

Oxford Research Encyclopedia of Psychology

Theoretical Approaches to Physical Activity Promotion



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Subject: Health Psychology, Sport Psychology Online Publication Date: Dec 2018

DOI: 10.1093/acrefore/9780190236557.013.212

Summary and Keywords

Compelling evidence worldwide suggests that the number of physically inactive individuals is high, and it is increasing. Given that lack of physical activity has been linked to a number of physical and mental health problems, identifying sustainable, cost-effective, and scalable initiatives to increase physical activity has become a priority for researchers, health practitioners, and policymakers. One way to identify such initiatives is to use knowledge derived from psychological theories of motivation and behavior change. There is a plethora of such theories and models that describe a variety of cognitive, affective, and behavioral mechanisms that can target behavior at a conscious or an unconscious level. Such theories have been applied, with varying degrees of success, to inform exercise and physical activity interventions in different life settings (e.g., schools, hospitals, and workplaces) using both traditional (e.g., face-to-face counseling and printed material) and digital technology platforms (e.g., smartphone applications and customized websites). This work has offered important insights into how to create optimal motivational conditions, both within individuals and in the social environments in which they operate, to facilitate long-term engagement in exercise and physical activity. However, we need to identify overlap and synergies across different theoretical frameworks in an effort to develop more comprehensive, and at the same time more distinct, theoretical accounts of behavior change with reference to physical activity promotion. It is also important that researchers and practitioners utilize such theories in interdisciplinary research endeavors that take into account the enabling or restrictive role of cultural norms, the built environment, and national policies on physical activity.

Keywords: physical activity, exercise, motivation, behavior change, psychological theory

Introduction

A frequent distinction made in the sport and exercise science literature is between physical activity (PA) and exercise. PA refers to any movement carried out by skeletal muscles. In contrast, exercise is a type of PA which is structured, repetitive, and planned (e.g., attending an exercise class at a fitness center), with the explicit aim of improving fitness and health (Caspersen, Powell, & Christenson, 1985). In this article the term “PA” is used to refer to any type of movement by skeletal muscles that can potentially yield health benefits, if carried out regularly. The significant changes in technology, living environments (e.g., urbanization), and job options (e.g., office work) over the last few decades have had a profound impact on the levels of human PA. Population-level surveys of adult populations globally indicate that about a third (Hallal et al., 2012) or about a fourth (Sallis et al., 2016) of the global population does not meet physical activity recommendations (i.e., currently defined as not achieving 150 minutes of moderate-intensity activity or 75 minutes of vigorous-intensity activity per week, or equivalent combinations; World Health Organisation, 2010). Population-level estimates of PA are based on self-reports of PA which, more often than not, tend to under-report PA, when compared to more objective measures of PA, such as those obtained by accelerometers (Dyrstad, Hansen, Holme, & Andersen, 2014). Physical inactivity has been shown to increase the risk for a number of chronic diseases (e.g., type 2 diabetes, cardiovascular disease, osteoporosis, and different types of cancer) and mental health problems, with conservatively estimated healthcare costs of \$53.8 billion worldwide in 2013 (Ding et al., 2016).

Numerous health and professional organizations (e.g., World Health Organisation and American College of Sports Medicine), as well as government reports (e.g., U.K. Department of Health, 2011), have identified the need to reverse this decline in PA levels by developing interdisciplinary intervention strategies and policies. In the field of exercise psychology, researchers have investigated the potential utility of psychological theories of motivation and behavior change in promoting physical activity programs across the lifespan. Such programs have been implemented in diverse social contexts such as schools, rehabilitation clinics, workplaces, and community centers.

The purpose of this article is not to present a comprehensive list of all psychological theories and models used to understand and promote PA behavior; interested readers are referred to specialized textbooks (e.g., Biddle, Mutrie, & Gorely, 2013). Instead, this article aims to critically discuss, in a succinct fashion, some of the most widely utilized theories and models of PA promotion and to review their key constructs and applications in intervention research. The article reviews three such “popular” theories/models: self-determination theory, the transtheoretical model, and the theory of planned behavior. These theories/models have emerged as the top three approaches for studying exercise motivation in a bibliometric review study (Lindahl, Stenling, Lindwall, & Colliander, 2015). Of course, being a “popular” theory or model does not necessarily imply that such

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a theory/model is not without its criticisms and we outline some of these criticisms here. It is important to acknowledge that there are other widely used theories (e.g., social cognitive theory; Bandura, 2001) not reviewed here due to lack of space. We also do not review based on implicit/automatic factors (e.g., habits and priming effects) that regulate PA (see Rebar et al., 2017, for a review on this topic). This article also discusses some less frequently used (in the exercise psychology literature) theoretical frameworks (socioecological model, Behavior Change Wheel, and taxonomy of behavior change techniques) which provide more comprehensive views of the determinants of physical activity by moving beyond individual factors (conscious or automatic processes) and the social environment. We also examine the role of the physical environment and government or local authority policies for PA promotion.

Self-Determination Theory

Self-determination theory (SDT; Deci & Ryan, 1985; Ryan & Deci, 2017) has been widely used to study motivation for PA in survey designs, as well as to develop interventions for the promotion of PA. The theory emphasizes the importance of focusing not just on the quantity but also on the quality of motivation to engage in behaviors such as PA. Quantity of motivation is not necessarily beneficial as some types of motivation reflect internal and external pressures for behavioral engagement. Such pressures might result in a high quantity of motivation but low quality of support for long-term behavioral adherence and psychological well-being (Edmunds, Ntoumanis, & Duda, 2007).

The SDT literature identifies *three broad types of motivation*, namely, self-determined motivation, controlled motivation, and amotivation. Self-determined motivation is the only motivation that has high quality. It encompasses both intrinsic reasons that capture the enjoyment of performing an activity (e.g., “I love running”) and extrinsic reasons. The extrinsic reasons reflect high degrees of internalization of the value of the behavior and are termed “integrated regulation” (e.g., “I run because running is part of who I am”) and “identified regulation” (e.g., “I run to keep healthy and slim”). Controlled motivation encompasses extrinsic reasons that reflect a low degree of internalization of the value of the behavior. Such reasons are usually distinguished as being “introjected,” reflecting internal pressures and contingencies (e.g., “I need to run to feel good about myself”), and “external,” reflecting external pressures or rewards (e.g., “I run because my partner is pressuring me to lose weight”). Finally, amotivation reflects lack of either self-determined or controlled motivation for behavioral engagement (e.g., “I have started running but I don’t really know if it is worth continuing”).

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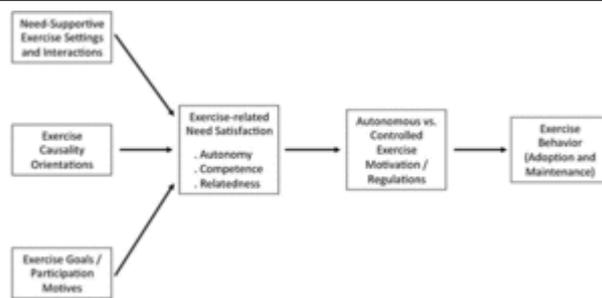


Figure 1. A graphical representation of SDT. Reproduced with permission from Teixeira, Carraca, Markland, Silva, and Ryan (2012).

According to Ryan and Deci (2017), self-determined motivation for behavioral engagement is more likely to be observed when individuals experience satisfaction of *three basic psychological needs*. These are the needs for autonomy (e.g., “I run of my own free will”), competence (e.g., “I am

good at running”), and relatedness (e.g., “I get along well with my running buddy”). In contrast, when such needs are frustrated, individuals are likely to develop controlled or amotivated reasons for behavioral engagement. A central tenet of SDT is that the social environment is a key factor in *supporting or thwarting* individuals’ *psychological needs* and, hence, promoting self-determined motivation for PA. Finally, the SDT literature has also shown that the content of individuals’ goals matter in terms of supporting versus frustrating the three psychological needs. *Intrinsic goal content* (e.g., health and affiliation) relative to *extrinsic goal content* (e.g., image and social recognition) is more likely to satisfy the three basic psychological needs (Sebire, Standage, & Vansteenkiste, 2009). For a graphic representation of the main components of SDT, as applied to PA, see Figure 1.

Applications

Teixeira et al. (2012) conducted a systematic review of the literature that has applied SDT to study motivation for PA. Sixty-six studies (72 independent samples) were included in the review, primarily cross-sectional, although the number of experimental studies in this field has substantially increased since then. The review showed that self-determined forms of motivation were positive predictors of PA. Teixeira et al. suggested that identified regulation might be more important for initiating a new exercise program whereas intrinsic motivation might be more instrumental for long-term adherence. However, there was no strong empirical evidence base for this hypothesis, which needs testing in future research. Controlled forms of motivation were primarily unrelated to PA; there were studies demonstrating that introjected regulation positively predicted PA cross-sectionally but not over time, suggesting that this type of motivation is not conducive to long-term PA adherence. In addition, there are some psychological costs (e.g., lower quality of life and higher anxiety) associated with being motivated by introjected regulation. Amotivation was either unrelated or negatively related to PA. With regard to the three psychological needs put forward by SDT, competence was the most consistent correlate of PA. Lastly, intrinsic goals were consistently associated with higher

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PA, whereas the findings pertaining to extrinsic goals and PA were mixed. The findings of survey and experimental studies were comparable.

Experimental research applying SDT principles to promote PA has primarily focused on the interpersonal style used by individuals in position of authority and expertise (e.g., physiotherapists, fitness instructors, physical education teachers, and healthcare professionals) when communicating with individuals they seek to motivate. Training programs typically aim to enhance need-supportive communication and minimize the use of need-thwarting statements or behaviors. Examples of such programs include intervention research with physical education teachers (Reeve & Cheon, 2014), physiotherapists (Murray et al., 2015), and exercise professionals (Ntoumanis, Thøgersen-Ntoumani, Quested, & Hancox, 2017). For example, see the Ntoumanis et al. study in which fitness instructors were trained in utilizing more frequently and consistently 10 need-supportive motivational strategies, and avoid using 10 need-thwarting strategies. Table 1 presents these strategies.

Table 1. The LARS and PEAS Motivational Strategies

Category	Motivational Strategy
Motivationally Adaptive Strategies (LARS)	
L istening to your participants	Taking time to listen and be responsive to your participants' needs
	Encouraging questions and feedback from your participants about their goals, problems, or preferences
A dvising your participants	Giving meaningful and appropriate explanations
	Giving specific and constructive feedback
	Using inclusive language (e.g., "we could try . . .")
R elating to your participants	Acknowledging the participants' feelings and responding appropriately
	Offering meaningful praise which is unconditional
S tructuring your class	Creating opportunities for participants to have input and make decisions about the workout

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	Offering choice and variety which are realistic and relevant to your participants' needs
	Finding opportunities to interact with all participants
Motivationally Maladaptive Strategies (PEAS)	
<u>P</u>ressuring language	Using commands and directives ("must," "should," "need you to") or inducing guilt and shame
	Criticizing, belittling, devaluing, or dismissing participants
<u>E</u>mpy communication	Imposing goals and rules with no explanations, or explanations which are confusing, inappropriate, or pressuring
	Offering no specific feedback/praise, or talking in ways that are motivationally "empty" (e.g., "keep going")
<u>A</u>ppearing "cold"	Appearing cold and indifferent to your participants' positive and negative feelings; appearing to talk to a "camera"
	Appearing unresponsive to or discouraging your participants' preferences, opinions, and feedback
	Using "no pain-no gain" language
<u>S</u>tructuring your class	Offering little variety and/or choices that are not meaningful
	Not mixing with your participants
	Comparing participants against each other or being overly competitive

Hancox, Quested, Ntoumanis, and Thøgersen-Ntoumani (2018) provide a detailed description of the application of these strategies and the feedback received by the trained instructors. Face-to-face workshops in this intervention were complemented by rich narrative descriptions of each of the recommended communication strategies, personal action planning sheets for strategy implementation, and self-reflection diaries outlining successes and failures in these implementation attempts. A Facebook page was utilized to provide additional resources (e.g., video clips), information (e.g., further ideas regarding how the strategies could be implemented), support (e.g., responses to questions and difficulties faced by the instructors), and discussion (e.g., between instructors regarding

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their experiences and/or with the research team) throughout the intervention period. Results reported by Ntoumanis et al. (2017) indicated increases over time in exercisers' perceptions of their instructor's need-supportive strategies, psychological need satisfaction, and intentions to remain in the class. Further, trained instructors reported being less controlling and experiencing more need satisfaction over time. Ng et al. (2012) conducted a meta-analysis of correlational and experimental studies in the health domain that have used SDT as a theoretical framework. The meta-analysis showed positive associations between leaders' need-supportive communication style and individuals' levels of psychological need satisfaction and mental health (e.g., depression and quality of life) and correlates of physical health (e.g., exercise and healthy diet).

Critical Considerations

Ntoumanis, Quested, Reeve, and Cheon (2018) have outlined a number of concerns regarding the way in which researchers have applied SDT in the PA domain, as well as more general concerns regarding moderators of effectiveness of SDT training. One frequent problem identified in the Ntoumanis et al. review was the absence of sufficient detail in terms of how key SDT components have been operationalized in different interventions, thus hampering replication attempts. In addition, different SDT studies have manipulated different constellations of need-supportive and need-thwarting behaviors, making comparisons across studies difficult. Further problems have been the lack of systematic process evaluations to ascertain the content, fidelity to the theory (cf. Quested, Ntoumanis, Thøgersen-Ntoumani, Hagger, & Hancox, 2017), and consistency in the training of individuals to adopt a SDT-based style of communication.

Ntoumanis et al. (2018) also suggested that a challenge faced when providing need-supportive communication training is that some individuals have personality dispositions and beliefs about motivating style that are more aligned with a controlling/need-thwarting style of interaction. These individuals believe that need-supportive communication is ineffective, idealistic, impractical, and too time-consuming; hence they are less receptive to SDT interventions (and probably unlikely to volunteer to participate in such programs in the first place). A related challenge is that in some cultures a need-supportive communication style is viewed as a non-normative approach to motivating and communicating with others. This is especially true for individuals in a position of authority who are expected to appear in control and not in need of others' input. Time constraints, practical constraints when working with large groups, and pressures from management can also limit the degree to which individuals are prepared to apply need-supportive communication. The Ntoumanis et al. review discusses solutions to these and other challenges in applying SDT to promote PA.

From a conceptual standpoint, SDT does not examine proximal or automatic predictors of behavior or how the broader context (physical environment, policies) shapes motivation for PA. Efforts have been made to link SDT with other theoretical frameworks that propose more proximal predictors of PA behavior than SDT does, including behavioral

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intentions and non-conscious predictors such as implicit attitudes and implicit motivation (Hagger & Chatzisarantis, 2014). Additional efforts exist that aim to link the personal and social environment factors put forward by SDT with natural environment characteristics (e.g., neighborhood safety, access to facilities; Gay, Saunders, & Dowda, 2011).

The Theory of Planned Behavior

The theory of planned behavior (TPB) is one of the most influential theories used to predict and explain PA participation (Ajzen, 1991). According to this theory, participation in physical activity is a function of a person's intention (Figure 2). This construct indicates how much effort people plan to exert in their performance of behavior. Intention is, in turn, a function of three variables: attitudes, subjective norms, and perceptions of control. Attitudes represent an overall positive or negative evaluation toward a behavior (Ajzen & Fishbein, 1980). Subjective norms represent perceived influences that significant others, such as parents, peers, or teachers, may exert on the execution of behavior. Perceived behavioral control refers to general perceptions of control, and it is similar to Bandura's (2001) construct of self-efficacy. The TPB also suggests that when perceptions of control are realistic, perceived behavioral control will predict PA behavior directly alongside intentions (Ajzen, 1991).

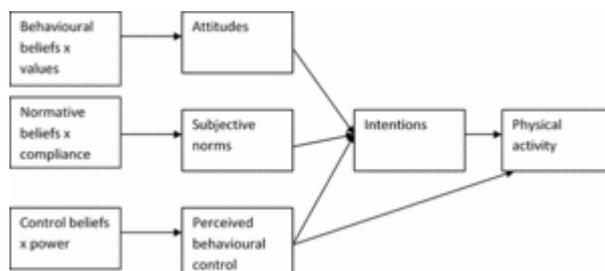


Figure 2. The theory of planned behavior.

The TPB also outlines the antecedents of attitudes, subjective norms, and perceptions of control. It proposes that attitudes arise out of a combination (in a multiplicative function) of beliefs that behavior will lead to certain outcomes

(behavioral beliefs) and the subjective evaluation of these outcomes (Ajzen & Fishbein, 1980). Similarly, the origins of subjective norms can be traced to a combination of normative beliefs on whether important referent individuals or groups approve or disapprove of the behavior, and a motivation to comply with these referent groups (Ajzen, 1991; Ajzen & Fishbein, 1980). Finally, perceived behavioral control is determined by a combination of control beliefs that refer to the perceived frequency of the presence of factors that may facilitate or impede performance of , and the perceived impact that these factors may have on behavior.

Applications

The TPB has been tested in numerous studies to understand participation in sports, leisure-time PA, or exercise (Hagger, Chatzisarantis, & Biddle, 2002A). In a meta-analysis of studies employing this theory, Hagger et al. reported a medium effect size between intentions and PA participation. The effect of perceived behavioral control was smaller than the corresponding effect of intentions. Additionally, Hagger et al. showed that whereas attitudes and perceptions of control consistently predicted intentions, the effect of subjective norms on intentions varied considerably across studies. Broadly speaking, empirical evidence suggests that subjective norms are more likely to predict the PA intentions of younger rather than older populations (see also Hausenblas, Carron, & Mack, 1997).

The TPB has been supported, in part, by a number of interventions that aimed to foster PA participation by changing individuals' attitudes, subjective norms, or perceptions of control. According to this theory, practitioners can facilitate positive attitudes, subjective norms, or perceptions of control through persuasive messages that change behavioral beliefs, normative beliefs, or control beliefs. In a meta-analysis of 47 experimental studies on PA and other behaviors, Webb and Sheeran (2006) documented that medium to large changes in intentions led to small to medium changes in behavior. However, interventions based on this theory have not always been successful in changing PA. For example, Chatzisarantis and Hagger (2005) showed that although an intervention that targeted attitudes was successful in changing PA intentions, it was not successful in motivating actual participation in PA. Such findings have led some researchers to question the utility of TPB (Sniehotta, Penseau, & Araujo-Soares, 2014).

Critical Considerations

In introducing the TPB, Ajzen (1991) proposed that the theory is sufficient in capturing the most immediate determinants of behavior, and that more distal determinants of behavior are background factors that influence intentions and behavior through their impact on behavioral, normative, and control beliefs. However, one clear conclusion that emerges from previous research is that the theory does not account for all determinants of intentions and behavior (Sniehotta et al., 2014). For example, Rhodes, Courneya, and Hayduk (2002) showed that personality traits such as extraversion and conscientiousness predicted intentions and PA participation, after components of the TPB were taken into consideration. As a consequence, researchers have proposed extensions and modifications to the theory that can assist in further explaining the formation of intentions and behavior. Ajzen (1991) posits that the TPB is open to additional predictors if they are shown to capture a significant portion of variance in intentions or behavior after taking the theory's current variables into account.

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As an example, one limitation of the TPB is that it assumes that intentions are formed on the basis of deliberative processes that involve a careful consideration of costs and benefits associated with PA participation (Fazio, 1990). However, in real-life settings, intentions may be formed on the basis of habitual or more automatic processes that involve the employment of simple rules (heuristics) that individuals develop through past experience and observation (Bargh, 1994). Additionally, habitual processes may involve implicit attitudes or motives, even outside awareness, that predispose individuals to engage in PA (Hagger & Chatzisarantis, 2014). In accordance with the proposition that habitual processes motivate PA participation, a number of studies have documented that, after taking the theory's current variables into account, measures of habit strength predict a substantial amount of variance in PA intentions and behavior (e.g., Hagger, Chatzisarantis, & Biddle, 2002B).

Another limitation of the TPB is related to processes that underpin the translation of intentions into action. Specifically, a number of researchers have suggested that the TPB is a motivational theory in that it explains how intentions are formed or change (Gollwitzer, 1999). However, the TPB does not explain volitional processes that indicate how people carry out their previously formed intentions. For example, people often forget to engage in PA or they may temporarily refrain from PA participation because other competing goal-behaviors gain priority over PA (Verplanken & Faes, 1999). These more specific processes that underpin the translation of intentions into action are not captured by the TPB, and for this reason a number of researchers have tested whether particular forms of planning, such as implementation intentions, assist individuals in acting upon their PA intentions.

Implementation intentions are a self-regulatory strategy that involves the formulation of specific plans that specify when, how, and where the performance of behavior will take place (Gollwitzer, 1999). In accordance with the proposition that implementation intentions promote enactment of behavioral intentions, research has indicated that individuals who form implementation intentions are more likely to engage in physical activities than individuals who did not form implementation intentions (Chatzisarantis, Hagger, & Thøgersen-Ntoumani, 2008). Importantly, a number of studies have documented that implementation intentions increase behavioral engagement through automatic mechanisms, and not by concomitant increases in motivation or intention (Orbell, Hodgkins, & Sheeran, 1997). That said, evidence also suggests that implementation intentions are more likely to increase behavioral engagement among individuals who already express strong, rather than weak, intentions to engage in physical activities (Sheeran & Silverman, 2003).

Another criticism of the TPB focuses on the construct of subjective norms and its utility in capturing social influence. In particular, a number of researchers have suggested that one reason for which studies do not *always* observe effects of subjective norms on intentions may be owed to the fact that subjective norms insufficiently capture social influences. Several studies have shown that descriptive norms, a construct that aims to indicate the extent to which significant others are actually engaging in social behavior,

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exert a unique effect on intentions independent of the traditional subjective norms (Grube, Morgan, & McGree, 1986). Likewise, it has been argued that social support, a construct that indicates the extent to which significant others are perceived to assist performance of behavior, can also exert unique effects on intentions (Rhodes, Jones, & Courneya, 2002). Moreover, Theodorakis (1994) documented that self-identity, a construct that aimed to capture individuals' tendency to view themselves as exercisers, predicted PA intentions and PA participation, after the effects from the components of the TPB were taken into consideration.

Another key modification of the TPB is related to attitude structure and its role in the attitude-behavior relationship. A number of researchers have argued that individuals' evaluations can be differentiated into affective evaluations that indicate the extent to which people think that PA is enjoyable or interesting (Bagozzi, 1982). However, attitudes and evaluations can also have an instrumental component that indicates the extent to which individuals believe PA to be personally useful and important (Hagger & Chatzisarantis, 2005). This distinction is meaningful because although PA may not be perceived to be interesting or enjoyable, it may nevertheless be perceived as useful in a sense that it brings health benefits. In accordance with the distinction between affective and instrumental attitudes, studies have shown that the affective, but not the instrumental, component of attitudes exerted direct effects on PA participation, after taking into consideration components of the TPB and past behavior (Hagger & Chatzisarantis, 2005).

An issue that deserves attention in future research concerns the conceptual overlap between additional variables. Arguably, some psychological variables that have been incorporated within the TPB are similar. For example, the constructs of social support, descriptive norms, and self-identity are similar given that these constructs aim to capture different forms of social influence. Conceptual overlap between constructs raises in turn an important practical question, namely, the degree to which manipulations implied by different psychological constructs overlap. For example, it is difficult to justify how interventions that target affective attitudes would not have an effect on instrumental attitudes or vice versa.

Finally, individuals cannot simultaneously process large amounts of information. As a consequence, the practice of adding new variables within the TPB may provide an unrealistic picture of decision-making processes because extended models imply that people can process different pieces of information at the same time. A case in point is an intervention by Chatzisarantis, Kamarova, Kawabata, Wang, and Hagger (2015) which showed that a program that targeted perceptions of control was more successful in promoting PA than a program designed to change perceptions of control and attitudes. Therefore, it may also be important for future research to examine which particular combinations of additional variables yield the most optimal levels of PA participation.

Transtheoretical Model of Behavior Change

As the name suggests, the transtheoretical model of behavior change (TTM; Prochaska & Marcus, 1994) is an integration of different theories emanating from the fields of psychotherapy and behavior change. The TTM is sometimes referred to as the stages of change model, although this is rather misleading given that these stages represent one of the several components in the model.

The TTM is a widely researched theoretical framework in the PA domain. It proposes that individuals go through a series of stages from behavioral adoption to behavioral maintenance. These stages are labeled pre-contemplation, contemplation, preparation, action, and maintenance. The pre-contemplation stage is a non-intentional stage insofar as individuals in this stage are unwilling to change their behaviors. In the contemplation stage individuals are starting to *consider* making behavioral changes, but they have yet to take any action. The preparation stage is a true intentional stage, wherein individuals have made a clear plan (e.g., to be physically active) and have started to make changes in their PA levels. Individuals reach the action stage when they have engaged in the behavior regularly for up to six months. In the maintenance stage, individuals have been regularly performing the behavior for six months or more. There is general agreement that the movement across stages is not linear but cyclical, in that individuals move back and forth between these stages in their attempts to become regularly physically active. Adam and White (2003, p. 238) present a schematic diagram of the TTM.

The TTM outlines a range of mechanisms that can be used to move individuals through the stages. These mechanisms are called processes of change and constitute another important component of the TTM, in addition to the stages of change. Processes of change can be broadly grouped as experiential or behavioral in nature. Broadly speaking, experiential processes are those that target cognitions or thought processes, while behavioral processes aim to directly modify behavior. An overview of these processes and examples of strategies illustrating each process can be found in Table 2, taken from Romain, Attalin, Sultan, Boegner, Gernigon, and Avignon (2014).

Table 2. Process of Change from the Transtheoretical Model

Processes of Change	Description	Examples of Strategies
Consciousness raising	Efforts by the individual to look for information to better understand the problematic behavior	Provide information about physical activity and its benefits and risks related to inactivity

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Dramatic relief	Affective aspects of behavior change	Provide feedback about the consequences; playing role
Self-reevaluation	Cognitive or emotional appraisal of the impact of the behavior on the individual	Clarify values regarding the individual and the problematic behavior
Environmental reevaluation	Impact of the (negative or positive) behavior on the individual's social and physical environment	Encourage thoughts about how the behavior can affect the individual's life and how it can be further modified
Social liberation	Recognition that actual social norms encourage individual to move toward healthier life	Make the individual realize the different public health campaigns Show alternatives and opportunities to the problematic behavior
Self-liberation	Making a commitment to change and believing in this commitment	Strategies of goal fixation: Create plan about physical activity
Helping relationships	Using the support of caring others (family, friends, doctor) to modify the behavior	Ask individuals to enlist persons that can encourage and support the practice of physical activity
Counterconditioning	Substituting the behavior for another healthier behavior	Identify the situation that led to sedentarity and the different scenarios that can be established to include physical activity
Reinforcement management	Using reinforcement and reward to continually reinforce the positive behavior	Establish a reward list with each attained goal of physical activity
Stimulus control	Modifying the environment to encourage the positive behavior	Hang some pictures or message that can encourage practicing physical activity

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There is some evidence (e.g., Romain et al., 2014) suggesting that cognitive processes of change are most relevant for early stages of PA behavior change, and that the behavioral processes become increasingly important during the latter stages of behavior change.

In addition to the stages and processes of change, the TTM also considers the roles of decision balance and self-efficacy as relevant to the behavior change processes. Decision balance refers to weighing up the pros and cons of behavior change (Velicer, DiClemente, Prochaska, & Brandenburg, 1985). According to the TTM, this construct is most relevant during the first three stages of change as the individual considers whether or not to take part in the behavior. Self-efficacy for the behavior (i.e., confidence to achieve certain outcomes) is assumed to be low at the first few stages of change, and increasing linearly as a result of progression through the stages (Prochaska & Marcus, 1994).

Applications

Marshall and Biddle (2001) meta-analyzed studies ($k = 71$) that applied the TTM in the PA domain. The results showed that, in support of theoretical propositions, the stages of change were associated with different levels of PA, self-efficacy, and perceived pros and cons of the behavior. However, the review could not definitively conclude whether the behaviors occur in distinct series of stages. Additionally, while participants tended to use most processes of change to modify their behavior, the pattern of process use across the stages was not distinct by stage, thus suggesting a lack of support for the proposed stage-by-process process interactions.

Hutchison, Breckon, and Johnston (2009) conducted a systematic review of intervention-only studies ($k = 34$). The authors concluded that the majority of those studies did not consider all relevant components of the TTM (only 29% of studies included all four components). When the authors compared the effects of studies that did include all components and those that did not, they found similar short-term effects, with a lack of evidence demonstrating any long-term effects of the interventions. This precluded definitive conclusions regarding the efficacy of the TTM (and its components) in changing PA behavior.

Probably the most stringent test on the efficacy of TTM-based interventions involves randomized control trials (RCTs) which have compared interventions with material matched to individuals' stages of change versus interventions in which material given to participants was not matched to their stage of change. Romain et al. (2018) undertook a meta-analysis of such RCTs ($k = 33$) and their effects on PA levels. The meta-analysis revealed that regardless of whether or not the interventions were customized to participants' stages of change, there was a significant effect of TTM interventions on PA behavior ($d = .36$ for targeted approaches; $d = .23$ for non-targeted interventions). This finding suggests that the stages of change construct might not be the best construct to target when developing interventions designed to increase PA levels. However, the meta-analysis also revealed that processes of change and self-efficacy moderated the

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intervention effects, such that those interventions that addressed these constructs were most effective; this finding provides support for the TTM. Importantly, Romain et al. also concluded that approximately half of the studies included in the meta-analysis were “TTM-inspired” rather than truly TTM-driven. For an optimal test of the TTM as a theoretical framework, it is critical that researchers implementing future interventions include all constructs from the model, and that they carry out tests of intervention fidelity to the TTM.

To evaluate the efficacy of the TTM in changing PA behavior, it is useful to consider how the TTM compares to other key behavior change theories. In a meta-analysis of RCTs ($k = 82$), Gourlan et al. (2015) compared the efficacy of TTM to that of other well-established theories, including the theory of planned behavior and self-determination theory (both reviewed in this article). Gourlan et al. found no differences in terms of the efficacy of interventions based on those theories to change PA behavior. This finding suggests that the TTM might be *as useful as* other widely applied theories of behavior change to promote PA.

Critical Considerations

There are several articles criticizing the TTM (e.g., Armitage, 2009; Nigg et al., 2011), but this article has summarized only some of the limitations discussed in the literature. One limitation of the TTM literature is that the algorithms that have been developed to categorize individuals into different stages have not been validated. In addition, the majority of studies have not employed the full range of TTM constructs and/or have been cross-sectional in nature. Further, in terms of outcome assessments, only two studies (of 33) identified in the meta-analysis by Romain et al. (2018) included objective measures of PA as an outcome measure. It is well established that self-reported measures tend to overestimate levels of PA (Dyrstad et al., 2014). These limitations of existing research preclude firm conclusions regarding the efficacy of the TTM in the promotion of PA. Another criticism relates to the model itself (rather than the research which has tested it), albeit this limitation applies to many other behavioral theories. Specifically, Adams and White (2004) argued that TTM does not address key variables that predict stages of change, such as factors external to the individual (e.g., the physical environment). Supporting this argument, Thøgersen-Ntoumani (2009; $n = 318$ older adults) employed an ecological model (consisting of a range of personal, psychosocial, and physical environmental variables) which revealed that many constructs not covered by the TTM (including perceptions of health, number of friends exercising, and seeing others exercising in the neighborhood) significantly predicted stages of change.

Social Ecological Model

Most theories of PA focus on the importance of individual characteristics for changing behavior and, in some cases (e.g., SDT and TPB), on individuals' immediate social environment. However, social ecological models (SEM) take a broader approach in that they propose that behavior is the result of interactions between individual characteristics (e.g., age, gender, body mass index, and employment status), the social environment (e.g., family or peer social support and social norms), the physical environment (e.g., weather, attributes of the physical environment such as green space, and safety), and aspects of the macro-environment, in particular policy (e.g., urban planning policies, workplace policies, and active transport policies). See Figure 3 for a graphic illustration of SEM.

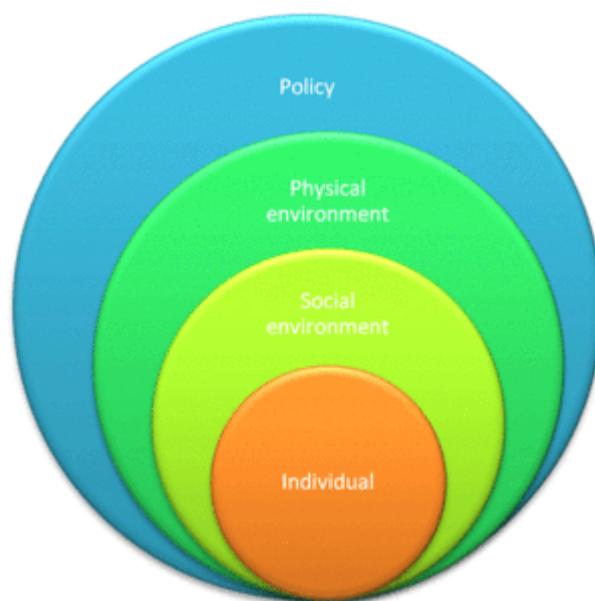


Figure 3. Overview of social ecological models.

SEM is rooted in Brofenbrenner's (1979) ecological systems theory, the ecological model of health behaviors (McLeroy et al., 1988), and the social ecology model of health promotion (Stokols, 1992). Common to these theories and frameworks is the assumption that behavior needs to be understood in light of environmental and societal constraints and enablers. As an example, a woman may have a favorable attitude and intention to exercise (e.g.,

she recognizes the health benefits of being active and is inclined to participate), and her husband is supportive of her doing it. Although she has a job, her income is limited (so she cannot afford to attend a gym) and her workplace lacks a policy designed to support the health and well-being of its staff. She also lives in a crime-infested neighborhood with limited green space. As a result, she is worried about exercising in her neighborhood and feels that the immediate risks of being active in her neighborhood (especially in the evening when she does have time to exercise) outweigh any potential benefits. This example illustrates how obstacles in the physical and workplace policy environment affect decisions to be physically active despite favorable individual motivation. At the same time, it is important to note that the SEM approach acknowledges that it is not sufficient to implement the right policies (e.g., providing options for PA breaks in the workplace) to

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change behavior if individuals are not motivated or do not intend to change their behavior (i.e., it is not a case of “build it and they will come”).

Applications

Evidence suggests that a supportive physical environment can predict engagement in PA (e.g., Humpel, Owen, & Leslie, 2003; McGrath, Hopkins, & Hinckson, 2015; Wang, Chau, Ng, & Leung, 2016; Yang, Griffin, Khaw, Wareham, & Panter, 2017), although a review conducted with studies ($k = 31$) including older adults revealed a lack of significant associations between a range of environmental characteristics and PA (Van Cauwenberg et al., 2011). However, others suggest that multiple components from the SEM rather than the consideration of single layers of influence are better able to explain PA behavior (Brownson, Hoehner, Day, Forsyth, & Sallis, 2009; Spence & Lee, 2003). Indeed, as examples, in a relatively large ($n = 1,803$) cross-sectional study, Giles-Corti and Donovan (2002) examined the relative influence of individual, social, and physical environmental determinants of PA. They found that all levels of influence were important predictors of behavior, although the individual (in particular) and social variables were more powerful predictors of self-reported behavior. A more recent large observational study with older adults ($n = 726$) showed that indicators of all levels of the SEM were associated with objectively assessed PA (Thornton et al., 2017). Specifically, Thornton et al. examined whether built environment characteristics (e.g., mixed land use and intersection density), which was objectively assessed using geographic information systems, added to the explanation of objectively assessed PA above and beyond individual (e.g., demographics) and psychosocial variables (e.g., self-efficacy and social support). For moderate-to-vigorous physical activity (MVPA), only one environmental characteristic (proximity to a park) was a significant predictor, but further environmental characteristics were important predictors of walking behavior.

The majority of studies to date that have employed the SEM have tended to select psychosocial variables without any theoretical justification. However, there are some exceptions. A limited range of studies has specifically focused on integrating aspects of SEM with other theories of behavior change. Rhodes, Brown, and McIntyre (2006) examined how perceptions of the neighborhood environment interacted with TPB variables in the prediction of walking in Canadian adults. Results revealed that attitudes (affective and instrumental) mediated associations between retail land mix use plus neighborhood esthetics and walking. Moderation analyses also showed that the intention-behavior relationship was strengthened for individuals who had closer access to recreational facilities. Gay et al. (2011) considered how the association between exercise behavior and psychological need satisfaction (derived from SDT) may be moderated by perceptions of the built environment. Using a cross-sectional survey design and a sample of adults undergoing a weight loss program, the authors found that positive perceptions of neighborhood characteristics and convenience strengthened the positive association between psychological need satisfaction and self-reported PA. D'Angelo, Fowler, Nebeling, and Oh (2017) examined how variables from both TPB and SDT interacted with perceptions of the neighborhood environment in the prediction of self-reported minutes of MVPA in a national sample of adolescents. They found that some neighborhood features supportive of PA strengthened the associations between TPB variables with MVPA, and

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between autonomous plus controlled motivation with MVPA. Finally, in one of the few studies that has examined the interaction between psychosocial constructs and environmental variables in the context of a randomized controlled trial, Merom et al. (2009) showed that motivational variables derived from social cognitive theory (Bandura, 2001) could override the effects of an unsupportive physical environment in their prediction of walking.

Critical Considerations

The majority of studies that have examined the role of SEM in relation to exercise and PA have been cross-sectional. This precludes any definitive answers about the direction of causality between the layers of influence and the behavior. In other words, just as it is possible that the layers of influence determine how much PA is undertaken by individuals, it is equally possible that people who are more physically active perceive the influences differently (i.e., more supportive) *because* they are active. This possibility is fairly plausible as most studies to date have employed self-reported measures of the environment. The reliance on self-reported measures of PA also undermines the quality of research in this area. Further, while some studies have selected psychosocial variables from established motivation theories, such as TPB and SDT, when employing SEM, the majority of studies have used a degree of randomness in the selection of individual-level variables. A more systematic approach in variable selection is essential for providing a clear structure for the design, implementation, and evaluation of interventions. Finally and critically, there is also a lack of RCTs employing SEM to increase PA. This limits any firm conclusions about the effects of each layer of influence, and their interactions, on PA. The lack of RCTs is most likely due to the difficulty in manipulating the policy and physical environment. Leveraging opportunities to conduct research in the context of “natural experiments” (e.g., where changes to the physical environment are made to address new policy) may be a useful starting point. For example, Dobbinson et al. (2017) discussed the impact of park refurbishments on park-based PA.

The Behavior Change Wheel and Taxonomy of Behavior Change Techniques

In order to improve the number of interventions that are effective, and to increase the rate of translating research into practice, Michie and colleagues (Michie, Atkins, & West, 2014; Michie & Johnston, 2013; Michie et al., 2013; Michie, van Stralen, & West, 2011) created a set of practices and resources intended to encourage and facilitate a more systematic and rationalized approach to the design and reporting of interventions. This body of work included a more systematic approach to identifying (from a comprehensive range of available options) the type of intervention that might be expected to be effective for the targeted population, behavior, and context (i.e., the Behavior Change Wheel). It

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also led to the creation of a taxonomy of specific intervention components that act as mechanisms in the process of change (i.e., the taxonomy of behavior change techniques; BCTs).

The Behavior Change Wheel was designed with the intention of creating a comprehensive framework that could be used to characterize interventions that have been developed or could be created in the future (Michie, van Stralen, et al., 2011). Michie and colleagues used a three-layered wheel to represent the framework, including policy categories (base layer), intervention functions (mid layer), and sources of behavior (top layer) (see Figure 4).

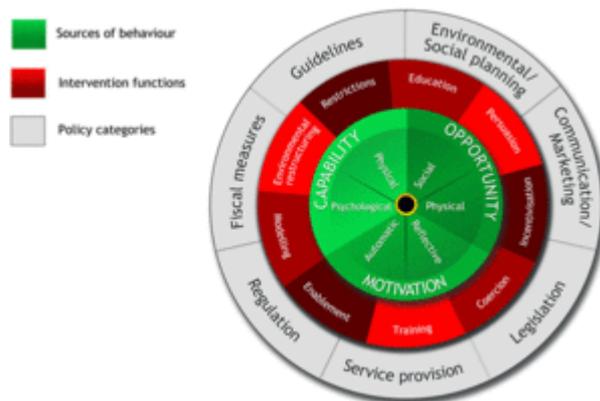


Figure 4. The Behaviour Change Wheel. Reprinted with permission from Michie et al. (2013).

This form of representation aims to illustrate that the components in the model are not hypothesized to interact in a linear function. Rather, components interact within layers (e.g., intervention functions of training would interact with enablement), whereas the layers can only interact with the neighboring layer

(e.g., policy categories can only influence behavior via the intervention functions). It was also intended that the specified categories in the wheel's three-layer framework should be relatively similar with regard to their specificity and type. Importantly, the categories specified in the framework are intended to be comprehensive, to be coherent, and to link to a model of human behavior (Michie, van Stralen, et al., 2011).

The behavior system central to the wheel is known as COM-B, and this hub of the wheel is helpful in identifying what the problem is, or in other words, what must be targeted to lead to behavior change. In relation to exercise interventions, COM-B represents the interaction between an individual's Capability (i.e., physical and psychological capacity to perform the exercise behaviors), Opportunity (i.e., external factors that may influence or prompt engagement in exercise behavior), and Motivation (i.e., all brain processes relevant to the degree to which the individual directs and energizes exercise behavior) resulting in the targeted exercise Behavior (Michie et al., 2014). When designing exercise interventions, researchers can identify which one (or more) of the three components (capability, opportunity, or motivation) needs to be targeted to result in behavioral change, and this can form the basis of intervention design.

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The intermediary layer of the wheel includes nine intervention functions from which the researcher can select the most appropriate approaches to target the issues identified in COM-B. The seven policy categories in the outer layer describe a range of policy-level changes that authorities would need to make in order to enable the intervention functions, and as such, they target organizational or population change. See Table 3, taken from Michie, van Stralen, et al. (2011). Thus, although this theoretical approach considers the role of motivational factors in terms of exercise behavior, it also identifies a broader range of enabling or constraining factors that can affect behavior change.

Table 3. Interventions and Policies in the COM-B Model

Interventions	Definition	Examples
Education	Increasing knowledge or understanding	Providing information to promote healthy eating
Persuasion	Using communication to induce positive or negative feelings or stimulate action	Using imagery to motivate increases in physical activity
Incentivization	Creating expectation of reward	Using prize draws to induce attempts to stop smoking
Coercion	Creating expectation of punishment or cost	Raising the financial cost to reduce excessive alcohol consumption
Training	Imparting skills	Providing advanced driver training to increase safe driving
Restriction	Using rules to reduce the opportunity to engage in the target behavior (or to increase the target behavior by reducing the opportunity to engage in competing behaviors)	Prohibiting sales of solvents to people under 18 to reduce use for intoxication
Environmental restructuring	Changing the physical or social context	Providing on-screen prompts for GPs to ask about smoking behavior

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Modeling	Providing an example for people to aspire to or imitate	Using TV drama scenes involving safe-sex practices to increase condom use
Enablement	Increasing means/reducing barriers to increase capability or opportunity	Offering behavioral support for smoking cessation, medication for cognitive deficits, surgery to reduce obesity, prostheses to promote physical activity
Policies		
Communication/ marketing	Using print, electronic, telephonic or broadcast media	Conducting mass media campaigns
Guidelines	Creating documents that recommend or mandate practice This includes all changes to service provision	Producing and disseminating treatment protocols
Fiscal	Using the tax system to reduce or increase the financial cost	Increasing duty or increasing anti-smuggling activities
Regulation	Establishing rules or principles of behavior or practice	Establishing voluntary agreements on advertising
Legislation	Making or changing laws	Prohibiting sale or use
Environmental/ social planning	Designing and/or controlling the physical or social environment	Using town planning
Service provision	Delivering a service	Establishing support services in workplaces, communities, etc.

Note: (*) Capability beyond education and training; opportunity beyond environmental restructuring.

Michie et al. (2014) provide a more thorough description of the Behavior Change Wheel, including definitions of the seven policy and nine intervention components and linking COM-B components to the intervention functions, in their book dedicated to this topic. Having used the wheel to identify target behaviors and select relevant intervention and

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policy components to target, researchers can then populate their intervention with specific techniques to act as the active ingredients in the intervention in order to change behavior. The behavior change taxonomy can be a useful tool in this process.

BCTs are the lowest components of interventions designed to influence human behavior. During the development of the taxonomy, the goal was to produce a nomenclature that was specific to behavior change and could be applied to multiple settings and types of behaviors. This agreed language has also been termed “active ingredients.” By definition, BCTs must be observable and replicable (Michie, Abraham, et al., 2011). If implemented in appropriate and favorable conditions, BCTs would be expected to influence behavior in the desired direction (Michie & Johnston, 2013).

As a resource for use in intervention development, the taxonomy provides a thorough list of specific techniques from which researchers can select for inclusion in the relevant intervention components. As a language, the taxonomy equips researchers to precisely and consistently report the techniques used in intervention delivery, enabling a more specific record of the intervention features that may have had an effect on exercise behavior. In creating the taxonomy, Michie et al. (2013) identified 93 distinct BCTs and provided each with a specific definition and label (see Michie et al., 2013, Table 5). The published taxonomy also includes examples of each case. To aid in the human memory limitations faced by a 93-item long taxonomy, the taxonomy is organized into 16 chunks (Michie et al., 2013). This makes it easier for users to recall the key areas when designing or reporting on behavior change interventions. Work on the production and refinement of the taxonomy was rigorous and extensive and involved consultation with several hundred researchers, practitioners, and policymakers. The BCT taxonomy is considered to be a reliable approach for specifying, interpreting, and implementing techniques that are used to change behavior.

Applications

In the case of PA and exercise behaviors, researchers have identified specific BCTs that have been shown to offer more promise in changing behaviors and maintaining that change. Michie, Abraham, Whittington, McAteer, and Gupta (2009) conducted a meta-analysis of studies targeting exercise and healthy eating behaviors of adults from the general population who were age 18 and over and would be deemed by a physician as healthy enough to participate. Of the 122 evaluations included in the study ($N = 44,747$), “self-monitoring” was the most influential BCT when evaluations of PA and eating behavior were analyzed together. Target behavior (PA or healthy eating) did not account for any of the heterogeneity among studies. The study also found that interventions that employed other techniques (such as setting goals and receiving feedback), alongside self-monitoring, were more effective. More recently, Samdal (Samdal, Eide, Barth, Williams, & Meland, 2017) conducted a systematic review of 48 intervention studies with the goal of identify those BCTs that were more effective in changing PA and promoting healthy eating behaviors among overweight and obese adults. The findings further supported the

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use of self-monitoring and goal setting in predicting for short- and long-term intervention changes in PA and dieting behaviors. The study also identified the use of other BCTs (outcome goals, feedback on outcome of behavior, implementing graded tasks, and adding objects such as step counter to the environment) as significant predictors of long-term intervention effects. These findings underscore the importance of identifying BCTs for initiating behavior change, as well as those that lead to the maintenance of behavior change. The study also highlighted the role of a need-supportive (Ryan & Deci, 2017) approach for changes to be sustained over time. Hence, it is important to consider how interventions are delivered (i.e., in a need-supportive way) alongside their content. Consideration of the population characteristics is also imperative when selecting BCTs, as there is evidence that the same BCTs may not be as effective for older and younger people (French, Olander, Chisholm, & McSharry, 2014), or among those with chronic conditions (e.g., Craddock et al., 2017; Larkin et al., 2015).

Critical Considerations

There are several potential advantages to using the Behavior Change Wheel and taxonomy as a basis for the design of exercise interventions. For example, the wheel encourages researchers to make a very specific assessment of what aspects of behavior should be targeted. This may help researchers to design more customized interventions. In addition, the intervention and policy components within the wheel, as well as the BCTs in the taxonomy, are evidence-based. Therefore, exercise researchers do not need to begin from a blank canvas or have training in motivational psychology; they can use these resources to build intervention and policy-related components that have previously been shown to be successful in behavioral change. The taxonomy also helps to address a long-standing issue in behavior change intervention research, that is, the lack of an agreed common language. Manifestations of this include the use of multiple terms to describe the same construct or the use of the same term to describe different intervention techniques. As an example of the latter, exercise interventions may use “goal setting” to describe any form of planning or target setting, regardless of the nature of the goal, or how goals would be set or how they would be used within the intervention. The delivery and interpretation of this technique may therefore widely differ. The taxonomy addresses this type of inconsistency in label terminology, by offering a suite of BCTs within the subcategory of “goal setting and planning,” including goal setting (behavior), problem solving, goal setting (outcome), action planning, review behavior goal(s), discrepancy between current behavior and goal, review outcome goal(s), behavioral contract, and commitment. Each of these nine BCT labels is accompanied by a precise definition (Michie et al., 2013). As such, the taxonomy has the potential to remove accuracy problems when key ingredients that led to the success (or failure) of an intervention are described or replicated. The specificity of descriptions in the taxonomy also aids in identifying appropriate theoretical mechanisms that undergird behavior change.

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The thoroughness and complexity of the BCT taxonomy is both its strength and its weakness; the taxonomy is quite complex and it would be difficult to make appropriate use of it without thorough training. Owing to this complexity, however, and presumably in an effort to improve adherence to accurate use of the terms, researchers can receive online training in using this taxonomy; there is also a free smartphone application which lists the 93 BCTs (see <http://www.ucl.ac.uk/health-psychology/bcttaxonomy>).

The Behavior Change Wheel and taxonomy have also been criticized for attempting to reduce variability in intervention design and implementation, rather than to celebrate it. Ogden (2016) argued that there are challenges in terms of how BCTs specified in a protocol are subsequently translated into behavior. In addition, Ogden raised the point that attempts to streamline and integrate theories (in approaches such as the COM-B model) may do so at the cost of creativity, and they may constrain the discipline rather than enable it to grow. The taxonomy has also been criticized for failing to acknowledge that the BCTs would only be effective within controlled or specific conditions (Peters, de Bruin, & Crutzen, 2015).

Conclusions

Theoretical approaches to exercise and PA promotion are abundant; this article reviewed only a small number of them. Theoretically informed interventions are purported to be superior than atheoretical approaches to health behavior change because they identify key mediator mechanisms of change and pinpoint areas of improvement in case interventions are not successful (Baranowski, Lin, Wetter, Resnicow, & Hearn, 1997). However, an analysis by Prestwich et al. (2014) of studies included in two systematic reviews of PA and healthy eating interventions showed that theory was not used extensively in the design of such interventions. Further, the degree of theory use did not correlate strongly with intervention effectiveness. A follow-up meta-analysis specific to PA by Gourlan et al. (2015) also showed that the effect of theory-based interventions on PA behavior was small (effect size $d = .31$), and that single-theory interventions produced slightly stronger effect sizes than multiple theory interventions ($d = .35$ vs. $d = .21$). These reviews raise questions regarding the way in which theory-based interventions are designed, implemented, monitored, and evaluated. They also raise questions regarding the merits of using theory-based approaches to promote PA. Moving forward, these reviews suggest that theory-based interventions focus on the affective experiences of exercise and move beyond information-processing models that emphasize cognitive processes as determinants of exercise (Ekkekakis, 2017). The role of affective experiences and automatic processes (Hagger & Chatzisarantis, 2014; Rebar et al., 2017) in facilitating (or hindering) PA engagement is unquestionable. However, it is important that intervention work stemming from well-established or newer theoretical approaches to PA promotion move beyond individual-level factors (conscious or implicit, cognitive or affective) and also take into account variations in cultural practices and expectations, the

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built environment, and national policies on PA (Bauman et al., 2012). Such integrative efforts admittedly require more effort, time, and expense, as well as buy-in from diverse stakeholders, but potentially they hold greater promise in terms of impactful, scalable, and sustainable changes in PA levels.

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