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Why Do People Stop Treating Contaminated Drinking Water With Solar Water Disinfection (SODIS)?

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Abstract

Solar Water Disinfection (SODIS) is a simple method designed to treat microbiologically contaminated drinking water at household level. This article characterizes relapse behavior in comparison with continued SODIS use after a 7-month non-promotion period. In addition, different subtypes among relapsers and continuers were assumed to diverge mainly in their intention to use SODIS and their degree of cognition intensity. Data were taken from a longitudinal SODIS promotion study. Cluster analyses were applied to find subtypes among 166 relapsers and 123 continuers. Overall relapsers have lower values for all psychological variables compared to overall continuers. A low-value and a high-value relapser subtype as well as a low-value and a high-value continuer subtype were found. Low-value relapsers differ from high-value relapsers in one central belief (taste), in affective connotation, social norms, and dissonance. Interestingly, high-value relapsers have values almost as high as low-value continuers, differing only in their degree of habit. Only high-value continuers seem to be stable and did not show a decrease in critical habit variables over time. The different subtypes are placed along the behavior change process, and possible interventions for each type are highlighted.

Keywords

relapse behavior, continuation behavior, Solar Water Disinfection, intervention, habit

Introduction

For promoting changes in health behavior, it is an important but understudied matter to know why people drop out of health prevention programs and resume behavior that is a health risk. Drop-out rates can be as high as 60%, such as for exercise and sports programs (Fuchs, 1997; Pahmeier, 1994). This phenomenon inspired and developed stage models for explaining (health) behavior change (e.g., the transtheoretical model; Prochaska & DiClemente, 1982, 1983; or the health-action process approach; Schwarzer, 2008). These stage models of health behavior change aim at closing the intention-behavior gap prevalent in other models (e.g., theory of planned behavior, Ajzen, 1991) with the inclusion not only of motivational processes but also of an action phase. Most of these stage models explicitly include a separate phase of behavior maintenance, acknowledging that the behavior change process does not yet end with the uptake of the behavior.

This paper examines the health behavior known as SODIS. The Solar Water Disinfection (SODIS) process is a simple technology used to improve the microbiological quality of drinking water. SODIS uses solar radiation to destroy pathogenic microorganisms that cause waterborne diseases. Contaminated water is filled into transparent PET bottles and exposed to full sunlight for six hours (or for 2 days if the sky is more than 50% cloudy; www.sodis.ch). SODIS is especially designed for use at the household level, and it relies only on locally available resources such as plastic bottles and sunlight. The method has been shown to kill a large number of pathogens efficiently in the laboratory (e.g., Berney, Weilenmann, Simonetti, & Egli, 2006; McGuigan, Joyce, Conroy, Gillespie, & Elmore-Meegan, 1998) and in field settings (Sommer et al., 1997). SODIS has been disseminated by various NGOs in many developing countries for more than 10 years (www.sodis.ch). Some research has been conducted on predictors of SODIS behavior (Altherr, Mosler, Tobias, & Butera, 2008; Heri & Mosler, 2008; Moser & Mosler, 2008), but no study so far has investigated the often-occurring relapse from using SODIS to resuming consumption of untreated water (Tamas, Tobias, & Mosler, 2009). The present paper intends to close this gap and to contribute to a general understanding of why preventive health behaviors are often discontinued (Fuchs, 1997; Fuchs, Seelig, & Kilian, 2005; Pahmeier, 1994).

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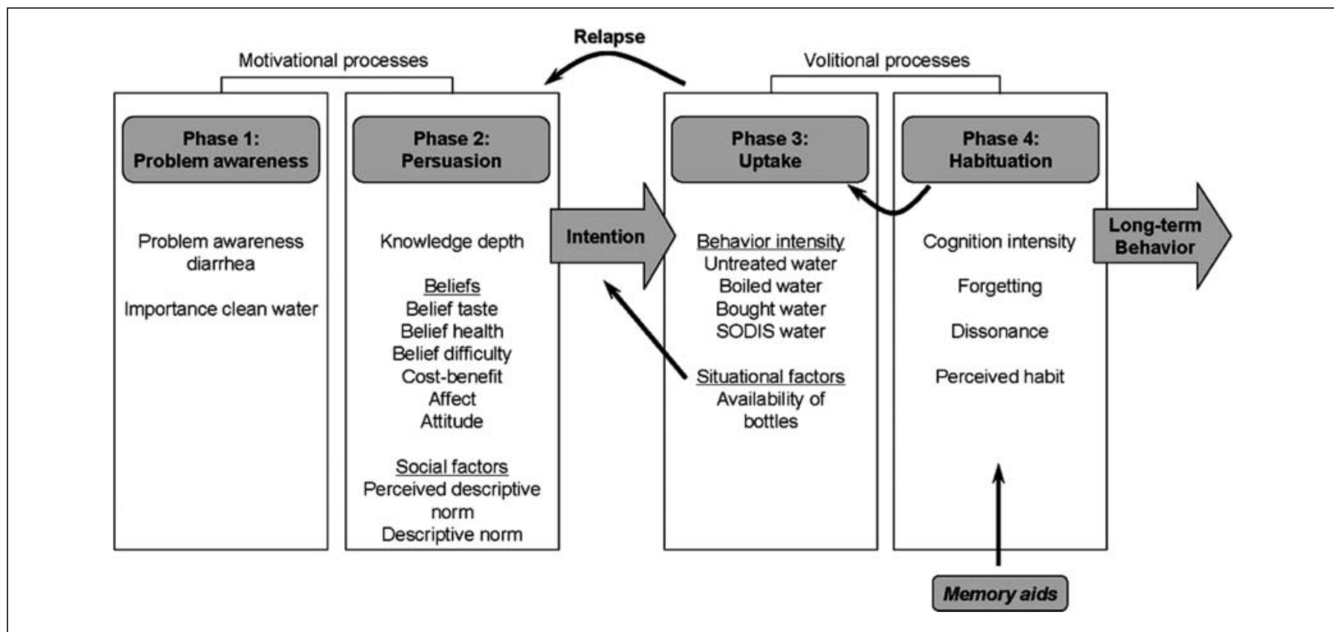

Figure 1. Behavior change model
Source: Adapted from Tamas (2009).

The models most commonly used to explain behavior change are stage models. Recent contributions have differentiated only two qualitatively distinct stages (Schwarzer, 2008; West, 2005), in contrast to older stage models that distinguished between four and five stages (Heckhausen & Gollwitzer, 1987; Gollwitzer, 1996; Prochaska & DiClemente, 1982, 1983). The simpler two-stage approaches differentiate between a motivational phase, leading to the development of a behavioral intention, and a volitional phase, leading to the development of habitual behavior (Schwarzer, 2008).

Several of these behavioral theories can contribute to the understanding of the behavior change process. We propose various groups of factors being important for developing a behavioral intention, initiating behavior performance and ultimately a new habit. For the overall model see Figure 1.

Problem awareness, cognitive and affective beliefs are developed and an intention toward the target behavior is formed during the motivational phase (Prochaska & DiClemente, 1983; Schwarzer, 2008). At this stage, social influences can take place and resource limitations (behavioral control) may affect intention development (Ajzen, 1991). Important aspects of the motivational phase for SODIS are developing a problem awareness (i.e., understanding that diarrhea is a dangerous disease, particularly for young children) and an internal persuasion process. Sufficient knowledge about the SODIS process has to be acquired, costs and benefits of the method have to be weighted against each other based on several cognitive beliefs, and the affective connotation should be positive. Social peers may influence this process (Heri & Mosler, 2008; Moser & Mosler, 2008). In case of a positive evaluation, a positive intention to take up SODIS develops and the individual starts using it (Kraemer & Mosler, 2010). With the uptake of SODIS, the individual enters the action or volitional phase. The motivational evaluation of the behavior can be repeated several times on the basis of the experiences gained with the behavior. However, even in the case of a positive motivation and intention, the individual will stop the behavior if he or she fails to develop a habit related to its performance. So apart from motivational factors, habit development seems to be of crucial importance in making the difference between a relapser and someone who continues to perform the behavior. Habit development is therefore described more in detail in the following.

Being in the habituation phase, the individual has to perform the behavior, that is, SODIS, with certain continuity and despite hindering situational factors. Then, after some time, a new habit will develop. However, neither depending factors for habit nor the time frame are clearly defined by today's research about behavior change (Tobias, 2007, p. 109). Some authors rely on the frequency of behavior execution as an indicator of habit development (Breckler & Wiggins, 1989; Ouellette & Wood, 1998; Ronis, Yates, & Kirscht, 1989), without reflecting on the underlying processes. It is questionable whether time frames can be generalized across behaviors of different complexity. Rather, it is likely that just as the uptake of some behaviors occurs more quickly than that of others, the period of time needed to develop a habit also depends on the innovation and the individual himself or herself (Rogers, 2003, p. 191). Individual factors related to habit that have been included in behavior-predicting models have been shown to explain additional variance compared to motivational

factors alone (Bamberg, Ajzen, & Schmidt, 2003; Ouellette & Wood, 1998; Ronis et al., 1989). Conceptualizations of habit, however, vary considerably across studies. The aforementioned studies used past behavior as an indicator, but this approach has been criticized (Bamberg et al., 2003; Verplanken & Orbell, 2003). Instead, assessing different facets of the habit construct is seen as a preferable alternative (Verplanken & Orbell, 2003). A number of authors have shown that the strength with which people perceive a behavior as being habitual represents quite a reliable measure (Knussen, Yule, MacKenzie, & Wells, 2004; Orbell, Blair, Sherlock, & Conner, 2001; Wood, Quinn, & Kashy, 2002). In addition, different facets of habit should be assessed (Verplanken & Orbell, 2003). For example, simply forgetting the behavior, low cognitive presence (i.e., how often an individual thinks about the behavior), or the degree to which a person perceives dissonance when the behavior execution was forgotten are viewed as important in the context of SODIS behavior. If a behavior is not yet habitual, it has to be cognitively active to prevent forgetting (Logan, 1980). Only when a behavior has become truly habitual will cognition intensity be much lower, because automatic behavior has only a marginal need for cognitive resources (Ouellette & Wood, 1998; Tobias, 2007, p. 101). The degree of perceived dissonance depends on the goals the person has defined for herself or himself beforehand. If an individual has already started using SODIS, it is most likely that the goal corresponds to this action. Therefore, if a high degree of dissonance is perceived when the behavior execution was forgotten, the behavior is even more likely to be cognitively activated (Festinger, 1957). To ensure that the new behavior is not forgotten, the correct moment for its execution has to be detected. Furthermore, it has to be remembered how the behavior has to be performed. Memory aids represent a possible intervention to support people in remembering when and how to perform the behavior (e.g., Cox, Cox, & Cox, 2005; Hill, Abraham, & Wright, 2007; Tobias, 2009). Memory aids are written, signed, or spoken cues, appeals, or requests that urge a person to act in a defined situation. The medium of these messages can be a tag, sticker, flyer, poster, brochure, tone, a spoken message, etc. Examples are tags like “Turn off the light when leaving a room” or the beep when not buckling up.

Summarizing, the main question that this study intends to answer is, How do people who continue with the behavior (continuers) differ from those who stop it (relapsers) in terms of motivational factors and, more importantly, habit indicators? It is hypothesized that relapsers have a lower intention to do SODIS, because intention is the key transition point to the uptake phase (e.g., Ajzen, 1991; Schwarzer, 2008). Furthermore, it is assumed that relapsers have a lower cognition intensity concerning SODIS behavior, a higher rate of forgetting than the continuers, and do not perceive forgetting as very dissonant. The fact that people had previously received a memory aid (prompt) should have an influence at this stage. Motivational factors, such as problem awareness, social norms, and cognitive and affective beliefs, are not expected to show any differences between relapsers and continuers.

Finally, we explore whether different types of continuers and relapsers exist, as had been suggested by Fuchs (1997), who investigated continuance and relapse in sports exercise behavior.

Method

Study Area and Design

The data of this investigation is part of a 4-point panel study with an active phase for SODIS promotion of 2 months and an inactive phase during subsequent 7 months. The study took place between August 2005 and June 2006 in Bolivia, where most sources of drinking water are contaminated. Our investigation areas were located in the periurban zone of Cochabamba and in the rural zone of the municipality of San Julian (near Santa Cruz de la Sierra) in Bolivia. In our periurban study areas, water is delivered by trucks at intervals of between every 2 days up to only once a week. In the rural area, water sources are bore holes and wells. Neither water from trucks nor from bore holes or wells can be consumed directly without prior treatment. Further recontamination is likely to happen because of storage in open containers (Rufener, Mäusezahl, Mosler, & Weingartner, 2010). Nearly everybody boils one part of the drinking water in the morning to make tea or coffee, but usually later during the day people consume untreated water. Boiling was introduced during a cholera outbreak some years ago. People in all investigated areas are mostly of indigenous cultural background and speak, apart from Spanish, the local language Quechua. Information on demographics of our sample can be found in Table 2.

Measurements took place at the beginning of the study (Panel 1), during the promotion phase (Panel 2), at the end of the promotion phase (Panel 3), and then after the 7-month inactive phase (Panel 4). The measurements made before and after the inactive phase (panels 3 and 4) are of greatest interest for this paper. Various SODIS promotion activities took place during the promotional campaigns. In brief, in one community SODIS was introduced during a health fair, in another community trained promoters conducted household visits, and in a third community an opinion leader approach was tested. Effects of these different activities are not studied in this paper; a detailed description can be found in Tamas et al. (2009). The following analyses include all households, independently of which promotional campaign they received. The distributed prompts were asking, “Have you already put your bottles into the sun today?” People were instructed to hang them visibly at the place where water is usually prepared. The effects of prompts will be briefly looked at during the analysis of relapse behavior.

Measurement

The measurements were made with questionnaires conducted in the form of interviews because of the illiteracy of the local people. Households were selected using a random route procedure (Hoffmeyer-Zlotnik, 1997). The person selected for the

interview had to be the one responsible for water in the household (a woman in 90% of cases). The interviewed person was told that the study would consist of two additional measurements. Initial rejection rates were about 10%. For the fourth panel measurement after the inactive phase, no prior warning was given to the households. A total of 369 of 537 households could be identified and interviewed again at that time point. The revision procedure of the questionnaires consisted of discussing every item with experts from the local NGO who have extensive experience with surveys in the Bolivian cultural and linguistic context. Identical understanding of items was ensured during a 1-day interviewer training in which items were discussed for clarity and the questionnaire was practiced during role-plays. The questionnaire collected data about demographic characteristics, detailed information on water consumption (for drinking only), psychological variables preceding SODIS use, and where people had heard about SODIS. The exact wording of the items is shown in Table 1.

Results

The results part consists of two major analyses: the first explores whether different subtypes of relapsers and continuers can be identified. This is done with two separate cluster analyses—one for the relapsers to classify relapser types and one for the continuers with the aim of identifying continuer types. In a second part, the subtypes found as well as relapsers and continuers in general will be compared with each other in different aspects of the behavior change process using variance analyses.

Of the 369 interviewed households, 33% reported using SODIS at the fourth measurement ($N = 123$). These entered the analysis as *continuers*, irrespective of whether they had been using SODIS at the end of the active promotion phase or whether they started afterwards during the inactive phase. A total of 45% ($n = 166$) of all households had used SODIS before, but had stopped by the fourth panel. They entered the analysis as *relapsers*. The remaining 22% ($n = 80$) of households had never reported using SODIS and did not enter the present analysis.

Subtypes of Relapsers and Continuers

A cluster analysis was run including all relapsers. Cluster analysis (e.g., Ketchen & Shook, 1996) is a multivariate method used to classify objects in homogenous groups (types, classes, and clusters). It is based on a given number of predetermined criteria (here referred to as *cluster variables*) and calculates the degree of similarity between different individuals and then places them into groups according to their similarity. Ideally, differences between group members should be small, whereas differences between groups should be big. The chosen cluster algorithm was a two-step cluster algorithm using SPSS, which classifies cases first into small subclusters and then in a second step into the final cluster solution. The two-step cluster algorithm was performed with unknown number of clusters (types) and a probability-based distance measure (log-likelihood), because distances of clusters were also unknown (Chiu, Fang, Chen, Wang, & Jeris, 2001). The analysis using the cluster variables intention and cognition intensity measured at Panel 4 identified a two-cluster solution among relapsers ($n_{r1} = 96$, $n_{r2} = 70$). The same cluster analysis including all continuers revealed a three-cluster solution ($n_{u1} = 34$, $n_{u2} = 33$, $n_{u3} = 56$). A corresponding discriminant analysis to validate the clusters confirmed that the clusters are well distinguishable. Both discriminant analyses, for relapsers and continuers, revealed 100% correctly classified cases.

Cluster subtypes that were found in the two cluster analyses are described below. Relapser Type 1 has a medium level of intention ($M = 0.53$, $SD = 0.31$), but never thinks about SODIS ($M = 0.02$, $SD = 0.09$). Relapser Type 2 has higher levels of both variables: a medium cognition intensity ($M = 0.55$, $SD = 0.21$) and quite a high intention ($M = 0.89$, $SD = 0.20$). Continuer Type 1 is the medium type: medium intention ($M = 0.59$, $SD = 0.15$) and medium cognition intensity ($M = 0.57$, $SD = 0.29$). All cases of continuer Type 2 have a maximum intention ($M = 1.0$, $SD = 0$) but only a medium cognition intensity ($M = 0.54$, $SD = 0.22$). This pattern appears to be similar to that of the Relapser Type 2. Finally, Continuer Type 3 has a maximum intention ($M = 1.0$, $SD = 0$) and a maximum cognition intensity ($M = 1.0$, $SD = 0$).

Characterization of Relapsers, Continuers, and Their Subtypes

Mean values of all variables of the behavior change process were calculated for the two relapser and three continuer types separately as well as for all relapsers and all continuers together (see Table 2). Differences were analyzed with post hoc Bonferroni tests (between the five subtypes), *t* tests (relapsers vs. continuers), and chi-square tests in case of non-ordinal data. Only the cluster factor intention showed a significant difference between continuer types 1 and 2 (means as listed earlier, $p < .001$). Because of their similarity, it was decided to unite continuer types 1 and 2 in this step, resulting in a final solution with two relapser types and two continuer types. These four subtypes are characterized in more detail in the following (see Table 2 for all *M* and *SD* as well as significance values).

A comparison of overall relapsers and continuers showed clearly that continuers have significantly higher values than relapsers for nearly all psychological factors (see Table 2). Significant differences between relapsers and continuers were found for all motivational factors, that is, problem awareness, beliefs, and social influences (Table 2, column r-c). Because these differences are mostly only about one third of one scale step (approximately 0.10 on a scale ranging from 0 to 1), we view them as comparably unimportant. Some of the differences are slightly greater than $\Delta M = 0.15$, and these were found for the belief about the taste of SODIS water, the cost–benefit evaluation, affect, as well as attitude toward doing SODIS. In general,

Table 1. Exact Wording of Items With Scale End Points

Variable name	Item formulation	Scale end points
Problem awareness diarrhea: 2 Items, Cronbach's $\alpha = .53$	Do you think it is a serious disease when a child has diarrhea?	0 *It's something normal* 1 *It's very serious*
	How much does it bother you when you have diarrhea?	0 *Doesn't bother me* 1 *Bothers me a lot*
Importance clean water	How important is it for you to have clean water?	0 *Not at all* 1 *A lot*
Knowledge depth SODIS[a]	Could you please explain SODIS to me?	0 *Does not know SODIS* 1 *Knows SODIS very well*
Belief taste	What do you think about the taste of SODIS water?	–1 *Tastes very bad* 1 *Tastes very good*
Belief health	Do you think that SODIS water is good or bad for your health?	–1 *Very bad* 1 *Very good*
Belief difficulty	Do you think that preparing SODIS is difficult?	–1 *Costs a lot* 0 *Does not cost anything*
Cost–benefit evaluation	How much is it worth to prepare SODIS water?	–1 *It costs a lot more than it's worth* 1 *It's a lot more beneficial than it costs*
Affect	Do you like/enjoy preparing SODIS?	–1 *I dislike it a lot* 1 *I like it a lot*
Attitude	How good or bad do you think is using SODIS?	–1 *It's very bad* 1 *It's very good*
Perceived descriptive norm	What do you think—how many other people (neighbors) use SODIS?	0 *(Almost) no one* 1 *(Almost) everyone*
Descriptive norm	How many people you know have you seen using SODIS during the last month?	Open, numeric
Availability of bottles	Are there sufficient bottles available to prepare SODIS?	0 *No bottles available* 1 *Always available*
Intention	How much water you think you will disinfect with SODIS in the future?	0 *None* 1 *As much as possible*
Perceived habit	Do you think you have the habit to prepare SODIS?	0 *Not at all* 1 *A lot*
Cognition intensity	Do you always remember doing SODIS?	0 *Never* 1 *Always*
Forgetting	How often do you have the intention to prepare SODIS, but then you forget it?	–1 *Always* 0 *Never*
Dissonance	How much does it bother you in case you forget preparing SODIS?	0 *Not at all* 1 *A lot*
Behavior intensity[b]	How much of your water consumption is SODIS/boiled/untreated/other water?	0 *0%* 1 *100%*
Relapse time point	When did you stop using SODIS?	Open, categorization into the respective month
Reasons for relapse	Why did you stop using SODIS?	Multiple open answers, all answers were then grouped into categories
Intervention check (dichotomous)	Did you receive a reminder since the last interview?	0 *No* 1 *Yes*
Demographic variables	Age (years), education (years), persons per household (no.), Children <5 years' age per household (no.), Job (0 = *no*, 1 = *yes*)	

Note: If the given scale range is between 0 and 1 or –1 and 0 (negative formulation), scales are unipolar 4-point Likert-type scales, unless stated otherwise. If the given scale range is between –1 and 1, scales are bipolar 7-point Likert-type scales with a neutral (neither–nor) formulation in the middle at 0.

a. Knowledge depth: open answer that was instantly categorized by the interviewer into one of the five possible categories, using the following criteria. These criteria were written on the questionnaire for the interviewers' own use. 0 = *no knowledge*, criteria: has never heard about SODIS; 0.1 = *very little knowledge*, criteria: has heard about SODIS but does not know how to prepare it and that SODIS disinfects water; 0.33 = *some knowledge*, criteria: knows in principle how to prepare SODIS and that it disinfects water but does not know why or gives some "magic" explanation; 0.67 = *good knowledge*, criteria: knows how to prepare SODIS and either the sun or the temperature as the cause of the disinfection process is mentioned; 1 = *very good knowledge*, criteria: complete understanding of how to do SODIS and how it works.

b. Open answer in liters per day for the entire family, subsequent calculation of percentages based on total water consumption (calculated out of all separate water consumptions).

Table 2. Means, Standard Deviations, and Results of Significance Tests of Factors of the Behavior Change Process Including the Two Cluster Variables, Measured in Panel 4, and Demographic Variables

	P3[a]	Subtypes P4				Main types P4		Significance tests P4[b]						
	All	r1	r2	c1	c2	r	c	r1-r2	r1-c1	r1-c2	r2-c1	r2-c2	c1-c2	r-c
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*p*	*p*	*p*	*p*	*p*	*p*	*p*
Motivational variables														
PAD	.75 (.19)	.77 (.20)	.78 (.15)	.79 (.16)	.86 (.15)	.77 (.18)	.82 (.16)			.05				.05
ICW	.83 (.17)	.76 (.17)	.71 (.17)	.78 (.17)	.79 (.17)	.74 (.17)	.79 (.17)					.05		.05
KD	.81 (.19)	.72 (.29)	.81 (.23)	.83 (.18)	.88 (.16)	.75 (.27)	.86 (.17)		.01	.001				.001
BT	n.d.	.41 (.40)	.61 (.20)	.63 (.24)	.70 (.22)	.50 (.34)	.66 (.23)	.001	.001	.001				.001
BH	n.d.	.54 (.33)	.64 (.19)	.67 (.16)	.70 (.16)	.58 (.29)	.68 (.16)		.01	.01				.01
BD	–.05 (.16)	–.10 (.20)	–.06 (.16)	–.03 (.13)	–.01 (.04)	–.08 (.18)	–.02 (.10)			.01				.01
CB	.72 (.26)	.59 (.31)	.66 (.27)	.71 (.27)	.83 (.18)	.62 (.29)	.77 (.24)		.05	.001		.01		.001
Af	.69 (.19)	.47 (.32)	.60 (.17)	.67 (.19)	.75 (.16)	.52 (.28)	.71 (.71)	.01	.001	.001		.01		.001
At	.84 (.18)	.61 (.30)	.67 (.13)	.77 (.18)	.84 (.17)	.63 (.25)	.80 (.17)		.001	.001	.05	.001		.001
PDN	n.d.	.07 (.13)	.13 (.15)	.19 (.20)	.28 (.24)	.10 (.14)	.23 (.23)		.01	.001		.001	.05	.001
DN	2.9 (3.9)	0.6 (1.2)	1.1 (1.5)	1.7 (2.0)	2.4 (2.5)	0.8 (1.4)	2.0 (2.2)		.01	.001		.001		.001
I	.92 (.20)	.53 (.31)	.89 (.20)	.79 (.23)	1.0 (.00)	.68 (.32)	.89 (.20)	.001	.001	.001		.05	.001	.001
Volitional variables														
CI	.67 (.29)	.02 (.09)	.55 (.21)	.55 (.26)	1.0 (.00)	.25 (.30)	.76 (.29)	.001	.001	.001		.001	.001	.001
F	–.28 (.22)	–.78 (.28)	–.70 (.33)	–.42 (.27)	–.24 (.21)	–.74 (.31)	–.34 (.26)		.001	.001	.001	.001	.01	.001
D	.49 (.33)	.12 (.19)	.24 (.24)	.37 (.30)	.63 (.20)	.17 (.22)	.49 (.29)	.05	.001	.001	.01	.001	.001	.001
PH	n.d.	.09 (.18)	.20 (.27)	.43 (.23)	.64 (.27)	.14 (.23)	.52 (.27)	.05	.001	.001	.001	.001	.001	.001
Water consumption behavior														
UW	n.d.	.15 (.28)	.18 (.30)	.06 (.13)	.03 (.07)	.16 (.29)	.05 (.11)			.05	.05	.01		.001
BoiW	n.d.	.72 (.28)	.71 (.30)	.52 (.19)	.42 (.15)	.72 (.29)	.47 (.18)		.001	.001	.001	.001		.001
BouW	n.d.	.12 (.18)	.11 (.17)	.04 (.08)	.04 (.09)	.12 (.18)	.04 (.09)		.001	.01	.05			.001
SW	n.d.	0 (0)	0 (0)	.38 (.16)	.51 (.15)	0 (0)	.44 (.17)	–	–	–	–	–	.001	–
Demographic variables														
Age		39 (16)	40 (15)	38 (14)	38 (12)	40 (16)	38 (14)							
Edu		7.3 (4.9)	6.3 (4.7)	7.8 (5.0)	6.8 (4.6)	6.9 (4.9)	7.4 (4.8)							
PpHH		4.8 (2.0)	5.0 (2.0)	5.4 (1.9)	5.6 (2.0)	4.9 (2.0)	5.5 (1.9)							.05
CpHH		0.8 (0.9)	0.9 (0.9)	0.9 (1.0)	0.8 (1.0)	0.8 (0.9)	0.8 (1.0)							
m/f (%)		93	91	97	87	92	93							
Job (%)		43	18	33	36	33	34	.01						
Other variables														
RAP (%)		49	76	58	50	60	54	.01				.05		
RPP (%)		24	30	42	38	27	40							.05
RTP		4.2 (2.4)	6.5 (2.9)	–	–	5.2 (2.8)	–	.001	–	–	–	–	–	–
n	211	96	70	67	56	166	123							

Note: All empty cells are nonsignificant. Values are presented separately for the two relapser and the two continuer subtypes as well as for total relapsers and total continuers. Additionally, values from Panel 3 are presented. P3 = third panel; P4 = fourth panel. Sub and main types: r1 = low relapser; r2 = high relapser; c1 = low continuer; c2 = high continuer; r = total relapser; c = total continuer. Analyzed factors: PAD = problem awareness, diarrhea; ICW = importance, clean water; KD = knowledge depth, SODIS; BT = belief taste; BH = belief health; BD = belief difficulty; CB = cost-benefit; Af = affect; At = attitude; PDN = perceived descriptive norm; DN = descriptive norm; I = intention; CI = cognition intensity; F = forgetting; D = dissonance; PH = perceived habit; UW = untreated water consumption; BoiW = boiled water consumption; BouW = bought water consumption; SW = SODIS water consumption; Age = age (years); Edu = education (years); PpHH = no. of persons per household; CpHH = no. of children <5 years per household; m/f = percentage of female interviewees; Job = percentage of people having a job; RAP = percentage of people who had received a reminder during the active phase; RPP = percentage of people still having a reminder after the inactive phase; RTP = time point of relapse in months after start of study; n.d. = no data.

a. For Panel 3, no differences between the subtypes were found (post hoc Bonferroni), except for CB between r1-c2 (M_{r1} = .65, M_{c2} = .79, p = .04).

b. The presented significance values are from post hoc Bonferroni analyses. For the comparison relapsers total vs. continuers total (r-c) *t* tests were calculated. In case of the variables m/f, job, RAP, and RPP, chi-square tests were calculated.

the level of the motivational factors is quite positive, except for the perceived descriptive norm. The intention to use SODIS—although a significant difference was found between relapsers and continuers—is also quite positive. Only the descriptive norm shows a substantial difference between relapsers and continuers. Relapsers know less than half as many people using SODIS as continuers. The indicators for habit (volitional variables) show much greater differences between relapsers and continuers than those previously mentioned. Differences are at least one scale step (between $\Delta M = 0.32$ and $\Delta M = 0.51$) for cognition intensity, forgetting of SODIS, the perceived dissonance in case of forgetting, and perceived habit. Similar percentages of relapsers and continuers had received a reminder during the active phase of the study (60% and 54%, respectively; see Table 2), so a habit-supporting intervention cannot be made responsible for continuance. Interestingly, continuers were more likely to keep the reminder during the entire inactive phase (40%) compared to relapsers (27%). The investigated behavioral indicators show that relapsers consume 11% more untreated water than continuers but also boil a greater proportion of their water (difference 25%) and buy 8% more water. Continuers consume an average of 44% of SODIS-treated water.

A comparison of the two relapser types with each other shows that Type 2 relapsers (column r2, Table 2) have higher values for all those factors that show significant differences between both relapser types: the belief about the taste of SODIS water, the affect toward SODIS, the intention to do SODIS, cognition intensity, dissonance, and perceived habit. The greatest differences are those in the belief about the taste of SODIS water ($\Delta M = 0.20$) and the two cluster variables, intention ($\Delta M = 0.36$) and cognition intensity ($\Delta M = 0.53$). According to the values of the psychological factors, we labeled Relapsers 1 "low relapsers" and Relapsers 2 "high relapsers." A comparison of the effects of the habit-supporting intervention on the two relapser types revealed the interesting fact that high relapsers experienced the greatest "loss" of reminders, which they had received during the active phase, compared with low relapsers and also continuers, who kept their reminders until after the inactive phase (Table 2). Another significant difference was found regarding job situation: Only 18% of high relapsers have a job, whereas 43% of low relapsers have a job. Low relapsers showed their relapse on average 2 months earlier (after 4.2 months) than high relapsers (after 6.5 months).

The comparison of the two continuer types shows relevant significant differences for perceived descriptive norm ($\Delta M = 0.09$) and intention ($\Delta M = 0.21$) as well as for the habit indicators of cognition intensity ($\Delta M = 0.45$), forgetting ($\Delta M = 0.18$), dissonance ($\Delta M = 0.26$), and perceived habit ($\Delta M = 0.21$). Continuers of Type 2 show more positive values for all these variables. They also consume significantly more SODIS water than continuers of Type 1 ($\Delta M = 13\%$). Interestingly, the consumption of untreated water shows no difference (3% and 6%). However, continuers of Type 1 consume 10% more boiled water, but this difference is not significant. Just as for the relapser types, a low and a high subtype of continuers was found. Continuers of Type 1 are labeled "low continuers" and continuers of Type 2 "high continuers" in the following. For the continuer subtypes, no difference was found in either the reception of reminders or in demographic variables.

Comparing relapser subtypes with continuer subtypes, it is apparent from Table 2 that low relapsers differ from both continuer types in several aspects (except for demographics and intervention variables). In contrast, a comparison of the two continuer types shows that high relapsers differ from high continuers in many respects. However, the difference to low continuers (Table 2, column r2-c1) is limited to behavioral and habit (volitional) factors. High relapsers consume more untreated water ($\Delta M = 12\%$), but also more boiled water ($\Delta M = 19\%$), than low continuers, but they also forget to do SODIS more often ($\Delta M = 0.28$), feel less dissonance ($\Delta M = 0.13$), and have a lower perceived habit ($\Delta M = 0.23$). Interestingly, intention is even higher (not significant, $\Delta M = 0.10$) and cognition intensity the same ($\Delta M = 0.00$) for high relapsers compared to low continuers. In fact, for many variables not only do relapsers together have lower values than continuers together, but a clear overall sequence for motivational and volitional variables of the four subtypes is found: low relapsers < high relapsers ≤ low continuers < high continuers with the exception of the importance of clean water and intention.

To control for any differences that may have already existed before the occurrence of relapse or continuance behavior, like for the fourth panel, the values of all available indicators of all four subtypes of the third panel were compared with each other. Except for the overall cost–benefit evaluation, where a small difference was found between the low relapsers and high continuers, all four subtypes had very similar and quite high levels of all motivational and volitional variables at the time of the third panel (Table 2, column P3, mean of all types). Because no significant differences between the four subtypes were found, only overall mean values of all 4 subtypes are presented in the table (because of readability). Detailed data of Panel 3 for each subtype are available from the authors.

Discussion

The discussion characterizes relapsers, continuers, and their subtypes using all the presented data and relates them to the behavior change process.

Relapser or Continuer?

The results have shown that relapsers have significantly lower values than continuers for almost all factors along the behavior change process. Two aspects are apparent: first, the mean level of the motivational factors is in the upper half of the scale (with the exception of perceived descriptive norm) whereas the volitional factors are in the lower half of the scale for relapsers. The perceived descriptive norm indicator shows that people greatly underestimate the proportion of other people in their community using SODIS. The reason may be that SODIS is

usually prepared privately and this action is not easily observed by neighbors. Second, differences between relapsers and continuers are smaller for motivational factors than for volitional ones. The entire difference pattern between relapsers and continuers shows that the further the behavior change process advances, the greater are the differences between relapsers and continuers, and the lower the level of the variables for the relapsers. Large differences and generally lower mean values were found for all habit indicators. For relapsers, all habit indicators show very low values. It can be reasoned that the cause of people becoming relapsers lies mainly in the lack of habit, which they obviously did not manage to maintain, unlike those who remained as continuers. This reasoning is backed up by the results of the panel before relapse occurred (third panel, where relapsers and continuers still had equally high levels of all indicators). On one hand, this makes it impossible to detect beforehand who would become a relapser and who would continue. On the other hand, it shows that relapsing is not predetermined by an initial lack of problem awareness, negative beliefs, or low initial habit intensity.

Low or High Relapser, Low or High Continuer?

The differences between low and high relapsers indicate that low relapsers have taken an early and conscious decision against using SODIS. The lower perception of the taste of SODIS water may have been responsible for causing a less positive affect and a lower overall intention, and the decision was therefore taken to boil or buy water instead. In addition, among friends and neighbors, almost nobody was known who used SODIS and could have exerted a positive influence. Boiling or buying water may also have been more convenient for the high percentage of employed persons. Because the decision was taken quite early without a long period of time spent trying to develop a habit, it is only logical that a SODIS habit would basically be nonexistent. Unfortunately, the consumption of untreated water was not reduced to zero. According to multiphase behavior change processes (e.g., Prochaska & DiClemente, 1982; Rogers, 2003, p. 170), low relapsers fall out of the process after having been in the uptake phase for a short while. However, they keep a high problem awareness and still think positively about SODIS. In contrast, it seems that high relapsers have tried to develop a habit for quite some time, probably because they had quite a high level of initial external support from the reminders they had previously received. Most of the factors show that high relapsers could also have been low continuers. High relapsers still show some signs of habit; it did not vanish completely. They even think about SODIS as often as low continuers, but report forgetting it more often and perceiving SODIS as being less habitual. It seems that high relapsers had relied on the external cue to remind them, and as the reminders slowly disappeared they forgot to do SODIS more and more often. The often small differences between high relapsers and low continuers suggest a habit-level threshold before it leads to typical behavior. Only when habit rises over a certain threshold is the behavior performed (Tobias, 2009). It seems that only the higher amount of felt dissonance of low continuers compared to high relapsers made the difference, because all other factors are similar. Although low continuers are in the action phase of the behavior change process, they seem to be at risk of becoming high relapsers, because both the two relapser types and the low continuers have experienced a decline of motivational and volitional factors.

High continuers actually do not indicate much need for improvement and seem to be in the stable last stage of the behavior change process: they have a maximum level of intention and high values for habit variables, and have remained stable or even improved since the third panel. However, referring back to previous assumptions of the habit phase, the high value of cognition intensity indicates that even high continuers cannot yet be viewed as finally being "safe" from relapses. The high degree of cognition intensity is only necessary during the process of establishing a new habit, because it then prevents early relapses, as was already observed for the relapsers. However, the goal is to establish a behavior that is truly habitual and mostly automatic, and then only low cognitive resources would be necessary (Ouellette & Wood, 1998; Tobias, 2007, p. 101). Obviously, this goal has not yet been reached for high continuers. One could argue that low continuers instead are the ones that already are on the way to fully habitual behavior, because their cognition intensity declined. However, the higher degree of forgetting in combination with a lower dissonance and a lower perceived habit excludes this explanation, because if forgetting is still prevalent, dissonance must be high to reduce forgetting (under the assumption that the goal is not to forget SODIS), and the perceived habit should be much stronger. Only if the behavior is no longer forgotten, is no more dissonance needed.

Implications for Practice

Comparing relapsers with continuers, the results indicate that relapsers started at the same point as the continuers, but something was missing to support them in the fragile and often situation-dependent establishment of a long-term habit. Therefore, targeted interventions would be very appropriate like stimulus control (remove reminders or cues to engage in old behaviors and add cues or reminders to engage in the new behavior); identify risky situations where one can fall back into the old behavior; plan coping responses; practice these responses until they become automatic. Support for the possible usefulness of habit-supporting interventions is already given by the fact that those people who still possessed their reminder after the inactive phase were more likely to still be continuers. The results in general show that there is high intervention potential among relapsers to make them stay continuers.

To get low relapsers to use SODIS in the future, we have to inquire more precisely the hindering reasons for not using it. Perhaps SODIS really is not suitable for them, or it may also be possible to find solutions to the apparent hindering factors on an individual basis.

For both high relapsers and low continuers, similar intervention approaches should be useful. For example, dissonance could be induced with a commitment intervention (e.g., Kantola,

Syme, & Campell, 1984), forgetting prevented with prompts or other reminders (Guynn, McDaniel, & Einstein, 1998; Mosler & Tobias, 2007), and cognition intensity increased with anything increasing the presence of the topic of water and SODIS. Further ways of influencing cognition intensity are provided by the Elaboration Likelihood Model (Petty & Cacioppo, 1986), which should be applied to increase this factor, such as via issue involvement or self-responsibility. This may be a social intervention, which would have an additional positive influence on the currently rather low descriptive norm. However, we have to make sure that the motivation becomes internalized at some point in order to prevent people falling back to old habits when the external cues are gone.

In the situation of high continuers, it is recommended to keep track of whether they remain showing the same stability, and to intervene only in case of changing behavioral indicators. Interventions per se on almost habitual continuers are not recommended, because this could lead to an externalization of already internalized motivations, or even to reactance. In the case of the present study, where different continuer and relapser types live in the same community, it is recommended to try to motivate high continuers to become some sort of role models and opinion leaders to support the spread of SODIS behavior to the other types. This would not be an explicit intervention aimed at high continuers, but would still ensure the continuance of SODIS use due to the newly acquired function.

Limitations and Conclusion

A clear limitation of this analysis is the lack of data as to what happened between the two analyzed time points. Only the time point of stopping SODIS use was assessed retrospectively. More measured time points with shorter time intervals would probably have provided a better insight into what actually happened in those 7 months between the two measurements. However, the actual application of questionnaires would have been an intervention and relapsers may not have been observable in the same "natural" pattern as was currently possible.

The approach presented here of not only characterizing relapsers and continuers as such, but also of looking for differences within these two groups, proves to produce some very valuable insights. The placement of the different subtypes along a theoretical model of the behavior change process gives additional hints for future interventions to get relapsers back to using SODIS and to prevent continuers from relapsing. Particularly interesting in this context is the finding that the differences within both relapsers and continuers are in some cases greater than those between certain subtypes of relapsers and continuers, which implies the need for quite different approaches to relapser subtypes and continuer subtypes. Another valuable finding is the fact that all types reach more or less equally high levels at the third panel, and it should therefore be generally possible to find appropriate interventions for all. Furthermore, the results indicate that for all types of people who are already using SODIS, interventions should rather aim at habit formation and social support than at providing more information about SODIS or trying to use persuasion to inculcate certain convictions or beliefs, as it is often done.

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