Introduction

Behaviors can influence health, healthcare and health outcomes by influencing the likelihood of becoming ill, enabling people to manage their condition when ill and/or disabled, and in delivering safe and evidence-based healthcare. The Global Burden of Disease study found that 72.3% of the 39.5 million global deaths in 2016 were due to non-communicable diseases (Naghavi et al., 2017), largely attributable to modifiable behaviors, such as smoking, diet, physical activity and alcohol. Behaviors also contribute to the transmission of infectious diseases, such as risky sex behaviors, spreading HIV in low- and middle-income countries (Coates, Richter, & Caceres, 2008) and poor hand hygiene behaviors transmitting bacterial infections in wealthier countries (Gould, Moralejo, Drey, & Chudleigh, 2010). The majority of global health challenges outlined by the United Nations Sustainable Development Goals require behavior change, for example ensuring clean water and climate action (United Nations, 2015).

Modifiable delays in seeking medical help (Galdas, Cheater, & Marshall, 2005) and reduced adherence to medication (Easthall, Song, & Bhattacharya, 2013) are associated with impaired health outcomes. Effective delivery of healthcare is also dependent on behaviors, such as adhering to treatment guidelines (Lugtenberg, Zegers-van Schaick, Westert, & Burgers, 2009).

To reduce disease and disability and improve life expectancy and quality of life in the 21st century, we require population-level changes in these modifiable behaviors. Behavioral science has much to contribute, in applying theory, evidence and systematic methods to understand the nature of those behaviors and their influences, as the first necessary step to bringing about change. In this chapter, we introduce some frequently used theories; explore limitations of current behavior change theories; discuss how theory can be used to develop behavior change interventions for prevention, disease management and healthcare practice; and introduce current work aiming to advance behavior change theory.

Behavior Change for Health

Behavior change interventions are coordinated sets of activities designed to change specified behavior patterns (Michie, van Stralen, & West, 2011). For interventions to be effective, we need to know ‘What works, compared with what, how well, with what exposure, with what behaviors, for how long, for whom, in what settings and why?’ However, as Cochrane reviews demonstrate, evidence
of intervention effectiveness suggests a mixed picture (Michie et al., 2017). Interventions have been successfully delivered to target a wide range of health risk behaviors, such as smoking (Scott-Sheldon, Lantini, Jennings, Thind, & Rosen, 2016) and sedentary behavior (Gardner, Smith, Lor-encatto, Hamer, & Biddle, 2016), and in a wide range of populations, such as low-income (Bull, Dombrowski, McCleary, & Johnston, 2014) and ethnic minority groups (Netto, Bhopal, Lederle, Khatoon, & Jackson, 2010). Even very brief interventions can have benefits for population health. For example, one community outreach session aimed at tobacco cessation in very poor areas of India was effective in achieving sustained quitting over six months (Sarkar et al., 2017).

What Are Behavior Change Theories and Why Are They Useful?

Theories of behavior change can elucidate both the complex processes of change and reasons for variation in outcomes. A theory can be defined as ‘a set of concepts and/or statements which specify how phenomena relate to each other, providing an organizing description of a system that accounts for what is known, and explains and predicts phenomena’ (Davis, Campbell, Hildon, Hobbs, & Michie, 2015, p. 327). In the context of behavior change, theories seek to explain why, when and how a behavior does or does not occur, and to identify sources of influence to be targeted in order to alter behavior.

Theories allow investigators to study the same phenomena by specifying concepts and defining variables in a standardized way, thus enabling the accumulation of evidence in a specified area. Second, theory can explain and predict behavior by specifying antecedents or influences on behavior (e.g. skills, goals, motivation, social influences). Third, theory can guide behavior change interventions by identifying targets for intervention, explaining how and why interventions have an effect (or don’t), and optimizing the effects of an intervention (Johnston, 2015).

But what constitutes a good theory? Nine criteria agreed by an expert multidisciplinary panel of psychologists, sociologists, anthropologists, economists, health service researchers, epidemiologists and policy researchers are listed in Box 6.1.

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<th>Box 6.1</th>
<th>Criteria to assess the quality of a theory</th>
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<tr>
<td>1.</td>
<td>Clarity of constructs (i.e. independence of constructs)</td>
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<td>2.</td>
<td>Clarity of relationships between constructs</td>
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<td>3.</td>
<td>Explicit methodology for measuring constructs</td>
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<td>4.</td>
<td>Theory specified in a way that can be tested</td>
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<td>5.</td>
<td>Theory used to explain a set of observations</td>
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<td>6.</td>
<td>Describes causality (i.e., mechanisms of change)</td>
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<td>7.</td>
<td>Achieves parsimony</td>
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<td>8.</td>
<td>Generalizations investigated across behaviors, populations and contexts</td>
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<td>9.</td>
<td>Propositions are empirically supported</td>
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Source: Michie, West, Campbell, Brown, & Gainforth, 2014.

Theories of Behavior Change

Theories of behavior change can be characterized in many ways. One distinction is between predictive vs. dynamic theories. The former are mainly concerned with understanding and explaining
the factors that predict a given behavior, with much of the evidence for them coming from cross-sectional or longitudinal studies of group differences. Dynamic or change theories specify how to change behavior and the temporal nature of that change, with much of the evidence coming from studies of interventions that implement a method of changing behavior and examine change over time within individuals. Dynamic theories deal with processes of change over time, such that change in one component of the model precedes change in another component and that these processes may be continuously changing. Theories of behavior change also have been characterized according to whether they address mainly deliberative, reflective processes (e.g. attitudes, goal setting), automatic, associative processes (e.g. emotions, habits) or both (dual-process model, e.g. Strack and Deutsch’s reflective-impulsive model, 2004). Theories dealing with reflective processes can address behavior change as a continuum or as representing sequential processes (Abraham, Sheeran, & Johnston, 1998), focusing on motivational processes or post-intentional, action self-regulation, volitional processes; in some models this is described as moving through distinct stages (Schüz, Sniehotta, Mallach, Wiedemann, & Schwarzer, 2007). It is possible to conduct studies using examples of each type of theory; for example, healthcare professionals’ clinical behaviors were explained by predictive, dynamic and associative theories (Eccles et al., 2012).

A multidisciplinary literature review identified 83 theories of behavior and behavior change (Davis et al., 2015), too many to present here. (A summary of these theories has been published in a compendium, along with lists of their 1,725 component constructs and network analyses of reported theoretical influences; Michie, West, et al., 2014). Therefore, in this chapter, we briefly present illustrative examples of predictive (Theory of Planned Behavior: Ajzen, 1991, 2006) and dynamic theories (Control Theory: Carver & Scheier, 1982, 1998; Social Cognitive Theory: Bandura, 1986; Transtheoretical Model: Prochaska, DiClemente, & Norcross, 1992; Learning Theory, Pavlov, 1927; Skinner, 1953) and discuss how these theories have informed the design and evaluation of behavior change interventions. More detailed descriptions of these theories can be found in the original references and in other sources (e.g. Conner & Norman, 2015; Michie, West, et al., 2014).

Predictive Theories of Behavior Change

The Theory of Planned Behavior (TPB; Ajzen, 1991, 2006) is one of the most commonly used predictive theories (see Figure 6.1). It is a model of deliberate human behavior and proposes intentions as the direct precursors of behavior. It extends and improves the predictive power of the Theory of Reasoned Action (Fishbein & Ajzen, 1975) by including perceived behavioral control. Intentions are determined by three cognitions. Attitude toward the behavior is the degree to which the behavior is positively or negatively valued, and is determined by behavioral beliefs about the link between the behavior and expected outcomes and the valuation of these outcomes. Subjective norm is the perceived social pressure to engage or not engage in the behavior determined by the normative beliefs, i.e. perceived behavioral expectations of important others, and the person’s motivation to comply with them. Perceived behavior control is the extent to which people perceives themselves as capable of performing a given behavior, determined by control beliefs, i.e., beliefs about the presence of factors that may facilitate or impede performance of the behavior. These three concepts are described by TPB to influence the primary determinant of behavior, intention, or the readiness to perform the behavior. Intentions include both the willingness and the amount of effort one wants to put in the behavior. Perceived behavior control also predicts behavior, but only to the extent that it is predictive of actual control.

Research has shown the TPB to have small but consistent predictive validity in explaining health-related behaviors. A systematic review of 237 prospective statistical tests found that the TPB accounted for approximately 19% of variability in health behavior, with intention being the strongest predictor as posited by the theory (McEachan, Conner, Taylor, & Lawton, 2011). By
contrast, TPB is very successful in predicting that those declaring no intention will not perform the behavior (Rhodes & de Bruijn, 2013). Intention is hence a necessary but not sufficient predictor of deliberative behavior.

The TPB has typically been evaluated in non-experimental, non-intervention studies that test the predictive but not the causal relationships in the theory. Other criticisms of TPB include problems in operationalizing key constructs (Sniehotta, Presseau, & Araújo-Soares, 2014); for example, it is difficult to assess ‘perceived behavioral control’ separately from other control constructs such as self-efficacy (Johnston et al., 2014). Although TPB explains and predicts behavior change to some extent, it is less successful in predicting behavior in those with the intention to act and it gives little guidance on how to develop a behavior change intervention (Hardeman et al., 2002).

**Dynamic Theories of Behavior Change**

**Control Theory** (Carver & Scheier, 1982, 1998) is a self-regulation theory, i.e. it explains how individuals exert control to achieve their goals (see Figure 6.2). It follows engineering principles and proposes that behavior is regulated to meet goals by negative feedback loops, i.e. the perceived discrepancy between an individual’s current state (given by input value) and a desired goal state (the standard value); people strive to reduce perceived discrepancies between the two states by modifying their behaviors. For example, a discrepancy between a desired weight and current weight may lead to a specific goal of increasing physical activity. Performance of the behavior, in turn, has an impact on weight, leading to changes in a person’s perception of their current condition, and a new comparison with the reference value and so on. Failure to reduce the discrepancy may lead to disengagement with the goal. Goals are organized hierarchically and even when there is disengagement from a specific goal, the higher order goal may be achieved by a different behavioral goal; in the preceding example, the person may change to a goal of reducing calorie consumption.

Control Theory identifies clear methods of changing behavior that can be included in behavior change interventions. Individuals must engage in some form of self-monitoring of their behavior to detect the discrepancy between current and goal states (e.g. use an activity tracker) and have been found to achieve more behavior change when implementing self-monitoring (Boutelle & Kirschenbaum, 1998). When a discrepancy is present, individuals need to enact their self-regulatory strategies, such as action control (self-regulatory efforts that can help prevent abandonment of the action due to interruptions, competing intentions or tendencies towards other actions), to reduce the discrepancy and achieve their goals. The use of control strategies is also relevant when facing factors external to the feedback system that can influence behavior (disturbances). This will lead to more effective
self-regulation when it comes to enacting intended behavior and overcoming potential barriers through planning for contingencies in which there is an action-standards discrepancy (Hagger, 2010; Sniehotta, Scholz, & Schwarzer, 2006). For a review of other self-regulation theories, see Michie, West, et al. (2014).

In a meta-analysis, interventions combining self-monitoring with other skills derived from Control Theory, such as goal setting, provision of feedback, planning and goal revisiting, were more effective in promoting changes in physical activity and healthy eating in the general population than other interventions not using these techniques (122 analyses; $d = 0.42$ vs. $0.26$; Michie, Fixsen, Grimshaw, & Eccles, 2009). Behavior change interventions using self-regulation principles have been effective in promoting long-lasting health behavior change for a variety of health behaviors and conditions (e.g., Dombrowski et al., 2012; Ivers et al., 2012).

The **Common Sense Model of Self-Regulation** (Leventhal, Leventhal, & Contrada, 1998) is a version of Control Theory. It proposes that in the context of a health threat, individuals have two main goals: danger control and emotion control, and that the representations of the illness and the emotions determine how the individual behaves and how they evaluate their responses. This model has been used both to predict how people behave when ill and to change representations with resulting behavior change and has received empirical support (Hagger & Orbell, 2003; Leventhal, Brissette, & Leventhal, 2003).

**Social Cognitive Theory** (SCT; Bandura, 1986) proposes that personal and cognitive factors, behavior and the environment interact to determine each other, under the term *triadic reciprocality or reciprocal determinism*. As a theory focusing on human actions, thoughts and motivation, it describes human functioning through its basic capabilities: *symbolic thought* (capacity to use symbols, which is used to transform experiences into mental models to guide future behavior), *foresight* (capability to regulate behavior on the basis of the future, through planning courses of action to achieve a desired future outcome), *observational learning* (ability to learn through observing others),
self-regulation (capability to regulate one’s own behavior based on personal standards and evaluations) and self-reflection (unique to humans, is the capability of analyzing personal experiences and knowledge, leading to new knowledge).

In SCT, the most influential type of self-reflection for behavior is self-efficacy: people’s beliefs or confidence of their capability to change, specifically, to engage in certain courses of action that will lead to desired outcomes and cope with difficulties to this achievement (e.g. ‘I am confident that I can eat an apple a day, even if I am away from home’). Self-efficacy is distinct from outcome expectancies, the belief that a certain behavior can lead to desired outcomes (e.g. eating a healthier diet can help to lose weight). Self-efficacy expectations are hypothesized to have a direct impact on the probability of engaging in a given behavior, as well as the effort and persistence invested in performing that behavior, and an indirect effect by influencing the goals that are set by individuals (i.e. plans or intentions to perform a behavior).

Self-efficacy is influenced by (1) previous mastery experiences—experiences of success strengthen efficacy expectations, which can promote generalization to perception of capability to other situations, whereas unsuccessful experiences are detrimental to efficacy expectations; (2) vicarious experiences—observation of others, with similar characteristics, performing the behavior with success (i.e. modeling); (3) verbal persuasion—by suggestion, people can feel they are more capable of success, although this is considered to have a weaker impact than the actual experience of success; and (4) emotional/physiological feedback—physiological changes associated with the behavior can undermine or promote the success in performing a behavior, e.g. reducing anxiety and vulnerability to stress can increase self-efficacy expectations.

SCT has been used as the basis for many health behavior change interventions. Meta-analyses of interventions targeting self-efficacy for physical activity have found small effects in older adults ($d = 0.14$; French, Olander, Ahisholm, & McSharry, 2014) and moderate effects in obese adults ($d = 0.50$; Olander et al., 2013). Given the dynamic nature of social cognitive theory constructs such as reciprocal determinism, a group of researchers has recently proposed the application of computational dynamic systems modeling to the theory. These allow the specification of the direction and magnitude of influence between social cognitive theory constructs, as well as the estimation of the required change in the theory constructs to produce meaningful changes in target behaviors (Riley et al., 2016).

The central construct in the Transtheoretical Model of Behavior Change (TTM; Prochaska et al., 1992) is stages of change. TTM posits that health behavior change involves progress through five discrete stages of change: precontemplation—where an individual has no intention to change their behavior in the foreseeable future (criteria is usually six months); contemplation—intention to change behavior within the next six months; preparation—intention to take action in the near future (usually within one month) or already engaged in some preparatory actions for change, e.g. registering at a gym; action—engaged in the behavior for less than six months, classification in this stage depends on the behavior, e.g. for physical activity the action stage is considered when individuals engage in regular physical activity according to guidelines; maintenance—engaged in the behavior for more than six months (Prochaska et al., 1992).

According to TTM, stages are both open and stable; individuals move through these stages in sequence and can relapse to earlier stages at any time. Transitions between stages are triggered by processes of change, i.e. cognitive or experiential (e.g. self-re-evaluation, consciousness raising, dramatic relief) and behavioral processes (e.g. counter conditioning, helping relationships, stimulus control). Specific processes need to be emphasized at specific stages for progress to occur, with cognitive processes being more important for pre-action stages and behavior processes more important in action and maintenance stages (DiClemente et al., 1991).

TTM also considers three other constructs to influence movement through stages of change: decisional balance, self-efficacy and temptation. Decisional balance, from Janis and Mann’s (1977)
decision-making model, is the result of the assessment between the pros (advantages) and cons (disadvantages) of changing a behavior. If there are more pros than cons, change is more likely. This balance varies from stage to stage in the TTM, with cons outweighing pros in the precontemplation stage, being more equal in the contemplation stage, and moving to pros outweighing cons in the remaining stages. Self-efficacy (derived from SCT) corresponds to the confidence in engaging in or maintaining a desired behavior in situations that may trigger relapse, and temptation is the desire to carry out the unhealthy behavior(s) in risk situations. In the TTM, self-efficacy and temptation are interrelated. For example, in the precontemplation and contemplation stages, temptation to engage in unhealthy behaviors is greater than self-efficacy to change that behavior. This difference is reduced as individuals move from preparation to action. Moreover, effective health behavior change interventions should be tailored to the individual stage of change, focusing on the strategies and beliefs that are most relevant for that stage.

The TTM is one of the most frequently used theories in health behavior change interventions with an extensive body of research (Prestwich et al., 2014), reflecting its strong intuitive appeal as a guide to intervention rather than existing simply to predict behavior change. Nevertheless, various meta-analyses have shown the effects of TTM interventions on outcomes to be inconsistent across and within health behaviors (e.g. Adams & White, 2005; Gourian et al., 2015).

Detailed critiques of the TTM (e.g. Adams & White, 2005; Sutton, 2005; West, 2005) focus on two main criticisms. First, the distinction between stages is arbitrary, presenting limitations in their definitions and assessment of stages (construct validity of algorithms), and being based on an external factor—time. Although Guo, Aveyard, Fielding, and Sutton (2009) found support for staging algorithms in a study using latent class and latent transition analysis with adolescent smokers, they found no evidence for the sequential stage transition. Second, tests of the stage model have frequently been inadequate, and showing only change over time rather than discrete stages. A recent meta-analysis of TTM intervention studies of physical activity found that when studies used appropriate tests examining the effects of stage-matched and non-matched interventions, the TTM-based interventions had a beneficial effect on physical activity (Romain et al., 2016). However, the effect was similar for different stages, suggesting a continuum rather than a stage model. By contrast, a similar test of a slightly different stage model, the Precaution Adoption Process Model (PAPM; Weinstein, 1988), found that a radon risk information intervention was effective in changing behavior among uninterested people but not among those who were motivated, whereas an intervention to make radon testing easier was only effective for people who had decided to act, confirming the hypothesized staging (Weinstein, Lyon, Sandman, & Cuite, 1998).

Schüz et al., (2007) note that several models including the TTM and the Precaution Adoption Process Model and the Health Action Process Approach (HAPA; Schwarzer, 2008) share a differentiation between pre- and post-intentional processes and posit a decisional or intention-formation transition. Although TTM staging may not have strong support, it is still possible that some simpler stage model, such as the HAPA offers, may be useful in guiding interventions matched to individual stages, although models that differ between ‘pre-’ and ‘post-’ intention are based on the assumption of intentions that are stable over time.

Learning Theory

A limitation of the other theories described so far is the lack of explicit consideration of associative processes. Learning Theory (LT) includes both operant conditioning (Skinner, 1953) and classical conditioning (Pavlov, 1927). In LT, behavior changes as a result of contingencies between behaviors, their antecedents, and their consequences. Repeated experience of rewarding consequences for a behavior in a given context leads to automatic elicitation of the behavior in that context, i.e. the behavior becomes habitual and under stimulus control. Reinforcement may either be the addition
of something positive (e.g. financial rewards) or removal of a negative consequence (e.g. criticism). Schedules of reinforcement may be designed to follow every performance, or intermittently, after a fixed or variable amount of time or of responses. For the behavior to be sustainable after removal of the reinforcement, the schedule of the reinforcement during acquisition should be intermittent rather than continuous to avoid extinction (Johnston, 2016b). Alternatively, the reinforcement needs to be maintained, as in continuing contingent payment of healthcare professionals for clinical behaviors (Clarkson et al., 2008).

There is ample evidence of the use and effectiveness of the principles of learning theory in health psychology. Many of the behavior change techniques used in health-related interventions derive from LT (Johnston, 2016b). In the context of health behavior change, reinforcing other behaviors can be an effective technique, for example, rewarding periods of absence from the behavior targeted for decrease (differential reinforcement of other behavior) or rewarding other behaviors that compete with the target behavior (differential reinforcement of alternative behavior) (Johnston, 2016b).

Behavior may also be changed by association of its context with contexts in which the desired behavior occurs. For example, it has been proposed that placebo effects are due to the association of the paraphernalia of drug delivery with the effects of the drugs (Schafer, Colloca, & Wager, 2015). Similarly, the discovery that anticipatory nausea associated with chemotherapy is due to the association of the context in which chemotherapy is delivered with the effects of chemotherapy has resulted in behavior change interventions based on this finding (especially desensitization) that have proved effective (Kamen et al., 2014; Redd, Montgomery, & DuHamel, 2001).

Critical Overview of Theories and Potential for Theoretical Advance

There are a large number of health behavior change theories that vary in their complexity and range of application. Four critical observations on the current state of behavior change theories can be made. First, there is often a lack of clarity in theory descriptions, notably in their scope, target and specification of component constructs and their relationships. Second, many of the theories of behavior may be useful in describing or explaining the processes involved but do not provide guidance on how to change behavior. Third, the predominant theories do not successfully integrate the multiple physical, economic, policy and sociocultural environmental influences on behavior change. Future advances in behavior change theory include exploring the dynamics of the systems-individual relationship, as well as extending what we already know about individual-level influences on behavior (Sniehotta et al., 2017). Fourth, there is considerable overlap between the theories and their constructs, with many theories appearing to use different labels for similar constructs or the same labels for different constructs.

Two pieces of our work address the problem of proliferation and overlap of constructs and theories. First, a collaboration of behavioral scientists and implementation researchers used a variety of consensus processes to identify 14 domains of closely related theoretical constructs, termed the Theoretical Domains Framework (TDF; Cane, O’Connor, & Michie, 2012; Michie et al., 2005). These domains are knowledge; skills; memory, attention and decision processes; behavioral regulation; social/professional role and identity; beliefs about capabilities; optimism; beliefs about consequences; intentions; goals; reinforcement; emotion; environmental context and resources; and social influences. The TDF has been used in intervention development and design for a variety of health-related behaviors (Little, Presseau, & Eccles, 2015; Munce et al., 2017) as well as to guide intervention implementation (Atkins et al., 2017).

Second, a new model of behavior change, the COM-B model can be used to guide the development of interventions. The COM-B simplifies the TDF and identifies the high-level influences of
capability, opportunity and motivation on behavior (Michie, Atkins & West, 2014; Michie, van Stralen, & West, 2011). Capability refers to people’s physical skills, strength and stamina (e.g. being able to climb stairs) and psychological capability such as knowledge, behavioral regulation, and psychological skills (e.g., information about healthy foods) to perform the behavior. Opportunity refers to the social environment involving aspects such as social norms or social influences (e.g. joining a running club) and physical environmental in terms of resources, locations and time (e.g. being able to access a weight loss program) that permit the behavior. Motivation involves automatic processes such as habits or emotional states (e.g. having an urge to smoke), and reflective processes such as self-conscious intentions or beliefs (e.g. intending to follow a recommended medical treatment) that energize and direct behavior (Michie et al., 2011). The COM-B model has been used successfully to identify theoretical targets (Atkins et al., 2016; Barker, Atkins, & Lusignan, 2016) and to design behavior change interventions. (Barker, Lusignan, & Cooke, 2016). The simplicity of the model has proved to be of value in addressing a range of healthcare problems, including delivery of obstetric care, training of midwives and use of ward records, and has been used globally in several African countries (Byrne-Davis et al., 2017).

**Developing Theory-Based Interventions**

Underlying every intervention there is a theory, either implicit or explicit. If theories are implicit it is difficult to examine the processes underlying the intervention effects, develop more effective interventions, or advance theory. Using explicit theory when developing and evaluating interventions allows the identification of what needs to change (i.e., the factors influencing the target behavior), the barriers and facilitators to changing those influences and the identification of mechanisms of action that operate along the pathway to change. In addition, understanding how behavior change interventions are informed by theories, and developing interventions that are theory-based, also can contribute to theory testing and refinement.

There is a broad consensus that health behavior change interventions should be informed by theory. For example, the UK’s Medical Research Council recommends the identification of relevant theories to understand the process of change in complex interventions (Craig et al., 2013) as does the U.S. Department of Health and Human Services and National Institutes of Health (Rimer & Glanz, 2005). Nevertheless, reviews of published empirical research in health journals find that only about a third were informed by theory (Davies, Walker, & Grimshaw, 2010; Painter, Borba, Hynes, Mays, & Glanz, 2008). Some systematic reviews and meta-analysis have found beneficial effects of theory-based interventions (e.g. Gourlan et al., 2015), whereas others have not (e.g. Gardner, Wardle, Poston, & Croker, 2011). Critical evaluation of the application of theory is needed for a more integrated understanding of behavior change interventions, their usefulness, and their effectiveness (Michie, West, et al., 2014). A review of 190 interventions targeting physical activity and/or healthy eating found that only a small proportion systematically applied theory although they reported using theory in their development (Prestwich et al., 2014). The review was conducted using a reliable research tool to describe and evaluate the extent to which a behavior change is based on theory, the 19-item Theory Coding Scheme (TCS; Michie & Prestwich, 2010).

**Frameworks for Behavior Change Interventions**

Several frameworks have been developed from a combination of literature review and expert consultation to support the development of effective theory-based behavior change interventions, and their evaluation and implementation. Two will be presented here: Intervention Mapping (Bartholomew
et al., 2016; Kok et al., 2016) and the Behavior Change Wheel (Michie et al., 2011). For a review of frameworks, see Michie et al. (2011) and Nilsen (2015).

**Intervention Mapping**

Intervention mapping is a systematic method for the development and evaluation of theory-based and evidence-based health promotion interventions (Bartholomew et al., 2016; Kok et al., 2016). It consists of six cumulative steps: (1) conducting a needs assessment by identifying what needs to be changed and for whom, through literature review and consultation with stakeholders; (2) developing matrices of change objectives to identify the influencing behavioral factors the intervention will target; (3) selecting theory- and evidence-based intervention methods and practical applications that satisfy the parameters for effectiveness of the selected methods to change influencing factors; (4) integrating these into program components, design and production; (5) anticipating program adoption, implementation and sustainability in real-life contexts by identifying stakeholders needs; and (6) generating process and effect evaluation of the program. In identifying and selecting intervention content, Intervention Mapping emphasizes that intervention strategies derived from theories of behavior change should take into consideration the theoretical parameters for their effectiveness.

Intervention Mapping has been successfully used in the development of a range of behavior change programs (Garba & Gadany, 2017), such as HIV/STI prevention (Albritton et al., 2014), chronic disease management (Detaille, van der Gulden, Engels, Heerkens, & van Dijk, 2010), and healthcare professional behavior (Byrne et al., 2005). For more examples of IM interventions, visit www.interventionmapping.com/references.

**Behavior Change Wheel**

The Behavior Change Wheel (Michie et al., 2011; Michie, Atkins, & West, 2014) is an integrative framework to aid the systematic development and evaluation of behavior change interventions (Figure 6.3). It was derived from a synthesis of 19 frameworks of behavior change identified in a systematic literature review and linked to the COM-B model of behavior change. The starting point is a ‘behavioral diagnosis’, that is, the identification of the problem and definition in behavioral terms and in its context. This involves identifying what needs to change for the target behavior to change in terms of capabilities, opportunities (the physical and social environment) and motivation.

The COM-B model is the hub of the wheel, with a first ring representing intervention functions, or the means by which behavior change is implemented, such as *education* (increasing knowledge or understanding) or *environmental restructuring* (changing the physical or social environment). The outer ring represents seven policy categories, which are high-level societal and organizational strategies for implementing and sustaining behavior change, such as *guidelines or legislation*. These policies can only influence behavior through at least one of the intervention functions, each incorporating more fine-grained specific behavior change techniques.

The Behavior Change Wheel has been widely used to design interventions across a range of behavioral domains, clinical conditions and settings, such as sepsis prevention (Steinmo, Fuller, Stone, & Michie, 2015), medication management (Sinnott et al., 2015) and increased uptake and attendance of NHS Stop Smoking services (Fulton, Brown, Kwah, & Wild, 2016).

Both these frameworks are examples of systematized and rigorous processes of intervention development. A difference between them is that the change objectives in IM derive from a range of theories, whereas the BCW incorporates the COM-B model and proposes change in capability, opportunity and/or motivation.
Precise Reporting of Behavior Change Interventions

Behavior change interventions are frequently poorly described in published literature leading to difficulties in evidence synthesis and in implementation of effective interventions. An international, interdisciplinary consortium has developed the Template for Intervention Description and Replication (TIDieR) checklist to guide reporting and replication of interventions of all types, including medical, surgical, rehabilitation, psychotherapeutic and behavioral interventions. Following a recognized consensus procedure involving literature reviews, Delphi procedures and intensive cross-disciplinary discussion, the checklist was designed to overcome the problem of omissions in intervention reports by describing the elements that should be included (Hoffman et al., 2014). TIDieR is available at the EQUATOR website (www.equator-network.org/wp-content/uploads/2014/03/TIDieR-Checklist-PDF.pdf) with further elaboration available (Hoffman et al., 2014).

The 12 items in the TIDieR checklist identify the minimum required to describe an intervention, all of which have been omitted in some published intervention reports. They include: ‘why’—the rationale, theory and goal of the intervention; ‘what’—the materials and procedures implemented; ‘who provided’—the expertise, discipline and training of the person delivering the intervention; ‘how’—the modes of delivery of the intervention; ‘where’—the types of location where the intervention took place; ‘when and how much’—the schedule, duration and intensity of the intervention; and ‘how well’—assessment of intervention fidelity and adherence. In addition to ensuring that these features are reported, the TIDieR checklist guides reporting of where the relevant information can be found. Some of this information may not be available in published material and only be obtainable by directly
contacting authors (De Bruin et al., 2016). Adopting the TIDieR checklist as a minimum standard of reporting, including specification of where relevant materials can be found, is likely to enhance the quality of reporting of interventions in the same way that CONSORT (Consolidated Standards of Reporting Trials) guidance has improved reporting of randomized controlled trials (Schulz, Altman, & Moher, 2010). Use of controlled and shared terminologies like TIDieR can enable precision of reporting, synthesis and replication of behavior change interventions (Michie, Johnston, & Carey, 2016).

An extensive shared vocabulary is used for specifying the ‘content’ of interventions in terms of their component Behavior Change Techniques (BCTs), defined as ‘the active components designed to change behavior’. A ‘taxonomy’ of BCTs has been developed in a program of research involving 400 experts from around the world providing a common language and organized structure for reporting interventions: the Behavior Change Techniques Taxonomy version 1 (BCTTv1; Michie et al., 2015). BCTTv1 provides an extensive list of 93 clearly labeled, well-defined BCTs, clustered into 16 groupings (Michie et al., 2013, 2015; Box 6.2).

### Box 6.2  Examples of Behavior Change Techniques (BCTs) in the Behavior Change Techniques Taxonomy Version 1 (BCTTv1) (Michie et al., 2013)

**BCT 1.1: Goal Setting (Behavior)**

Definition: Set or agree on a goal defined in terms of the behavior to be achieved.

Example: Agree on a daily walking goal (e.g. three miles) with the person and reach agreement about the goal. Set the goal of eating five pieces of fruit per day as specified in public health guidelines.

**BCT 2.3: Self-Monitoring of Behavior**

Definition: Establish a method for the person to monitor and record their behavior(s) as part of a behavior change strategy.

Example: Ask the person to record daily, in a diary, whether or not they have brushed their teeth for at least two minutes before going to bed. Give patient a pedometer and a form for recording daily total number of steps.

**BCT 8.3: Habit Formation**

Definition: Prompt rehearsal and repetition of the behavior in the same context repeatedly so that the context elicits the behavior.

Example: Prompt patients to take their statin tablet before brushing their teeth every evening.

BCTTv1 is intentionally named ‘version 1’ to reflect the need for further revisions based on emerging evidence in the future. BCTTv1 has been used to code the presence of BCTs across a wide range of behavior change interventions in diverse populations. Resources have been developed to support the use of BCTTv1, including an app (www.ucl.ac.uk/health-psychology/bcttaxonomy/BCT_app1), a database of studies coded using BCTTv1 (www.bct-taxonomy.com/interventions) and an online training to guide the identification of BCTs in published papers (www.bct-taxonomy.com/), which has been shown to improve accuracy of an individual’s BCT coding compared to expert assessment (Wood et al., 2015). An online portal for users
To give feedback on BCTTv1 can be found here: https://uclpsych.eu.qualtrics.com/jfe/form/SV_1KXXz5VkbkzEZBX.

Taxonomies such as BCTTv1 allow similarities and differences between the content of different interventions to be made explicit, which has been very useful for evidence syntheses (e.g. French et al., 2014). Taxonomies have also been used to assess the extent to which interventions are delivered in the way they were intended in the real world, also known as ‘intervention fidelity’ (Lorencatto, West, Christopherson, & Michie, 2013).

Although these frameworks offer guidance as to which BCTs to select for changing the factors influencing behavior, there is also a need for a clearer, transparent and agreed specification of the links between BCTs and their mechanisms of action (the processes through which BCTs affect behavior). The Theories and Techniques of Behavior Change Project (www.ucl.ac.uk/behaviour-change-techniques), is an example of a project developing a method for linking behavior change techniques to their mechanisms of action, through research synthesis and expert consensus (Michie et al., 2016). This will allow provide a resource for researchers to develop and evaluate theory-based interventions, better understand and test the processes through which behavior change interventions are hypothesized to have their effects, and, in turn, contribute to theory development and the utility of theory in guiding behavior change intervention design.

Controlled vocabularies, organized into taxonomies are also being developed to specify other features of behavior change interventions, such as mode of delivery and context (defined as target population and setting). There has also been work to classify micro-level aspects of the physical environment interventions to change the consumption and purchasing behaviors associated with eating, drinking alcohol and smoking, producing the TIPPME typology (Hollands et al., 2017). Shared language organized into classification systems such as taxonomies enables better synthesis of behavior change knowledge and strengthens the methods of behavioral science.

**Advances in Investigating Theories of Behavior Change**

There are many new approaches to advancing theories of behavior change. We discuss two, the possibilities offered by new technologies, and the use of ontologies to structure knowledge.

**Digital Technologies**

The development of technologies such as smartphone apps, ecological momentary assessment (EMA; Johnston, 2016a), physiological monitors and environmental sensors allow the collection of data about behavior, attitudes, emotions, internal bodily states and the environment in real time and in people’s everyday contexts (Lusczynska & Hagger, 2016). The possibilities of obtaining more evidence of how individuals change from moment-to-moment is advancing the testing of within-person theoretical formulations paving the way for theoretical refinement. Data provided by social media such as Facebook and Twitter allow unprecedented methods for investigating social networks, allowing much better understanding of the influences of people on each others’ behavior and providing the basis for developing online interventions (Latkin & Knowlton, 2015; Maher et al., 2014). Chapter 40 provides a more detailed overview of digital technologies.

**Ontologies**

Hierarchical taxonomies can be extended in the form of an ontology. An ontology is a systematic method for organizing knowledge, including a controlled vocabulary of agreed-upon terms and the inter-relationships between these terms (Arp, Smith, & Spear, 2015; Larsen et al., 2016). They enable concepts and languages to be compared across fields of study and allow large data sets to be
Ontologies are edited and developed according to new patterns arising in data and developments in the field that the ontology represents (Arp et al., 2015). Ontologies have hugely advanced other fields such as the Gene Ontology (www.geneontology.org) and been used for psychology-related topics with the Mental Functioning Ontology (https://bioportal.bioontology.org/ontologies/MF). Ontologies hold out much promise for advancing behavioral science given the accelerating volume of published research on interventions involving behavior change (Michie & Johnston, 2017).

A multidisciplinary effort to develop an Ontology of Behavior Change Interventions is underway: the Human Behaviour-Change Project (Michie et al., 2017; www.humanbehaviourchange.org). An upper-level representation of this ontology is shown in Figure 6.4, which includes not only mechanisms of change but also the modifying influences of reach, population and setting on the change process. A collaboration of behavioral, computer and information scientists are linking this ontology with an automated system to identify and interpret this information from published papers and a user interface to allow researchers, practitioners and policy makers to query these data (Michie et al., 2017).

Computation allows vast amounts of evidence to feed into a query system allowing variants of the following question to be addressed: ‘What works, compared with what, how well, with what exposure, with what behaviors, for how long, for whom, in what settings and why?’ This will have far-reaching consequences for the ability to extrapolate knowledge to under-researched populations within high income as well as low and middle-income countries. This is a key advantage of this approach, given that the greatest health burden is in populations, countries and settings where the least research is conducted, as Cochrane reviews illustrate (Michie et al., 2017). Combining computational process such as machine learning and reasoning algorithms with the application of the Behavior Change Intervention Ontology holds great promise. This will work to generate new insights and hypotheses about behavior change across a wide range of cultural, ethnic and social groups.

Figure 6.4 Upper-level Entities of the Behavior Change Intervention Ontology, and Their Causal Links
Source: Michie et al. (2017).
Theories summarize explanations of the influences on behavior and behavior change, providing information to guide the development of interventions to change behavior and potentially test the theories that have been applied. This chapter has described the challenges of the large number of overlapping theories relevant to changing behavior and introduced several frameworks aimed at integrating and simplifying theoretical approaches and methods. The chapter has also introduced work aiming to develop consistent terminologies for theoretical concepts and change techniques, aimed at supporting communication, coordination and collaboration across research labs, academic disciplines and study domains. Such work aims to promote more efficient, rapid and effective accumulation of knowledge about behavior change across a wide range of cultural, ethnic and social populations and settings.

References


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