

A primer on self-regulation and health behavior change

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INTRODUCTION

Let us think of activities such as recreational walking, biking, or running, all of which are good examples of popular health behaviors. Looking at key journals in Exercise Science¹ in the past 40 years, it is clear that a majority of research has been devoted to documenting the health outcomes of such behaviors and the associated biological mechanisms, but comparatively less research explored the antecedents of those behaviors (also called determinants). Although the earlier trend was important to establish the social and public health relevance of this field as a whole, the time has now come when exploring how to get people to be more physically active is as important as showing why and how physical activity improves health. As an example, an exercise science researcher might be interested in exploring why some people are motivated to engage in walking or running while others are not. In turn, a government official might be interested in finding a cost-effective intervention to influence more people to take up bicycling as a means of transportation to work. Finally, a health practitioner, such as a fitness trainer or a physician, could find good use for techniques that effectively increase the adoption and maintenance of these activities by a client or patient. At the center of all these questions is the issue of how these behaviors are causally determined and regulated. That is, identifying which factors - whether they reside in the individual in the surrounding socio-cultural, economic, or built environment - influence the likelihood of adherence to certain behavioral patterns by individuals and groups. It is also critical to explore how these factors

dynamically interact to influence behavior or behavior change in predictable ways; how models and theories can be used to coherently organize these determinants or predictors; and how interventions can be designed to effectively impact predictors and, consequently, behavior. This article explores some of these topics with the aim of providing a bird's eye view of the field of health behavior self-regulation, drawing primarily on adult research in non-clinical populations.

What is self-regulation?

For the purpose of this text, the use of "self" in self-regulation denotes a common bias present in most theories of health behavior towards the characteristics of the individual (i.e., the self) as the most critical factors in influencing his or her behavior. Psychological aspects such as perceptions, attitudes, beliefs, emotions, or goals are examples of such individual-level factors. The term self-regulation is used in different areas of Psychology (e.g. education, child development, health) and has many definitions, originating from equally different perspectives (1). Even within the same area, such as the one highlighted in this text - health - it is obvious that different experts mean different things when they use this expression. Very simply, one can generally think of self-regulation (SR) as describing the psychological and behavioral processes by which people move towards certain goals. A goal could be stopping eating when full, getting up at 7:00 AM, or starting an exercise program. Despite its simplicity, this definition highlights the fact that SR is mostly thought of as a process, not an individual trait; that it involves

¹E.g., *Exercise and Sport Sciences Review or Medicine and Science in Sports and Exercise*

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movement or action (often referred to as steering processes); and that is inherently goal-directed (not merely thoughts in people's mind or other subjective experiences). It also accepted that both conscious and automatic processes can be involved in self-regulation (2).

A more precise definition of SR is "a multi-component, multi-level, iterative, self-steering process that targets one's own cognitions, affect, and actions, as well as features of the environment for modulation in the service of one's goals" (1). A fundamental distinction is often made between goal setting processes, or how people decide about what to achieve or be like; and goal striving, or how people act to get there (3). The former is concerned with the nature of goals (e.g. whether they are personally chosen or imposed; whether they are approach- or avoidance-type; performance/outcome vs. mastery/process-oriented, etc.). Goal striving processes, in contrast, concern issues of implementing and performing certain actions, such as creating coping plans, applying if-then contingencies (sometimes called implementation intentions), using inhibition, monitoring or evaluation processes, etc. This basic distinction will be explored again later in this paper.

A common perspective on SR is that of a higher-level control mechanism that allows individuals to do what they want or what they have chosen, instead of what they "feel like" at each moment in time (e.g., like a dog or a cat might). Often called self-control, this perspective on SR emphasizes the effort involved in overriding automatic responses and impulses, and is sometimes referred to as a strength model of SR (4). Self-control is thought to be dependent on trait-like individual tendencies and is conceptualized as a resource (e.g., willpower or inhibitory capacity) that is finite and can be exhausted with intensive use, and consequently needs to be replenished frequently. Simply put, resisting temptations is tiring and one cannot do it endlessly or it will result in ego depletion and self-regulatory failure (4). Terms such as self-control, willpower, or resisting temptation are attractive and very popular in lay explanations of human behavior. However, the self-control model of self-regulation, although it provides an interesting hypothesis to explain behavior in very specific single tasks (e.g. resisting eating a cookie), has not yet translated into substantial advances in the fields of health behavior (5) or exercise science (6). Indeed, interventions to change self-control in meaningful ways (that impact health) have not yet been tested and refinements to the model may be necessary (and/or alternative hypothesis explored) before it is accepted more widely (7).

The strength model of SR is often presented as an

alternative (or a complementary explanation) in relation to more established social cognition models of health behavior (see Table 1 later in this text). As an example, and just to illustrate the diversity of perspectives on self-regulatory processes, one could use self-determination theory or SDT (8). This is a framework that emphasizes one aspect of SR not present in other theories, i.e. the extent to which a goal or action is truly self-endorsed. That is, whether it is relatively internal to the individual (sometimes called intrinsic), or alien to and "pressured upon" the self (thus, more external), a distinction expected to markedly influence motivation. According to this view of human motivation, the content of goals (what people pursue) is also important and, along with the quality of motivation (internal vs. external), is associated with having more or less energy to persist in difficult tasks, maintain the behavior in the long-term, and derive more satisfaction from it (9, 10). As such, internal or autonomous SR appears to increase self-regulatory capacity, rendering self-control less tiring and willpower less decisive (11). Indeed, motivation has been highlighted as a potential important moderator of ego depletion and self-control, as presented before (7). In relation to the notion of control, SDT essentially contrasts feeling "in control" with feeling "controlled," placing the emphasis on the personal and internal experience (the phenomenology) of behavioral regulation as a key determinant of desired outcomes.

The emerging area of Health Behavior Change

The previous section was partially meant to introduce the reader to the area of SR, which is a central topic in the broader movement known as Health Behavior Change (HBC). With the paradigm shift towards a chronic disease model of health care, there was an exponential growth in interest in and need for scientifically based knowledge in the areas of preventive, behavioral, and lifestyle medicine and health (12). Indeed, gains and losses in public health have never been so dependent on individual decisions made by citizens in how they use their free time, what and how they eat, drink, and consume, how well they rest, how they care for their bodies, etc. Even failing to take prescribed medication is currently seen as a behavioral problem (13). With widespread access to information (via easy and pervasive information and communication technologies) and the growing tendency towards individualism and self-reliance that defines western societies, the need to understand how individuals make decisions about behaviors that affect their health is greater than ever.

The number of scientific fields that currently contribute to advances in HBC theory and practice is large. Examples are various areas of Psychology (e.g., social psychology, exercise psychology, decision-making); cross-disciplinary areas such as appetite and eating regulation, behavioral economics, and behavioral neurosciences; education (e.g. parenting) and other social sciences such as sociology, communication, marketing, and urban planning; and of course public health and medicine. However, it is fair to say that health psychology on one hand, and behavioral/preventive medicine on the other, and especially their interface with areas such as nutrition, physical activity, sleep, addiction, and stress management (among others), are probably responsible for the lion's share of progress in HBC. This notwithstanding, the areas of self-regulation and HBC are good examples of truly cross-disciplinary fields.

An analysis of studies in HBC reveals the emergence of certain key themes and topics. First is the development, testing, and use of theory to understand patterns of health-related behaviors. Second are studies evaluating behavior prediction models, based on certain groups of determinants (note: often selected a priori from a theory or theories, but not necessarily so). Third is the design, testing, translation, implementation, and dissemination of behavior change interventions. In this case, recent emphasis has been placed on identifying and classifying the elementary aspects of an intervention, commonly referred to as behavior change techniques (14). These three topics are addressed in the remainder of this article.

Theory

It is fair to say that people involved in HBC interventions are often at a loss about what to do with (behavior change) theory. Policy makers and officials are commonly too distant from theoretical, sometimes even scientific, considerations and mostly want to be told "what works" (12). Health professionals might want to use theory, but most have had little training on behavior change and do not know how (or if) it can inform their practices. Finally, researchers involved in behavior change interventions have frequently neglected theory or have used it inadequately. However, things seem to be changing. Theory discussions abound (e.g. (15, 16)), new theories are being developed (PRIME Theory (17), I-Change model (18), CEOS theory (19)), older theories are being refined or made more accessible (e.g., SDT (9)), and promising links to policy are being explored (e.g. (20)). Indeed, the topic is currently a lively and exciting area of discussion and new developments; one recent example is the debate on whether some popular theories should be put to rest (e.g. (21)). At the same

time, well-known intervention methods, such as Motivational Interviewing or Health Coaching, are "looking for a theory" to explain how they work, or why and when they do not (22). Importantly, a broad consensus emerged indicating that HBC interventions should be informed by theory, and ways are being pursued to further translate theory to practice (23).

Many definitions of theory exist. A popular one is a "systematic way of understanding events or situations and (...) a set of concepts, definitions, and propositions that explain or predict these events or situations by illustrating the relationships between variables" (24). Generally, three reasons can be offered to support using theory when designing HBC interventions. First, interventions should be more effective if they target true causal determinants of behavior change, which theories describe in detail. Second, theory can be tested and improved by intervention research only if those interventions are appropriately theory-based. Third, theory-based interventions facilitate the understanding of what does and does not work during intervention research (25). As it is the best way to organize current knowledge into coherent models that confer predictability to a set of constructs, one can confidently say that, in HBC research, theory is here to stay.

A lingering problem with HBC theory is simply how many theories there are! Recently, a panel has identified 83 theories of HBC, and authors noted that some were still left out, such as models coming from sociology and economics (26). Navigating such a populated scenario is no easy task and it is indeed understandable that more people claim to be theoretical in their work than those who effectively are (27). For instance, researchers are often at a crossroads between using a single theory to inform their work – and being criticized for leaving out other perspectives or potentially important determinants – or being theory-eclectic, trying to include concepts from multiple theories in their interventions – in turn risking superficiality in the use of each model, and potentially mixing "apples and oranges" in their integrative quest. The detail and internal coherence offered by single-theory approaches is obviously limited by the fact that no unique perspective appears to encompass all factors influencing a particular behavior. On the other hand, the most integrative and comprehensive theories are presented as very complex models that may resist being tested in scientifically-practical ways (e.g. (18, 19)). Learning the principles of complex models in accessible ways may also pose a high burden on practitioners, making translation and dissemination difficult. As one of the first papers to directly address this issue, a very recent review of physical activity interventions suggests that single-theory approaches

may be more effective than eclectic, multiple-theory approaches to theory application (28).

One often forgotten theme in discussions about HBC theory is that each theory has underlying, fundamental views about human motivation and behavior, which may or be not be compatible with views from other theories. Thus, integrating two or more perspectives that do not share ontological assumptions about how humans function may increase the model's statistical predictive power, but may also result in a hybrid of sorts, lacking internal coherence and parsimony. More importantly, it can limit the task of developing the new model further (as inconsistencies are likely to emerge (29)), and communicating to others about it in reasonably simple ways may also be difficult – it's difficult enough to know one theory well!

Finally, applying theory to specific behavior change contexts faces a multitude of potential “moderating” factors, such as the endpoint behavior (e.g. whether it has an addictive component or not), the population targeted (age; clinical situation; socially stigmatized conditions, etc.), whether the goal is to change a one-off behavior (e.g. vaccination) or a pattern of inter-related behaviors to be adopted for life (e.g. healthy eating), or if it is an “avoidance” vs. an “approach” behavior (e.g., smoking vs. physical activity).

Markers of progress

One direction to help those involved in the business of using theory to change behavior is to make the necessary effort to speak approximately the same language, know (sufficiently) what others are doing, be clear and explicit when reporting what we are doing (and why), and evaluate what is produced rigorously and systematically. In more concrete terms, this means deciding what a good HBC theory is (and presumably choosing those primarily); being clear about which theory-derived elements will be targeted by an intervention, and be effective in influencing those “mediators”; and describing which behaviors and strategies interventionists should use and evaluating whether they are indeed using them, and with how much fidelity. Although this may look at least feasible, the fact is that it has not been the norm (30). As a result, we currently know little about whether using theory makes interventions more effective than being atheoretical and which theories outperform others (and for which settings and outcomes). Progress is also needed on whether single-theory approaches are more or less effective than multiple-theory ones, and on how to adequately implement theory A or theory B in terms of the strategies and techniques that best impact their key constructs (28, 30). This is a scenario that may favor those inclined to discount theory as too complex

and lacking practical usefulness. It is also a reality where true scientific progress – in theory development and theory application – may be too slow and not easily transferred across fields, among scientists, and between academia and practitioners in the field.

Fortunately, progress is also visible. For instance, using an open, participated, cross-disciplinary approach, Susan Michie and colleagues have been working systematically at various levels of HBC theory and intervention, trying to coherently bring together science, policy, and the practice of theory-based health behavior change. Perhaps their best-known work is the Behavior Change Techniques (BCTs) Taxonomy, a systematic description and organization of strategies used by interventionists in real life (or in research trials) to help change their patients' and clients' behavior (31). Through the same process that took place to develop the BCC Taxonomy, a panel of experts is also undertaking the effort to link these techniques to theories and theoretical constructs. They are also active in producing a consensus definition of criteria to evaluate the quality of theory in respect to HBC interventions (32), and have also developed the Behavior Change Wheel in an effort to organize descriptive information about HBC interventions and make communication to all interested parties, namely funding agencies and government officials, more coherent (20). Finally, and more specific to the present topic, they have recently published the “ABC of Behavior Change Theories” (26), a comprehensive compendium where policy makers, practitioners, and especially researchers can easily find rigorous and succinct information about most HBC theories, including their constructs, main tenets, and their relationships with other theoretical perspectives. Although other initiatives have taken place to advance the use and testing of HBC theory (e.g. the Intervention Mapping Approach (33)), the Centre for Behaviour Change's collective work stands out, in recent years at least, as one of the most significant.

So how useful is theory to inform HBC interventions and make them more effective? The painful truth is that, while many agree theory should be useful, proof remains elusive, and the available evidence is not yet conclusive as to the superiority of using theory. A most recent example is a systematic review and meta-analysis of what is probably the most popular theory in HBC – Social Cognitive Theory (SCT, (34)) – and how well it predicts physical activity (35). While the authors concluded that SCT is useful to explain PA, they also stated in their abstract that “higher quality models explained more PA variance, but overall methodological quality was poor. As such, high-quality studies examining the utility of SCT to explain

Table 1. A selection of current Health Behavior Change theories.

	Sound and well-accepted?	Practical for intervention?	Evidence for effectiveness?
Theory of Planned Behavior	***	*	**
Social Cognitive Theory	***	**	**
Self-Determination Theory	**	***	**
Self-Regulation Theories	**	***	**
PRIME Theory	**	**	*

PA are warranted” (35). If this is the reality for the most popular framework to understand physical activity (44 studies and 55 models were analyzed) and many other health behaviors, one can easily conclude that the scenario is worse for other frameworks. For instance, we have reviewed studies using SDT for predicting PA, eating, and weight control, and could only find 18 SDT-based intervention studies, with considerable variability in study quality (36). It is clear that conclusions must, at best, be suggestive in this scenario. A recent review by Gurlan and colleagues (28) provides a more positive scenario regarding the use of theory (for changing PA) by showing that theory-based interventions significantly impacted behavior with a significant pooled effect size of 0.31 in 82 intervention groups.

As tentative as the current situation may seem, being atheoretical is not a good option. Whether the process involved was theory-driven (“top down”) or reality-driven (“bottom up”), the fact is that theories have always been needed to pave the way to effective knowledge accumulation, refinement, and dissemination, and it shall be no different in the field of HBC. While predicting human behavior is probably among the greatest challenges there are in science, we must continue to be “scientific” about it and progress shall occur. The fact that so many important scientific societies², which include HBC theory within their key themes, as well as their highly-ranked journals and annual meetings are more vibrant than ever is evidence that researchers are up for the challenge. We should also be reminded that, despite its popularity, this is still a relatively new and emerging field. For instance, a key society such as ISBNPA is only 12 years old,

² E.g., *International Society of Behavioral Nutrition and Physical Activity (ISBNPA)*, *European Health Psychology Society (EHPS)*, *Society of Behavioral Medicine (SBM)*.

and obesity has only recently been recognized as primarily a behavioral or lifestyle problem.

Which theories are most promising?

To adequately answer this question, one would have to agree on the best criteria to judge the usefulness of a given HBC theory. Although this is not an easy task, it should probably include a combination of “internal validity” (theoretical soundness, as well as being well-known and reasonably accepted by the scientific community), “external validity” (practical applicability to the behaviors du jour, from smoking to weight control-related diet and exercise), and a sufficient evidence base for effectiveness. In other words, to be useful, a theory should be recognized by most experts as valid, be reasonably simple and practical, and of course be effective. From the previous sections, it may already be apparent that the challenge is progressively greater as we move from the first (internal coherence) to the last (effectiveness) of these criteria.

Table 1 presents a list of some of the most popular HBC frameworks (e.g., The Theory of Planned Behavior (37) and Social Cognitive Theory (34)) along with some newer and/or promising approaches, all of which are rated subjectively on the three previous criteria. It should be noted that self-regulation theories can include the aforementioned strength model of SR as well as models focused on goals (3), on implementation intentions (38), or even on more comprehensive models focused primarily on the intention-behavior gap, such as the Health Action Process Approach (HAPA) (39). Although these clearly represent different perspectives on SR, they have in common a more functional approach to behavior change and a limited reliance on traditional social cognition processes such as attitudes and motives. Included are also PRIME theory (17), as perhaps the best example of broad integrative theories which include various levels of regulation and motivation (such as reflective and automatic); and SDT, considering its in-depth analysis of motivation and its current popularity in the health field (although it has been developed and used for a few decades in other areas of psychology) (40). More detailed descriptions of these models/theories can be found in the original references and in many other sources (e.g. (26)).

The first criteria, theory soundness and acceptability (which are in fact two different but related factors), includes aspects such as clarity of constructs, their inter-relationships and measurability, causality mechanisms towards behavior change, and generalizability (41,42). The Theory of Planned

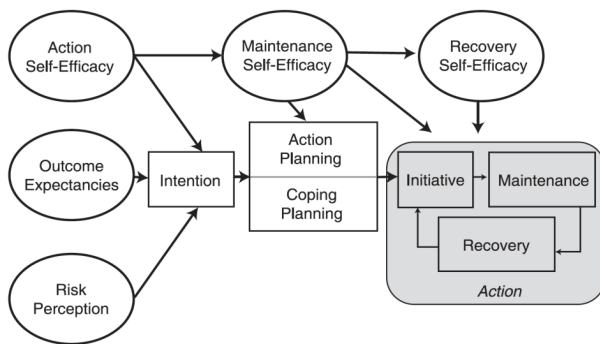


Figure 1. A causal model of behavior.

Behavior (TPB) (37) and PRIME Theory (17) are well-developed, detailed theories of human behavior that nevertheless are not favored by the scientific community, either because time has taken its toll and they have been progressively abandoned in favor of newer models (TPB) or because they are relatively new and not well-known (PRIME). It should be said that there are other examples of integrative models, which seem coherent and valid at face value, but have not been tested in experimental studies (e.g., the Integrated Behavior-Change Model (43)). As stated before, self-regulation theories are generally well-accepted and promising approaches, although they are at variable stages of evaluation, especially using experimental designs, which limits acceptability. They also have a limited scope, as they tend to assume that motivation is already present, which of course is not always the case. Finally, SCT and SDT score highest on both internal coherence and widespread recognition and acceptability.

Practical utility refers to the extent to which one can easily find (in the description of the model/theory) what its implications are for real life interventions. In simple terms, if a practitioner wants to use a certain theory to influence his/her work, will he/she find easy guidelines on what to do in order to respect the theory's premises and aptly target its key constructs? This is of course also relevant for applied research, where intervention fidelity is necessary and where a fine balance must be found between precision (to be replicable and measurable) and parsimony (for translation to practice to be feasible). In this respect, perhaps because theories have generally been developed with a top-down approach, emphasizing psychological mechanisms before practical use, no theory scores very high. Self-regulation theories describe clear behaviors and strategies to be implemented in real life HBC interventions (e.g. self-monitoring, goal selection and goal progress, action

planning, etc.), although it is not always clear which mediating mechanisms will ensure long-term retention of the target behaviors. In turn, SDT and SCT have posited detailed mechanisms underlying behavior change (and lasting motivation, in the case of SDT) but the strategies to change them are still incompletely described. The links between SDT and Motivational Interviewing, a reasonably successful and very popular clinical method to enhance internal motivation for change, are to be noted here (44). Conversely, the TPB, which was primarily conceived as a model to explain individual differences (i.e., variance) in intention and behavior, and PRIME Theory, a complex model requiring considerable "breaking down" to be properly applied and tested, score the lowest on this item. While PRIME currently represents a wide-spanning conceptual integration of determinants of behavior change, its proponents have the well-grounded ambition to use it to influence real life and clinical practice (and have attempted to do so in the area of smoking (45)). It is therefore a promising model for the future.

As far as evidence, the TPB, SCT, and SDT share moderately consistent supportive (if mostly cross-sectional) evidence for its association with lifestyle behaviors, and they also share some evidence for its efficacy in actually changing behavior, experimentally (28). Of these, the TPB is perhaps the least likely to be pursued in the future (21, 46), while SDT is perhaps the most promising, not only considering what experimental studies are currently showing (28) but also because it is considerably popular at the present time. As two examples of large multi-site studies, both the FP-7 EuroFIT project (<http://eurofitfp7.eu>, 2013-2018) and the Horizon2020 NoHow project (<http://nohow.eu>, 2015-2020) interventions have been strongly influenced by SDT. It is also expected that PRIME Theory and several SR theories might see considerable progress in the near future.

Determinants

Theories are useful to model, explain, and predict behavior, and they are based on a set of interrelated variables or predictors. These are commonly named determinants, and both terms – predictors and determinants – imply the causal inferences assumed in most HBC theories: variable A predicts variable B (etc...), which in turn predicts behavior (see Figure 1). Prediction is needed not only in the statistical sense (i.e., models being reliably or significantly associated with outcome) but also in the most applied sense: interventions are expected to cause behavior change and need theories to help "significant causation" to be manifest in real life change. However, interventionists

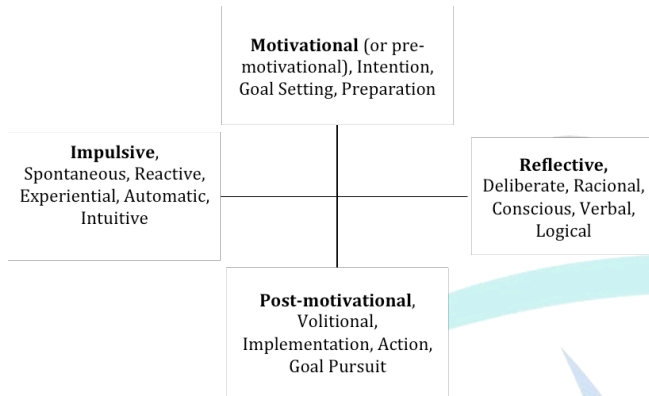


Figure 2. Simple conceptualization of dual-process models of behavioral regulation.

generally do not have the power to directly and immediately change another person's behavior, at least not in way that affects relevant health outcomes and for long periods. Clearly, most health behaviors occur in real life, outside the professionals' direct influence, and over extended periods of time. This means that the goal should be to influence behavioral determinants, i.e., the critical variables that intermediate the effects of the intervention on health behavior. This explains why HBC research is currently focused on studying the best formal mediators of interventions (47). To the extent that an intervention is successful in changing certain mediators (e.g. motivation and key skills), and studies show these to be reliably predictive of behavior (e.g. change in physical activity), we have a model from which we can infer how behavior can be changed in future replications. Unfortunately, as stated above, if we consider the multitude of theories available and the various health behaviors of interest, there are still few (good quality) mediator studies per theory-behavior to confidently derive solid conclusions. Figure 1 shows the HAPA model (42) including multiple mediating paths, just as a graphical illustration.

Individual-level determinants or mediators have been organized in several ways. At a functional level, they can be organized into two large groups consisting of motivation, related to the direction of intentions or behavior (but also to the energy necessary to actually "move" in that direction); and skills and abilities, which can be summarized as enabling factors within the individual. As used here, motivation describes a very broad category that includes, for instance, issues of identity and self-perceptions, values, beliefs, goals, and expectations. Skills and abilities include aspects like goal setting skills, self-awareness, emotional regulation, problem solving, or executive function (note: although there are many empirical questions to be tested here, self-regulation skills and abilities can

be conceived as independent of the direction of and the motives driving behavior).

Another common organization of behavior determinants distinguishes the regulatory level, in the brain, at which they occur. These so-called dual-process models classically pit higher-level, deliberate, reflective processes (e.g. cognitive processes such as goals and explicit attitudes) against lower-level, spontaneous, automatic processes that occur without conscious control and are often based on affective associations related to seeking pleasure or avoiding displeasure (e.g., impulses and reactions). One can imagine, for instance, how many food-related decisions are made on a daily basis for a good example of the potential of such lower-level processes to "determine" behavior. The more deliberative system has also been named the "cold system," and the impulsive system, the "hot system" (48) (see Figure 2). PRIME theory (17) as a good example of a framework that explicitly includes both systems.

Another organization of personal variables involved in behavioral regulation distinguishes between "pre-motivational" (or pre-intentional) and "post-motivational" (e.g., planning, implementation, action control) phases. In a way, it is similar to the first categorization above (motivation + ability), but focuses more on the phase in which it is functional, the former preceding and providing the rationale for the latter. It can also be conceived as a dual-process system (Figure 2). As a classical psychological theory (9), SDT is one good example of a theory mostly focused on "pre-motivational" aspects. Again, interesting empirical questions can be formulated and tested relating to the interface of "pre" and "post" motivational determinants (e.g. (11)).

As we will see later, modeling and organizing determinants (or self-regulation) in such ways serves not only a theoretical purpose but can also help guide intervention design. This notwithstanding, these models are limited in real life since processes on both "sides" are intertwined and influence each other in dynamic ways that challenge simple conceptual organizations. For instance, skills and competence clearly influence motivation; one tends to prefer activities that one feels more competent in. In turn, the content of motives (the "why" of motivation) can potentially influence the effectiveness of self-regulatory strategies (49). Finally, "conversations" between our impulses or drives (the "elephant" in some metaphors) and our most rational selves (the "cold rider") are well-known phenomena, at least to those familiar with the concept (and pains) of procrastination!

In addition to intra- and inter-individual factors, such as the ones highlighted so far, the role of the context or the environment – whether it is physical, cultural, or

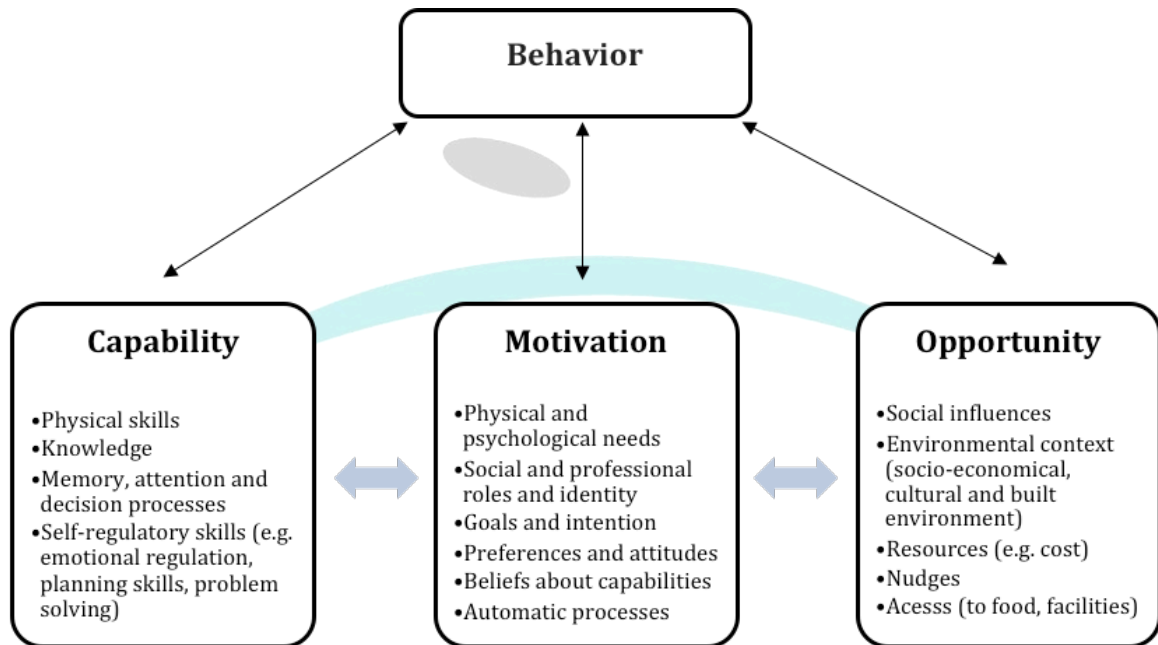


Figure 3. The COM-B system of behavior. Adapted from *Michie et al 2011* (20) and *Cane et al (2014)* (60).

social - is also never too far from sight in the area of behavioral self-regulation. The best example is thinking of how social agents, such as health professionals or family members (e.g. parents), can influence a person's path towards a certain lifestyle. This exemplifies the change element in HBC (or behavior modification, as its often called), partially referring to how interventions can be designed to effectively create the conditions that best support individuals and groups to modify or maintain certain socially-valued behavioral patterns. Another example is the way certain environmental factors residing outside the influence of single individuals, such as financial constraints and low accessibility; barriers, prompts or "nudges" in the built or social environment; or the effects of marketing and advertising, can powerfully influence and even constrain people's decisions. Of course, individual factors can and often interact with contextual factors in producing important behavioral outcomes, such as when powerful motives energize the creative manipulation of one's proximal environment, finding effective ways around socio-environmental barriers, whatever they may be.

Behavior Change Interventions and Techniques

The final section of this paper concerns the most applied and socially meaningful aspects of self-regulation and behavior change: namely, how lessons

learned from theory and its constructs are brought to life in concrete ways – in the form of interventions, large and small – to influence real world behaviors. In many regards, HBC intervention development, along with testing, translation, and dissemination initiatives, are the most important outcome of the collective work of all those dedicated to improving population health. Indeed, interventions often bring together many of the agents involved in public, clinical, or preventive health: funding agencies, governmental bodies, researchers, educators, practitioners, and the end user (a client, a patient, or a member of the population at large). In this respect, it is interesting to note that individuals at each of these stakeholder levels (e.g. a public official, a health professional) can themselves be the target of behavior change interventions! And not only some theories may apply specifically to each level as, ultimately, all levels are important for effective translation of theory to practice (50). For instance, if a certain clinical model (e.g. Motivational Interviewing) or a certain behavior change technique (e.g. prompting self-monitoring) is found to be particularly effective in research studies, but the health care system fails to support its adoption by clinicians in the field (e.g., through lack of funding or training opportunities), effective translation and dissemination will not occur. In this scenario, the "science" of communicating research findings to decision makers could be lagging behind the science of behavior change (51).

Since interventions are meant for the real world, context-sensitivity is paramount. In other words, an

intervention is only as successful as its capacity to adequately respond to a problem in a particular environment, for a certain target population, and focused on certain outcomes (whether behavioral, psychological, or biological). This creates a considerable problem for dissemination, since the accumulation of evidence, including adequate replication of findings, is typically slow to respond to all possible combinations of factors, which in turn also evolve dynamically. New treatments (e.g. based on information technologies), new conditions or old conditions in new populations (e.g., type II diabetes in children), new risk factors (e.g., excessive sedentary time), and changing environments (e.g., an economic crisis) are just a few examples of factors involved in the complexity of designing and testing HBC interventions. This, of course, is in addition to the “default” large variety of contexts already encompassed within the health domain. Although this is a scenario whose breadth defies simple solutions, trying to find the “lowest denominators” in HBC theory and applications is a possible approach, especially for those who have to make decisions despite an incomplete evidence base (e.g. health professionals, those responsible for training programs and academic curricula, etc.). In other words, exploring those theories, intervention principles, and applied techniques whose simplicity and large applicability are already well-accepted may prove a useful way forward, as manifest in the latest guidelines from the UK’s National Institute for Health and Care Excellence (NICE) on individual behavior change (52).

The COM-B model (see Figure 3) is one such example (20). It provides those involved in HBC interventions with a basic framework around which determinants can be identified and targeted, identifying three key areas (competence, opportunity, and motivation) to be explored by policy makers, applied researchers, and health professionals in specific ways. Another example is the dual-process model, described above, that distinguishes between motivational and volitional processes and phases of behavior change, which also allows interventions to be structured primarily around one or the other, depending on the problem at hand. For instance, if an intervention is needed for an audience consisting largely of unmotivated individuals, emphasizing aspects such as goal setting and action plans may be unwarranted; this is easy to explain to a practicing clinician or a student. Alternatively, if motivation exists but adherence is still low or intermittent, issues around self-regulatory skills training may be in order, focusing more on the “how to” than the “why” of change (53). As a final example, exploring different qualitative facets of motives and goals (e.g. (54)) may also be fruitful and easy to describe to an interventionist.

Indeed, some applied intervention strategies, although they may lack sufficient “behavior change pull” per se, are nevertheless thought to be broadly positive and can be included in most interventions today, with some benefit. That may be the case for strategies such as encouraging self-monitoring and building action plans; providing choice and asking for patient/client’s input (e.g., on goal selection); giving informational feedback on progress; creating a positive interpersonal climate and empathizing with difficulties; increasing knowledge about the condition and treatments available; and providing a meaningful rationale for behavior change (e.g. (55), (56)). Broader intervention targets such as increasing participants’ autonomy, intrinsic motivation, and self-efficacy are also relatively consensual in HBC. Of course, it is good to remember that lasting health behavior change often presents challenges that simple approaches may not sufficiently address, and this is precisely where present and future HBC research is most needed.

Behavior Change Techniques (BCTs)

A recent and important development in the field of HBC is improving the description and classification of actions and strategies used in interventions to help change another’s behavior. These techniques represent the lowest-level, irreducible, fundamental elements that can be observed in an interventionist doing his or her job. They are sometimes considered the active ingredients of an intervention and should be replicable across interventions. Some examples are “prompt self-monitoring,” “provide feedback on progress,” “discuss realistic goals,” or “show regard for client” (see Table 2). Naturally, complex interventions typically involve several such techniques in various combinations. There are also interventions models, such as Motivational Interviewing or Relapse Prevention programs, which already include a predefined set of these techniques. Finally, although BCTs are typically thought of as aspects of an interpersonal interaction, it is possible that at least some techniques can be delivered in other contexts, such as through written or online materials.

Detailed taxonomies of BCTs that can be applied to different health settings can be of use to both research and practice. One example is that interventions can be described in clearer and more consistent ways, and be more rigorously tested and compared, in research studies, when their active ingredients are reliably used. In turn, practitioners can more easily and consistently be trained in, and be evaluated based on, the use of standardized techniques (e.g. (57)). A better linkage between BCT and HBC theories is another potential benefit, since psychological constructs present in theories are presumably well-targeted by some techniques but not (or less so) by others. As such, the

Table 2. Taxonomy of Behavior Change Techniques

Categories	Examples of BCTs
Goals and planning	<ul style="list-style-type: none"> • Goal setting (behavior) • Action planning
Feedback and monitoring	<ul style="list-style-type: none"> • Self-monitoring of behavior • Feedback on outcome behavior
Social support	<ul style="list-style-type: none"> • Practical social support • Emotional social support
Shaping knowledge	<ul style="list-style-type: none"> • Instruction on how to perform the behavior • Re-attribution
Natural consequences	<ul style="list-style-type: none"> • Monitoring of emotional consequences • Information about health consequences
Comparison of behavior	<ul style="list-style-type: none"> • Demonstration of the behavior • Social comparison
Associations	<ul style="list-style-type: none"> • Prompts/Cues • Exposure
Repetition and substitution	<ul style="list-style-type: none"> • Behavior substitution • Behavioral practice/rehearsal
Comparison of outcomes	<ul style="list-style-type: none"> • Credible source • Pros and cons
Reward and threat	<ul style="list-style-type: none"> • Social incentive • Self-reward
Regulation	<ul style="list-style-type: none"> • Reduce negative emotions • Conserving mental resources
Antecedents	<ul style="list-style-type: none"> • Distraction • Restructuring the physical environment
Identity	<ul style="list-style-type: none"> • Identification of self as role model • identity associated with changed behavior
Scheduled consequences	<ul style="list-style-type: none"> • Remove reward • Reward approximation
Self-belief	<ul style="list-style-type: none"> • Verbal persuasion about capabilities • Focus on past success
Covert learning	<ul style="list-style-type: none"> • Imaginary punishment • Vicarious consequences

task of applying theory and testing whether theory is being properly used should also be facilitated by the development of “BCT science.” Currently, the description of BCT used in theory-based research is often incomplete and confusing across studies (even when they are based on the same theory), which limits progress (14). As an example, intervention components are sometimes described in vague terms (e.g. “behavioral counseling” or “social support”) making the process of critical evaluation and replication considerably difficult. Although several BCT taxonomies have been proposed, the work of Michie and colleagues (31) is

perhaps the most comprehensive and resulted in taxonomies for a range of behaviors, including physical activity, diet, smoking, and HIV prevention (14, 58, 59). More recently, these were collapsed into one overarching list – the BCT Taxonomy v1 – including 93 behaviors or techniques (31). These can be divided into clusters or domains (see Table 2) although this organization is still a work in progress (60). While this particular taxonomy was produced with no particular theory in mind, taxonomies can also be sought for specific theories, where details techniques are described that target the constructs of that particular framework. For instance, Motivational Interviewing includes a specific set of skills that practitioners are trained in, and their proficiencies are regularly assessed (61, 62). Another study reviewed the techniques that have been used to increase self-efficacy, a key tenet of SCT (63). Also, a comprehensive list of techniques used to influence key SDT variables is currently being developed (64).

There are ongoing issues to be resolved related to the nature and organization of these techniques, including a debate on how some techniques (e.g. related to interpersonal style) may interact with other techniques in influencing behavior (65); how some techniques may target key psychological processes (e.g. attitudes and motivation) while others are largely “technical” and skill-based (e.g. making an action plan); or the inclusion of additional constructs/techniques that may be currently missing (e.g. autonomy and autonomy-supportive techniques (64, 65)). Indeed the term “technique” itself may cause some resistance in practitioners more sensitive to client/patient-centeredness and relational issues in health behavior change. Concepts such as “the spirit” (of Motivational Interviewing) and “health care climate” (commonly used in SDT to mean an autonomy- and relatedness-supportive intervention) partially capture elements that may be underrepresented in current BCT taxonomies.

CONCLUSION

This text was meant to provide a broad-brush analysis of the connected fields of self-regulation and health behavior change, at the present time. Many additional topics and areas could have also been mentioned, including self-regulation in children and adolescents, non-conscious processes in self-regulation, the role of personality and individual differences, genetic and biological factors, the role of affect and emotion, and habit and habit formation, among many others. This text is also focused on individual determinants and interventions, mostly leaving aside considerations more relevant to community, environmental, or public health interventions. Overall, while seasoned researchers in this area will not find considerable

novelty in this paper, I hope initiates to the field such as graduate students, young researchers in preventive health and health psychology, as well as researchers in other areas (e.g., exercise science, diet and nutrition, chronic disease, or rehabilitation medicine), may find it useful, especially if they have come to recognize the importance of behavior and behavior change in their work or topic of research.

Successfully influencing individual health behaviors has never been so important in society as it is today. This is apparent in the public discourse and in the media, in the way scientific societies, journals, and research groups are directing their focus, and in priorities set by funding agencies. In the US, the National Institutes of Health responded to this trend in 1995 by creating the Office of Behavioral and Social Sciences Research (<http://obssr.od.nih.gov>), certainly foreseeing what became known as the “decade of behavior” (2000-2010). More recently, both the Affordable Care Act and the Health Information Technology for Economic and Clinical Health (HITECH) Act have provisions that reinforce the importance of patient involvement in medical decisions, the success of which clearly involves issues of motivation and self-regulation. In 2011, the UK’s House of Lords issued a major report clearly stating that understanding behavior and behavior change is essential for developing cost-effective policies (66). More recently, the importance of individual behavior was also recognized in many of the European Commission’s Horizon 2020 funding programs for health, such as the popular Personalizing Health and Care 2014-2015 calls.

CONCLUSION

In conclusion, while considerable progress is evident in this area – a small portion of which is highlighted in this article – it is fair to say that many important questions remain insufficiently answered, whether they relate to measurement, theory, interventions, technologies, or effective dissemination of knowledge into real life contexts. However, all things considered, this may be the perfect time to get introduced to this exciting field and take an active part in its future.

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