is much more likely to be tied to a specific setting than others (e.g., Burke et al., 2006; Calogiuri & Elliott, 2017). For example, you can run on a treadmill, but you can also run on a road or in the woods; however, if you go skiing or mountain biking, you will inevitably perform those activities outside. Therefore, contextual factors, associated motives, and affects shape the image of the respective type of exercise and an individual’s reason for exercise (e.g., Box et al., 2019; Burton et al., 2012). For example, Calogiuri and Elliott (2017) show that people who exercise in fitness centers report stronger motives for physical health and sociability whereas people who exercise outdoors report stronger motives concerning convenience and experiencing nature. In general, it is unlikely that individuals will engage in exercise-related behavior on a regular basis if they feel uncomfortable in this particular setting (Kaushal & Rhodes, 2015). For example, Sudeck et al. (2016) have pointed out the predictive role of affective attitudes experiences for exercise behavior. In addition to the importance of consciously retrievable affect, motivational aspects and attitudinal components toward exercise, and underlying psychological processes also play a central role in explaining regular exercise behavior (e.g., Rhodes et al., 2019; Teixeira et al., 2018).

According to Chevance et al. (2019) and Schinkoeth and Antoniewicz (2017), it can be assumed that exercisers provide more positive automatic affective associations with exercise than non-exercisers. Therefore, the amount or frequency of exercise is interrelated with the automatic affective process toward exercise. However, also the preferred type of exercise or

the preferred exercise setting are important for the development of automatic affective processes toward exercise (Antoniewicz & Brand, 2014; Limmeroth & Hagemann, 2020). These underlying psychological processes could probably help to explain why on the one hand some people exercise more than others do and on the other hand, why some people prefer a certain setting and others avoid it (Chevance et al., 2019; Schinkoeth & Antoniewicz, 2017). For this purpose, this study investigated whether people who exercise in specific exercise settings and prefer one specific type of exercise differ in their automatic affective processes toward this type of exercise.

Dual Process approaches and the Affective–Reflective Theory of physical inactivity and exercise

Regarding people’s exercise setting preferences, their choices between different forms of exercise and their decisions about when or even whether to exercise are affected by numerous factors in many different ways (Bodin & Hartig, 2003; Box et al., 2019). Dual process theories offer a theoretical framework to understand the role of automatic processes in this behavioral regulation process (Rhodes et al., 2019). These approaches assume that two interactive but distinct types of information processing influence human behavior and play important roles in explaining behavioral variations (Evans & Stanovich, 2013). Thereby, researchers distinguish between reflective (type-II) and automatic (type-I) processing of information (Brand & Cheval, 2019).

The ART, introduced by Brand and Ekkekakis (2018), is a dual-process theory with a default-intervention approach. It focuses directly on exercise and physical (in-)activity to conceptualize the psychological mechanisms underlying these behaviors (Ekkekakis & Brand, 2019). ART emphasizes the role of affect for and as part of exercise-related decision-making and provides theoretical assumptions about the processing of affective experiences with exercise, suggesting that exercise experiences influence associative pairing as part of the automatic (type-I) process. A central postulation is that experiences with exercise are stored as mental associations in memory. Experiences in the past are linked with their attendant affective responses, as well as their associated "motor tendencies and other somatic manifestations" (Zajonc & Markus, 1982, p. 129). These mental associations rely on repeated, (negative or positive) affective experiences that individuals derive from exercise and may be the result of valenced bodily sensations such as bliss or exhaustion. Furthermore, complex and culturally framed emotions such as pride or embarrassment are associated with them (Brand & Ekkekakis, 2018). It is assumed that every time an internal or an external stimulus (e.g., remembering a doctor's advice to start to train in a fitness center) occurs, mental associations are spontaneously activated. Through this, associative pairing of exercise experiences with either a positive or negative affective valence (i.e., affective valuation) takes

place with the evocation of a positively or negatively valenced somato-affective reaction (Damasio, 1996). The somato-affective reaction can be described as a “gut feeling” toward exercise that results in an action impulse and, if negative, discourages a person from exercising (Ekkekakis & Brand, 2021). Finally, the automatic affective process seems to be distinct from the reflective process, although both processes possibly interact via reciprocal feedback (e.g., Brand & Ekkekakis, 2018). According to ART, reflective (type-II) processes, such as reflective evaluations, can overwrite the automatic action impulse, but only if sufficient self-control is available. Automatic affective processes can thus directly influence exercise behavior, especially when self-control is low (Brand & Ekkekakis, 2018). There is already profound empirical evidence about the interrelation between automatic affective processes toward exercise and the amount and frequency of exercise (Chevance et al., 2019; Schinkoeth & Antoniewicz, 2017).

Much less is known about the specificity of automatic affective processes regarding specific types of exercise or exercise settings (e.g., Antoniewicz & Brand, 2014; Limmeroth & Hagemann, 2020). For example, Antoniewicz and Brand (2014) used the Affect Misattribution Procedure (AMP; Payne et al., 2005) to investigate the idea that the preferred exercise setting is relevant for automatic affective processes. They found that exercisers in fitness centers hold more positive automatic associations of fitness-related stimuli than a similar physically active comparison group that preferred other exercise settings. The same existed for the reflective processes. These controlled evaluations were more positive in fitness center exercisers than in the comparison group. However, the correlations of automatic affective and reflective processes were nonsignificant in both groups. Limmeroth and Hagemann (2020) used an Evaluative Priming task (EP; Fazio et al., 1986) to assess automatic affective processes toward running. They combined approaches assuming that the amount of exercise and the preferred exercise setting or type of exercise is important for the formation of automatic affective processes. They showed that highly active runners provided significantly more positive automatic associations toward running than non-exercisers and individuals who exercise less and do not run. Further differences could be found in reflections about the affective attitude toward running.

The present study

The goal of the present study was to provide evidence for differences in automatic affective processes regarding the specific exercise setting or type of exercise in frequent, habitual exercisers. Specific exercise setting preference might differ between individuals according to their automatic as well as reflective affective processes. For example, exercising in fitness centers, may be directly linked to the exercise behavior itself (e.g., when you go to a fitness-center, you do workouts or weight lifting etc. and in the vast majority of cases nothing

else either). Motivational aspects might also play a role: some motives to exercise are more intrinsically embedded or activity-centered than others. Therefore, especially if the main motive is enjoyment of the specific type of exercise, this should be reflected more strongly in the automatic affective process and of course much more in the reflective affective process. Therefore, the aims of our study are twofold: First, our study can contribute to a better understanding of preferences for specific types of exercise. We assume that exercisers in fitness centers have more positive automatic associations toward fitness-related stimuli than mountain bikers and people engaging in little or no exercise. Regular mountain bikers should provide more positive associations toward mountain bike-related stimuli than exercisers in fitness centers and people engaging in little or no exerciser. Second, the practice of a particular type of exercise also should result in differences in the reflective affective processes (e.g., mountain bikers will provide more positive reflections about mountain biking than exercisers in fitness centers and people engaging in little or no exercise). In detail, the novelty of the present study is whether not only exercisers can be distinguished from non-exercisers, but also whether automatic affective processes are so specific that they can also distinguish between exercise setting preferences. To detect differences in automatic affective processes toward different types of exercise an adequate measurement instrument needs to be established.

5.4.2 Method

Participants

Potential participants were recruited from various settings, such as fitness clubs, university sport, mountain biking courses, the university campus, medical fields, and different city center halls. To answer our research question, we needed one fitness group (FIT), one mountain biking group (MTB) and a group of people engaging in little or no exercise (L-NE). To be part of the FIT or the MTB group, first, individuals had to indicate the particular exercise as their preferred setting (or type). Second, the individuals had to perform their preferred type of exercise for more than 90 minutes per week and to exercise in general for more than 112.5 min per week[11]. To be part of the L-NE group, participants needed to exercise less than 45 min per week (based on corresponding WHO recommendations; World Health Organization, 2020). Therefore, we differentiated among the three groups using a quasi-experimental design.

Seventy-six individuals were recruited and participated voluntarily in the EP task, but eight of them did not complete the online questionnaire. Three participants were removed because they were too physically active for the L-NE group, and four were removed because they made too many mistakes (M = 30.31%; SD = 8.25) during the EP task. Furthermore, one

[11] This represents the recommended mean (at least 71-150 minutes per week) by the WHO (2020) for vigorous-intensity aerobic physical activity.

statistical outlier was identified within the amount of exercise and therefore was also removed. Finally, we analyzed the data of sixty participants with the mean age of *M* = 30.87 (*SD* = 7.53) and the proportion of women was 33 %. A further description of the sample can be found in Table 6.

Procedure

Potential participants were invited to the experimental setting or directly tested (in local fitness centers or buildings from the university). A quasi-experimental design was conducted using a computer-based EP task and a short online questionnaire about their reflective affective attitudes (Brand, 2006) and their time spent exercising for the last four weeks (Fuchs et al., 2015). First, the participants received general information about the procedure. Second, they completed the EP task. In a further step, they received a QR code or online link to complete the online questionnaire. The local ethics committee approved the study, and informed consent was obtained from all participants. All procedures followed were in accordance with the Helsinki Declaration and its later amendments.

Power analysis

Based on previous results by Antoniewicz and Brand (2014) and Limmeroth and Hagemann (2020), we began our power analysis for an analysis of variance with the assumption of large effect size (Cohen’s *d* = 0.80) for a main effect of “automatic affective process” regarding on the one hand the fitness center setting and on the other hand the mountain biking setting with three groups as independent variable. We set the test power at 0.80, with a Type I error rate of α = .05 for two-sided testing. The statistical power analysis conducted with G*Power 3.1 indicated that 66 respondents were required.

Measures

Evaluative Priming Task. Various measurement methods exist to assess automatic affective processes in the context of exercise (for an overview, see Brand & Gutman, 2020). We drew on the experimental methodology introduced by Fazio et al. (1986): the EP. This methodology is based on reaction time and serves to assess automatic processes to predict the corresponding behavior (Eves et al., 2007). The task is computer based and involves two task features. We followed the same procedure as Limmeroth and Hagemann (2020) but eliminated their neutral targets[12]. The first feature consisted of the instruction to neglect the

[12] Limmeroth and Hagemann (2020) assume that using neutral adjectives requires more concentration/ cognitive resources of the participants and thus, could possibly make the test more challenging. For this reason, the neutral category was excluded.

primary presented prime stimulus, which, in our task, was a picture. We used twenty pictures for each exercise case (exercising in fitness-centers, mountain biking and various types of exercise[13]), and twenty “work on computers” pictures as control category. Each picture was shown twice, which resulted in 160 trials. Example pictures are presented in Figure 9. The second feature is the correct identification of a positive or negative target as quickly as possible (Fazio et al., 1986). Positive and negative valenced words functioned as targets. The adjectives were taken from the Berlin Affective Word List (Vo et al., 2009). Based on the study by Limmeroth and Hagemann (2020), the chosen words had between four and six letters (M = 5.36, SD = .80) and both, positive and negative adjectives had a similar positive or negative valence of $M_{positive}$ = 1.98 (SD = 0.17) and $M_{negative}$ = −1.79 (SD = 0.17)[14]. The positive and negative valenced adjectives can be found in Chapter 5.2.7.

A trial ended by pressing one of two response keys to indicate the positive or negative valence of the presented target. Importantly, prime-target combinations were randomly chosen and presented in each trial. Hermans et al. (1994) argue that either response facilitation or response inhibition for the reaction toward a target can be provoked by the valence of the prime. For example, if the target stimulus was correctly identified as positive and the previously presented prime was subjectively evaluated positive, then response facilitation occurred. This trial can be classified as congruent. If the prime-target combination is more incongruent than the contrary effect, so-called response inhibition with a prolonged reaction time occurs (Figure 10).

Fazio and Olson (2003) hypothesize that primes with a similar concept should generate equal valence across several trials. Thus, they have concluded that the evaluation of the underlying concept (in our case, exercising in fitness centers or mountain biking) can be calculated by the amount of response facilitation and response inhibition, the so-called priming effect (Limmeroth & Hagemann, 2020). The mean response latencies of these prime-target combinations are used to calculate the individual priming effect of, for example, the concept of exercising in fitness centers (e.g., Bluemke et al., 2010): $[(\mathbf{RT}_{\text{Negative Target | Fitness Prime}}) - (\mathbf{RT}_{\text{Negative Target | Control Prime}})] - [(\mathbf{RT}_{\text{Positive Target | Fitness Prime}}) - (\mathbf{RT}_{\text{Positive Target | Control Prime}})]$. The priming effect for exercisers in fitness centers should be greater if fitness center-related primes facilitate responses toward positive targets while responses toward negative targets are inhibited and thus prolonged.

Trials with responses lasting more than 2000 ms and trials that were answered incorrectly were omitted and randomly repeated during the further test. Two colored stickers

[13] We used pictures showing people swimming, golfing, running, climbing; inline skating or performing gymnastics; playing basketball, handball, soccer, volleyball, badminton, tennis or frisbee (originally presented in the supplementary material).

[14] Positive / negative valence was originally rated on a 7-point scale ranging from −3 (very negative) to 0 (neutral) to +3 (very positive).

visually marked the response keys: ‘x’ on the left side and ‘m’ on the right side of the keyboard. Half of the participants reacted with their left index finger toward positive valenced targets, and the other half reacted with their right index finger so that the reaction key sides were counterbalanced. Participants completed the experiment in quiet rooms always using the same computer (Fujitsu Life-book E782 with a 15.6” monitor, a resolution of 1280 x 1024 pixels and a refresh rate of 75 Hz; Fujitsu Technology Solutions GmbH, Munich, Germany). The experiment was programmed with E-Prime 3.0 (PST; Psychology Software Tools, Pittsburgh, USA). The task lasted approximately 15-20 minutes. Cronbach’s alpha for each priming score category was: α_{FIT} = .63; α_{MTB} = .59 and α_{EXE} = .30.

Questionnaires We used a part of the Physical Activity and Exercise questionnaire (BSA-F)[15] by Fuchs et al. (2015) to calculate the exercise time, mountain biking time and time spent in fitness centers per week. The reflective affective processes toward exercising, mountain biking and exercising in fitness centers (as an output of type II processes) were assessed via the attitude questionnaire by Brand (2006). This instrument consists of four items addressing the participant’s reflective affective attitude toward exercising and four items related to one’s cognitive attitude. We only used the affective attitude component because past research has shown that it was more distinctive than the cognitive attitude component (e.g., Brand & Schweizer, 2015). We also modified the component to the specific types of exercise: exercising in fitness centers and mountain biking. The components provide a description by means of semantic differentials, which must be evaluated on scales between 1 and 9. An example is the following: “Imagine: ‘When I think of mountain biking, I feel’: not relaxed/extremely relaxed, not satisfied/extremely satisfied, not happy/extremely happy, or not well/extremely well.” For each category, the mean score was calculated.

Data analyses

Means and standard deviations were calculated as indicators of the descriptive statistics. We prepared the latency measures in line with common recommendations to facilitate the interpretation of latency outcomes. Referring, for example, to Fazio et al. (1986), Hermans et al. (2001) and Koppehele-Gossel et al. (2020), trials with reactions that were 99% likely to fall outside the "normal” response time and response latencies under 250 ms were classified as outliers and thus eliminated from all subsequent analyses. Participants who achieved error rates over 20% were also excluded. Reaction times were directly expressed in measured milliseconds and used to calculate the priming effect. Consistent with our hypothesis, we fitted several independent one-way analyses of variance with “group” as the between-subject factor and each priming score (automatic affective association) as the

[15] The questionnaire is originally in German.

dependent variable. In a further step, the reflective variables were analyzed in separate analyses of variance. An alpha level of $p < .05$ was set throughout all analyses to indicate significant characteristics. For effect sizes, Cohen’s *d* is reported. The Welch test was used in the case of violations of the sphericity assumption. All analyses were conduct using SPSS 27 (IBM Corporation, Armonk NY, USA) for Windows.

5.4.3 Results

EP test-related considerations

Overall, the participants identified the target valence on average after *M* = 671.53 ms (*SD* = 63.78) and made few errors in the EP procedure (*M* = 4.20%; *SD* = 3.37). In general, the participants reacted faster with positive targets (*M* = 628.18, *SD* = 56.49) than with negative targets (*M* = 706.68, *SD* = 73.361). The mean reaction times after the control (*M* = 666.05, *SD* = 64.22), fitness (*M* = 665.02, *SD* = 66.698), mountain biking (*M* =669.16, *SD* = 67.17) and various types of exercise primes (*M* = 669.49, *SD* = 63.46) were similar. The groups showed no significant differences in their overall reaction times: $F(2, 57) = 1.82$, $p = .17$, $d = .51$ (FIT: *M* = 650.83, *SD* = 63.15; MTB: *M* = 687.14, *SD* = 65.20; and L-NE: *M* = 679.58, *SD* = 61.08). The data on reaction times and calculated priming effects were distributed normally.

Automatic affective processes

All three automatic affective processes are presented in Figure 11. The automatic affective process toward fitness showed a significant group difference: $F(2, 57) = 3.98$, $p = .03$; $d = .74$ (FIT: *M* = 23.17, *SD* = 54.01; MTB: *M* = 13.02, *SD* = 44.71; and L-NE: *M* = -18.69, *SD* = 54.13). The post hoc analysis (via Bonferroni correction) revealed a significant difference between the FIT group and the L-NE group ($p = .03$). Neither the automatic affective processes toward mountain biking, $F(2, 57) = 1.24$, $p = .30$; $d = 0.42$ (FIT: *M* = 8.79, *SD* = 45.10; MTB: *M* = 15.67, *SD* = 48.10; and L-NE: *M* = -9.62, *SD* = 61.52) nor toward the various types of exercise category showed significant group differences, $F(2, 57) = .92$, $p = .40$; $d = 0.36$ (FIT: *M* = -4.67, *SD* = 57.69; MTB: *M* = 2.81, *SD* = 54.29; and L-NE: *M* = -21.30, *SD* = 59.41).

Reflective affective processes

All reflective affect scales (fitness, mountain biking and exercise in general) are not normally distributed. However, according to Blanca et al. (2017), there is wide empirical evidence for the robustness of the F-test against violations of the normal distribution assumption, and ANOVA can still be a valid option. Therefore, we fitted three independent one-way analyses of variance. For two reflective affective scales (fitness and mountain biking),

the Welch test was used to correct for violations of sphericity. The descriptive data can be found in Table 7.

The results of the reflective affective process about fitness showed a significant group difference: Welch’s $F(2, 28.66) = 36.70$, $p < .01$, $d = 1.78$. Games-Howell post hoc analysis revealed a significant difference ($p < .01$) such that the mean level score was higher (more positive affect) in the FIT group than in the MTB group ($M = 3.13$, 95% CI [1.41, 4.85]) and the L-NE group ($M = 3.75$, 95% CI [2.57, 4.94]). The reflective affective process of mountain biking also demonstrated a significant group difference: Welch’s $F(2, 37.33) = 58.16$, $p < .01$, $d = 2.73$. Games-Howell post hoc analysis revealed a significant difference ($p < .01$) in favor of the MTB group. The mean level score for the affective attitude toward mountain biking was higher (more positive affect) in the MTB group than in the FIT group ($M = 4.03$, 95% CI [2.87, 5.20]) and the L-NE-group ($M = 4.53$, 95% CI [3.26, 5.80]).

In addition, the reflective affective process toward exercise in general differed significantly among the three groups: $F(2, 57) = 25.46$, $p < .01$, $d = 1.89$. Games-Howell post hoc analysis showed that the L-NE group had significantly ($p < .01$) lower scores (more negative affect) than the MTB group ($M = -2.43$, 95% CI [-3.54, -1.31]) and the FIT group ($M = -2.68$, 95% CI [-3.72, -1.64]).

Potential correlations between automatic and reflective affective processes

For the entire sample, the automatic affective process of fitness was not significantly correlated with the reflective affective process toward fitness ($r = .14$; $p = .27$) or that of mountain biking ($r = .12$; $p = .35$); furthermore, the automatic affective processes of exercising was not correlated with its corresponding reflective process ($r = .06$; $p = .66$). However, the automatic affective process of fitness was significantly correlated with the reflective affective process toward exercise ($r = .29$; $p = .02$).

5.4.4 Discussion

The central aim of the present study was to provide further evidence for a more precise relationship between automatic affective processes and a specific exercise setting or type of exercise. In short, we sought to answer the question of whether different types of exercise performed in different settings are (automatically) processed in a different manner in frequent, habitual exercisers. The results of this study show that automatic affective processes can be indicative of the preference for exercising in fitness centers. For mountain biking we see a nonsignificant but similar tendency on a descriptive level -with a smaller effect-. Automatic affective processes toward various types of exercise show no significant group differences. However, both exercising groups provide more positive scores on a descriptive level than

those who engage in no or only little exercise. According to this, our results provide evidence for the assumption that a positive automatic association of a specific exercise setting can reflect a liking for that specific setting and type of exercise. However, due to our results, it does not directly include every type or setting.

Automatic affective processes toward exercising in fitness centers and mountain biking

In particular, it must be emphasized that the significant result according to the automatic affective processes toward exercising in fitness centers is based on the difference between the fitness center group and the little or no exercising group. Compared to the group of mountain bikers, the difference was only found on a non-significant level in favor of the fitness center group. This reinforces the assumption that neither the exercise setting preference nor the amount of exercise alone influence the formation of automatic affective processes, but rather interact in some way (Limmeroth & Hagemann, 2020). Previous research has demonstrated that, first, automatic affective processes can be used to discriminate exercisers from non-exercisers (e.g., Bluemke et al., 2010). Second, these processes correlate with the amount of exercise people engage in (e.g., Schinkoeth & Antoniewicz, 2017). In addition, Antoniewicz and Brand (2014) have shown that automatic affective processes can be used to discriminate between types of highly active exercisers, particularly in a fitness-center setting and Limmeroth and Hagemann (2020) have extended this by showing that the amount of exercise (running) as well as the preference for a specific setting together influence automatic affective processes. Our findings extend this body of evidence in that frequent, habitual fitness-center exercisers provide significantly more positive automatic associations with fitness than individuals engaging in little or no exercise and descriptively, this difference is also evident to similarly active mountain bikers. Notwithstanding this, it should be remembered that results on automatic affective processes largely dependent on the stimuli and measure applied in this study and should not be overgeneralized.

However, automatic affective processes toward mountain biking have resulted in a nonsignificant group difference. Nevertheless, a similar tendency can be found as with the fitness center category. One reason may be the relatively small sample size and other factors could have potentially influenced the formation of these processes, which will later be discussed in detail. These results might suggest that exercising is multifaceted, and hence specific types of exercise could be associated with more sharply defined mental representations (Limmeroth & Hagemann, 2020). According to Rhodes et al. (2009), not all exercise settings necessarily provide positive affective experiences for everyone, not even for those who exercise frequently in this setting. Therefore, it might be even more important to choose an appropriate stimulus set to assess specific automatic affective processes. Furthermore, the general context of the presented exercise setting could play an important

side effect when evaluating the stimulus set. Being outside is rather associated with pleasurable feelings (e.g., Calogiuri & Elliott, 2017). Additionally, after exercising in nature, positive affective states are present or even increase, and negative affect is rather absent or decreases (de Vries et al., 2011). On the one hand, we suppose that the exercise setting, being outside (in nature), could generally provide positive associations. On the other hand, mountain biking is not only be performed outside, it is further defined as a risk sport, an activity on the extreme exercise continuum (Roberts et al., 2018), and associated with adrenergic experiences. This image is directly connected with a level of high arousal as well as sensations of fear. Therefore, sensations of fear or adrenaline-charged experiences could have elicited also negative affective associations. However, fear could be perceived in a reappraisal process as a challenge that needs to be mastered. In a consequence, satisfaction or pride can be experienced and thus, lead to pleasurable feelings (Willig, 2008). In this sense, the entire association with mountain biking could be an ambiguous and multifaceted one. This represents a possible explanation regarding why automatic affective processes seem to be relatively heterogeneous in our sample. Thereby, selecting a larger sample size could help to clarify this ambiguous result.

Reflective affective processes toward exercising in fitness centers and mountain biking

Regarding all reflective processes assessed by affective attitudes, they revealed in significant group differences such that exercisers who preferred mountain biking had the most positive reflective evaluations of mountain biking. The same occurred for those who preferred exercising in fitness centers and their reflective processes regarding their affective attitude toward exercising in fitness centers. Furthermore, people engaging in little or no exercise had fewer positive reflections about exercising than mountain bikers and exercisers in fitness centers. This underlines the importance of affective processes in general to understand why people exercise or do not (Ekkekakis et al., 2020). Correlations between the automatic affective processes and their corresponding reflective evaluation were nonsignificant. These results are in line with the assumption that reflective and automatic affective processes can independently contribute to the explanation of a specific exercise behavior (Brand & Schweizer, 2015). Solely, the automatic affective process toward exercising in fitness centers and the reflective affective process toward exercising were significantly correlated. This correlation suggests that exercising in fitness centers could be very directly linked with exercising. In addition, people often exercise in fitness centers to become more physically fit for their preferred type of exercise and to reduce the associated injury risk (Lauersen et al., 2018). Rebar, Schoeppe, et al. (2016) demonstrated that within the top 20 words people used to describe exercise behaviors, six terms describe exercise, which is related to fitness (center) context like gym workouts, weight lifting, exercise classes or aerobics.

Study limitations and recommendations for future studies

This last point leads directly to the limitations of the study. First, it remains unclear how, if, and under which conditions automatic and reflective processes are correlated (Chevance et al., 2019; Ekkekakis & Brand, 2021). Furthermore, McConnell and Rydell (2014) show that reflective processes can generally be formed or modified more quickly compared to automatic affective processes. According to ART, this could be the reason for the behavioral inconsistency between both processes (Brand & Ekkekakis, 2018). Second, a reaction time-based test to assess this process must be used with caution and with a precisely matched stimuli set for a specific exercise group. An exercising setting such as exercising (indoors) in a fitness center seems to provide more specific contextual cues than exercising in nature such as mountain biking. In this sense, an individual can focus on different aspects within the presented images, which, consequently, lead to various mental associations being triggered. According to this, the challenge is that it remains unclear which mental representation the spontaneous, affective response is based on because the automatic affective process naturally cannot be accessible to consciousness (Evans & Stanovich, 2013). In addition, EP tasks suffer from on-average-limited reliability (e.g., Gawronski & De Houwer, 2014). In our study, reliability varies by category and is definitely insufficient for the various exercise category. However, this category was not the focus of the analysis. Third, the relatively small sample size of 60 participants, especially the small group of only n = 16 mountain bikers, should also be seen as a limiting factor of this study. Particularly from this group, many subjects did not participate in the online survey.

Conclusion

Despite these limitations, our study contributes to a better understanding of the differentiation between specific exercise type preferences regarding the corresponding exercise settings and the automatic affective processes toward it. In this sense, we think that it is quite important to use an adequate stimulus set that should fit the sample under study. For future studies, it would be necessary to determine whether the findings obtained from our study can be generalized to other types of exercise. Thus, it might also be interesting to investigate whether there are differences within one type of exercise, such as running, regarding the setting and their expression in the automatic affective process, e.g., running on a treadmill (indoors) vs. running outdoors (in nature). Furthermore, a methodological approach using different stimulus sets to compare them could help to generate knowledge about differences in the underlying automatic processes (Rebar, Schoeppe, et al., 2016). In addition, our results are also in line with previous research insofar as reflections about affective attitudes toward exercising in fitness centers, mountain biking or any exercise are different depending on the preferred type of exercise (e.g., Kaushal & Rhodes, 2015; Limmeroth & Hagemann, 2020;

Rhodes et al., 2019). Furthermore, our findings support the assumptions by Phipps et al. (2021) that automatic and reflective evaluative information are conceptually distinct and that affective experiences in general are key in guiding exercise behavior regardless of whether such processes are automatic or consciously accessible. For future studies, it could be helpful to include potential moderators, which, for example, can compromise cognitive resources such as stress (Wirz et al., 2018) to clarify the relationship between reflective and automatic processes (Friese, Hofmann, & Wanke, 2008). Finally, much more attention should be given to the affective responses to exercise or while exercising because they importantly shape the probability of engaging in exercise in the future (Ekkekakis & Brand, 2021; Ekkekakis et al., 2020; Rodrigues, Faustino, et al., 2021).

5.4.5 References

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5.4.6 Tables

Table 6

Description of the sample

Group	*N*	Age	Time exercising	Time mountain biking	Time fitness activities
		M (*SD*) in years	*M* (*SD*) in min per week	*M* (*SD*) in min per week	*M* (*SD*) in min per week
L-NE	23	31.13 (7.36)	23.86 (35.05)	3.26 (11.04)	9.89 (27.70)
FIT	21	28.43 (8.10)	448.39 (284.80)	0 (0)	336.19 (150.70)
MTB	16	33.69 (6.25)	311.64 (200.17)	177.03 (121.75)	48.758 (84.05)

Note. The variable “time fitness activities” includes all kind of fitness-activities. The variable “time exercising” includes all types of exercise an individual performes.

Table 7

Reflective affective processes toward exercising in fitness centers, mountain biking and exercising in general

	Reflective affective process					
	Exercising in fitness-centers		Mountain biking		Exercising in general	
Group	*M (SD)*	95% CI	*M (SD)*	95% CI	*M (SD)*	95% CI
L-NE	4.43 (2.12)	[3.62, 5.45]	3.46 (2.18)	[2.52, 4.40]	5.37 (1.76)	[4.61, 6.13]
FIT	8.29 (.88)	[7.88, 8.69]	3.95 (1.85)	[3.11, 4.79]	8.05 (.98)	[7.60, 8.50]
MTB	5.16 (2.58)	[3.78, 6.53]	7.98 (1.00)	[7.45, 8.52]	7.80 (1.09)	[7.22, 8.38]

Note. The descriptive data (*M, SD*, 95% CI) for each variable is shown separately for each group (measured on a 9-point Likert scale).

5.4.7 Figures Captions

Figure 9

Example pictures / primes

Exercising in fitness-centers

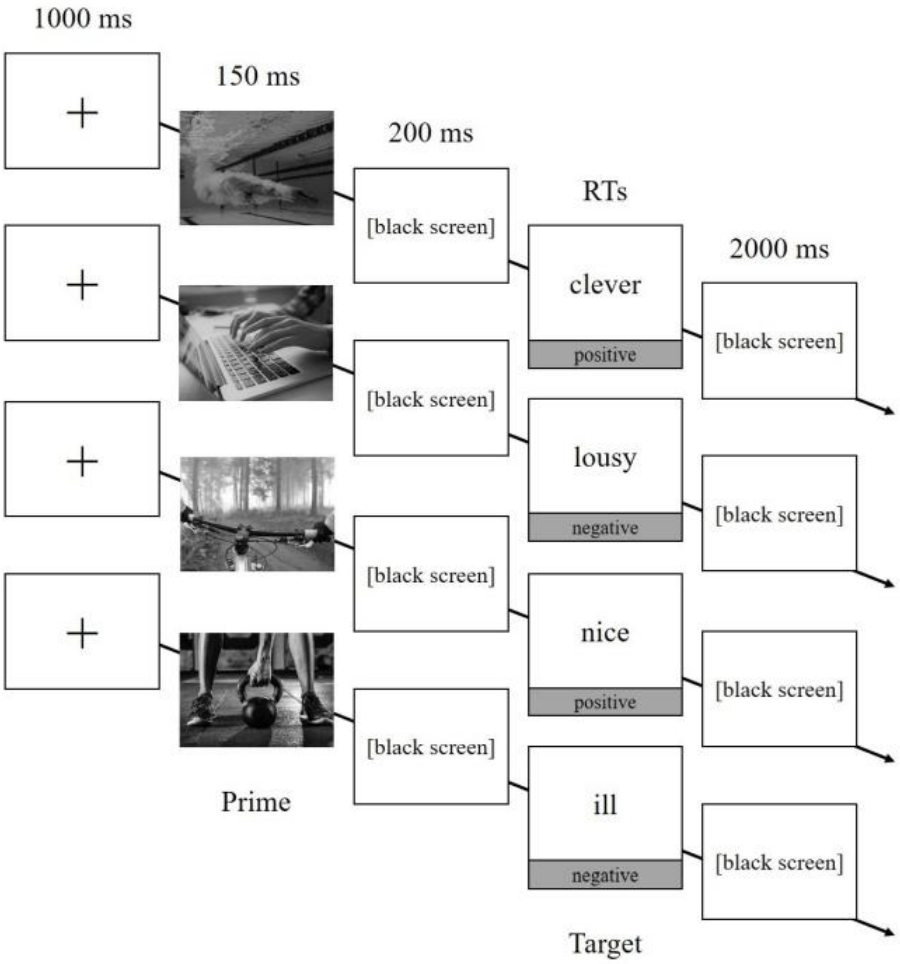
Mountain biking

Various types of exercise

Control (computer work)

Figure 10

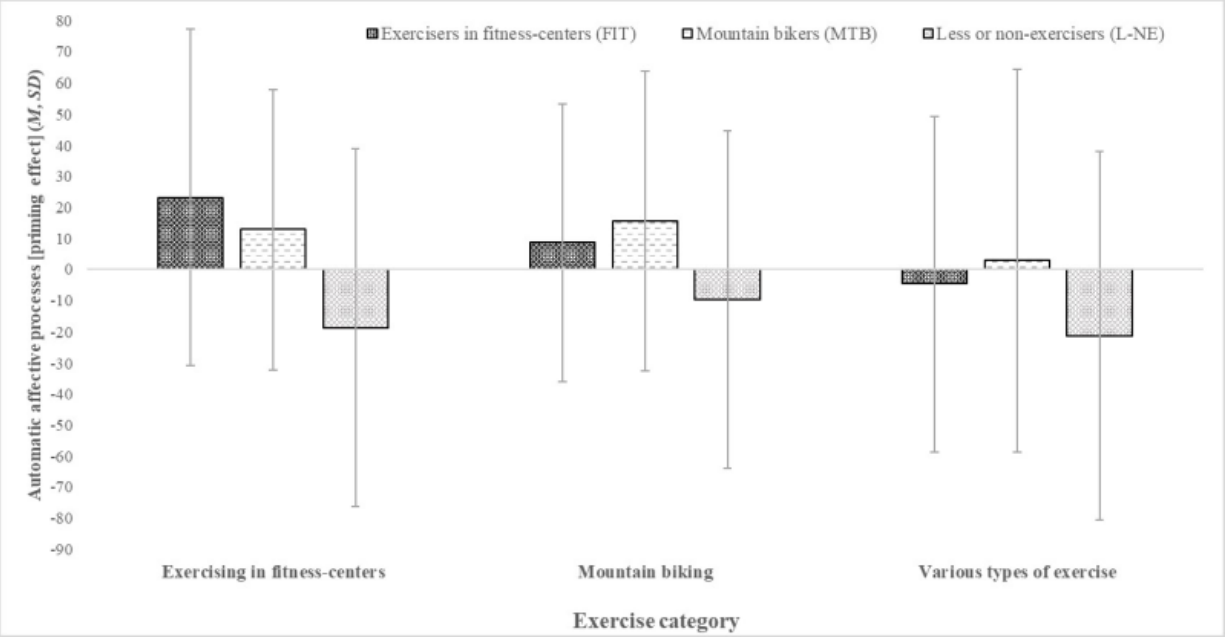
The EP procedure with duration of each feature (in ms)



Note. Target words were originally presented in German. RT indicates reaction time.

Figure 11

Automatic affective processes toward exercising in fitness centers, mountain biking and various types of exercise



Note. The automatic affective processes towards exercising in fitness-centers, mountain biking and exercising at all separated by groups are presented (error bars show standard deviations).

Automatic affective processes toward physical activity in children

Chapter 6

"The field of implicit processes is still in its infancy in the physical activity context and many other studies are needed to better understand how, for whom and in which situations, implicit attitudes are associated with physical activity behaviour"

(Chevance et al., 2019, p. 271).

6. Automatic affective processes toward physical activity in children

The effect of AAP on PA or exercise in adults is well documented (Chevance et al., 2019). There are several factors (contextual, situational or dispositional) that influence AAP (and reflective processes) toward exercise and PA in adults. But it still remains unclear how, for whom and in which situations, AAP are really associated with PA and exercise behavior. Especially studies focusing on children are rare and little is known about whether AAP have already developed during childhood (Dunham, 2008).

6.1 Derivation of the third publication

There exist relative consensus that reducing physical inactivity, in both adults and children, represents one of the greatest public health challenges of the 21st century (Guthold et al., 2018; Guthold et al., 2020). Several reviews and meta-analyses (e.g., Tremblay et al., 2014) proclaim a global “childhood physical inactivity crisis” (p. S114). Regarding several studies from Germany, experts estimate that not even 20% of children and adolescents reach the WHO’s (2020) minimum recommendation of 60 minutes of PA per day (e.g., Demetriou et al., 2019; Demetriou et al., 2018; Mauz et al., 2020). In addition, as children get older, they achieve the PA recommendations less and less (Finger et al., 2018). Overall, maintaining a physically active lifestyle during childhood reduces the risk for several diseases in adulthood. From early childhood, PA is positively related to physical, mental, and social health (Ahn & Fedewa, 2011; Janssen & LeBlanc, 2010; Timmons et al., 2012). Moreover, a physically active lifestyle in childhood is reflected in adulthood (Beauchamp et al., 2017; Physical Activity Guidelines Advisory Committee, 2018), and health in adulthood is influenced by PA in adolescence via different mechanisms (Hallal et al., 2006). In contrast, physical inactivity in childhood is strongly correlated with overweight, obesity and many other chronic diseases (Jochem et al., 2018) and being physically inactive, having poor cardiorespiratory fitness, and obesity as children go along with an increased risk of health complications in later life (Pahkala et al., 2013).

First, to prevent negative health effects for children, and second, to ensure that inactive children do not become inactive adults, it is important to comprehend why children are not sufficiently physically active or even do not like to perform PA. For this purpose, the underlying psychological processes that contribute to PA behavior in children need to be better understood. Affective experiences while being physically active play a central role for further participation in the activity (Maturo & Cunningham, 2013). Experiencing positive affect leads to more engagement in PA and thus have an influence on later PA participation and it is from great importance to foster positive affective PA experiences from the beginning of the child’s

life. It can be suggested that prior PA experiences are stored as mental associations in memory where experiences are linked with their attendant affective responses. Regarding publication 1 and 2, it can be assumed that specific AAP are shaped not only by the amount of exercise (Schinkoeth & Antoniewicz, 2017) but also by the specific, preferred type of exercise (e.g., Antoniewicz & Brand, 2014; Limmeroth & Hagemann, 2020). Therefore, a bit more is now known about differences arising due to the specific exercise context.

However, according to Chevance et al. (2019) and Schinkoeth and Antoniewicz (2017) only two studies (Craeynest et al., 2005; 2008)[16] focus on children or adolescents. Only recently, a new study by Muecke et al. (2021) was published concerning 10-14 year old children. Therefore, as of today, to my knowledge there are only three studies that have even looked at AAP toward PA in children. So, for whom exactly or from what age on are AAP associated with PA? As already indicated, very little is known about whether these processes are already interrelated with children's PA level. If this correlation already exists in childhood, it could probably influence adults' PA behavior (Hyde et al., 2012). In order to better understand the underlying automatic processes in children, publication 3 focuses on whether AAP toward PA are already related to PA behavior in childhood.

[16] Due to the very specific setting (obesity treatment including a mandatory exercise program), the results of these two studies should be interpreted with caution.

“I do what I like”: 8- to 10-year-old children’s physical activity behavior is already interrelated with their automatic affective processes

6.2 Publication 3

Abstract The majority of middle-aged children do not meet current physical activity guidelines. There is growing evidence that adults’ physical activity is partially influenced by automatic affective processes, which are derived from affective experiences with physical activity. However, little is known about whether these processes are interrelated with children’s physical activity level. A prospective design is used to examine whether automatic affective processes assessed by an Evaluative Priming procedure predict physical activity of children. Physical activity of forty-eight children (8.71 ± 0.71 years; 65% girls) were measured for one week with activity trackers. In a linear regression model, automatic affective processes (β = .36) significantly predicted physical activity, accounting for 11.02% of variance. These results indicate that physical activity-related automatic affective processes are associated with children’s physical activity, as has previously been found in adults. This study emphasizes the importance of fostering positive affective experiences associated with physical activity during childhood.

Keywords: dual-process; evaluative priming; activity tracker; childhood; physical inactivity

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It is presented within this dissertation in form of the final manuscript “as accepted for publication in *Journal of Sport & Exercise Psychology*, ©Human Kinetics”.

6.2.1 Introduction

The health benefits of maintaining a physically active lifestyle are well documented (Lee et al., 2012). In contrast, physical inactivity is a leading risk factor for developing noncommunicable diseases (Guthold et al., 2018). Of particular concern in this context is that already the majority of children and adolescents do not meet current physical activity (PA) guidelines: engaging in moderate- to vigorous-intense PA for at least 60 min per day (World Health Organization, 2020). PA can be described as “any bodily movement produced by skeletal muscles that results in energy expenditure” (Caspersen et al., 1985, p. 126), whereas exercise forms a subcategory of PA. The negative consequences of physical inactivity during childhood can be far-reaching. PA has short-term positive effects on children's health (e.g., bone and mental health; Hallal et al., 2006). Moreover, being physically active in childhood generally continues into adulthood (Beauchamp et al., 2017; Physical Activity Guidelines Advisory Committee, 2018), and PA in adolescence influences health in adulthood via different mechanisms (Hallal et al., 2006). Being physically inactive, having poor cardiorespiratory fitness and obesity during childhood are associated with an increased risk of health complications later in life (Pahkala et al., 2013). To prevent negative health effects on children and to ensure that inactive children do not become inactive adults, it is important to understand why children are not sufficiently physically active. This study aims to understand underlying psychological processes that contribute to PA behavior in children. For this purpose, we investigated whether automatic affective processes already have an influence on PA in children. While the effect of automatic affective processes on PA in adults is well documented, for children, evidence is still lacking (e.g., Chevance et al., 2019).

For approximately three decades, the impact of positive and negative affective experiences during PA on future PA has been repeatedly discussed in academia. Ntoumanis and Biddle (1999) argued that experiencing negative affect during PA plays a central role in further participation in the activity. Individuals with negative affective experiences in PA tend to avoid being physically active and are less physically active than those who experience positive affect (Schneider et al., 2009). Positive affective experiences with PA, on the other hand, are strongly positively correlated with PA behavior (Moore et al., 2009). A systematic review from Maturo and Cunningham (2013) underpins that perceived fun can be seen as a driving force, motivating children and adolescents to engage in PA. Furthermore, enjoyment of physical education predicts participation in PA among girls (in grades 7–12) and boys (in grades 4–12; Sallis et al., 1999). Recent research underlines that affective experiences during (but not following) PA (i.e., exercise) have an impact on future PA behavior (Ekkekakis et al., 2020; Rhodes & Kates, 2015).

One of the major current challenges is to identify the underlying psychological processes behind the association of (prior) affective PA experiences and (prospective) PA behavior. Only recently Brand and Ekkekakis (2018) proposed the affective-reflective theory of physical inactivity and exercise (ART), a dual-process theory that was specifically developed to conceptualize the psychological mechanisms underlying the behaviors of exercise and physical inactivity. Thereby, the ART also emphasizes the role of affect as it provides theoretical assumptions about the processing of affective experiences with PA for and as part of exercise-related decision making (Ekkekakis & Brand, 2019). As other dual-process theories, the ART suggests that information processing occurs on both a reflective and an automatic path (e.g., Evans & Stanovich, 2013; Strack & Deutsch, 2004). Whereas the automatic path (type-1) is under study here.

The ART suggests that prior PA experiences influence associative pairing as part of the type-I process. A central assumption here is that experiences with PA are stored as mental associations in memory where experiences are linked with their attendant affective responses (Ekkekakis & Brand, 2021). According to Brand and Ekekkakis (2018), these mental associations rely on repeated, pleasant or unpleasant experiences that individuals derive from PA, whether these were the result of valenced bodily sensations (such as bliss or exhaustion) or were associated with complex and culturally framed emotions (such as pride or embarrassment). It is assumed that every time an internal stimulus (e.g., remembering your teacher's advice to practice push-ups at home) or external stimulus (e.g., the inquiry of a friend to play soccer together) occurs, these mental associations are spontaneously activated (Sloman, 1996). As a result, associative pairing (or "tagging") of PA experiences with either a positive or negative affective valence (i.e., affective valuation) takes place with the evocation of a positively or negatively valenced somato-affective reaction (comparable to the somatic marker hypothesis; Damasio, 1994, 1996). The somato-affective reaction can be described as a “gut feeling” toward PA that results in an action impulse and, if negative, discourages a person from becoming physically active (Ekkekakis & Brand, 2021). Ultimately, automatic affective processes can directly influence PA behavior, especially when self-control is low (Brand & Ekkekakis, 2018) and therefore, are also important for health behavior as this behavior is often related with problems of self-control or self-regulation (e.g., Ekkekakis & Brand, 2021; Hagger, 2016). For adults, there is already profound empirical evidence about the impact of automatic affective processes on PA behavior (Chevance et al., 2019; Phipps et al., 2021; Schinkoeth & Antoniewicz, 2017). Thereby, diverse studies indicate that automatic affective processes are at least partly unrelated with reflective evaluative processes (type-II) and both processes independently can explain PA behavior (e.g., Schinkoeth & Antoniewicz, 2017).

The first approaches indicate that the strength of the automatic processes in children is comparable to those held by adults (Baron & Banaji, 2006; Dunham et al., 2008). At the same time, there is some controversial empirical evidence that children's behavior might be even more impacted by automatic processes as self-control is less developed in children compared to adults (Blakemore & Choudhury, 2006; Tao et al., 2014). Raffaelli et al. (2005) assessed levels of self-regulation with 12 maternal-report items (regulation of affect, behavior and attention). Self-regulation increased from early childhood (4-5 years old) to middle childhood (8-9 years old), but not from middle childhood to early adolescence (12-13 years old). Especially in younger children, research indicates that the acquisition of an integrated set of domain-specific control mechanisms (self-regulation) and the development of more cognitive–behavioral forms of self-regulation take place (e.g., Calkins, 2007; Montroy et al., 2016).

However, to date, studies on the role of automatic affective processes for PA in children are scarce. To the best knowledge of the authors, to date, only three studies have investigated the role of automatic affective processes in PA behavior in children. Two studies were conducted by Craeynest and colleagues (2005; 2008). In the first study (Craeynest et al., 2005), differences in PA-related automatic affective processes between obese and normal-weight children were investigated. For this purpose, automatic affective processes were assessed using an Extrinsic Affective Simon Task (EAST; De Houwer, 2003). The authors did not find differences between children and adolescents with or without obesity regarding their automatic affective categorization of moderate- or high-intensity PA words in the EAST. In a longitudinal study (Craeynest et al., 2008), it was investigated whether the automatic affective categorization of PA words for obese children and adolescents would change during obesity treatment and whether this change could explain a decrease in their weight. Again, the EAST was used. PA-related automatic affective processes did not change significantly during the treatment. Nevertheless, a decrease in overweight was related to a more negative automatic affective categorization of high intense PA at the end of the treatment. A within-person change toward a more negative automatic affective categorization of moderate PA predicted a decrease in weight after one year of treatment. However, in this very specific setting (obesity treatment including a mandatory exercise program), the results of these studies should be interpreted with caution.

Only recently, Muecke et al. (2021) found significant positive associations between PA-related automatic affective processes and vigorous PA in 10-14 year old children, but not with moderate-to-vigorous PA. In addition, basic motor competencies were positively associated with automatic affective processes towards PA. Automatic affective processes were assessed using a single target implicit association task (ST-IAT, Bluemke & Friese, 2008; Greenwald et al., 1998). PA was measured via wrist-worn actigraphy over seven days. This study provides

first evidence for the relation between automatic affective processes and PA in older children. The authors concluded that targeting automatic affective processes could be relevant for interventions to promote PA in children.

The purpose of this study was to examine whether positive associations between automatic affective processes and PA can be found in young school-aged children, as was already found in adults. We hypothesized that positive PA-related automatic affective processes would be associated with higher PA behavior of children objectively measured as steps per week. Given the lack of previous research, this study represents an important next step in understanding the role of automatic affective processes in PA in younger children. Additionally, this study may contribute to methodological progress in the measurement of PA-related automatic affective processes in children as we present an Evaluative Priming Task (EP; Fazio et al., 1986) that has been adapted for the children sample. We, thus, aimed to additionally reflect on whether our EP is suitable to assess PA-related automatic affective processes in children (for more information, see the “Methods” section).

6.2.2 Method

Participants

Fifty-six individuals between the ages of 8–10 years were recruited and participated voluntarily[17]. They attended five different primary schools and came from different social backgrounds (e.g., two schools in the city, two schools in the village and one on the outskirts of the city with, diverse socioeconomic backgrounds). The participants’ data were considered for the final analysis when their PA behavior over at least five days was available. Data from eight participants had to be excluded from the analysis for the following reasons: seven children did not wear their activity tracker for more than two days (n = 4) or became ill during data collection (n = 3). Outlier analysis indicated that one participant had an unusually high priming effect, indicating incorrect test execution (z = 2.68; z-transformed values below -2.58 and above 2.58 are considered as outliers[18]). Data from this participant (n = 1) was excluded. The final sample consisted of forty-eight participants (M_{age} = 8.71 years, SD = 0.71; 65% female). The majority were attending third grade in school (83%).

[17] The German lockdown imposed by the national government because of the Covid-19 pandemic stopped data collection. The lockdown started on March 22, 2020. The authors believe that it is very likely that the lockdown had an effect on children’s PA behavior and PA behavior before and during the COVID-19 pandemic are therefore not comparable to each other. Hence, the authors decided to refrain from collecting additional PA data.

[18] It should be mentioned here that two more outliers were identified within the fitness tracker data. Both data sets remained in the final sample, since the measured data (although compared to the others were unusually high) can still be considered as authentic. Nevertheless, the authors analyzed the data with and without these outliers and the outliers do not substantially affect the main findings. The results of these analyses can be found in the supplementary materials (Chapter 6.2.7).

Procedure

This study adopted a quasi-experimental prospective design. First, while sitting in a quiet environment (i.e., in a quiet room at home or in school), the participants completed a computer-based EP. A test supervisor was always present. Additionally, the parents were asked about their children’s age, gender. Afterward, the children’s PA was objectively measured for one week using activity trackers. Ethical approval was obtained from the local ethics committee. All procedures met the ethical requirements defined by the Declaration of Helsinki and its later amendments.

Power analysis

Based on an expected medium effect (Cohen’s *d* = 0.50) for automatic affective processes on PA (Schinkoeth & Antoniewicz, 2017), a Type-I error rate of α = .05 for one-sided testing and a power of .80, statistical power analysis conducted with G*Power (version 3.1; Faul et al., 2009) indicated that 51 participants were required. The authors anticipated participant dropouts (e.g., due to low compliance, irregular or incorrect use of the activity trackers) and thus aimed to assess 20% more participants[17].

Measures

Evaluative Priming Task. In our study, we used a computer-based EP (Fazio et al., 1986) to assess the children’s automatic affective processes. The EP is an indirect reaction time-based test used to assess automatic processes (Eves et al., 2007). In this test, a prime stimulus (first feature) was followed by a target stimulus (second feature), where the participants were instructed to neglect the prime stimulus and react only to the target. For each trial, the prime-target combinations were randomly presented. The target had to be identified correctly and as quickly as possible according to its valence as “positive” or “negative” (Fazio et al., 1986). The targets endure on the screen until the participant presses one of two response keys to indicate their positive or negative valence.

In this study, images instead of words were used in the EP. By completely avoiding the use of words as primes or targets in the EP procedure, the EP is more suitable for children. Using images as primes in an EP procedure has already been successfully applied to adults (Limmeroth & Hagemann, 2020). In this study, 40 PA-related images (a bike, a rope, a basketball, running shoes, etc.) representing moderate- and high-intensity PA behavior were used as PA primes. As neutral primes, 40 images showing furniture (a couch, a chair, a table, etc.) were shown. Twenty positively and 20 negatively valenced emoticons were used as the target stimuli. A detailed description of the procedure can be found in Figure 12.

The task lasted for less than 10 minutes. All participants completed 80 trials, whereas trials with false target categorization had to be repeated. Additionally, trials lasting more than 2000 ms were automatically repeated randomly during the test. Half of the participants reacted with their left index finger toward negatively valenced targets and with their right index finger toward positively valenced targets (and the other half vice versa). The response keys ‘x’ (on the left side of the keyboard) and ‘m’ (on the right side) were visually marked by a colored sticker. The same computer (Fujitsu Life-book E782 with a 15.6” monitor, a resolution of 1280 x 1024 pixels, and a refresh rate of 75 Hz; Fujitsu Technology Solutions GmbH, Munich, Germany) was used for all participants. The EP was programmed with E-Prime 3.0 (PST; Psychology Software Tools, Pittsburgh, USA).

The basic idea of the EP is that the provoked valence of each prime can lead to either response facilitation or response inhibition of the reaction toward the target (Hermans et al., 1994). Response facilitation occurs if the target stimulus (e.g., a smiling emoticon) valence is classified as congruent with the valence of the previously presented prime (e.g., a basketball). The contrary effect accounts for valence-incongruent (e.g., a frowning emoticon as target stimulus after a PA prime) trials. According to Fazio and Olson (2003), an associated positive or negative valence is automatically activated by the prime stimulus within a few hundred milliseconds and can be interpreted as spreading activation in an associative network. Primes that represent a similar concept (e.g., PA behavior) should activate equal affective valence across several trials. The automatic affective association with the underlying concept is derived from the discrepancy of response facilitation in concept congruent target trials and response inhibition in incongruent target trials (Limmeroth & Hagemann, 2020). To calculate the individual priming effect, the mean response latencies of prime-target combinations are used (e.g., Bluemke et al., 2010): $[(\mathbf{RT}_{\text{Negative Target | PA Prime}}) - (\mathbf{RT}_{\text{Negative Target | Control Prime}})] - [(\mathbf{RT}_{\text{Positive Target | PA Prime}}) - (\mathbf{RT}_{\text{Positive Target | Control Prime}})]$.

The resulting priming effect is greater (and more positive) if responses toward positive targets after showing the PA-related primes are facilitated and even more pronounced if responses toward negative targets are inhibited. Accordingly, individuals with positive automatic affective associations of PA should have a larger and more positive priming effect than individuals with negative affective associations. In our view, EP is an appropriate task for children to measure automatic affective processes. First, this task can be performed by very young children, as we used almost no words and only images (words were only used to declare the categories “positive” and “negative”). Second, the task is easy for children, and it might even be “fun” for children to categorize positive and negative emoticons in terms of their valence as quickly as possible. Emoticons are also familiar to children, as they are commonly used within digital communication. The performance-related test characteristics are examined

in the results section. The internal consistency calculated using the split half procedure was acceptable, α = .78.

Activity tracking. To measure the children’s PA activity, the participants wore an activity tracker (Xiaomi Band 3; model: XMSH05HM; Xiaomi - Haidian District, Beijing (China)) over a one-week period (following the recommendations of Clemes & Biddle, 2013) for seven consecutive days. The parents and children were instructed that the child had to wear the activity tracker for the whole day and to only take it off when sleeping (and to recharge it during this time). Steps per week are a suitable indicator of habitual PA (Bassett et al., 2017; Craig et al., 2010). It can be expected that within the children’s PA behavior, numerous accounts of moderate- and high-intensity exercise activity are included. As daily steps varied considerably per subject, each child’s median number of steps per week was used as their PA index in this study.

Data analyses

In line with previous studies (e.g., Limmeroth & Hagemann, 2020), response latencies under 250 ms in the EP were classified as unrealistic fast reactions, and trials with reaction times that fell outside the 99% confidence interval indicating inattention were subsequently excluded from the analyses (see Wilcox & Keselman, 2003). The priming effect and PA-behavior were calculated as described in the methods section. EP test-related parameters (e.g., error rates) were inspected. Potential confounding factors of the demographic variables age and gender on the two main study variables were analyzed. We further checked for differences in PA behavior between weekdays and weekend days. Means and standard deviations for PA-related automatic affective processes and PA behavior (whole week, weekdays, and weekend) as well as correlations between these variables were calculated. To check our hypothesis, we fitted a linear regression model with the priming effect as a predictive variable and steps per week as the factor variable for testing the link between the automatic affective processes and the PA behavior. An alpha level of p<.05 was set throughout all analyses to indicate significant characteristics. All analyses were carried out using SPSS 27 (IBM Corporation, Armonk NY, USA) for Windows.

6.2.3 Results

EP test-related parameters

The participants' mean error rate was M = 5.68% (SD = 0.72). The error rates differed slightly but not significantly by age (8-year-old: n = 21, M = 5.99%, SD = 4.64; 9-year-old: n = 20, M = 6.01%, SD = 5.93; 10-year-old: n = 7, M = 3.79%, SD = 3.05; F(2,45) = 0.57, p = .56, d = 0.32). The children needed on average M = 817.74 ms (SD = 25.48) to categorize the

valence of the presented target. The four subcategories of the EP did not show significant reaction time differences (Table 8): F (2.25, 105.79) = 1.43, p = .24, d = 0.35. The Huynh-Feldt adjustment was used to correct for violations of sphericity.

Advance analyses

Age had no significant impact on PA (F(2, 45) = 2.04, p = .14, d = 0.60) or PA-related automatic affective processes (F(2, 45) = 1.20, p = .31, d = 0.46). Gender had no significant effect on automatic affective processes (t(46) = 1.64, p = .11, d = 0.50) but it did on PA: t(46) = 3.40, p = .001, d = 1.03. Girls (M = 9326.02; SD = 1799.37) were less active than boys (M = 11951.50; SD = 3565.03). Furthermore, a repeated measures t-test revealed that overall PA-behavior was significantly higher on weekdays (Monday - Friday) than on weekends, t(47) = 4.16, p < .001, d = 0.60.

Main analyses

Descriptive data and correlations between PA variables and PA-related automatic affective processes are shown in Table 9. A linear regression revealed that automatic affective processes (β = .36) were associated with PA (whole week), F (1, 47) = 6.82, p = .01, ΔR^2 = .11, 95%CI [3.11, 23.97] (Figure 13).

Additional analyses

The linear regression shows that automatic affective processes (β = .36) can also significantly be associated with PA-behavior (from Monday until Friday): F (1, 47) = 6.66, p = .01, ΔR^2 = .11, 95%CI [3.15, 25.51]. In contrast, the linear regression predicting PA behavior on the weekend was not significant, F (1, 47) = 2.07, p = .16 (β = .21, ΔR^2 = .02, 95%CI [-4.46, 26.83]). An additional regression model including gender as a control variable within the model can be found in the supplementary material (Chapter 6.2.7).

6.2.4 Discussion

In this quasi-experimental prospective study, we aimed to provide empirical evidence for the association of PA-related automatic affective processes with young children’s prospectively measured PA behavior. Automatic affective processes were assessed by an EP task, adjusted to the special requirements of a child sample. Taken together, our results reveal that automatic affective processes are interrelated with PA behavior in children: as expected, a positive relation was found. Moreover, EP seems to represent a suitable method to assess children's automatic affective processes. As this study is among the first to investigate the impact of PA-related automatic affective processes on PA in children, our results expand upon

previous research that mainly focused on adults. Our results emphasize that automatic processes have already developed during childhood (Dunham et al., 2008). As hypothesized and following the assumptions of the ART (Brand & Ekkekakis, 2018), children’s automatic affective processes manifest in their PA behavior with a medium-sized effect in our study. Past systematic reviews and a meta-analysis revealed small- to medium-sized effects for adults (Chevance et al., 2019; Schinkoeth & Antoniewicz, 2017). Additional analyses indicated that the effect of automatic affective processes on PA is independent of gender, but gender also influences PA behavior. In our study, girls were less physically active than boys. This is in line with previous results showing that only 9.7% of girls meet daily (minimum) step recommendations compared to 47.1% of boys (Kantanista et al., 2015). Such differences in PA activity between boys and girls were also reported by the WHO (Inchley et al., 2017) and by a German representative study by Schmidt et al. (2020). Due to this, target group-specific interventions for girls are important (Labbrozzi et al., 2013).

PA activity during the week was higher than that on the weekend, which is in line with current findings by Brazendale et al. (2021). Moreover, we found links between automatic affective processes on PA behavior over the whole week and from Monday to Friday but not for PA behavior that takes place on the weekend. Children’s PA behavior seems to be particularly dependent on the more structured weekdays compared to less structured weekends, which may also affect our aforementioned (non)correlations (Brazendale et al., 2017; Lin et al., 2018). However, our data must be interpreted with caution, as it was not the aim of this study to investigate such differences, therefore, we only measured a single weekend, which cannot be representative of general weekend PA behavior.

An adapted version of the EP was applied in this study. Instead of words, pictures were used as the primes and emoticons as targets. The mean error rate in this study (*M* = 5.68%) is comparable to adult samples (6.8%; Bluemke et al., 2010; 4.52%; Limmeroth & Hagemann, 2020). Additionally, the time needed to categorize the valence of the presented target (*M* = 817.74 ms, *SD* = 25.48) is equivalent to adults in a similar version of the EP (*M* = 804.20, *SD* = 112.85; Limmeroth & Hagemann, 2020). The applied EP version seems to be a promising method to assess PA-related automatic affective processes in children. The circumstance under which participants had to respond as quickly as possible and in the correct manner to the presented target was feasible for children. Nevertheless, the psychometric properties of EP among children should be further evaluated in future studies.

As shown in other surveys, in our study, only 22.91% of the children met daily (minimum) step recommendations based on a systematic review by Pereira da Silva et al. (2015). This circumstance first highlights the importance of school and community-based interventions or programs to increase daily PA among children and, second, emphasizes the need of a better understanding of the psychological processes underlying physical inactivity in

childhood. For example, it can be assumed that the automatic affective processes assessed in this study, at least partly, rely on (past) affective experiences (Brand & Ekkekakis, 2018; Zajonc & Markus, 1982). The results of this study thus imply that PA-related affective experiences are already stored in children’s memory as mental associations. This underlines the relevance of positive affective experience with PA during childhood (Ekkekakis & Brand, 2021). The affective experiences during PA should be given more attention, especially in the setting of physical education. First, physical education for some children and adolescents is their only opportunity for regular PA (Kjønniksen et al., 2010). Second, a recent study highlighted the long-term effects of affective experiences during physical education in childhood on adults’ PA behavior. It was shown that childhood memories of physical education classes are linked with PA attitude, intention to perform PA, and sedentary behavior in adulthood (Ladwig et al., 2018). It is possible that such childhood memories also influence automatic affective processes toward PA in adults. Early PA experiences, such as childhood experiences with physical education, might build a stable component of adults’ associative memory, and together with recent experiences (Hyde et al., 2012) might impact adults’ PA behavior. However, for practical implementation, there is a need for intervention approaches that can robustly and reliably improve the affective experience of exercise and PA, including physical education classes (Ekkekakis et al., 2020).

Our study points to the relevance of further research on children’s PA-related automatic affective processes. Investigating automatic affective processes in children may contribute to understanding why a majority of children currently do not meet physical activity guidelines. It is possible that young children’s PA behavior might be even more impacted by automatic affective processes than among adults. According to the ART, self-control is needed to start the reflective type-II process and to overwrite the action impulse initiated by the automatic affective process with a (rational) action plan (Brand & Ekkekakis, 2018). This is of special importance if the automatic affective process results in a negative core affect and thus, in an action impulse pointing away from PA. In this case, the child would be required to exert self-control to overwrite this impulse and start with PA, such as going out to practice for a the running test. Especially among younger children, these requirements might be lacking, as important aspects of self-control (e.g., executive function, inhibitory control) develop during childhood in a nonlinear fashion with rapid gains during preschool (Montroy et al., 2016). Studies from other research areas assume, for example, that brain regions associated with behavioral control (such as inhibiting alcohol consumption) are still not fully developed in childhood and adolescence (Spear, 2002), and Folkvord et al. (2016) concluded that changing implicit processes can help reduce unhealthy eating behaviors among children. It should be mentioned that a recent yet unpublished meta-analysis could not find any effects of age on the impact of automatic and reflective processes on diverse kinds of behavior, including PA

(Phipps et al., preprint). More research using longitudinal designs and an investigation of within-person changes is necessary to further evaluate the potential age-related differences in the correlation between reflective and automatic affective processes with PA behavior in children and their associations with self-control.

Limitations, strengths, and implications for future research

The present research is not without limitations. First, we had to deal with a slightly smaller sample size than planned because we had to stop recruitment due to the COVID-19 pandemic. As mentioned before, we also decided not to continue with further data collection because of the changes in the possibilities to be physically active during the COVID-19 pandemic. Second, there are no basic research on criterion validity for the test procedure used. However, we understand the modified test procedure as a sensible procedure adapted to the needs of children, and our data show acceptable reliability for the EP task. Third, activity trackers can be used as a highly practical tool to objectively measure PA behavior, but they are also subject to other biases. For example, our devices rely primarily on activities that are directed forward. Their accuracy may be limited if the movement is multidirectional (Duncan et al., 2020). For future studies, we recommend using accelerometers, which are internationally recognized as an objective measurement method for PA with good to very good validity (Assah et al., 2011). Fourth, our study did not include a measure of reflective processes. For future studies, it would be worth to additionally assess reflective processes to quantify unique effects on behavior as well as interrelations with the automatic affective processes.

Considering that a large number of studies in the field of PA and exercise are still applying questionnaires to retrospectively assess PA or exercise behavior (Hidding et al., 2018), using activity trackers measuring PA over seven days can also be seen as a methodological strength of the study (Matthews et al., 2012). Moreover, the prospective design in our study provides insights into the predictive capacity of automatic affective processes for PA behavior. Unfortunately, most studies in adults used correlational designs (Chevance et al., 2019; Schinkoeth & Antoniewicz, 2017). Our EP procedure seems well suited for children. Finally, our study is one of the first studies in which PA-related automatic affective processes were investigated in children. Thus, our study represents a first step in understanding the role of these processes in PA behavior in children.

For future research, it is still important to take a closer look how automatic affective processes toward PA evolve during childhood and how they proceed into adulthood (Dunham et al., 2008). From an applied standpoint, it is of great interest to implement interventions that can directly improve affective PA experiences, especially for children (Ekkekakis et al., 2020). Future studies are required to determine whether improved affective experiences can ultimately lead to increased and sustained exercise and PA participation over the whole

lifespan (Ekkekakis & Brand, 2021; Hyde et al., 2013), because “the traditional public health approach based on evidence and exhortation has - to some extent - been unsuccessful so far” (Hallal et al., 2012, p. 254). The present study marks an important starting point in understanding how automatic affective processes of PA correlate with the corresponding behavior already present during childhood and how important it is to foster positive affective PA experiences from the beginning of the child’s life.

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6.2.6 References

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6.2.7 Supplementary material

Additional analyses with gender

We decided to check whether gender moderates the effect of automatic affective processes and PA behavior in additional analyses. An additional moderation analysis was carried out to determine whether the interaction between automatic affective processes and gender significantly predicts PA behavior. The effect of automatic affective processes on PA behavior is not moderated by gender: ΔR^2 =.03, $F(1, 44)$ = .42, p = .52, 95%CI [-38.72, 29.36]. The interaction term was dropped from the model according to recommendations by (Hayes, 2018), resulting in a new simple effects model. This new model reveals that automatic affective processes (β = .27, p = .046, 95%CI [0.18, 20.07]) and gender (β = -.39, p = .005, 95%CI [-3800.94, -709.83]) can predict PA behavior: F (2, 45) = 8.30, p = .001, ΔR^2 =.24.

Outlier analyses

As mentioned in the main analyses, we decided to include both data sets from both statistical outliers due to considerations regarding the power and because they do not substantially affect the main findings. The linear regression with n = 46 revealed that automatic affective processes (β = .41) accounted for 14.83% of the variance in PA (whole week), F (1, 45) = 8.83, p = .005, 95%CI [3.71, 19.39]. Furthermore, five outliers could be identified by optical inspection of the data distribution. The linear regression excluding this cluster of five outliers (n = 43) showed that automatic affective processes (β = .30) accounted for 6.90% of the variance in PA (whole week), F (1, 42) = 4.11, p = .049, 95%CI [0.06, 29.66].

6.2.8 Tables

Table 8

Mean reaction times of all subcategories of the EP task

	Subcategory			
	Control negative	Control positive	PA negative	PA positive
M	824.00	808.36	813.34	825.27
SD	169.94	193.36	189.94	170.73

Note. This table shows the mean reaction times (in ms) for the four subcategories of the EP task. Data sets from *N* = 48 participants could be analyzed.

Table 9

Correlations between automatic affective processes (priming effect) and PA behaviors (steps)

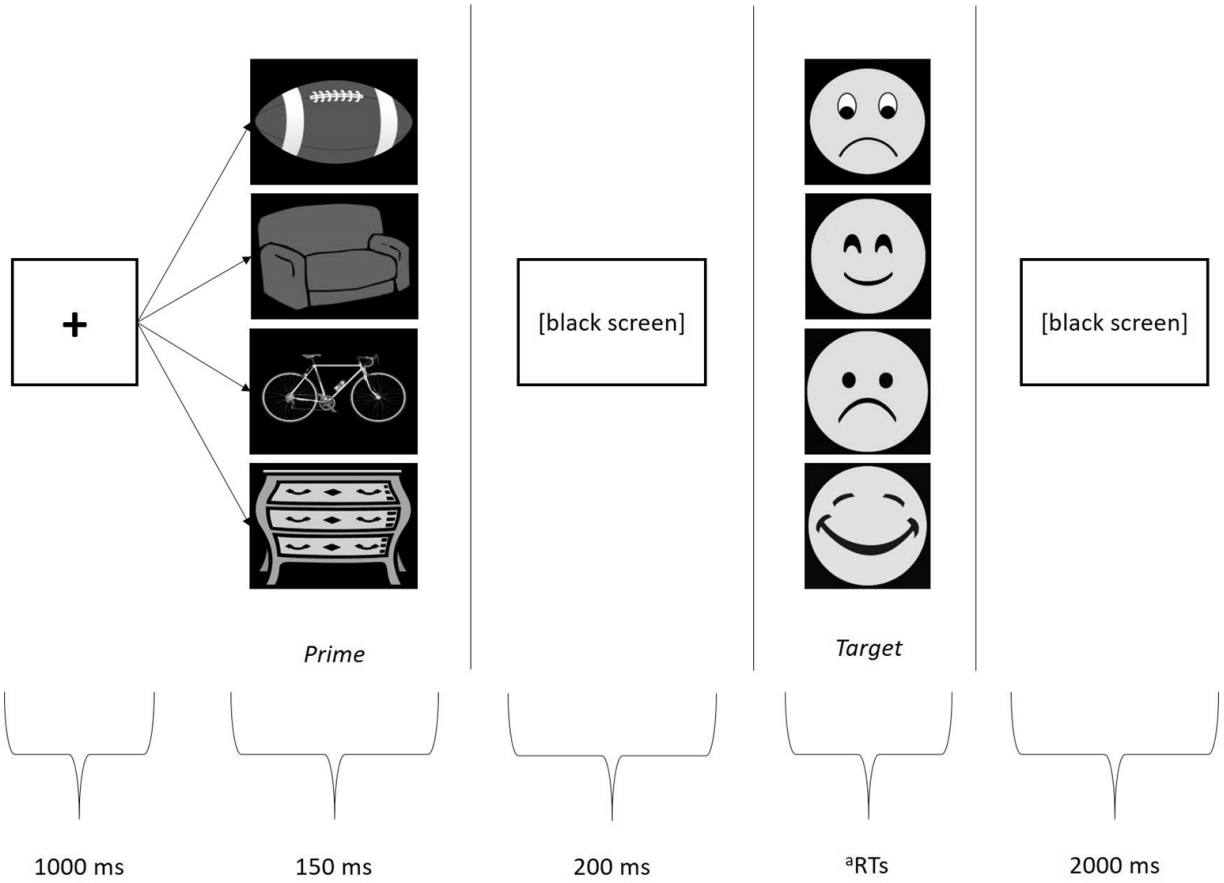
Variable	*M*	*SD*	1	2	3
1. Automatic affective processes [priming effect]	-3.72	75.11	-		
2. Physical activity [steps] (whole week)	10255.88	2829.04	.36*	-	
3. Physical activity [steps] (Monday - Friday)	10762.70	3027.00	.36*	.93**	-
4. Physical activity [steps] (Weekend)	8327.38	4046.74	.21	.54**	.37**

Note. *M* = Mean, *SD* = Standard Deviation, *N* = 48 participants; *$p < .05$. **$p < .01$.

6.2.9 Figures Captions

Figure 12

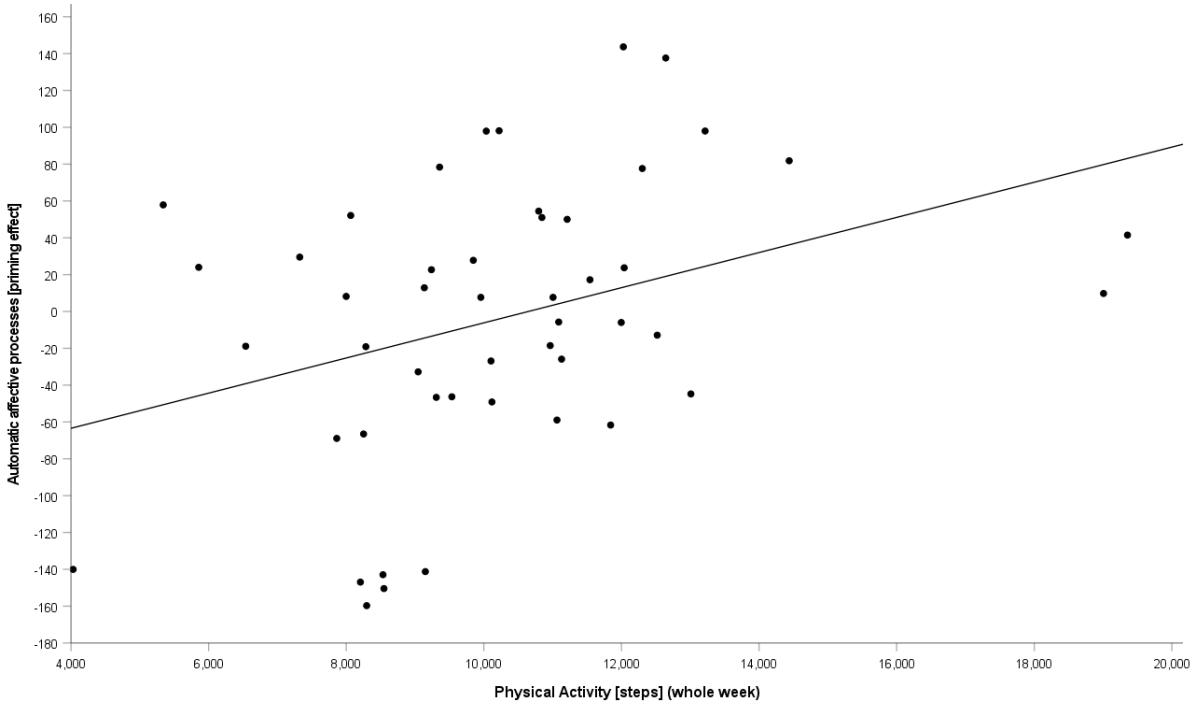
The EP task with PA-related pictures and furniture pictures as primes and emoticons as targets



Note. The EP with the duration of each feature in milliseconds. PA-related pictures and furniture were presented as primes and emoticons as targets. [a]RTs = reaction time.

Figure 13

Scatter plot of PA and automatic affective processes towards PA



Note. Scatter plot of the relation between PA and PA related automatic affective processes (*N* = 48).

General discussion

Chapter 7

“Perhaps fresh starts can be leveraged to help people overcome this tendency [to completely abandon goals after initial experiences with failure] and understand that no matter how many times they experience lapses in self-control, the next day provides an opportunity for a fresh start”

(Zenko et al., 2021, p. 34).

7. General discussion

Building on the findings that have emerged from each of the three publications, this chapter discusses the derived results and follows up with a theoretical discussion about AAP toward different types of exercise and toward PA in adults and children. This is followed by a methodological discussion referring to the EP task (Chapter 7.2). Chapter 7.3 addresses the resulting general conclusions. Finally, in Chapter 7.4 (practical) implications are given.

7.1 Theoretical discussion

Although there have been many efforts within exercise psychology to explain physical inactivity, overall it must be assumed that the underlying psychological mechanisms for exercise and PA behavior change are not well understood or even unknown (Ekkekakis & Brand, 2021; Rhodes et al., 2019). However, for millennia, humans have been interested in affective responses to PA and exercise (Ekkekakis et al., 2020). Notwithstanding this interest, research (in exercise psychology) on the role of exercise-/PA-related affect has not been pursued for too long, although research effort on it is fast growing (Ekkekakis, 2017; Ekkekakis et al., 2018; Williams, 2008). Therefore, studying and better understanding affective determinants, whether labeled automatic or reflective, regarding the motivation to exercise or to be physically active still represents an alternative and recent theoretical approach in exercise psychology (Phipps et al., 2021). This is also reflected in the still understudied theoretical framework of dual-process theories (Rhodes et al., 2019). Based on theoretical assumption of the ART, research on AAP toward exercise (PA) still stand for an innovative and not fully understood approach within exercise psychology. According to Chevance et al. (2019), AAP and PA in adults correlate on a small[19], significant, and positive level but little is known about other (situational, contextual or dispositional) variables that possibly interact with AAP:

(1) In which or for which situations are AAP important drivers of exercise- or PA-related decisions?

(2) Do contextual factors influence specific AAP?

(3) At the beginning of what age AAP correlate with the corresponding PA behavior?

[19] According to Schinkoeth and Antoniewicz (2017), the relation between AAP and exercise or PA variables differed between small to large effect-sizes.

To summarize, I wanted to better understand “how, for whom and in which situations” (Chevance et al., 2019, p. 271) AAP are important. First, the results of, for example, Bluemke et al. (2010) and Antoniewicz and Brand (2014) could be confirmed and extended insofar as not only the correlation between overall exercise amount and AAP but also the importance of the specific, preferred type of exercise (running) plays a role in explaining differences in AAP (Limmeroth & Hagemann, 2020). Second, in publication 2 (Limmeroth & Braun, 2022), we primarily built on the findings by Limmeroth & Hagemann (2020) and wanted provide further evidence for a more precise relationship between AAP and a specific type of exercise in specific exercise setting preferences (e.g., exercising in fitness centers, mountain biking). The results of this study show that AAP are indicative of the preference for exercising in fitness centers. But for mountain biking, we could only find a nonsignificant but similar tendency on a descriptive level with a smaller effect. For the category of various types of exercise, we found no significant difference. These studies allow for two conclusions: first, it can be concluded that people who are active in specific types of exercise do not necessarily exhibit generally positive AAP (toward all types of exercise). Second, it seems to play a role whether AAP are assessed toward specific types of exercise, to then be able to distinguish between exercise-specific and differently or non-physically active individuals. All in all, in both publications the hypothesized results were obtained, at least on a descriptive level. Selecting a larger sample size, especially regarding Publication 2 could help to clarify the partly ambiguous result. At the same time, further questions remain unresolved (see outlook) and methodological limitations should be mentioned (see below).

Furthermore, both studies underline the importance of affective responses for exercise behavior, regardless of whether such processes are automatic or reflective. Our findings are in line with previous assumptions (e.g., Brand & Schweizer, 2015; Phipps et al., 2021) that automatic and reflective processes can independently contribute to exercise behavior. This underlines, that in general, affective experiences are fundamental for exercise behavior regardless of whether such processes proceed automatically or depend on deliberative processes. Based on the ART (Brand & Ekkekakis, 2018), exercise behavior is always shaped by this interaction of automatic affective and reflective (affective) processes. In addition, the results of publication 2 that refer to the reflective processes indicate that exercise is not all the same and that it can make a big difference whether people go mountain biking or to the fitness center. Both behaviors can be independent of each other, but they can also influence the more general attitude towards exercise in general and thus, be reflected in the AAP. In detail, the consciously available, reflective affective process is tremendously important and strongly correlated with the corresponding specific exercise behavior and exercise behavioral decisions.

With the first two publications focusing mainly on the "how" and the "in which situations", Publication 3 was dedicated specifically to the "whom", namely to children. This study is among one of the first that investigated in the impact of PA-related AAP on children's PA behavior expanding upon previous research that mainly focused on adults. The results accentuate that AAP are already developed during childhood (Dunham et al., 2008) and as hypothesized following the assumptions of the ART (Brand & Ekkekakis, 2018), children's AAP are associated with their PA behavior with a medium-sized effect. Furthermore, our findings are in line with some of Muecke et al.'s (2021) who found significant positive associations between PA-related AAP and vigorous PA in 10-14 year old children, but not with moderate-to-vigorous PA. We emphasize that AAP have already developed during childhood (Dunham et al., 2008) but as additional analyses revealed, are independent of gender, although gender influences PA behavior. Based on the fact that not only in our study (e.g., Inchley et al., 2017; Nader et al., 2008), girls are less physically active than boys, it seems important to develop specific PA and/or exercise interventions (exclusively) for girls (Labbrozzi et al., 2013; Pearson et al., 2015).

7.2 Methodological discussion

Especially the EP task used in publication 3 seems to be well suited for children and a promising method adapted to the needs of children. In this context, we also discussed EP test-related parameters, whereby the mean error rate in this study (M = 5.68%, SD = 0.72) was comparable to adult samples (6.8%; Bluemke et al., 2010; 4.52%; Limmeroth & Hagemann, 2020) as well as the time needed to categorize the valence of the presented target with a clearly lower standard deviation (M = 817.74 ms, SD = 25.48) compared with M = 804.20 ms (SD = 112.85; Limmeroth & Hagemann, 2020). However, there is a lack of basic research on criterion validity for indirect measures in general and it should be noted that reliability presents a basic problem for EP tasks (Gawronski & De Houwer, 2014). For example, in publication 1 Cronbach's alpha was considerably lower with α = .58 as it was in publication 3 (α = .78) and in publication 2 it differed depending on the type of exercise category (α_{FIT} = .63; α_{MTB} = .59 and α_{EXE} = .30). Further psychometric evaluation and refinement of measures, including the EP task, should be undertaken (Zenko & Ekkekakis, 2019b). This could also include a discussion geared toward reaction-time-based experiments that addresses specific methods for measuring internal consistency for such indirect test procedures.

Focusing on the methodological approach and, in particular, on the measuring instrument (the indirect test: the EP task), methodological strengths as well as limitations can be identified in the process. Especially the modification of publication 1 and 2 of the first feature within the EP procedure (pictures instead of words) is in line with empirical evidence that pictures, in

contrast to words, show advantages in access to a semantic network containing affective information (De Houwer & Hermans, 1994; Kensinger & Schacter, 2006). However, the use of pictures is also accompanied by various challenges. According to findings by Cope et al. (2018), participants indicated stronger automatic associations to exercise if the pictures were displayed outside in contrast to settings inside. In turn, these findings fit with previous results that showed that exercising outside possibly provides more substantial mood-enhancing effects than exercising indoors (Plante et al., 2007), and the general preference toward pictures displaying natural environments (Franek & Rezny, 2017). In Publication 1, only pictures showing running activity outside were presented but in Publication 2 an indoor setting (exercising in fitness centers) compared to an outdoor setting (mountain biking) was used. This may be reflected in the results in that the outdoor setting within the mountain biking pictures could partly be positively associated, whereas this could not have been the case within the indoor setting of exercising in fitness centers. This leads to a great difficulty. Ultimately, it is not clear on which content the participants are focusing. Despite mitigating measures, such as directing participants' attention to the exercise-specific stimulus by displaying a fixation cross in the center of the screen at the beginning of each trial, and by ensuring that the indoor or outdoor settings only form the outer frame, it remains unknown what individuals' mental representation and their spontaneous, affective response is based on (Evans & Stanovich, 2013).

The modification of the EP task for publication 3 concerning not only the prime (first feature) but also the target (second feature) seems to be a suitable method to assess children's AAP. This further development (clipart instead of pictures as prime) circumvented the fact that the context would be additionally and unconsciously processed. Moreover, as the targets were now also presented in form of emoticons, it was possible to avoid that children differ in how fast they read (process words), which created easy access. Finally, the character of the test ("to respond as quickly as possible and in the correct manner to the presented target") seems adequate and realizable for children.

7.3 Conclusion

In sum, my dissertation provides answers to the question posed initially in Chapter 2: *"how, for whom and in which situations" (Chevance et al., 2019, p. 271) are AAP associated with PA behavior?* can now be answered in more detail, according to the results of the three publications presented:

(1) Previous research could be confirmed, since these publications also associated AAP with PA or exercise behavior with medium to large effect sizes.

(2) Not only the amount of performed exercise results in variation in AAP, but also the preferred type of exercise / exercise setting.
(3) Automatic and reflective affective processes seem to independently contribute to the explanation of a (specific) exercise behavior.
(4) Affect is tremendously important for exercise and physical (in-)activity behavior, initially regardless of whether it is automatically or reflectively produced.
(5) AAP are important and associated with the corresponding PA behavior in both adults and children.

The results of this dissertation, referring primarily to AAP assessed by the EP task, are consistent with one of the central assumptions of the ART (Brand & Ekkekakis, 2018), namely the presence of a detectable automatic affective response to exercise- and PA-related stimuli. A positive automatic affective reaction to the thought of exercise / PA (exercise or PA-related stimulus) can act as a driving force, facilitating sustained exercise and PA participation over the whole lifespan (Ekkekakis & Brand, 2021; Hyde et al., 2013).
All in all, the results of the conducted studies might, first, facilitate a better understanding of AAP and their role for exercise- and PA-related decisions. Second, the modification of the EP task to assess AAP seems a promising development of the original procedure, especially regarding younger participants. Overall, it was envisioned that the three presented publications as part of this dissertation may contribute to the further development of the field of exercise psychology regarding the theoretical framework of dual-process approaches and its assumptions about the influence of automaticity and affective experiences for exercise and PA motivation.

7.4 Implications

Future studies could possibly determine whether the findings obtained from these presented publications can be generalized to other types of exercise, to other populations (perhaps also individuals of older age), and to further clarify if and how automatic and reflective (affective) processes are related (Brand & Ekkekakis, 2018) or how they independently contribute to exercise and PA behavior (Brand & Schweizer, 2015; Phipps et al., 2021). In this context, future studies might benefit from including potential moderators like, for example, the socioeconomic status (Schüz et al., 2017). Manz et al. (2014) suggest, that the access to green spaces in residential areas in which a high proportion of people with low socio-economic status live is often impeded. In this way, the “fine differences” manifest themselves in a more complex inequality structure (Bourdieu, 1984; Nobis & Albert, 2018). This sociological approach highlights those vertical factors for PA commitment and exercise engagement are important in

childhood and act as the basis for further PA-behavior in adulthood. This is supported by a huge study by Guthold et al. (2020) who recognized that adolescents with higher socio-economic status had the tendency to be more physically active than those with a lower one. The authors suggest that this tendency could arise from the fact that they obtain more opportunities at school and in their communities for PA. In a further sense, if the access to exercise is also socially determined, AAP's may also be influenced by this, as they develop from past experiences with PA or exercise. Including potential moderators could, on the one hand, help to better understand, how, for whom and in which situations (Chevance et al., 2019, p. 271) are AAP associated with PA behavior. On the other hand, the relationship between automatic and reflective processes toward exercise or PA behavior itself could be more finely differentiated (Friese, Hofmann, & Schmitt, 2008). Furthermore, it might be of interest to examine whether indoor or outdoor settings (within one type of exercise) influence AAP (e.g., Blanchard et al., 2004; Turner & Stevinson, 2017). In general, future studies should include theoretical considerations about AAP in their theorizing to improve the output of interventions promoting PA or exercise behavior.

In addition, a methodological approach that uses different types of stimuli and compares them could help to improve measurement methods within dual-process approaches (Rebar, Schoeppe, et al., 2016). Additionally, as already mentioned, some research suggests that especially pictures can activate AAP and are more affectively proceeded (De Houwer & Hermans, 1994; Rawolle et al., 2017). Therefore, future studies could improve the utilized pictures building especially on the potential for specific types of exercise (Cope et al., 2018). Moreover, the last modified EP task version developed for the needs of children might be also suitable for the needs of persons of older age. To date, relatively little research focuses on older people and the impact of AAP on their PA behavior (e.g, Chevance et al., 2017). Additionally, other measurement techniques should be further developed and perhaps combined with indirect methods like the EP procedure to assess both the affective dimension of valence (pleasure – displeasure) and arousal (activation). For this purpose, the following parameters could be considered: pupil size or movement, general affective facial expressions or heart-rate variability (e.g., Alghowinem et al., 2013; Bradley et al., 2008; Koval et al., 2013; Kozlik & Neumann, 2017; Laeng et al., 2012) . These parameters are linked to core affective feelings and associated with activity patterns in the autonomic nervous system. For example, focusing on heart-variability, Schinkoeth et al. (2019) have shown that the somato-affective core of individuals' affective valuations of exercise (see assumption by the ART; Brand & Ekkekakis, 2018) can be captured using heart-rate variability analysis.

As our results indicate that affective experiences in general are key in guiding exercise behavior regardless of whether such processes are automatically driven or based on reflections, much more research focus should be placed on affective experiences of exercise

(Ekkekakis et al., 2018; Rhodes & Kates, 2015). At the very least, the more rational or cognitive models of PA or health behavior change should take into account the impact of positive as well as negative affective experiences on future behavior (Allen Catellier & Yang, 2013; Chen et al., 2020). Future studies should also examine whether improved affective experiences with exercise and PA can ultimately lead to increased and sustained exercise and PA participation (Maher et al., 2019; Rhodes & Nigg, 2011). Reports from physical education classes, for example, show contrary trends, according to Cardinal et al. (2013): “The finding that stands out is that being picked or chosen last for a team earlier in life is associated with a reduction of 7.7 exercise MET [exercise metabolic] units per week later in life” (p. 51). By now it should have become clear that “the traditional public health approach based on evidence and exhortation has - to some extent - been unsuccessful so far” (Hallal et al., 2012, p. 254) and that AAP are already present and correlated with PA at a very young age of 8-10 years. Therefore, I will end with the claim that it is of the utmost importance to improve positive affective PA experiences from the beginning of the human’s life.

Summary

Chapter 8

“Knowledge of and belief in the health benefits of physical activity may motivate initial involvement, but feelings of enjoyment and well-being seem to be stronger motives for continued [physical activity] participation”

(Dishman et al., 1985, p. 162).

8. Summary

Taking a closer look at affective responses to exercise- and PA-related stimuli (regardless of whether they are automatic or deliberative in nature) still represents an area of research on exercise or PA motivation that involves many open questions. From this starting point, the main aim of this dissertation was to provide new insights into AAP toward PA and exercise according to different types of exercise, and adults as well as to children. Based on ART's assumption, I focused on the type-1 process by establishing an EP task to assess APP. Furthermore, I related the automatic type-1 process to outcomes of the reflective (type-2) process. Besides the still small focus on the specificity of APP related to different types of exercise, the study on AAP toward PA in children was one of the first of its kind.

After giving an outline of the research program, I introduced in Chapter 2 how exercise motivation is generally described, on which theoretical assumptions exercise promotion is generally based and that physical inactivity is described as one of the biggest public health problems of the 21st century. In this context, I presented frameworks of PA behavior change with examples of popular theories and ended with the assumption that exercise psychologists are searching for a new pathway to explain these huge numbers of physically inactive individuals.

In Chapter 3, dual-process-theorizing is described as a post-cognitivist perspective on physical inactivity, exercise motivation and its promotion. First, it is outlined, how dual-process approaches in general, and the more specific exercise and physical (in-)activity related ART are evolved. Additionally, general assumptions of dual-process theories are given. Second, the ART is presented as the main theoretical framework of this dissertation. Third, AAP are introduced, which, in turn, are the variable of all presented publications as the main aim of this dissertation was to provide insights into AAP toward different types of exercise and PA in adults and children.

Chapter 4 focuses on indirect measures, which were most commonly used to assess AAP. Different kinds of indirect tests, such as the IAT or the AMP are presented, to then go into detail about the methodological approach of all three publications: the adapted EP task. The EP task was further developed and modified, so that it can also be understood visually. Chapter 5 presents my first publication. It expands the general finding that the greater the amount of exercise, the more positive AAP toward exercise (in this case toward running stimuli), and vice versa (Chevance et al., 2019; Schinkoeth & Antoniewicz, 2017). Importantly, based on assumptions by Antoniewicz and Brand (2014), the preferred type of exercise (in our case running) also accounts for differences in automatic affective processes toward running. In addition, according to the results of this study, it can be suggested that that reflective processes and AAP can independently contribute to exercise (i.e., running) behavior. Referring

now to the used indirect measurement instrument, the EP task (Fazio et al., 1986), the adapted version seems suitable to assess AAP toward running. On the other side, reliability was still relatively low (Cronbach's α = .58), which is why it is essential to improve the ratability of this specific indirect measure (e.g., Gawronski & De Houwer, 2014), and to improve the ratability of indirect measurement methods (e.g., Znanewitz et al., 2018). Overall, it represents a general claim that decisions for the use of any indirect measurement instrument should always be based on previously made theoretical and methodological considerations (De Houwer et al., 2009).

My second study represents an development and improvement of the first study (Limmeroth & Hagemann, 2020) and is dedicated to the degree of specificity of AAP regarding different types of exercise: exercising in fitness centers and mountain biking. The results indicate that AAP toward exercising in fitness centers can be differentiated between those, who perform fitness activities compared to those, who do not or only participate little in exercise activity. In contrast, AAP toward mountain biking resulted in a nonsignificant group difference. However, the tendency on a descriptive level was similar (active mountain bikers provided the most positive AAP toward mountain biking) with a smaller effect. Nevertheless, these results contribute to a better understanding of individual's choices for specific preferences for different types and settings of exercise. Furthermore, AAP and reflective processes were unrelated in this study as well, which adds to existing knowledge that both processes can independently influence exercise related decisions (e.g., Phipps et al., 2021). All in all, results underline that affective responses to exercise, whether automatically driven or reflexively accessible, are maybe the most important driving or restraining force for future exercise- and PA-behavioral decisions (Ekkekakis et al., 2020; Ekkekakis et al., 2018; Lewin, 1951). As already mentioned in the context of my first publication, the further adapted EP task seems a useful tool to assess AAP. But it also became clear that the stimulus set must be selected very precisely to adequately assess different types of exercise related to different exercise settings. Therefore, it is worth highlighting the need to carefully select the stimulus set, adapted to the appropriate design and to the appropriate sample (e.g., Zenko & Ekkekakis, 2019b).

Chapter 6 includes my last and third publication. After previously focusing on different types and settings of exercise, this study now aims to investigate AAP toward PA in a different, much younger sample, namely in children. This study marks one of the first of its kind in assessing AAP toward PA in children. The results indicate PA-related AAP are associated with children's PA behavior, as has previously been found in adults (Chevance et al., 2019). Furthermore, the following should be emphasized:

(1) The adapted EP procedure seems to be well suited to the needs of children.
(2) PA was objectively assessed by activity trackers over seven days, which is a methodical strength of this study (Matthews et al., 2012).

(3) In line with other studies, in this study less than 23% of the children met daily (minimum) step recommendations (Pereira da Silva et al., 2015).
(4) Compared to boys, girls are less physically active, in our study too (e.g., Kantanista et al., 2015).

For a better understanding of how and whether AAP toward PA are associated with the corresponding PA behavior already present in children and how important it is to foster positive affective experiences associated with PA during childhood, this study marks an important starting point for further research. In Chapter 7, the results of the studies conducted within this thesis were summed up and discussed. Furthermore, additional theoretical as well as methodological suggestions regarding AAP were proposed. In general, the conducted studies could lead to a better understanding of AAP and their role for exercise- and PA-related decisions. Additionally, the slightly modified EP tasks seem a promising pathway to assess AAP, especially regarding younger populations. Overall, the importance of making exercise and PA feel good is emphasized, and making this happen for as many people as possible is a major challenge both for research and practical implementations.

> “Perhaps we need to find a way to make doing the right thing ‘feel good’ [to the people]”
>
> (Shrank & Choudhry, 2012, p. 264).

References

Chapter 9

“Think before you speak. Read before you think”

(Lebowitz, 1979).

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