Title:

Rethinking Social Psychology and intervention design: A model of energy savings and human behavior

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Abstract:

This theoretical-review article contributes to the discussion on individual energy savings by developing a hypothetical classification of interventions and linking them to socio-psychological factors affecting the transition points of four phases of behavior change (predecision, preaction, action, and postaction). It helps to segment a population into subgroups, clarifies the dynamic process for individuals, and groups examples of interventions to achieve substantial behavioral change. The generic integrative model presents

academic study designers and practitioners with a theoretical viewpoint and an orientation framework for their intervention designs. A systematic literature review of the empirical evidence for the model and interventions is presented. This blueprint of a model can be adapted, specified, further developed and implemented as a backbone for empirically-grounded intervention design.

Keywords:

energy consumption savings, phase model, socio-psychological factors, interventions, climate change

1. Introduction

Although the destructive effects of human behavior on the environment are well known in much of the industrialized world, observers failed to note a fundamental change in human behavior in the last decades. Energy savings from technical innovations are overcompensated for by ever-increasing energy consumption [1,2,3,4]. Human behavior and leverage for change of energy consumption are the main focuses of research and provide the basis for various interventions [5]. Research on behavior change discusses specific factors that influence energy consumption and numerous studies investigate the effects of interventions to reduce household energy consumption [6,7].

Research consensus suggests possibilities to foster energy-saving practices and points toward effective measures to achieve this goal. However, with regard to the increasing number of approaches it becomes particularly and increasingly difficult for practitioners to decide what actions to take in order to support such changes. *Stage* or *phase* models [8,9] claim to provide a theoretical and heuristic framework which helps to segment the population according to its actual behavior and to categorize interventions along the process of behavior change. This should allow practitioners to address population segments with appropriate, and ideally, scientifically-proven interventions, based on the status in a certain behavior phase.

According to Sovacool [10, p. 17], "[y]et the fields of social psychology and sociology have immense potential to enhance the understanding of consumer behavior". The main contribution of this article is that it connects the different phases of behavior change (and the different transition points between the phases) with interventions. The main output of the article is thus a model which postulates causal influences from interventions on socio-psychological factors within and between the phases and also considers environmental contexts. By linking interventions with socio-psychological factors we combine insights from the socio-psychological literature with insights from the field of policy analysis. So far, such an approach has not been followed in neither of the two disciplines. Therefore, it fills a

research gap between work for theory and for application in practice, especially with regard to the question how do people's behavior and attitudes toward energy influence their use of it today and how can they guided through behavior change? [see e.g. research question 29 in 10].

This article is structured as follows: first, the concept of a phase model is introduced. Second, we apply approaches from environmental and social psychology to explain pro-environmental behavior in each phase. Third, we provide an overview of interventions used to promote individual energy savings while linking them to socio-psychological factors, and thereby to respective phases. Finally, we examine the contribution of these insights in light of previous research and discuss possible topics for the model's applications and future research.

2. Phase models of behavioral change

Psychological phase models explain behavior change as a linear process with different phases reaching, for example, from precontemplation to postactional [8,9]. These models suitably categorize interventions for pro-environmental behavior by integrating the dynamic nature of human behavior, accounting for the procedural character of behavior change, and outlining a decisional basis in order to deliver the right interventions. This goal is accomplished by dividing the population into different segments based on their problem awareness and actual or intended behavior.

The self-regulation model [11,12,13] is a theory-based and empirically utilizable approach that includes elements of the phase model of action (PMA) and the trans-theoretical model (TTM) [8,9]. According to the PMA, there are four phases between goal setting and goal achievement: the predecisional phase (1), preactional phase (2), actional phase (3), and the postactional phase (4). The PMA uses three transition points between the four phases, each with specific psychological tasks and goal intention activation ('be' goals), behavioral intentions ('do' goals) and implementation intentions (see Table 1).

Table 1: Phase model with transition points and psychological tasks based on Bamberg [12,13] and Lindenberg and Steg [14]

No	Phase	Transition point to next phase	Psychological task
1	Predecision	Goal intention ('be' goals) • Gain goals • Normative goals • Hedonic goals [see 14]	Re-evaluation of actual and habitualized behavior
2	Preaction	Behavioral intention ('do' goals)	Select new behavioral alternative
3	Action	Implementation intention ('motor control' goals)	Implement new behavior
4	Postaction		Habitualization of new behavior

During the predecisional phase (1), the main psychological task is to re-evaluate actual and habitualized behavior. The aim is to motivate people to consider the individual and collective disadvantages of their behavior and to form a binding goal intention (e.g., with the activation of a 'be' goal). This can be enhanced by including three goal frames into the predecisional phase, following Lindenberg and Steg [14, p. 119] who distinguish gain goals (to guard and improve one's resources), normative goals (to act appropriately), and the hedonic goal frame (to feel better right now). Appropriate 'be' goal formulation could be as follows: I want to be thrifty by reducing my energy costs (gain). I want to be socially responsible by reducing my consumption of fossil energy (normative). I want to feel healthier by using physically active modes of travel (hedonic).

In the preactional phase (2), an individual's task is to select a new behavioral strategy and form a goal intention. The formation of the respective behavioral intention as a 'do' goal

and marks the completion of the preactional phase (e.g., “I intend to use the bicycle to reach my destinations daily.”)

The psychological task of the actional phase (3) is to prepare for the implementation of the behavioral intention [15]. To do that, the individual has to define precisely which activity is performed when and how (‘motor control’ goals, e.g., “I will use my bicycle each morning when I go to work and take the quiet road along the river instead of the noisy main road.”) Implementation represents the completion of the third stage and transition to the fourth phase.

In the postactional phase (4), the task is to avoid regressing to old behavioral patterns and thus, previous phases. The individual’s aim is to reach a habituation or automatic activation of the new, desired behavior.

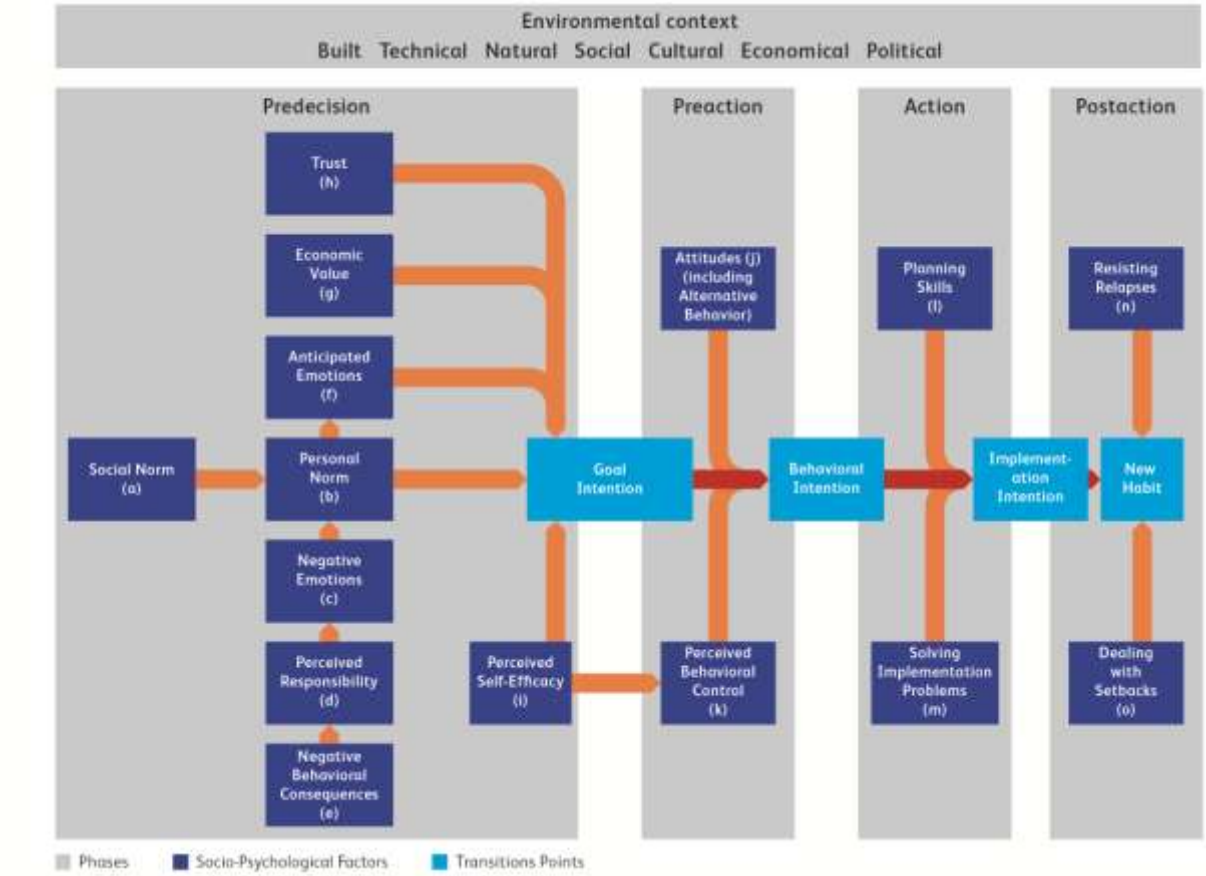
Bamberg [12] tested a phase model approach as a new theoretical framework in the field of sustainable transportation. Drawing on Gollwitzer [15], Bamberg [12] used this four-phase model to classify individuals based on a latent class analysis. Comparing the effect of phase-based interventions with ‘traditional’ interventions (i.e. without accounting for phases), Bamberg [12, p. 74] shows a positive effect of phase-tailored interventions. Due to its empirical proof of concept and clear theoretical structure, the self-regulation model is adapted as a framework, referring to the work of Bamberg [11,12,13], and developing it further by integrating exemplary interventions that aim to reduce individual energy consumption. We present an extension of and deeper theoretical insight into the link between phases, socio-psychological factors, and interventions (see sections 3 and 4).

3. Factors for transition to the next phase

The insights into the factors that are able to explain the intention towards a specific behavior are a prerequisite and currently underexposed with regard to the presented phases. Thus, this section links socio-psychological factors to the transition points of the four phases and provides the conceptual basis for the allocation of interventions in Section 4. Figure 1

summarizes the subsequent socio-psychological factors combined with and structured along the phase model.

Figure 1: Phase model and socio-psychological factors (adapted from Bamberg [12,13], enhanced with environmental context)



3.1 Factors for the predecisional phase

The indicator of transition from the predecisional to the preactional phase is the goal intention ('be' goal) (see Table 1, Figure 1, and Section 2). The various socio-psychological factors associated with the goal intention are as follows: subjective social norms (a) are defined as an individual's perception of social normative force (behavior is perceived as right, wrong, good, or bad) that provides a framework for which behavior should or should not be performed [16, p. 182]. According to Bamberg [12,13], subjective social norms (a) are assumed to influence personal norms (b). The latter are then defined as internalized social norms [14]. A personal norm (b) is the individual conviction that acting in a certain way is

right or wrong [17,18,19]. In this model, direct influence on the goal intention does not stem directly from social norms (a). It is indirectly mediated through personal norms (b) [12,13,20].

Negative emotions (c) towards actual behavior can be understood as goal incongruent emotions such as anger, anxiety, and disgust. According to Lazarus [21], negative emotions arise when people are frustrated or fail in their pursuit of goals. Negative emotions (c) towards an actual behavior that is in conflict with the goal intention for new behavior are assumed to affect personal norms (b) and thus, indirectly, the transition point of goal intention. A perceived mismatch between the individual's own recent behavior and awareness of their behavior's contribution to environmental problems increases a sense of guilt. A value frame which places high importance on altruistic and normative values leads to a perceived obligation that likewise leads to pro-environmental behavior (goal intention) and reaffirms a personal norm (b).

Perceived responsibility (d) is understood as "outcome to causal processes, to a person's capacity to foresee the consequences of events, to role behavior, to legal and moral liability, to intentionality, to mitigating circumstances, to negligence, and to legal and moral justifications [22,p.29]." In this context, perceived responsibility is related to the individual's awareness of an environmental problem. It (d) creates their standpoint regarding the protection of the environment and their perception of individual identity as 'ecologically responsible'. It is assumed that a personal conflict with the individual's perceived responsibility (d) and their actual behavior can provoke negative emotions (c).

Perceived negative behavioral consequences (e) are understood as what happens "when an individual becomes aware that her or his current behavior has harmful consequences for other people and/or the environment (awareness of consequences)" [13, p.153] and themselves. This is linked directly to perceived personal responsibility (d); causing harm (ascription of responsibility) may elicit negative feelings such as guilt (see the link to

negative emotion (c)), again to be incorporated into personal norms (b) to avoid such negative feelings.

Anticipated emotions (f) towards the new or modified ‘be’ goal are linked to the goal intention. Anticipated emotions (f) are defined as anticipating future positive and negative emotions that propose a mechanism by which emotional processes can guide (or bias) behavior; particularly decision making. They are affected by personal norms (b). In contrast to negative emotions (c) that are linked to the actual behavior, the socio-psychological determinant of anticipated emotions (f) also includes positive feelings that are anticipated by the new behavior linked to the goal intention.

In line with Lindenberg and Steg [14], a positive economic value (g) is understood as guarding and improving one's resources, and are linked to the goal intention (gain goal). The selected behavioral strategy linked to the goal intention should be characterized by a high level of personal benefit and low cost. Economic value (g) may serve as an extrinsic motivational determinant, (e.g. “Being better aware of the costs of energy, I will be able to save money.”) to execute a target behavior by suppressing the influence of past habits [23]. A positive economic value (g) increases the probability that an individual will form a respective goal intention.

Trust (h) can be attributed to belief in the positive expected outcome of the goal intention in a way that makes a difference in this context with regard to the reduction of energy consumption. Importantly, trust (h) seems to directly influence the behavioral intention to execute a new target behavior [24]. Generally, trust (h) is identified as an important factor contributing to a target behavior, especially when the true content of the goal intention or its direct derived benefit (e.g., less energy consumption in order to help forthcoming generations) is not recognizable to individuals [25].

Perceived self-efficacy (i) is also needed to build a strong goal intention. Bandura [26] defined self-efficacy (i) as belief in one's ability to succeed in specific situations or

accomplish a task. There is substantial evidence that self-efficacy (i) generally influences goal setting [26] and pro-environmental behavior [17, 27]. This is also why self-efficacy (i) is linked to goal intention and also directly linked as a preliminary stage to perceived behavioral control (k) concerning concrete behavioral alternatives in the next phase (see discussion below).

3.2 Factors for the preactional phase

The transition point of the preactional phase to the actional phase is the act of behavioral intention ('do' goal) (see Table 1 and Figure 1). The formations of pro-environmental behavioral intentions are often explained using the theory of planned behavior (TPB) [16, p.665]. One of the main factors influencing the behavioral intention to execute the target behavior are attitudes (j) towards specific forms of behavior, including alternative behavior. The determinant attitude (j) measures the anticipated instrumental and emotional consequences of a behavior.

Perceived behavioral control (k) is understood as people's perceptions of the difficulty of performing a given behavior, and is also affected by perceived self-efficacy (i), from where the ease or difficulty of reaching the goal intention is anticipated [28]. It (k) is associated with beliefs about the presence of factors that may facilitate or impede performance of the behavior [16]. Perceived behavioral control (k) is given a special status in empirical modeling approaches; it is assumed to have a direct effect on intention and concrete behavior [29]. The latter applies in those situations where individuals have no voluntary control over an action; for example, they do not have access to environmentally-sustainable technology. In such situations, a change of elements of the environment is necessary (context). Individuals either do not have access to or have a very restricted allowance for, a pro-environmental behavior and the given obstacles must be changed. A second direct effect of the environment on behavior can be modeled if it is assumed that affordances of the environmental setting subconsciously lead to a certain behavior, thus overlapping the preactional phase [30]. Apart

from these two direct effects of certain elements of the environment on behavior (i.e., as mediators in the model), behavioral control will moderate environmental factors in a more moderate way, depending on the considered behavior. Given variations in technical infrastructures, the built environment, densities, natural and cultural amenities, and the availability of technical tools, virtual platforms and their algorithms are supposed to have an influence on control criteria such as functionality, ease of use, and effort. The same is assumed for the anticipated instrumental and affective outcomes of behavioral alternatives, as measured by the determinant attitude.

3.3 Factors for the actional phase

The transition between the actional and postactional phase (behavior maintenance) is the act of implementing an intention with the formation of a very precise ’if-then’ plan (see Table 1 and Figure 1). The socio-psychological factors associated with implementation intention are planning skills (l). Gollwitzer [31] showed that the efficiency of forming an implementation intention largely depends on planning. It seems that detailed planning enhances a strong mental connection between target behavior and situational context; a specific, previously-defined situational context that arises in everyday life may automatically trigger the target behavior [32]. The stronger the individual competence is to plan and simulate future behaviors, the more pronounced the implementation intention [12,13].

Fostering the intention to implement an alternative pro-environmental behavior is important when the actual (damaging) behavior is strongly habitualized, but a change of the (environmental) context in the sense of the downstream-plus-context-change strategy is not possible [33, p. 206-207, 34]. Thus, solving implementation problems (m) is a crucial step towards developing new habits. Increased efforts during difficult situations [35], compensation for shortcomings [26], or warding off distractions [15] bring initiated actions to a successful end.

3.4 Factors for the postactional phase

The last phase is linked to maintaining the ultimate result of a new behavior (see Figure 1 and Table 1) with the aim of habitualizing the new behavior. The ability to resist relapses (n) is a major determinant of whether or not an implementation intention results in a new or modified behavior over a longer period of time, and eventually, in a new habit. During the postactional phase, the main tasks are to overcome obstacles, deal with setbacks (o) or failure, and avoid relapsing into old behavioral patterns [12,13]. That is, even though a person has started to translate implementation intentions into actual behavior, goal-pursuit can be thwarted by attractive distractions, conflicting habits, or other goals [31]. Volitional factors like resistance to distractions or inhibition of unwanted habitual responses also influence the formation of a new habit [31,36].

3.5 Environmental context of behavior change

Apart from the influence of socio-psychological factors on phase transitions, another argument must be considered from an environmental psychology perspective. Environmental psychology focuses on the interplay between the individuals and their built, virtual, and natural environments, conceptualizing this interplay as a reciprocal, relational process [37, p.565, 38, p. 2, 39]. Environmental psychology extends the notion of the environment when it notes that multiple contexts affect individual experiences and behavior, including social, cultural, and economic contexts, which are conflated with the physical environment [40, p. 320]. Against the evidence that the environment makes a difference and is ‘never neutral’, two aspects are important for the aimed development of tailored and context-specific interventions.

The first challenge is to know the circumstances and environmental cues that foster pro-environmental behavior via the moderation of normative, gain, or hedonic goals; the moderation of socio-psychological factors (e.g., attitudes and perceived behavioral control); or via mediation [41, 42, p.127, 40, p. 320]. The second challenge is to address these elements of the environment via appropriate forms of intervention that are capable of transforming the

physical environment if necessary, together with elements of the social, economic, or political environment [39].

The phase model shown in Figure 1 must be sensitive to environmental contexts (i.e., the built, technical, natural, social, cultural, economic, and political) in which the behavior takes place, and which proposed interventions target in specific ways. Applications of the phase model in different urban contexts show significant differences in the explained variance of the model and the significance and strength of factors, such as perceived behavioral control and attitude [20]. In downstream-plus-context-change interventions, an important effect on the behavioral intention results from new, favorable circumstances and intervening incentives [34, 43]. Elements of the environment are relevant in the postactional phase, but hidden. They can be seen as elements of the situational cues which are linked to the habitualized behavior, be it via direct context cueing, which explains the connectionist approach; or as part of the scripts behind the habit, as the script-based approach argues [33, p.200].

These examples indicate the importance of context. Targeting relevant elements and cues in the environment is essential to intervention strategies, serving to strengthen their effectivity and durability. The scope of traditional information-based interventions targeting norms or attitudes is limited to situations within favorable existing contexts. Bear in mind that for different kinds of environmental behavior, different kinds of environmental factors and scales may be relevant, reaching from the individuals' immediate environment (e.g., the technical tools in the household and their energy efficiency), to their neighborhoods (e.g., density and connectivity) or the broader region (e.g., the regional transport system). This requires a careful study of the multiple intervention contexts as discussed in the following section [40, p. 319-320].

4. Classification of interventions for individual energy savings

A substantial body of literature in social psychology and policy analysis discusses the interventions necessary to promote pro-environmental behavior [44,45,7]. Several review articles propose an integrated view of different intervention strategies [6,7,44,46].

Kaufmann-Hayoz and Gutscher [7] provide a comprehensive overview, integrating psychological and policy-related interventions. De Young [45] argues that intervention strategies are based on three different persuasion techniques: informational interventions (1) include declarative knowledge and feedback or experience, motivational interventions (2) are incentives or social support, and coercive interventions (3) include fines, social pressure, and laws.

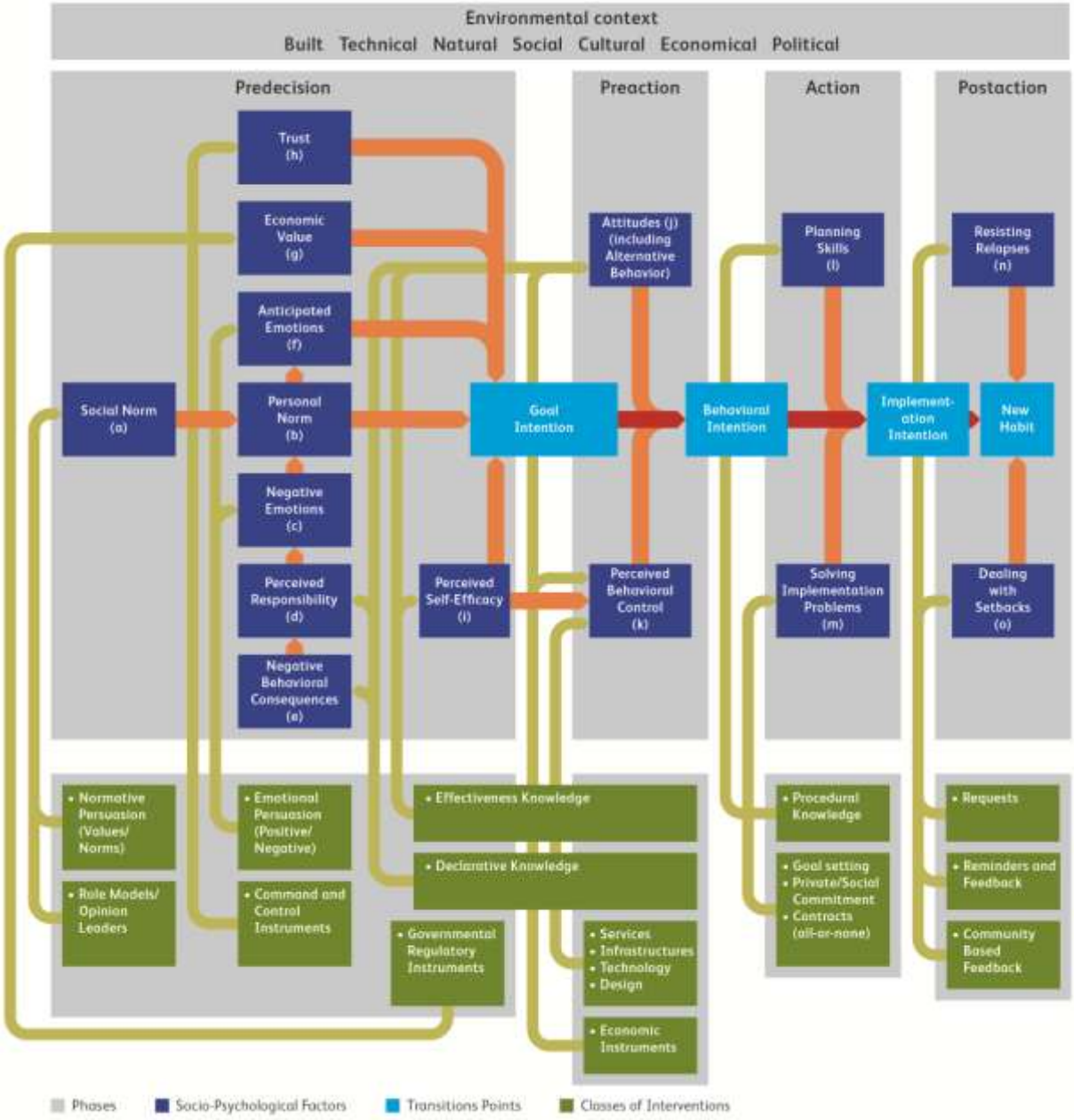
Geller et al. [47] differentiate intervention strategies based on whether they are aimed at influencing people before they take action (antecedent strategies, e.g., information and education, prompting, modeling, behavioral commitments, and environmental design) or afterward (consequence strategies, e.g., feedback, rewards, and penalties). Another type of classification is found in Messick et al. [48]: they differentiate between informational strategies that are designed to change prevalent motivations, perceptions, cognitions, and norms and context-related strategies that are designed to change the circumstances under which behavioral choices are made [34]. Mosler and Tobias [44] combine two classification systems, differentiating between strategies aimed at promoting new behavior and strategies that are designed to influence existing behavior.

The presented literature does not consistently link intervention strategies with socio-psychological factors and relevant phases to explain pro-environmental behavior. We develop a hypothetical generic classification system, based on the proposed phase model of behavior change and existing classification schemes stemming from [6,44,46,7].

Our framework that serve for a more systematic and transparent development of classes of interventions linked to socio-psychological factors is based on a bottom-up

approach. Based on an extensive literature review in *JSTOR*, *sciencedirect*, and *psyndex* on the topic, we identified interventions and instruments that are aimed at socio-psychological factors that significantly influence energy related behavior. The criterias on which the interventions are assigned to the different classes are as follows. We systematically grouped the interventions to classes based on the literature review. Furthermore, we enriched the amount of interventions grouped in the classes from the literature review with further related instruments in order to postulates causal influences from interventions on socio psychological factors. The result is summarized in Figure 2. It provides an overview of exemplary classes of interventions grouped by phases and serves as a blueprint for intervention designers.

Figure 2: Phase Model, social-psychological factors and classes of interventions (adapted from Bamberg, [12,13], enhanced with environmental context and classes of interventions)



4.1. Predecisional phase interventions

Normative persuasion plays a central role in influencing pro-environmental goal intentions [49] as a result of the shaping of goal intentions by normative factors. Moral norms are acquired through social learning from social reference groups that deliver standards for what is viewed as right or wrong. We propose that normative persuasion aims to influence social norms (a) and as a consequence, personal norms (b). There are several studies that

show a positive link between pro-environmental behavior and personal norms as well as normative persuasion and communication towards altruism and environmentalism [50,51].

Social strategies (viz., expectations of others) may serve as factors of goal intentions concerning energy-reductive behavior by addressing social norms (a). Examples are *role models, opinion leaders, and celebrities or (brand) ambassadors* that are asked to demonstrate the desired behavior in public or inform the public (viz., Leonardo DiCaprios movie "Before the flood" or Al Gore and his presentations on climate change). Similarly, these induced social norms (a) affect personal norms (b).

Trust (h) has a crucial impact on consumer behavior [52,53] and can be significantly influenced by *command and control instruments*, e.g. eco-labeling [54,55]. Because of their potential influence on trust (h), these instruments are assigned to the predecisional phase. Command and control instruments include standards (e.g., product standards), licensing, labeling, and regulations. These instruments may be used to promote trust (h) by showing that the government (or another institution) is convinced that goal intentions towards world improvement can make a difference towards environmental problems (e.g., the commitment of nation states to the Kyoto protocol).

Governmental regulatory instruments help change goal intentions through economic value (g); they raise costs for undesired behaviors or lower costs for desired ones. In the predecisional phase, we understand this instrument from a macro-perspective of governmental regulatory instruments (e.g., subsidization of photovoltaic energy). The implementation of tax and other financial incentives such as subsidies and deposit refunds reward goal intentions and charges punish undesired goal intentions [56]. Verplanken and Wood [34] classified this type of intervention as similar to the command and control instruments, and as such, particularly capable of changing habitual behavior by enabling new actions. For example, creating a market for CO_2 certificates artificially introduces costs for undesired behaviors and influences economic value (g).

Emotional persuasion interventions are congruent with the feelings-as-information framework, proposing that people change their goal intentions based on emotions they experience [57]. These strategies can induce either negative emotions (c) towards the actual behavior or anticipate positive emotions (f) towards the new goal intention [19]. In the context of pro-environmental behavior, communication strategies are usually designed to evoke negative emotions (c) such as guilt, fear, anxiety, and worry. Communication strategies evoking positive emotions such as happiness, comfort, or trust are less well established to promote pro-environmental behavior (i.e. you help save the planet) but are proven to effectively change behavior in the context of marketing [58,59].

The model suggests the introduction of an independent determinant of negative behavioral consequences (e). Knowledge is shown to play an important role in persuasion [17]. It is important to distinguish between declarative (assigned to the predecison and preaction phases), procedural (assigned to the action phase), and effectiveness knowledge (assigned to the predecision and preaction phases), which may have different impacts on intentions (see also [60] and the critical discussion on the formative role of knowledge in Section 5.1). *Declarative knowledge* is factual and answers how environmental systems work [61], for instance, that meat production substantially contributes to CO_2 emissions. *Procedural knowledge* addresses how to achieve a particular conservational goal, for example, riding to work on a bicycle. *Effectiveness knowledge* is concerned with the conservation potential of different actions. To illustrate, living in an energy-efficient house has a greater impact on energy conservation than switching off the lights when leaving a room [60].

Negative behavioral consequences (e) can be affected by *declarative knowledge* to raise problem awareness (e.g., “What happens if the majority of people use cars to commute to the city center?”) [61,62,63,64]. Likewise, perceived responsibility (d) can be influenced by *declarative knowledge* about the negative environmental outcome of a behavior (e.g., “My

lifestyle contributes to increasing energy consumption."). Here, causal declarative knowledge is involved (e.g., the increased living space per capita due to economic prosperity has increased energy consumption.) Kaiser et al. [65] found that perceived responsibility and declarative knowledge directly affected behavioral intentions. They also found interaction effects between perceived responsibility and declarative knowledge, providing support for our proposition that the influence of declarative knowledge on conservation behavior is mediated by perceived responsibility. Verplanken et al. [66] confirmed that environmentally-conscious people are likely to make pro-environmental choices in moments of contextual change under the condition that their environmental concern is activated. We propose that self-efficacy (i) is influenced by *effectiveness knowledge*. According to Meinhold and Malkus' research [67], self-efficacy interacts with environmental knowledge, lending support to our proposition.

Where does the environment come into play? At least some of the socio-psychological factors discussed will not be independent of the social context in which they are influenced, e.g., via public discourses about the environment, but also as a result of the everyday practices in concrete social settings in which the individual is embedded [39, p.346). Everyday practices are characterized by typical ways of perceiving, thinking, saying, and acting, and frame what is considered normal in certain social contexts [68, p.328]. In the proposed model, we argue that several factors moderate the social context: obviously social norms, but also problem awareness and perceived (ascribed) personal responsibility. Additionally, the economic and political contexts are supposed to be relevant decisions. Regulations in these domains limit the scope of available pro-environmental behavioral alternatives. The influence of environmental cues on central goals of behavior, be they normative, gain, or hedonic, is also fundamental. According to goal-framing theory, these goals are strengthened or weakened by environmental cues [42, p.122]. According to our framework and findings from the literature, we can group examples aimed at the reduction of personal energy consumption to the predecision action phase, as seen in Table 2 (see Figure 2 for classes of interventions).

Table 2: Predecison, class of interventions, and examples

Socio-psychological Factors	Class of interventions	Examples aiming at personal energy savings
Social norm (a)	- Normative persuasion and communication with arguments concerning social norms and values	- Energy-saving information events in associations/clubs - Social events (e.g., "slow-up" events/car-free days)
	- Role models/opinion leaders	- Advertisement with celebrities - Bertrand Piccard ("brand ambassador of solar energy") - Peer group marketing via social media
Personal norm (b)	- Normative persuasion and communication with arguments concerning social norms and values	- Governmental campaigns' appeal to altruism or environmentalism
Negative emotions (c)	- Negative emotional persuasion	- Mass media campaigns: Change of affective connotations evoking negative emotions, e.g., negative image campaign for air travel. - Shock image campaigns
Perceived responsibility (d)	- Declarative knowledge about personal responsibility	- "You cannot change the world, but you can change yourself" campaigns
Negative behavioral	- Declarative knowledge to	- Calculation of energy footprint of

consequences (e)	enhance problem awareness	an average individual of a society compared with population of emerging markets, mean of community, etc. (e.g., Swiss-2000 Watt Society) - Demonstrations of individual contributions (e.g., the link between CO_2-reduction and meat)
Anticipated emotions (f)	- Positive emotional persuasion	- Mass media campaigns: Change of affective connotations evoking positive emotions (e.g., positive image campaigns for public transportation) - Advertisement showing positive contexts and effects (e.g., setting in a beautiful landscape, laughing people)
	- Negative emotional persuasion	- Communicating that global warming causes natural disasters and mankind contributes to it - Shock image campaigns
Economic value (g)	- Governmental regulatory instruments	- Laws and policies (interest in avoiding fines/punishment) - Government subsidization (e.g., electro-mobility, photovoltaic

		energy)
Trust (h)	- Command and control instruments	- Labels (EU energy label) that are relevant for policy-makers in government and industry, but also for NGOs and citizens. - Environmental quality standards - Emissions standards - Product standards - Licensing - Liability regulations
Perceived self-efficacy (i)	- Effectiveness knowledge	- Information campaigns explaining the effectiveness of different courses of action. - Personal acceptance that the world could be rescued if mankind changes behavior (e.g., "It's easy to help the world"-campaigns)

4.2. Preactional phase interventions

Declarative knowledge interventions emphasize factual information-influencing attitudes (j). The diffusion of knowledge intervention strategy is based on the knowledge-attitude-behavior model [69]. Declarative knowledge addressing beliefs is proposed as the background factor that influences a person's attitude towards a certain behavior, giving rise to beliefs [70]. Attitudes, in turn, are assumed to influence behavioral intention. This approach assumes a linear relationship between increased declarative knowledge (beliefs) about the importance of pro-environmental behavior and favorable attitudes towards saving energy and

corresponding behaviors (see also critical discussion in Section 5.2.). The population that interventions target possesses differing degrees of knowledge about energy-saving behavior. The link between CO_2-reduction and installing solar panels on their house may be easily made by consumers. The difference between focal and background goals may be crucial when attempting to better target interventions. For instance, the population was rarely aware of the relationship between meat consumption and energy one decade ago. De Boer et al. [71] show that the effectiveness of consuming less meat as an option for climate change mitigation (as established by climate experts) is currently recognized by merely 12 % of their Dutch sample and 6 % of their American sample. This is incorporated in the model by the supposition that an empirically high share of the population is in the predecision phase if the link between CO_2 reduction and meat has not yet been made. Thus, the effect of declarative knowledge in the form of demonstrations of individual contributions (e.g., the link between CO_2 reduction and meat) is also proposed as a class of intervention in Table 2. As is the case with the discussion on labeling, veggie days or meatless Mondays (combined with decreased meat consumption campaigns) also support solving implementation problems during the action phase (see Table 4).

Service and infrastructure instruments lead to a change of situation, and therefore, the decision context of individuals; they are believed to influence perceived behavior control (k). These instruments include organizational or constructional measures. Potential interventions include the establishment of new bus lines, construction of new bike lanes, or a city offering to collect recyclables.

The generalized costs of behavioral intentions are important. Fujii and Kitamura [72] show that the distribution of a monthly free bus card positively affects bus use compared to car use [73, p.239]. Additionally, there are *economic instruments* that determine attitudes (j) towards a behavior, including low price strategies, charges, deposit-refund systems, incentives, and market creation on a micro-level. Diekmann and Preisendörfer [74] and

Poortinga et al. [56] demonstrated the strength of incentive use to encourage energy-saving behavior.

We group examples for reducing personal energy consumption in the preaction phase, as seen in Table 3 (see Figure 2 for classes of interventions).

Table 3: Preaction, class of interventions, and examples

Socio-psychological Factors	Class of interventions	Examples aiming at personal energy savings
Attitudes (j)	- Declarative knowledge	- Product information - Design of materials, sound and light (e.g., emotionalized body design for electric cars) - Information about outcomes of behavioral change (e.g., travel information comparing travel modes)
	- Knowledge of effectiveness	- Information campaigns explaining the effectiveness of different courses of action
Perceived behavioral control (k)	- Services - Infrastructures - Design - Technology	- Accessibility and usability through the built environment (e.g., new bike lanes that provide more security) - Mobility management at events (e.g., combined tickets for entrance and travel)

		- Behavior regulation (e.g., traffic calming, shared space, speed limits) - E-bikes to compensate lack of fitness
Perceived behavioral control (k) & Attitudes (j)	- Economic instruments	- Subsidies - Price reduction - Incentives - Low price strategies - Charges - Deposit-refund system

4.3. Actional phase interventions

Interventions for the actional phase are aimed at determining implementation intentions (see Figure 2 and Table 4). A *procedural knowledge strategy* is a diffusion-of-knowledge intervention strategy. Compared to the declarative knowledge strategy, it provides advice and training on saving energy at the household level ('how to' advice) and is therefore proposed to support planning skills (l). Examples are information brochures, consulting services of the city energy council, or training interventions (personal coaching). Solving implementation problems (m) can be influenced by commitments including oral or written pledges or promises to change behavior (e.g., to conserve energy) (*commitment related strategies*). Interventions may ask target groups to commit to pro-environmental behavior in specific situations [51,66]. More often than not, these promises are linked to specific goals, such as reducing energy use by 5 %. This promise can be a pledge to oneself, in which case it may activate a private norm (viz., a moral obligation) to conserve energy (*private commitment)*.

Empirical evidence for the effectiveness of private commitments is found in [75,76]. Baca-Motes et al. [75] found that making a small symbolic commitment, such as to reuse towels in a hotel, can lead to a considerable (25%–40%) increase in the desired behavior. Likewise, Bamberg [76] substantiates that commitment to purchase organic food effectively influences respective purchase habits. Additionally, evidence exists that reference points (i.e. goal setting) in the form of smart metering can reduce household energy conservation [77,78,79,80].

There are interventions that demand individuals to publicly disclose their commitment to pro-environmental behavior (*social commitment*). Additionally, there are *contracts* which help people keep their promises. 'All or nobody' contracts are collective oral or written pledges or promises to change behavior (e.g., to conserve energy), and help overcome problems related to the common good dilemma. The commitment can be made public through an announcement in the local newspaper, social media, or using any variety of public media.

Fewer studies investigate the effectiveness of social or public commitment [81]. For example, Pallak & Cummings [82] found a greater influence on energy usage (gas and electricity) from public commitment as compared to private commitment and a control group. Lokhorst et al. [81] provide a critical overview of the effectiveness of commitment strategies. They conclude that commitment leads to behavior change, particularly for long term effects.

According to our framework, we can group examples for reducing personal energy consumption to the action phase, as seen in Table 4 (see Figure 2 for classes of interventions).

Table 4: Action, class of interventions, and examples

Socio-psychological Factors	Class of interventions	Examples aiming at personal energy savings
Planning skills (l)	- Diffusion of procedural knowledge	- Newcomer marketing - Information brochures

		- Consulting service of city council (e.g., advice on saving energy) - Commuting plans (e.g., bike to work campaigns, walking, school and public buses) - Training (e.g., teaching senior citizens how to use public transportation) - Test offers (e.g., tickets for new inhabitants to test public transport offers, free bus cards)
Solving implementation problems (m)	- Goal setting - Private commitment - Social commitment - Contracts	- Reference points (e.g., smart metering saves 5 % of energy) - 'All or nobody' contracts (e.g., live car-free in a tenement) - Private contracts - Oral or written pledges/promises - Commitments made public by newspapers or digital (social) media - Personal coaching - Labeling (e.g., for citizens with the function of shopping aid) - Veggie days or meatless Mondays (combined with

		decreased meat consumption campaigns)

4.4. Postactional phase interventions

Community-based strategies are suggested to help resist relapses (n) by bringing individuals together and building confidence that the desired behaviors will be conducted by a substantial part of the community. These strategies connect pro-environment individuals (e.g. participation in gatherings, collective actions, informal markets or building of communities). Network-based interventions coordinate individuals' pro-environment actions, either through personal contact or mass media. Community-based strategies are often designed to address issues related to the common good dilemma [83]. Early research on collective actions substantiates that critical mass seems to be crucial to ensuring the effectiveness of this type of intervention [84,85].

Feedback interventions (self-feedback, external feedback, and reminders) can be an effective measure for resisting relapses (n), and are knowledge-related strategies that provide individuals with information regarding the current state of their pro-environmental behavior (e.g., smart metering). Reminders and feedback to support existing behavior are, according to Abrahamse et al. [6], effective when given continuously (e.g. prohibition signs). McCalley and Midden [86] and McCalley [87] show that interactive forms (setting goals and feedback) effectively enhance energy-efficient behavior. *General requests* are commonly used, but rarely listed in academic categorizations. They are often combined with persuasion or knowledge diffusion, but their psychological effectiveness relies on evoking a stress condition that asks people to reflect or to behave differently. An early study by Katzev and Johnson [88] found that requests effectively promote energy-saving behavior, particularly for the long term.

Relatively little empirical research deals with setbacks (k) in pro-environmental behavior. Schwarzer [89] proposes that an individual's confidence in their ability to maintain a difficult behavior may also impact the formation of a new behavior. He further proposes

that, in the postactional stage, an individual's confidence in their ability to resume a difficult behavior after a relapse (recovery) may increase the maintenance of the implemented new behavior. In general, dealing with setbacks (k) can also be supported by requests, reminders, and feedback, community-based strategies, and diffusion of knowledge regarding effectiveness. In a long-term field experiment, Staats et al. [90] found that feedback is most effective in combination with information and social influence. That is, feedback about individual performance in comparison to the performance of a peer group seems to help reduce household energy consumption [6,91]. We group examples for reducing personal energy consumption to the postaction phase, as seen in Table 5 (see Figure 2 for classes of interventions).

Table 5: Postaction, class of interventions, and examples

Socio-psychological Factors	Class of interventions	Examples aiming at personal energy savings
Resisting relapses (n) & Dealing with setbacks (k)	- Requests	- Direct behavioral requests (e.g., through city authorities, government)
	- Reminders and feedback	- Goal setting and reminders - Prohibition or warning signs - Feedback of results of individual behavioural change (e.g., personal CO_2 reduction)
	- Community-based strategies (e.g., positive social reinforcement)	- Gatherings - Critical mass (e.g., bicycle events) - Informal markets

		- Community building - Participation - Collective actions

5. Discussion

5.1. Operationalization of fields of action

We suggest the following steps as a means of encouraging pro-environmental behavior. First, empirically detect the phase in which an individual or group is found. Second, define which socio-psychological factors should be addressed to promote pro-environmental behavior. Third, choose the class of intervention that is connected to this socio-psychological determinant. Fourth, develop or apply an intervention that suits the socio-psychological determinant and the individual or group's phase.

Considering the first step, this approach implies that the population is not be treated as a single unit. It is hypothesized that phase models can segment the population into states of readiness to anticipate or perform a desirable behavior. This ordering can be empirically undertaken using self-reported items, staging algorithms, or by classification methods like latent cluster analysis by making use of a multitude of indicators that operationalize the relevant phase affiliations and lead to homogenous subgroups. Bamberg [20, p. 1773] provides empirical evidence for a four-cluster solution. On the basis of this empirical evidence, simple self-reported items can be used to measure those qualitatively different phases for empirical applications. As an example, for the energy-relevant action of meat consumption, the four phases can be operationalized as follows: I have never considered reducing my meat consumption (Phase 1). I've considered reducing my meat consumption. I haven't put this plan into practice yet (Phase 2). I make sure to occasionally consume less meat. In the future, I firmly intend to consume less meat on a regular basis (Phase 3). I take consuming little or no meat for granted (Phase 4).

Considering the second step, the presented socio-psychological factors may work out rather differently in various contexts and for different behaviors. The usefulness and applicability of any theoretical (multistage) model of behavior as presented in this conceptual framework often strongly depends on the type of behavior considered (e.g., field of action,

reasoned vs. automatic behavior, private vs. public). Interventions cannot target all phases. Study designers must prioritize the interventions linked to socio-psychological factors that affect the transition points to the next phases. Empirical work shows that socio-psychological factors can have an effect on all phases, but the size of that effect differs considerably [20, p. 1773]. The strength of effect size is an indicator for which interventions affecting socio-psychological factors work best for each phase. This is in keeping with empirical findings that socio-psychological factors play a central role in more than one phase transition. The strict links in Figure 2 are chosen based on where our literature review indicates they can make the highest potential impact. Consequently, Figure 2 does not imply that impacts can only be found based on the illustrated connecting lines.

Keeping in mind the third step, pointers of intervention can be conceptually and theoretically oriented along the proposed phase model and relevant socio-psychological factors. This implies that behavior change is a multiphase process, and the transitions between phases must be influenced differently.

Considering the fourth step, for example, as a policy instrument that can address various phases, labeling schemes can be mentioned. As can be seen for the socio-psychological factor of trust (h) in Table 2, labeling has an important function for policy makers in government and industry, but also for NGOs and citizens [92]. Likewise, in Table 4, labels for citizens that function as shopping aids (e.g., for nutrition of local suppliers), present a method of solving implementation problems during the action phase.

In summary, our proposed classes of interventions should be understood as prototypes that have to be reconsidered according to the fields of action based on empirical field works. Socio-psychological factors have to be carefully operationalized according to various fields of actions. This somewhat strict linking of socio-psychological factors with phases and classes of interventions provides a systematic, exemplary, and generic framework for the development of phase-specific interventions that must be adopted to encourage a given action. As a result,

this phase model is a useful tool for academic study designers and practitioners who intend to use socio-psychological, and thus soft, factors to support a desirable reduction in individual energy use.

5.2. The formative role of knowledge

The optimism of the formative role of knowledge in determining attitudes and behavior must also be problematized. In the context of risk communication, de Boer et al. [93, p. 2] postulate by referring to Higgins [94] that "an individual often makes an implicit trade-off between motivation to know 'what is real' and motivation to maintain prior beliefs, before reaching a personal conclusion." Individuals are strongly motivated to come to an accurate and unbiased conclusion, but are also motivated to maintain their beliefs and preserve their self-view [95].

If an individual's important belief is challenged, a self-protective process may be triggered in its defense [96]). This finding converges with psychological theories which posit that people are motivated to try to avoid acting inconsistently since it is perceived as uncomfortable [97, 98]. Additionally, people might not interpret environmentally unfriendly behavior as such, or they might justify it to preserve a positive self-view [99,100]. Referring to the discussion of CO_2-reduction and meat, this trade-off may explain why meat eaters tend to be much slower to recognize the negative effects of their meat consumption than other consumers [71].

With regard to knowledge-creating processes, information on the links between meat eating and climate change appears to even challenge science educators [101]. Saxe [102] empirically shows that the amount of meat consumption and a reduced number of food miles offer environmental advantages, whereas organic produce is disadvantageous. Thus, the issues are complex, potentially contradictory, and may require extensive communication with consumers.

5.3. Habitual vs. reasoned behavior

In many cases, environmental behavior is habitual and guided by automatic processes. As a result, initializing behavior change poses a great challenge for behavioral scientists and practitioners [5]. Habitual behavior is usually triggered by processes that are based on experience and retrieved from memory when individuals are in a particular situation. Hence, habitual behavior prompts motivational and informational biases that reduce the impact of interventions addressing attitudes and knowledge (i.e., emotional persuasion; effectiveness, declarative, and procedural knowledge; goal setting; or feedback).

Therefore, Verplanken and Wood [34] argue that these interventions must be combined with a context change, such as significant life changes (e.g., relocation to a new home or a new job). For practical interventions, growing evidence shows that life changes (e.g. residence, education, employment) or non-daily activities (e.g., holidays, day trips) increase individuals' interest in trying something new, such as biking instead of driving when on vacation [103].

We argue that implementing the model when living conditions allow for a habitual break is promising. These changes are likely to disrupt existing habits and to provide opportunities for interventions that address motivations and knowledge. Empirical support for the impact of contextual changes is provided in Wood et al. [104]. Moreover, there is evidence that even the anticipation of a move or a change in situation activates overthinking habits. Thus, interventions that simulate a certain event, such as a move or the loss of driver's license, can activate reasoned behavior that nudges individuals to build intentions linked to desirable behaviors (e.g. environmental friendly modes of transport), even though their degrees of habit are high. Verplanken and Wood [34] argue that large-scale, macro-level policy changes, economic incentives, infrastructure changes, and societal changes are particularly suited to addressing the societal and environmental structures that promote and sustain habits (i.e., command and control instruments, governmental regulatory instruments, economic instruments, infrastructure, and services).

5.4. Environmental context

In our framework, the environmental context is considered as shown in Figure 2 and discussed in Section 3.5. In sum, both situational-structural and socio-psychological factors make an impact, but in socio-psychological approaches, followers would argue that behind the situational-structural variable, such as the built environment, socio-psychological factors such as attitude, norms, and opinions that explain residential location to this area are more helpful to understanding behavior. Furthermore, followers of socio-psychological approaches would argue that situational contexts that also include the built environment are considered in the socio-psychological factor of perceived behavioral control (see Figure 2 classes of interventions of services, infrastructures, technology, and design). Individuals must be informed of their existence and motivated to use different options and alternatives with the help of socio-psychological factors. For example, if cycle lanes were considered by individuals as too steep to implement a behavior intention, respondents would express this in the measurement item that asks if cycling in the city is not easy for them. As an intervention, it would be helpful to provide services that offer electric bicycles for rent so that receptive individuals can experience this mode of transportation and begin to raise behavioral intention. In this context, formulating interventions based on socio-psychological factors increases the perception of situational contexts, be they the built environment or the existence of alternatives. This seems to be a promising approach for interventional research that adds value by directing soft policies to the built environment, e.g. when new services will be implemented. Thus, it is clear that new infrastructures, taxation, and services and addressing socio-psychological factors can mutually support substantial changes. In sum, campaign designers should not neglect situational contexts when applying socio-psychological approaches. Thoughtfully considered and mutually implemented approaches raise the possibility for behavioral change.

6. Conclusion and recommendation for further research

We argue that linking interventions to phase models is based on a deeper understanding of behavior change in order to support energy savings. The models application is for empirically-grounded intervention design. The contribution of this approach can be seen in the effective and efficient allocation of interventions due to three principles of the model: first, the linkage of interventions to the dynamic processes of behavioral changes over a long period of time for a single person (individual level) and, second, the linkage of interventions to the population allocated in different phases (aggregated level), and, third, the linkage of interventions with a direct reference to the socio-psychological determinants of the transition points of each phase (changeovers). On an individual level, authorities can monitor the process via personal coaching based on consulting service of city council (e.g., advice on saving energy). Based on the phase affiliation that will be identified by self-reported items of a citizen various information (Phase 1) or services (Phase 2-4) can be provided. On an aggregated level, by the means of surveys representative for the population, market shares for each phase can be analyzed and change can be monitored by panel surveys. For both individual and aggregated level interventions should be prioritized if a changeover from the recent phase to the subsequent phase should be supported by appropriate interventions.

Generally, the interventions based on established models of academic study designers and practitioners, such as social policy makers, campaign designers, and employees of local authorities, are targeted at whole populations without considering differences in actual behavior or intentions of the population (e.g., an information campaign about where to recycle batteries). The population is treated as a single entity and the different socio-psychological states of subgroups are not taken into account when planning interventions. Studies of tailored interventions in different areas of household energy use show that it is crucial to include characteristics of the targeted subgroup into the intervention design to support its success [105,106].

If interventions are carried out within such a model, the chances of a transition to the next relevant phase must be clarified, as must the reason(s) why certain people do not transition into the next phase despite an intervention. For practitioners who evaluate interventions, it is important to know how efficient the interventions are and how much effort is necessary to achieve the observed effect (e.g., a reduction in the use of energy within the examined field of behavior).

A systematic application of the model for different forms of household energy use is pending and should be the focus of future research.

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