MAP-IT: A Practical Tool for Planning Complex Behavior Modification Interventions

Sylvia Hansen, MSc[1]
Martina Kanning, PhD[1]
Romy Lauer, MSc[2]
Jürgen M. Steinacker, MD[2]
Wolfgang Schlicht, PhD[1]

Health research often aims to prevent noncommunicable diseases and to improve individual and public health by discovering intervention strategies that are effective in changing behavior and/or environments that are detrimental to one's health. Ideally, findings from original research support practitioners in planning and implementing effective interventions. Unfortunately, interventions often fail to overcome the translational block between science and practice. They often ignore theoretical knowledge, overlook empirical evidence, and underrate the impact of the environment. Accordingly, sustainable changes in individual behavior and/or the environment are difficult to achieve. Developing theory-driven and evidence-based interventions in the real world is a complex task. Existing implementation frameworks and theories often do not meet the needs of health practitioners. The purpose of this article is to synthesize existing frameworks and to provide a tool, the Matrix Assisting Practitioner's Intervention Planning Tool (MAP-IT), that links research to practice and helps practitioners to design multicomponent interventions. In this article, we use physical activity of older adults as an example to explain the rationale of MAP-IT. In MAP-IT, individual as well as environmental mechanisms are listed and behavior change techniques are linked to these mechanisms and to intervention components. MAP-IT is theory-driven and evidence-based. It is time-saving and helpful for practitioners when planning complex interventions.

Health Promotion Practice
September 2017 Vol. 18, No. (5) 696–705
DOI: 10.1177/1524839917710454

Keywords: *behavior change; program planning and evaluation; behavior change theory; physical activity/exercise*

INTRODUCTION

Noncommunicable, cardiometabolic diseases like diabetes, stroke, and coronary heart disease are the leading causes of morbidity and premature death worldwide. The World Health Organization (2003) has predicted that noncommunicable diseases will account for almost three quarters of all deaths worldwide by

[1]*University of Stuttgart, Stuttgart, Germany*
[2]*University Medical Center, Ulm, Germany*

Authors' Note: *Matrix Assisting Practitioner's Intervention Planning Tool was conducted and developed by Sylvia Hansen and Wolfgang Schlicht, with contributions from Romy Lauer and Jürgen Steinacker. Sylvia Hansen, Martina Kanning, and Wolfgang Schlicht drafted the manuscript. Romy Lauer and Jürgen Steinacker reviewed the manuscript and provided comments and revisions. All authors approved the final manuscript. The preparation of this article was supported by the DEDIPAC Knowledge Hub. The DEDIPAC project is the first initiative of the European Joint Action "A Healthy Diet for a Healthy Life." The content of this article reflects only the authors' views, and the Joint Programming Initiative, a Healthy Diet for a Healthy Life is not liable for any use that may be made of the information contained therein. This article is supported by the German Federal Ministry of Education and Research.* *Address correspondence to Sylvia Hansen, University of Stuttgart, Chair of Exercise and Health Science, Nobelstraße 15, Stuttgart 70569, Germany; e-mail: sylvia.hansen@inspo.uni-stuttgart.de.*

2020. An unhealthy diet (e.g., high sugar intake), sedentary behavior (e.g., extensive screen time), and physical inactivity (i.e., adults failing to reach the public health recommendation for physical activity) are known as significant risk factors for chronic diseases (Heath et al., 2012). An impressive number of interventions that aim to change unhealthy behaviors have been implemented in different settings and for different priority populations.

Unfortunately, large-scale interventions (e.g., Multiple Risk Factor Intervention Trial), based on behavioral change strategies, have often only a modest or even a negligible impact on a person's risky behaviors and health status (Glass & McAtee, 2006; Stokols, 1996). Relapses to the former habitual and risky behaviors are common during the intervention and after the intervention ends. The effectiveness of interventions—physical activity interventions or smoking cessation, for example—has proven to be unpredictable (Biddle, Brehm, Verheijden, & Hopman-Rock, 2012).

In accordance with our experiences and with Glanz and Bishop (2010) or Horodyska et al. (2015), there are a number of reasons for the poor success of interventions. These may include but are not limited to an approach (1) lacking theoretical knowledge and empirical evidence, (2) neglecting the environmental underpinnings of behavior and health or illness, and (3) failing to successfully translate scientific knowledge into practice.

The Matrix Assisting Practitioner's Intervention Planning Tool (MAP-IT) addresses the fact that extensive scientific knowledge is required to understand results of original research and that these results need to be applicable to real-life conditions. MAP-IT covers health practitioners' needs by linking scientific research with practical applications. The aim of this article is to highlight the role of MAP-IT in supporting practitioners in developing effective interventions.

THEORY-DRIVEN AND EVIDENCE-BASED INTERVENTIONS

"Commonsense interventions," which can often be seen in intervention practice, frequently ignore theories and fail to follow evidence-based results generated by systematic evaluations of former interventions. Instead of using a systematic approach driven by theories or theoretical models and frameworks and based on empirical evidence, less systematic and often even "down-to-earth" strategies are applied. Interventions often start without clearly defined objectives, aims, and targets. They therefore miss logical connections between components, activities, targets, and objectives (Michie, Fixsen, Grimshaw, & Eccles, 2009). As Trickett and Espino (2004) pointed out when they looked at community collaboration interventions in real life, "There is more theology than conclusion, more dogma than data" (p. 62). This statement applies to many interventions for changing unhealthy behaviors or environments that make the unhealthy choice, the easy choice (e.g., obesogenic environment).

The effectiveness of interventions depends in part on the use of a "program theory," specifying assumptions that answer why a given intervention component (e.g., education) and an appropriate activity (e.g., a fact sheet) will influence a behavioral or an environmental change under a given condition (e.g., Lacouture, Breton, Guichard, & Ridde, 2015). Program theories indicate the mechanisms that are likely to change behavior or environment. Theory-driven interventions identify mechanisms linked with behavior, and therefore, the mechanisms are "adjusting screws" to change the environment (e.g., organization) or the behavior (Michie & Prestwich, 2010). Mechanisms are supposed to operate as determinants, causes, or predictors of behavioral changes (Noar & Zimmerman, 2005). Mechanisms give rise to the causal regularities expected in the intervention. Reflecting the work of Pawson, Greenhalgh, Harvey, and Walshe (2004) and applying this to our objective, namely, to develop a tool for practitioners in health promotion, a mechanism represents the idea of how the environmental or behavioral change will be achieved through a specific intervention under a given condition or in a given setting. In another scientific context, according to Bauman, Sallis, Dzewaltowski, and Owen (2002), mechanisms are called determinants, defined as "causal factors, and variations in these factors are followed systematically by variations in . . . behavior" (p. 6).

Program theories answer "why" a given measure in a defined context has an effect. The answer is the basis of an evidence-based intervention. Theory-driven interventions contain statements about the proposed logical interaction of components and measures or activities to derive the reasons why a certain strategy may be effective in a given context. Evidence-based and theory-driven approaches follow a systematic path. Interventions can be successfully completed and replicated only if there are theoretical assumptions providing information about the mechanisms (Davidoff, Dixon-Woods, Leviton, & Michie, 2015) that are crucial to change a specific behavior or environment, and if they use components and measures or activities that have been proven to be effective.

With respect to the measures or activities intended to be used in an intervention, well-described behavior

change techniques (BCTs) help reach the objectives and aims of an intervention (Greaves et al., 2011). Michie et al. (2013) have published one of the most elaborate taxonomies for systematizing BCTs. Changing one's behavior is usually a complex task and often requires the use of multiple BCTs.

Unfortunately, health practitioners are often not trained to use models or theories of behavior change. They are often not trained in identifying relevant mechanisms and suitable BCTs to influence behaviors (Gonzales, Handley, Ackerman, & O'Sullivan, 2012). Thus, the existing frameworks—albeit reflecting the existing knowledge—are still too abstract to be used in interventions intending to change behavior in real life. They often lack the manual on how to implement a complex intervention in the real world.

ENVIRONMENTAL INFLUENCES

Different authors have pointed out that interventions often address only personal and, in particular, psychological factors (e.g., motives or attitudes), and the environment (e.g., the built or social environment) is less likely to be considered (Davis, Campbell, Hildon, Hobbs, & Michie, 2015). Neglecting the structural limitations given by the environment and addressing only motivational and volitional mechanisms have proven insufficient (Stokols, 1996). This has been postulated impressively in Glass and McAtee's (2006) seminal article. Multiple personal and environmental factors interact to either underpin or hinder individuals' health behaviors. As previously demonstrated, targeting both personal (i.e., psychological) and environmental mechanisms simultaneously in multicomponent interventions has proven helpful in increasing the effectiveness of an intervention (National Institute for Health and Clinical Excellence, 2007). Socioecological models deal with the "person × environment interaction" (e.g., Sallis et al., 2006).

Planning a theory-driven and evidence-based multicomponent intervention is a challenging task in a complex environment that includes hidden dynamic processes involving multiple factors resulting in inevitable uncertainty. To develop complex interventions, a deep understanding of the needs, wants, and underlying dynamic processes to change behavior in a given setting is essential. Due to insufficient financial resources or due to limited time, for example, practitioners are often not able to acquire the necessary expertise or deep insights into these complex processes (Glasgow & Emmons, 2007).

EXISTING FRAMEWORKS AND EXISTING KNOWLEDGE

Many frameworks for designing and evaluating interventions have been proposed to support practitioners to develop effective interventions. PRECEDE-PROCEED (Green & Kreuter, 1991) and intervention mapping (IM; Bartholomew, Parcel, Kok, Gottlieb, & Fernandez, 2011) are two prominent frameworks. Common throughout these planning tools is the alignment with a planning circle like the public health cycle (Ruckstuhl, Somaini, & Twisselmann, 1997), starting with an assessment of the demands and needs in a given setting, continuing with planning, and following with implementation, monitoring, and evaluation. Additional helpful frameworks for designing and evaluating interventions are composed as tools to address special public health issues like obesity. For example, the ANGELO framework (Analysis Grid for Environments linked to Obesity, developed by Swinburn, Egger, & Raza, 1999) is especially useful in the "Needs Assessment" phase of developing an intervention.

A recent framework that supports interventions aimed at behavioral changes is the behavior change wheel (BCW; Michie, van Stralen, & West, 2011), which summarizes knowledge from previous frameworks of different authors. The BCW is a helpful tool for compiling crucial elements of an intervention plan. It brings policy categories (e.g., fiscal measures), intervention functions or components (e.g., education), and behavioral sources or mechanisms (e.g., motivation) into a logical order. As Michie et al. (2013) pointed out, more than 90 different BCTs are currently available. The BCW can serve as a guide to keep a logical sequence between objectives and appropriate strategies for reaching the targets. Its practical application has been studied by Porcheret et al. (2014), and it ". . . proved to be a practical way of using theory to inform the development of complex interventions" (p. 7). The BCW may be applied to any health-relevant behavior in any setting, making it a powerful tool. But, identifying mechanisms of behavior and finding the links between the behavioral mechanisms, intervention functions, and BCTs are not straightforward tasks. Rather, we presume that the appropriate use of the BCW requires substantial knowledge of those psychological processes that accompany behavior modification.

Michie, Atkins, and West (2014) suggested using the APEASE criteria: *a*ffordability, *p*racticability, *e*ffectiveness/cost-effectiveness, *a*cceptability, *s*ide effects/safety, and *e*quality. These criteria help select the most

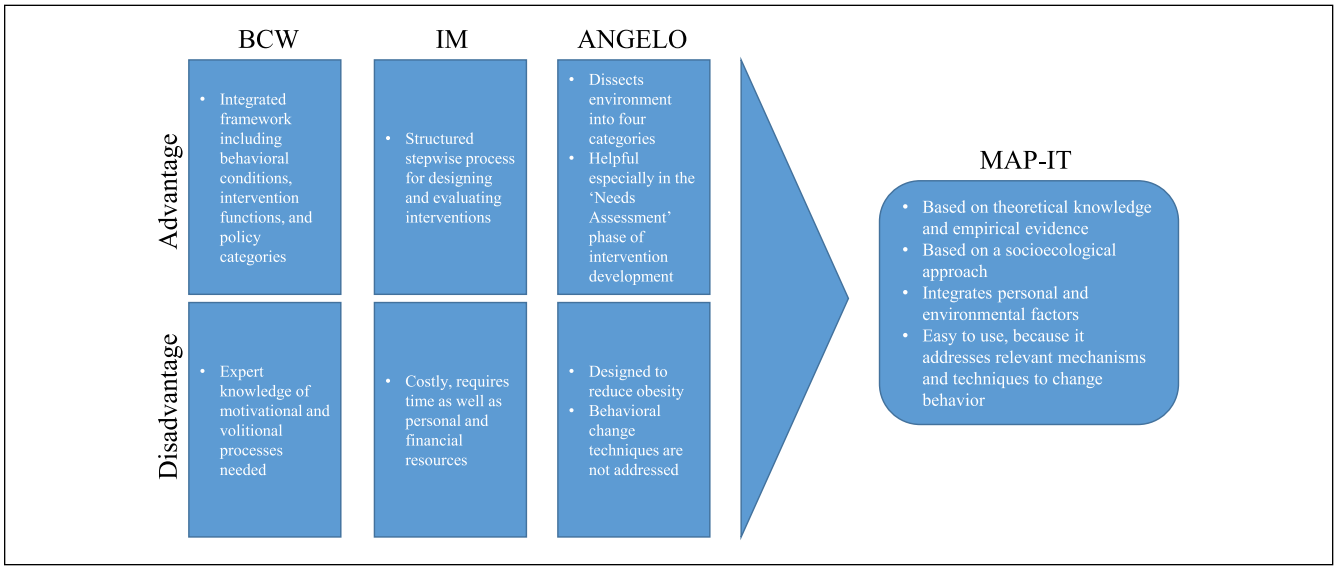

FIGURE 1 Existing Frameworks Integrated Into MAP-IT
NOTE: BCW = behavior change wheel; IM = intervention mapping; ANGELO = Analysis Grid for Environments linked to Obesity; MAP-IT = Matrix Assisting Practitioner's Intervention Planning Tool.

appropriate BCT for a specific intervention function. For this to be achieved, practitioners must know what each BCT means and how to work with it. The definition and meaning of each BCT can be found in Michie et al. (2013) and in the digital application (BCT taxonomy) for iPhones from David Crane (https://itunes.apple.com/de/app/bct-taxonomy/id871193535?mt=8).

However, most practitioners are neither psychologists nor experts in BCTs. Of course, the BCW pools existing knowledge in a compact but abstract form, leaving important decisions up to the intervention planner.

Another tool supporting practitioners to plan and evaluate health-enhancing interventions is IM (Bartholomew et al., 2011). IM includes a structured stepwise process that is iterative and cumulative rather than linear, providing appropriate elements to guide each of the six steps. First, intervention planners carry out a needs assessment and identify important personal and environmental determinants for a target behavior that should be changed. In subsequent steps, intervention, adoption, and implementation plans are developed by means of addressing objectives with specific methods and strategies. IM includes all the relevant steps, strategies, and tools for designing and evaluating interventions. However, its comprehensiveness reduces its feasibility, as it requires time and a significant amount of personal and financial resources.

Glanz and Bishop (2010) have highlighted the need for more theories that address environmental variables, as these are enablers or barriers to changing a risky behavior. IM addresses environmental determinants by addressing environmental agents (e.g., the mayor of a community), and it includes environmental strategies (e.g., systems change). ANGELO provides a further indication of important environmental barriers or enablers of health-related behaviors. Environment is seen as a risk regulator, determining the likelihood of individuals participating in a healthy behavior (see Glass & McAtee, 2006). The ANGELO framework separates the environment into four types (physical, economic, political, and sociocultural) and two sizes (macro and micro; Swinburn et al., 1999). The grid is helpful for answering questions such as the following: What is available? What are the costs for an intervention? What are the rules/policies/social norms/attitudes to consider?

All these tools or frameworks are helpful. They have advantages but also disadvantages. To work with them is challenging, is time-consuming, and requires extensive knowledge of motivational and volitional processes (see Figure 1).

Most frameworks are designed to change risky behavior into health-promoting and risk-reducing behavior. These frameworks are products of implementation science. As such, they are not applicable for practitioners of health promotion. They require further translation. The main objective of implementation science is to answer the question of what the "best" method is to treat a given public health problem. Four

steps in translational (T) research (Woolf, 2009) were recently distinguished (Lobb & Colditz, 2013): (T1) case series and efficacy trials; (T2) effectiveness studies, developing clinical guidelines, meta-analyses, and systematic reviews; (T3) effectiveness studies, developing implementation guidelines, and dissemination; and (T4) use of evidence-based interventions and implementation strategies in the real world. These four steps or translational blocks (T1 to T4) refer to the distinctions that are commonly made in medicinal translational research: (1) "from bench to bedside" and (2) "from bedside to community," that is, laboratory research results are tested in the clinical setting with patients, usually (1) using randomized controlled trials and (2) afterward transferring effective clinical findings to the community. The National Institute of Health distinguishes between research for "dissemination" and research for "implementation," where the former refers to the targeted distribution of information and intervention materials to a specific public health or clinical practice audience. The latter tries to find out the best use of strategies to introduce or change evidence-based health interventions within specific settings (Proctor et al., 2009; Proctor et al., 2011).

In developing MAP-IT, measures were carefully selected to ensure that it was adequate, appropriate, and feasible and offered low implementation costs. Given the distinctions between different steps in translational research, MAP-IT is designed to enable practitioners to perform their tasks effectively and efficiently. This represents the T4 step in translational research. Our experience working with practitioners indicates that there is a need for a planning tool that practitioners feel comfortable using. Recently, Nilsen (2015) argued that existing theories, models, and frameworks that aim to translate research into practice fail to support practitioners in choosing suitable techniques to influence behavioral mechanisms. Furthermore, most frameworks do not consider "external criteria" in terms of the practitioner's cost constraints. For practitioners, the amount of knowledge available for intervention planning as proposed in implementation research is, in our view, still challenging and difficult to understand.

THE RATIONALE OF MAP-IT

MAP-IT supports health practitioners in designing systematic (theory-based and evidence-based) interventions, which is usually a complex task. MAP-IT is time-saving and easy to use. MAP-IT helps practitioners when selecting techniques to address relevant mechanisms in a guided manner, reducing cognitive effort and the need for in-depth knowledge of all the techniques available. The tool is written in matrix form. It (1) lists the mechanisms of a specific behavior for a specific age-group and (2) links techniques to mechanisms grouped by intervention components in the columns. MAP-IT synthesizes existing concepts and tools; among them, the most prominent are the BCW (Michie et al., 2011), the ANGELO framework (Swinburn et al., 1999), the BCT taxonomy (Michie et al., 2013), and IM (Bartholomew et al., 2011).

MAP-IT is constructed as a logical model (connecting objectives with mechanisms and BCTs) following a rationale.

To show the rationale of MAP-IT, we exemplify its use on older adults. The objective chosen here is to enhance older adults' volume of physical activity. Several meta-analyses and narrative reviews confirmed the health-enhancing effect of regular physical activities in older adults (e.g. Bouaziz et al., 2017; Ludyga, Gerber, Brand, Holsboer-Trachsler, & Puhse, 2016).

METHOD

According to the socioecological paradigm, it is essential to address personal and environmental mechanisms to successfully achieve behavior modification. The MAP-IT matrix (see Figure 2) is divided into a personal segment, addressing social-cognitive mechanisms, and an environmental segment, focusing on mechanisms concerning the physical, political/economical, and sociocultural environment (the two leftmost columns). Taking physical activity as an example, the column labeled "mechanisms" includes theory- and evidence-based mechanisms that promote physical activity in older individuals. Experts have identified these mechanisms using a consensus approach, which will be described later.

Theories, models, and frameworks underlying the specific mechanism of physical activity in older adults, and objectives regarding the mechanism are identified and written down in the second and third columns of the matrix, respectively. The headings of the subsequent nine columns are components or "intervention functions," as outlined in the BCW (Michie et al., 2014; Michie et al., 2011; education, persuasion, incentivization, coercion, training, restriction, environmental restructuring, modeling, enablement). The rows link a mechanism to an objective and address a "theory." This enables practitioners to establish a program theory as a basis for completing a theory-driven evaluation. In each cell of the matrix, BCTs are stated. BCTs are linked to mechanisms (in our example linked to mechanisms enhancing physical activity in older adults). BCTs are categorized in one or more intervention components.

	Mechanisms		Theories	Objectives	Intervention (PA, older people)								
					Components								
					Education	Persuasion	Incentivization	Coercion	Training	Enablement	Modeling	Environmental Restructuring	Restrictions
Personal	Self efficacy		TPB, HBM, HAPA, any program theory	Increase self-efficacy	Self-monitoring of behavior	Credible source, Self-talk, Social support (emotional)	Feedback on behavior, Biofeedback, Self-monitoring		Graded tasks, Behavioral practice/rehearsal	Self-belief, Mental rehearsal of successful performance, Self-talk, Self-monitoring, Reattribution, Belief selection, Goal setting (behavior)	Demonstration of the behavior	Restructuring the social environment	
	Social support		Social support theory, TPB, any program theory	Increase social support	Information about others' approval, Social comparison	Participation	Social reward, Social support (unspecified, practical, emotional)			Social support, (unspecified), Enhancing network linkages	Demonstration of the behavior	Restructuring the social environment	
	Knowledge		Theories of information processing, any program theory	Increase knowledge	Information about health consequences, Instructions on how to perform a behavior, Behavioral practice/ rehearsal, Active learning, Chunking	Credible source, Information about health consequences	Material reward, Self-reward, Social reward, Biofeedback, Non-specific incentive		Behavioral practice/rehearsal, Mental rehearsal of successful performance	Self-monitoring of behavior			
	Intention		TPB, HAPA, any program theory	Ease implementation intentions	Pros and Cons, Information about health consequences, Associative learning	Credible source, Anticipated regret	Commitment, Nonspecific incentive, Information about health consequences, Feedback on behavior, Biofeedback, Facilitation	Behavioral contract	Mental rehearsal of successful performance	Action planning, Comparative imagining of future outcomes, Goal setting (behavior)		Restructuring the social environment, Restructuring the physical environment	
	Motivation		Theories of motivation (e.g., SDT), any program theory	Increase motivation	Consciousness raising	Social support (emotional), Self-talk, Discrepancy between current behavior and goal	Feedback on behavior, Social support (unspecified, practical, emotional), Social reward, Focus on past success, Information about health consequences, Information about social and environmental consequences, Self re-evaluation			Goal setting (behavior), Prompts/cues	Demonstration of the behavior, Identification of self as role model	Environmental re-evaluation	
	Attitude		TPB, any program theory	Build positive attitude towards PA	Pros and Cons, Information about health consequences, Consciousness raising	Credible source, Anticipated regret	Associative Learning, Self re-evaluation		Behavioral practice/rehearsal	Comparative imagining of future outcomes	Identity associated with changed behavior	Environmental re-evaluation	
	Barriers (injury, fear, health status)		Any program theory	Reduce barriers	Information about health consequences, Consciousness raising	Information about health consequences, Social support (emotional), Participation, Information about emotional consequences, Verbal persuasion about capability	Goal setting (behavior), Feedback on behavior, Biofeedback, Social reward, Social support (unspecified, practical, emotional), Nonspecific incentive			Goal setting (behavior), Prompts/cues, Self-belief, Self-talk	Demonstration of the behavior		

(continued)

FIGURE 2 *(CONTINUED)*

		Type of environment											
Environmental	Access to facilities Pedestrian and cyclist infrastructure Aesthetics Walkability (land use mix, street connectivity, density) Traffic Safety	Physical	e.g., ANGELO; program theories regarding environmental features; socio-ecological theories	a) Increase access to facilities b) Create active buildings c) Improve pedestrian and cyclist infrastructure d) Improve walkability, bikeability, inviteability e) High quality streets and spaces f) Create safer traffic environment	a) Educate older individuals about public transport possibilities (Use of lay health workers)	b) Fact sheets and other information for politicians, planners, transport planners to promote active design (Use of lay health workers)	c) Change traffic light control to longer green light phases (Advocacy and lobbying, Creating and enforcing laws and regulations) c) Connect walking and cycling routes d) Create green spaces (Advocacy and lobbying, Mobilizing social networks) d) Empower older people to participate in decisions concerning planning community design (Participatory problem solving) f) Improve transportation safety guidelines (Creating and enforcing laws and regulations)		f) Train people how to properly behave in road traffic (as a pedestrian) (Use of lay health workers, Behavioral practice/rehearsal)	a) Connect homes with destinations (Systems change, Advocacy and lobbying) d) Create community coalitions to improve public open space (Forming coalitions)		b) Providing opportunities for activity inside and around buildings (Systems change) c) Improve the footpath network (Systems change) c) Establish bicycle paths (Systems change) d) Establish resting areas in parks and around shopping facilities (Advocacy and lobbying, Systems change) d) Make sidewalks more accessible for people with walking aids (Advocacy and lobbying, Forming coalitions) d) Reduce dead-end streets (Advocacy and lobbying, Forming coalitions) e) Supporting well designed streets and spaces and sustain a broader variety of users and community activities (Systems change)	f) Reduce traffic speed (Creating and enforcing laws and regulations)
	General Safety/Crime Costs	Political/Economic	ANGELO; program theories regarding environmental features; socioecological theories	g) Create safe environments h) Reduce costs for gym membership/PA courses	g) Educate people about safety rules (Use of lay health workers)		g) Increase surveillance (Enhancing network linkages) g) Increase social control/coherence (Enhancing network linkages)		g) Provide balance/mobility training to prevent falls (Behavioral practice/rehearsal)	h) Provide affordable sport/exercise courses (e.g., walking groups) (Advocacy and lobbying, Mobilizing social networks, Developing new social network linkages)		g) Increase street lighting (Creating and enforcing laws and regulations, Advocacy and lobbying, Forming coalitions) g) Create more openness when building or rebuilding open spaces (Creating and enforcing laws and regulations, Advocacy and lobbying, Forming coalitions) g) Maintain open spaces (Creating and enforcing laws and regulations, Advocacy and lobbying, Forming coalitions)	
	Physician Advice	Sociocultural	e.g., ANGELO; program theories regarding environmental features; socioecological theories	i) Educate authorities about the importance of their opinion/advice	i) Educate healthcare staff in giving health advices (Use of lay health workers)				i) Train healthcare staff in staff–patient communication (use of lay health workers/ Behavioral practice/rehearsal)				

FIGURE 2 The Matrix Assisting Practitioner's Intervention Planning Tool (MAP-IT)
NOTE: PA = physical activity; TPB = theory of planned behavior; HBM = health belief model; HAPA = health action process approach; SDT = self-determination theory; ANGELO = Analysis Grid for Environments linked to Obesity.

The environmental section of the matrix is subdivided into different types of environment: physical, political/economic, and sociocultural. The cells here are filled in using BCTs from the taxonomy by Michie et al. (2013) to address individual behavior, and with methods to change environmental agents and policies taken from IM (Bartholomew et al., 2011).

Five experts who are familiar with health promotion in research and practice independently selected mechanisms for physical activity in older adults, using a qualitative round table discourse. Each expert was asked to independently evaluate the importance of each mechanism and to prioritize 10 mechanisms as particularly relevant for a physically active lifestyle in older adults. The 50 mechanisms were discussed afterward and evaluated by the whole group. The first step resulted in a list of 50 mechanisms, which, in a second step, were discussed at a round table in order to come to an agreement on the most important mechanisms. A mechanism was included in the list of most important mechanisms when at least three of the five experts reached consensus regarding its relevance. This resulted in 15 mechanisms, which were found relevant to changing the physical activity behavior of older adults. Four of the 15 mechanisms were immediately included, as all researchers had listed them during the first step.

Primarily using the work by Michie et al. (2014) and Michie, Johnston, Francis, Hardeman, and Eccles (2008), BCTs were categorized into the various cells of the matrix. To place them, the same qualitative discursive approach was used as previously. Five experts acquainted with multicomponent interventions independently ascribed the BCTs to the cells of the matrix. Different ascriptions between the researchers were again discussed at a round table. Consensus was reached when at least three out of the five researchers agreed to an ascription.

Some BCTs may appear in more than one intervention component and may apply to more than one mechanism. Self-monitoring, defined as to "monitor and provide informative or evaluative feedback on performance of the behaviour (e.g. form, frequency, duration, intensity)," is a technique helpful in education and in incentivization (Michie et al., 2014, pp. 151-152). Furthermore, self-monitoring can be applied to change skills and therefore can be an appropriate measure in trainings, or it can foster self-efficacy and therefore serve as an enablement technique (Michie et al., 2008). Michie et al. (2013) and Bartholomew et al. (2011) in IM provided all definitions and examples of the MAP-IT techniques.

As for behaviors in general and—as used as an example here—physical activity specifically, self-efficacy is an effective psychological belief to motivate and to promote behavioral adherence. When planning the intervention, therefore, practitioners may choose to increase an older adult's self-efficacy as a relevant psychological mechanism. To increase self-efficacy, they may choose the component "training" (action self-efficacy). As a relevant environmental mechanism, they may focus on "perceived traffic safety" in terms of making people feel safer to move around in their neighborhood, which will support their belief in their ability to overcome obstacles (coping self-efficacy). A suitable component to address "traffic safety" might be "restriction" (e.g., speed limit). A theory that addresses different dimensions of self-efficacy is, for instance, the health action process approach (Schwarzer, 1992). The ANGELO framework (Swinburn et al., 1999) helps identify environmental barriers or enablers. The mechanisms self-efficacy and traffic safety are based on these theories (see Figure 1).

Experts' task in designing a complex intervention by using MAP-IT is to collect ideally evidence-based or even plausible mechanisms of a behavior that should be changed. They then sort the corresponding BCTs to change the behavior into the matrix's cells. A definition and an example of the techniques are easily available. Using MAP-IT is straightforward. It reduces the effort, as it readily offers an applied logic for designing a multicomponent intervention.

When crossing mechanisms (self-efficacy and traffic safety) with appropriate components, several BCTs can be identified. Looking at the cross section cell for self-efficacy and training, one finds, for example, the BCT "graded task." This BCT is defined as "setting easy-to-perform tasks, making them increasingly difficult, but achievable, until behavior is performed" (Michie et al., 2013: online Supplementary Materials Table 3). An example is provided as well: "Ask the person to walk for 100 yards a day for the week, then half a mile a day after they have successfully achieved 100 yards, then two miles a day after they have successfully achieved one mile" (Michie et al., 2013: online Supplementary Materials Table 3). Knowing the content of the BCT and having an example, practitioners can use the BCT and apply it to their specific intervention objective.

FUTURE PROSPECTS

One of the future tasks will be to update MAP-IT concerning different behaviors (e.g., diet, nonsmoking, etc.) and different priority populations (e.g., children, adolescents, etc.). This remains necessary because mechanisms of certain behaviors differ and different populations need different attentions. There will never be a "one-size-fits-it all solution." For instance, where

(subjectively assessed) personal safety (e.g., from crime) is an important mechanism for older adults to be active outdoors, it may not be as important for children and adolescents. Furthermore, the BCT "identification of self as role model" may be much more important for adults than for children. Even though it is challenging to develop MAP-IT for other health-enhancing behaviors and for different populations, it is worth striving for. After accomplishing this work practitioners have available a time-saving but theory-driven and evidence-based tool to systematically plan complex interventions.

Despite all the wheels, matrices, tools, and other helpful planning devices, designing and implementing interventions remain challenging processes. Success depends not only on the content of the intervention but also on the characteristics of those delivering and those receiving the intervention (e.g., different age-groups, different groups of vulnerable individuals, etc.) on the setting in which the intervention occurs (e.g., school, workplace, etc.) and on the modes of delivery (e.g., Internet-based intervention, mass media campaign, etc.). Furthermore, the success of an intervention depends on the intensity and duration of particular measures as well as the extent to which an intervention is delivered as planned (Horodyska et al., 2015). In its current state, MAP-IT is useful but in one respect is still insufficient: It does not take into account the context in which an intervention takes place. Context includes "the wider socioeconomic background, the health service system, the characteristics of the population, the prevalence or severity of the condition and how these factors change over time" (Campbell et al., 2007, p. 455). The use of a contextual system is an important issue because even systematic and well-designed interventions based on theory will not be effective in an inappropriate context. Using MAP-IT does not give dispensation from determining an intervention objective, setting aims, and targeting and tailoring the intervention. If these preconditions are not met, and if BCTs are incorrectly understood and applied, MAP-IT as well as other existing tools may not prove successful for designing multicomponent interventions.

CONCLUSION

MAP-IT was designed to support practitioners in developing theory-driven and evidence-based interventions that aim to change the behavior of particular individuals or groups of people. The matrix offers a practical, time-saving tool for designing and evaluating multicomponent interventions. It leads practitioners to address relevant behavioral mechanisms and to link these with intervention components and related BCTs. Even when using MAP-IT there still remain challenging tasks. We hope that health practitioners will find that MAP-IT facilitates intervention development and evaluation.

REFERENCES

Bartholomew, L. K., Parcel, G. S., Kok, G., Gottlieb, N. H., & Fernandez, M. E. (2011). *Planning health promotion programs: An intervention mapping approach* (3rd ed.). San Francisco, CA: Jossey-Bass.

Bauman, A. E., Sallis, J. F., Dzewaltowski, D. A., & Owen, N. (2002). Toward a better understanding of the influences on physical activity: The role of determinants, correlates, causal variables, mediators, moderators, and confounders. *American Journal of Preventive Medicine, 23*(2 Suppl.), 5-14.

Biddle, S. J. H., Brehm, W., Verheijden, M., & Hopman-Rock, M. (2012). Population physical activity behaviour change: A review for the European College of Sport Science. *European Journal of Sport Science*, *12*, 367-383.

Bouaziz, W., Vogel, T., Schmitt, E., Kaltenbach, G., Geny, B., & Lang, P. O. (2017). Health benefits of aerobic training programs in adults aged 70 and over: A systematic review. *Archives of Gerontology and Geriatrics*, *69*, 110-127.

Campbell, N. C., Murray, E., Darbyshire, J., Emery, J., Farmer, A., Griffiths, F., . . . Kinmonth, A. L. (2007). Designing and evaluating complex interventions to improve health care. *British Medical Journal*, *334*, 455-459.

Davidoff, F., Dixon-Woods, M., Leviton, L., & Michie, S. (2015). Demystifying theory and its use in improvement. *BMJ Quality & Safety*, *24*, 228-238.

Davis, R., Campbell, R., Hildon, Z., Hobbs, L., & Michie, S. (2015). Theories of behaviour and behaviour change across the social and behavioural sciences: A scoping review. *Health Psychology Review*, *9*, 323-344.

Glanz, K., & Bishop, D. B. (2010). The role of behavioral science theory in development and implementation of public health interventions. *Annual Review of Public Health*, *31*, 399-418.

Glasgow, R. E., & Emmons, K. M. (2007). How can we increase translation of research into practice? Types of evidence needed. *Annual Review of Public Health*, *28*, 413-433.

Glass, T. A., & McAtee, M. J. (2006). Behavioral science at the crossroads in public health: Extending horizons, envisioning the future. *Social Science & Medicine*, *62*, 1650-1671.

Gonzales, R., Handley, M. A., Ackerman, S., & O'Sullivan, P. S. (2012). A framework for training health professionals in implementation and dissemination science. *Academic Medicine*, *87*, 271-278.

Greaves, C. J., Sheppard, K. E., Abraham, C., Hardeman, W., Roden, M., Evans, P. H., . . . The IMAGE study Group. (2011). Systematic review of reviews of intervention components associated with increased effectiveness in dietary and physical activity interventions. *BMC Public Health*, *11*, 119.

Green, L. W., & Kreuter, M. W. (1991). *Health promotion planning: An educational and environmental approach*. Mountain View, CA: Mayfield.

Heath, G. W., Parra, D. C., Sarmiento, O. L., Andersen, L. B., Owen, N., Goenka, S., . . . Brownson, R. C. (2012). Evidence-based intervention in physical activity: Lessons from around the world. *Lancet*, *380*, 272-281.

Horodyska, K., Luszczynska, A., van den Berg, M., Hendriksen, M., Roos, G., De Bourdeaudhuij, I., & Brug, J. (2015). Good practice characteristics of diet and physical activity interventions and policies: An umbrella review. *BMC Public Health*, *15*, 19.

Lacouture, A., Breton, E., Guichard, A., & Ridde, V. (2015). The concept of mechanism from a realist approach: A scoping review to facilitate its operationalization in public health program evaluation. *Implementation Science*, *10*, 153.

Lobb, R., & Colditz, G. A. (2013). Implementation science and its application to population health. *Annual Review of Public Health*, *34*, 235-251.

Ludyga, S., Gerber, M., Brand, S., Holsboer-Trachsler, E., & Puhse, U. (2016). Acute effects of moderate aerobic exercise on specific aspects of executive function in different age and fitness groups: A meta-analysis. *Psychophysiology*, *53*, 1611-1626.

Michie, S., Atkins, L., & West, R. (2014). *The behaviour change wheel: A guide to designing interventions*. London, England: Silverback.

Michie, S., Fixsen, D., Grimshaw, J. M., & Eccles, M. P. (2009). Specifying and reporting complex behaviour change interventions: The need for a scientific method. *Implementation Science*, *4*, 40-45.

Michie, S., Johnston, M., Francis, J., Hardeman, W., & Eccles, M. (2008). From theory to intervention: Mapping theoretically derived behavioural determinants to behaviour change techniques. *Applied Psychology*, *57*, 660-680.

Michie, S., & Prestwich, A. (2010). Are interventions theory-based? Development of a theory coding scheme. *Health Psychology*, *29*(1), 1-8.

Michie, S., Richardson, M., Johnston, M., Abraham, C., Francis, J., Hardeman, W., . . . Wood, C. E. (2013). The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: Building an international consensus for the reporting of behavior change interventions. *Annals of Behavioral Medicine*, *46*, 81-95. doi:10.1007/s12160-013-9486-6

Michie, S., van Stralen, M. M., & West, R. (2011). The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science*, *6*, 42.

National Institute for Health and Clinical Excellence. (2007). *Behaviour change: The principles for effective interventions* (Public Health Guidance No. 6). London, England: Author.

Nilsen, P. (2015). Making sense of implementation theories, models and frameworks. *Implementation Science*, *10*, 53.

Noar, S. M., & Zimmerman, R. S. (2005). Health behavior theory and cumulative knowledge regarding health behaviors: Are we moving in the right direction? *Health Education Research*, *20*, 275-290.

Pawson, R., Greenhalgh, T., Harvey, G., & Walshe, K. (2004). *Realist synthesis: An introduction* (ESRC Research Methods Programme. RMP Methods Paper 2/2004). Manchester, England: University of Manchester.

Porcheret, M., Main, C., Croft, P., McKinley, R., Hassell, A., & Dziedzic, K. (2014). Development of a behaviour change intervention: A case study on the practical application of theory. *Implementation Science*, *9*, 42.

Proctor, E., Landsverk, J., Aarons, G., Chambers, D., Glisson, C., & Mittman, B. (2009). Implementation research in mental health services: An emerging science with conceptual, methodological, and training challenges. *Administration and Policy in Mental Health*, *36*, 24-34.

Proctor, E., Silmere, H., Raghavan, R., Hovmand, P., Aarons, G., Bunger, A., . . . Hensley, M. (2011). Outcomes for implementation research: Conceptual distinctions, measurement challenges, and research agenda. *Administration and Policy in Mental Health*, *38*, 65-76.

Ruckstuhl, B., Somaini, B., & Twisselmann, W. (1997). *Förderung der Qualität in Gesundheitsprojekten. Der Public Health Action Cycle als Arbeitsinstrument*. Zürich, Germany: Insitut für Sozial und Präventivmedizin.

Sallis, J. E., Cervero, R. B., Ascher, W., Henderson, K. A., Kraft, M. K., & Kerr, J. (2006). An ecological approach to creating active living communities. *Annual Review of Public Health*, *27*, 297-322.

Schwarzer, R. (1992). Self-efficacy in the adoption and maintenance of health behaviors: Theoretical approaches and a new model. In R. Schwarzer (Ed.), *Self-efficacy: Thought control of action* (pp. 217-242). Washington, DC: Hemisphere.

Stokols, D. (1996). Translating social ecological theory into guidelines for community health promotion. *American Journal of Health Promotion*, *10*, 282-297.

Swinburn, B., Egger, G., & Raza, F. (1999). Dissecting obesogenic environments: The development and application of a framework for identifying and prioritizing environmental interventions for obesity. *Preventive Medicine*, *29*, 563-570.

Trickett, E. J., & Espino, S. L. R. (2004). Collaboration and social inquiry: Multiple meanings of a construct and its role in creating useful and valid knowledge. *American Journal of Community Psychology*, *34*, 1-69.

Woolf, S. H. (2009). The meaning of translational research and why it matters. *Journal of the American Medical Association*, *299*, 211-213.

World Health Organization. (2003). *Diet, nutrition and the prevention of chronic diseases* (WHO Techical Report Series No. 916). Geneva, Switzerland: Author.