SODIS Promotion – Investigating the behavior change process

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ABSTRACT

SODIS (Solar Water Disinfection) is a simple method to treat microbiologically contaminated drinking water at household level. SODIS promotion activities in many developing countries are taking place since several years, but only moderate success has been achieved in view of the inexpensiveness of the method and the effort applied for its promotion. One reason may be that SODIS promotion is seldom viewed as a behavior change process and therefore inappropriate measures have been taken to promote SODIS, i.e. to change people's behavior from drinking raw, untreated water to the regular use of the SODIS method.
The present study has the focus to investigate more closely which behavioral processes are crucial for a long-term adoption of SODIS and which promotion strategies work better than others in facilitating these processes. Basis of our theoretical framework are psychological behavior change theories and psychological types of interventions.
The results show that the continuous use of SODIS is determined by the degree to which an intention has been built and even more importantly, a habit has been established. Motivational factors like knowledge, beliefs and affect can partly explain the intention to use SODIS. Correspondingly, individuals that received situation-focused interventions that explicitly support habit formation treat more of their water with SODIS in comparison to individuals who only received person-focused interventions that had their focus on creating problem awareness and giving information about SODIS. Recommendations for future intervention strategies are given.

KEYWORDS

Solar Disinfection, behavior change, habit, intervention

INTRODUCTION

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 which cause water borne diseases. SODIS is ideal to treat small quantities of water. Contaminated water is filled into transparent PET bottles and exposed to full sunlight for six hours (or for two days if the sky is more than 50% cloudy). SODIS is especially designed for the use at household level, because it only relies on locally available resources such as PET bottles and sunlight. Sunlight is treating the contaminated water through two synergetic mechanisms: Radiation in the spectrum of UV-A (wavelength 320-400nm) and increased water temperature (SODIS Reference Center, 2008a).

Research at the Swiss Federal Institute of Aquatic Science and Technology (Eawag) revealed that at 30°C water temperature, a threshold solar radiation intensity of at least 500 W/m2 (all spectral light) is required for five hours for solar water disinfection to be efficient. This dose corresponds to five hours of mid-latitude midday summer sunshine. The bottles used for SODIS should not exceed three liters and as suspended solids block UV radiation, preliminary treatment is necessary if turbidity exceeds 30 NTU (sedimentation, flocculation, and filtration; Sommer et al., 1997). A large body of microbiological research assessed and demonstrated the effectiveness of SODIS in destroying diarrhea-causing bacteria and other parasites (e.g. Berney, et al., 2006; McGuigan, et al., 1998; Smith, et al., 2000; Wegelin, et al., 1994).

Regular application of SODIS has the potential to reduce diarrheal diseases by up to 50%. Studies conducted among Maasai children under the age of five showed a 16-24% diarrhea reduction and an 86% reduction in cholera cases during an outbreak (Conroy, et al., 1996, 1999, 2001). In a study in Bolivia, SODIS reduced diarrhea incidence by more than 35% among children below five (Hobbins, 2003), in an urban slum in Tamil Nadu the risk of diarrhea was reduced by 40% by using SODIS (Rose et al., 2006). Further health evaluation studies showed a reduction of 13 to 39% in Pakistan (Gamper, 2004), by 53-57% in Uzbekistan (Grimm, 2004; Grimm, 2006) and of about 50% in projects conducted in Nepal, East Lombok and Assam, India (SODIS Reference Center, 2008b). Graf et al. (2008) could show that children in the Kibera slum of Nairobi (Kenya) had a lower risk of contracting diarrhea when they consumes a high percentage of SODIS water and live in a household with relatively good hygiene behavior.

The SODIS method is quite recent. Therefore only little scientific research on its promotion has been carried out so far. Nonetheless, since 1995 SODIS has been promoted in many countries by international and local non-governmental organizations (NGOs) within the framework of general health promotion efforts. The numbers of users up to date has accumulated to about two million users worldwide. Unfortunately, often it is neither systematically investigated nor well understood why in some projects success rates are higher than in others. The studies often ignore why certain promotion campaigns were successful and others not. Moreover, the success that has been achieved so far can be described as rather moderate in view of the inexpensiveness of the method and the effort applied for its promotion. In addition, no spontaneous diffusion of the method has been observed after its initial introduction into a community (Meierhofer & Wegelin, 2002).
On one hand, the lack of self-promotion is not very surprising, since examples for the lacking

relationship of knowledge, pro-behavioral attitudes or intentions and the behaviors itself exist. Many can be found in the field of lacking health prevention practices such as using condoms to prevent AIDS, undertaking a cancer breast screening or to undertake exercise (for a review on these and similar examples see Sheeran, 2002). On the other hand, one might have expected a rather enthusiastic uptake of such an easy and cheap water disinfection method like SODIS, saving people money and effort. It is assumed that one reason is the lacking understanding of SODIS as a behavior change process and consequently, the use of inappropriate measures to promote SODIS, i.e. to change people's behavior from drinking untreated water to the regular use of the SODIS method.
The present study has the focus to investigate more closely which behavioral processes are crucial for a long-term adoption of SODIS and which promotion strategies work better than others in facilitating these processes. Basis of our theoretical framework are psychological behavior change theories and psychological types of interventions. In the following, first the behavior change process is described and secondly, psychological interventions supporting behavior change are described.

The behavior change process

Behavior change models in general postulate several stages of behavior change. The number of stages may vary, however, important phases or stages an individual has to pass through mentioned by most models are the four following. First, an individual has to be aware of the problem that is targeted to be solved with the new behavior and knowledge of the new behavior has to exist. Second, through persuasive and social exchange processes, important opinions, beliefs and attitudes towards the new behavior are developed. The result should be a certain positive intention to perform the new behavior. In addition to knowledge, positive attitudes and a high intention, it also needs the necessary resources to test the behavior. Then, in a third phase, the behavior can be tested, which is called uptake. Finally, for a constant behavior performance, habit formation processes are crucial. Without the fourth phase, successful habituation, behavior performance is at risk to be disrupted or stopped entirely after a short while. The most commonly used models are the "Transtheoretical Model" (Prochaska & DiClemente, 1983), the "Innovation decision process" (Rogers, 1995) or the "Health action process approach" (Schwarzer, 1992). The stages of behavior change are not linear. Passing through the stages is rather assumed to be a spiral like process, meaning that an individual may fall back to earlier stages or drop out of the entire process.
In the following, the four phases are described more in detail, using SODIS behavior change as the example.

First phase: Problem awareness. The first topic considered as being important to initiate successful behavior change is everything that relates to the awareness of the problem the target behavior is designed to solve. A certain need for a new behavior must be developed (Rogers, 1995, p. 164). The new behavior can trigger the perception of that need or vice versa. Of course, at some point the individual has to realize that the target behavior actually exists and may be a possible solution to the problem or need.
The problem the SODIS method intends to solve is the occurrence of diarrhea episodes by disinfecting drinking water. Hence, it has to be realized by the individual that diarrhea is dangerous not only for the adult itself, but particularly for young children (*problem awareness*

diarrhea[1]), the causality between consuming contaminated untreated water and contracting diarrhea has to be made (*causality contaminated water – diarrhea*) and it has to be realized that the individual's *own* drinking water is contaminated. Moreover, the topic of being healthy and having clean water has to be given a certain priority or importance (*importance health, awareness clean water*), which results in the motivation that is needed to take serious steps towards solving the problem (Prochaska & DiClemente, 1982). At this stage of the process the individual does not show the target behavior and maybe does not even know about the existence of SODIS.

Second phase: Persuasion. Persuasion involves all processes that support the individual in forming a favorable or unfavorable opinion about the target behavior and results in an at least temporarily valid decision to try out the behavior. This involves cognitive, affective, social and mental planning processes. Cognitive processes are the seeking and evaluating of different available information to reduce uncertainty about the new behavior. In developing an attitude toward the new behavior, an individual may also rely on social peers and their opinions and actions. Apart from a purely rational evaluation of information, affects or feelings toward the new behavior may also be of significance, especially in case of lower importance of the topic and therefore lower cognitive processing activity (see Elaboration Likelihood Model; Petty & Cacioppo, 1986). The end of the persuasion stage is marked by a decision and a certain degree of commitment to step into action and try out the behavior (Prochaska & DiClemente, 1982).
In SODIS terms, at the persuasion stage, the individual has realized that untreated drinking water is potentially dangerous and knows that SODIS could be a possible solution. However, the person is still not convinced that SODIS may be the best solution in his or her situation and may also not know exactly how it works. Consequently, the individual is perceptible for information about SODIS and action-related knowledge about SODIS increases (*knowledge depth*). Some studies have shown a positive relation between knowledge and behavior for recycling (De Young, 1988; Vining & Ebreo, 1990). However, Frick (2003) suggests that the influence of action knowledge is mediated by intention (Frick, 2003, p. 103). During the processing of SODIS information, certain beliefs about SODIS develop, which can predict behavior (Graf, et al., 2008). In this study, the various beliefs are understood as the cognitive process of evaluating information; hence, they contribute to form an intention. A wide range of beliefs was covered, adopted from Heri and Mosler (2008), who conducted a similar analysis, and further complemented by what people had mentioned at previous occasions as an advantage or disadvantage of the SODIS method. Concerns about the safety of SODIS water (*belief health*), its application costliness (*belief money*), time requirements (*belief time*) and difficulty (*belief difficulty*) of the SODIS method were measured. Not less important, but probably with a more affective connotation is the belief about the taste of the water (*belief taste*) and the general affect or feeling the person develops towards SODIS water (*affect*). Those cognitive and affective considerations lead to a favorable or unfavorable attitude towards SODIS (*attitude*). The two dimensions of attitude, cognitive and affective, have already been described by several authors (Breckler & Wiggins, 1989; Fabrigar & Petty, 1999; Mosler et al., 2008; Trafimow & Sheeran, 1998). Moreover, the differentiation into cognitive beliefs and affective elements is a lot more useful for evaluating the different aspects of an innovation that have to be addressed, particularly for future promotion campaigns (Van Der Pligt & De Vries, 1998).
Both, cognitive and affective processes can of course be influenced by the exchange with peers.

[1] The italic names in brackets are the item names that will be used later in the results and discussion section.

The perceived opinion of neighbors and friends regarding SODIS, and the assumption that they are using SODIS or not, should not be underestimated in their influence on someone's opinion. It is distinguished between the reputation SODIS has (*injunctive norm*) and the perceived percentage of people performing SODIS in the community (*subjective norm*; Ajzen, 1985, 1991; Cialdini, Reno & Kallgren, 1990; Cialdini, 2003). Finally, a decision will emerge. Either the individual decides that SODIS is nothing for him or her due to various reasons, or a decision is made to at least try out SODIS a little or a lot (*intention*), which marks the transition point to the action stages. Intention is represented as a kind of bottle neck in most models, being the repository of all the previously mentioned processes (e.g. Ajzen, 1991; Heckhausen & Gollwitzer, 1987; Schwarzer, 2008).

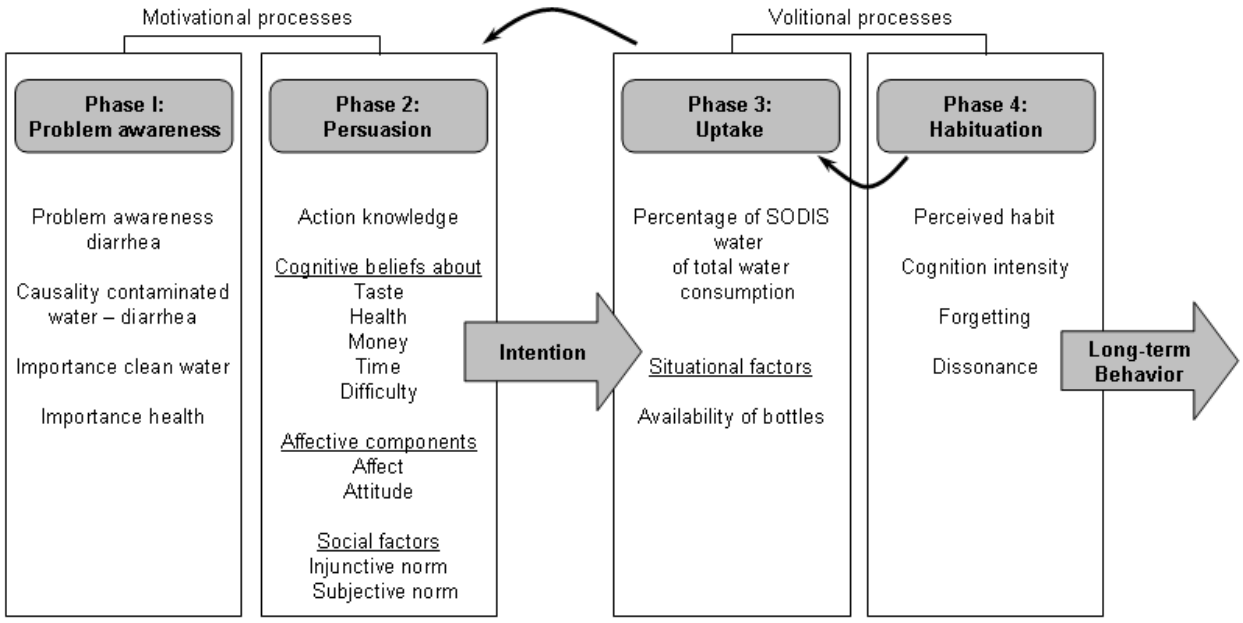
Third phase: Uptake. Until now, the behavior change process was only marked by motivational mental processes (Rogers, 1995, p. 172). Now, in the third phase the individual starts performing the behavior and volitional processes take over. At first, try out behavior is performed to evaluate the usefulness of the method in an individual's situation (Prochaska, DiClemente & Norcross, 1992). Situational factors can be very important during this early action phase (Fuchs, 2003, p. 133). If the trials are negatively evaluated, the individual may go back to the persuasion stage and maybe look for more information or social support. These relapses to a former stage may occur several times and are postulated as spiral-like processes (Rogers, 1995, p. 201; Prochaska & DiClemente, 1983). As during all previous stages, the individual also has the possibility to drop out of the process. Maybe an alternative behavior appears to be more convincing and suitable, or the old behavior is resumed. One of the challenges of the uptake phase is to evaluate the behavior test positively and keep the intention to continue the behavior. Then the next, the habituation phase can be entered.
Regarding SODIS, a person may try out SODIS once or a few times. Either doubts arise and another phase of persuasion is entered or SODIS will be used more or less regularly. Since the SODIS behavior is not very complicated, in promotion campaign areas most people at least reach this try-out phase. Depending on the initial intention, situational factors like bad weather, perceived difficulty or availability of bottles (*availability of bottles*) may or may not interrupt SODIS use (Ajzen, 1991). Not only testing SODIS during the uptake phase is important, but also which part of the daily consumed water is treated with SODIS. If only a small amount of water is treated with SODIS, initial commitment, i.e. intention, was probably low. Therefore, the intention to further use SODIS in the future should be kept high or increased if possible to successfully develop a habitual SODIS use.

Fourth phase: Habituation. The last stage is characterized by habit development with habit forming processes being active. If the behavior is not already during the uptake phase prevented from being performed in the future due to negative evaluations of motivational factors (e.g. taste of SODIS water or negative attitude), other performance hindering factors come in during the habit phase. One is simply forgetting the behavior. As long as a behavior is not yet habitual, it permanently has to be cognitively present to not be forgotten. High cognition intensity is important for the successful transition from the uptake phase to the habituation phase, because it prevents forgetting the behavior. That means, the less habitual a behavior is, the more it has to be cognitively active to prevent forgetting (Logan, 1980; Tobias, 2007). Only once a behavior is truly habitual, cognition intensity will be much lower, because the characteristic of an automatic behavior is an only marginal need for cognitive resources (Ouellette & Wood, 1998; Tobias,

2007, p. 101).
For a long-term use of SODIS, it is therefore important that people primarily do not forget preparing SODIS during their daily life routine or constantly prioritize other things (*forgetting*). Constant cognitive presence of the SODIS topic should prevent forgetting (*cognition intensity*). Once SODIS preparation is truly habitual, it is used rather unconsciously, despite of possibly hindering situational factors (*perceived habit*). However, the factors it depends on and how long exactly it takes until a new habit has developed, has not been answered clearly by today's behavior change research (Tobias, 2007, p. 109).

In Figure 1 the entire behavior change process is presented. The stages previously described are not strictly linear as it may appear from the graphical presentation. Particularly problem awareness and persuasion may in large parts be parallel processes. As Schwarzer (2008) suggests, it is sufficient to only distinguish between pre- and post-intentional processes (motivational and volitional), because in some empirical studies not all stages of models containing several stages could be replicated and for example, critics on the many stages of the transtheoretical model arose (Herzog, et al., 1999; Abraham, Norman & Conner, 2000; West, 2005). However, a model test is not intended to be performed within the presented study. The aim is rather to explore the relevant factors for predicting intention and behavior of SODIS water consumption. These results are hopefully valuable in deriving suitable interventions to promote or hinder the consumption of SODIS water. Therefore, no explicit hypotheses are stated, which factors are of lower or higher importance in predicting intention and behavior.

Figure 1 – The behavior change model



Note: Motivational processes take place in phases 1 and 2. These two phases are possibly running parallel in large parts. The outcome of phases 1 and 2 is intention. In case of a positive intention, volitional processes take place in phases 3 and 4. Relapse may occur to former phases. The outcome of phases 3 and 4 is a long-term behavior.

Psychological interventions

A standard dictionary defines intervention as a force or act that occurs in order to modify a given state of affairs. In the context of behavioral change, an intervention may be any outside influence that has the effect of modifying an individual's behavior, cognition, or emotional state.
Unlike on the topic of behavior change, on the mechanisms of interventions no theory as such exists. However, Mosler and Tobias (2007) have developed a person focused system that classifies interventions into categories partly corresponding to the phases of the behavior change process. On the first classification level, the intervention strategies were grouped into "behavior generating techniques" and "behavior supporting techniques".
The behavior generating techniques are further divided into structure and person-focused techniques. Structure-focused means to influence structures external to the person (e.g. building new infrastructures, making bottles available), whereas **person-focused techniques** operate at phases 1 and 2 of the behavior change model and comprise all kinds of motivational interventions. Relating back to the SODIS behavior, for making a person aware of the problem (phase 1) an appropriate intervention could be giving information on the link between water and diarrhea and pointing out the existence of SODIS. Once interest is awakened, influencing cognitive and affective beliefs can be achieved with persuasive communication in written or oral form. Key messages can be formulated addressing the beliefs about SODIS water, social norms and values, and behavioral goal setting can be evoked. Persuasion can take place in one-to-one communications (e.g. promoters) or mass communications (e.g. radio).
The second big group, behavior supporting techniques, comprises situation-focused and diffusion-focused techniques. Diffusion-focused techniques include all strategies that explicitly include the community or social network to further diffuse the new behavior and operate at all stages of the behavior change process. **Situation-focused techniques** are corresponding to the person-focused and operate at phases 3 and 4 of the behavior change process. They primarily aim at supporting the behavior at individual or social system level. An individual may simply receive a reminder or feedback to support habituation (phase 4), at the social level written public self-commitments could be applied, which would influence additional uptake by other individuals (phase 3). In general, particularly habituation processes call for small individualized techniques which support the constant presence of SODIS in people's every day life.

In the present study, person-focused intervention techniques aiming at the problem awareness and persuasion phase are compared with additionally applied situation-focused interventions aiming at the habituation phase. The other two types – structure focused and diffusion focused interventions – are not studied here, because they do not aim at a particular phase of the behavior change process.

METHODS

Study area

Our study area was located in Bolivia, one of Latin America's poorest countries. There is no piped water system in most of its periurban and rural areas. Our study was carried out in the department Chuquisaca. 22 villages from three different provinces were investigated. These

regions are situated in the highlands, more or less 3.000 meters above sea level. People use water from shallow wells or take it directly from the river. The water is assumed at least during rainfall to be contaminated, because the villages are surrounded by agricultural areas and cattle. Diarrhea incidence is known to be high in the department of Chuquisaca. Although in overall Bolivia a reduction of child mortality (children < 5 years) was achieved between 1998 and 2003 (from 67 to 54 per 1.000 live births), in Chuquisaca numbers stagnated during the same period of time (1998: 69, 2003: 67). While in 1998 Chuquisaca was at least Bolivian average, now it is clearly above average (all numbers from Montes & Dorado, 2007, p. 77). Moreover, the Bolivian goal by 2015 is to reduce child mortality to 30 per 1.000 live births. As a comparison, in the EU child mortality was 6.4 per 1.000 live births in 2003 (WHO, 2003). It was known that only few people in the study provinces knew SODIS before the start of the study and that almost no-one was using it.

The data this paper is based on was collected during a SODIS implementation project carried out by the Foundation SODIS (Fundación SODIS) in collaboration with the Ministry of Health of Chuquisaca and Departmental Health Service (SEDES; Sucre, Bolivia). The target areas of the overall project were 5 provinces of the department Chuquisaca with a total target population of 10.000 households. These provinces are very rural with almost no public transport, very bad road conditions and much dispersed settlement structures. Some so called nuclei exist with a more densely populated village structure.

The intervention strategies

Person-focused interventions. The main goal of this project was to promote SODIS and hand washing through existing structures. The widely present structure in rural areas of many Latin American countries is the existence of health volunteers. Each village has one or more of these health volunteers. They are people from the village and get elected, but work without payment. The purpose of having these health volunteers is to make the link between the employed health personnel (paid doctors and nurses) and the much dispersed living population. Their task is to visit households with small children or a pregnant woman about once a month and educate them in varying health topics like nutrition, child care etc. During the present project, it was aimed to use this structure of health volunteers and have them include SODIS and hand washing in addition to the topics they were already promoting. In a first step, these health volunteers had to be educated before they were able to promote SODIS directly in the households. The training was a half day workshop taking place in each village and also opened to interested parts of the population. The promoters were given a set of persuasive messages they were told to use during the household visits to inform and convince the people. Additionally, activities in schools and a radio campaign (starting after the second panel, August 2007) took place.

Situation-focused interventions. To support the habituation process, two different techniques were used: prompts and public commitments. Prompts are external memory aids and point out to an individual that a certain behavior has to be executed in a specific situation (Mosler & Tobias, 2007). There has been vast evidence that prompts are effective in influencing behavior. They have been successfully applied to increase recycling behavior (e.g. Hopper & McCarl-Nielsen, 1991), seat belt use (e.g. Cox, Cox & Cox, 2005), to reduce littering (e.g. Hansmann & Scholz, 2003) and to minimize the number of graffiti attacks (Craw, et al., 2006). Public commitment is a

promise to execute the behavior, which is given to the community. In the review of Dwyer and colleagues (1993), public commitment yielded increases in recycling behavior (e.g. Wang & Katzev, 1990) and energy conservation (e.g. Shippee & Gregory, 1982). Mosler, Gutscher and Artho (2001) successfully used public commitment during a driving speed reduction campaign.
The **prompt** was a cuboid made of cardboard of about 30 cm height. The cuboid contained information on how to do SODIS, photographs of people drinking SODIS water and a reminder sentence ("One has to put the bottles with water out into the sun)", a reminder picture and sentence for hand washing and a calendar to motivate people to keep the prompt. The cuboid could either be hung up to the ceiling, or put on top of some furniture. The handing over of the prompt was accompanied by the instruction that the prompt should be situated at the place where drinking water is normally prepared.
The **public commitment** was an A4 sized poster made to be hung up outside the house. A picture with a promoter and a local woman was added to underline the commitment character of the public commitment poster. The sentence on the poster said "We are committing ourselves to drink water treated with the SUN". It contained a SODIS logo, but no information on how to do SODIS. It was given away with the instruction to hang it visibly outside the house. Its function was to create a commitment within the person, a descriptive norm for other people and to remind the person it belonged to, to use SODIS.
One of these two different materials was handed out either during the workshops or during a household visit of the health volunteers, but only in some villages.

Out of the 22 selected villages, 2 were assigned to the control group where no intervention was supposed to take place, except a radio spot. These 2 villages were in a different district than the other 20, so they would not be hit by the other intervention strategies. In most of the remaining 20 villages, prompts and public commitments were distributed. Naturally, not all households that were part of the investigation sample actually received a prompt or public commitment, so assignment to one of the two treatment groups was done post-hoc. The two different treatment conditions were: 1) only person-focused intervention and 2) person-focused AND situation-focused intervention. These villages also were targeted by the SODIS radio campaign (the radio campaign reached almost the entire department of Chuquisaca, but only started after some time into the project).

Measurement

Measurements were realized with questionnaires that were conducted in the form of interviews, because many people in Bolivia cannot read and write. The questionnaires were revised and validated with local experts and the interviewers to ensure identical understanding of the items. The questionnaire contained demographic characteristics, more detailed information on water consumption, psychological variables preceding SODIS use, and the degree of knowledge of SODIS.
The operationalization of all variables used in this study can be found in the Appendix, Table A-1. Presented are the variable name as used throughout this paper, a translation of the item from Spanish, the scale endpoints and possible restrictions. Restrictions are for the psychological measures about SODIS that the person has at least to know SODIS and for the habit related measures that the person has to use SODIS. The scales of the psychological measures were 5-point scales for unipolar items and 9-point scales for bipolar items.

Selection of the households

22 villages were selected for measurements. The instruction at the first panel to the interviewers was simply to interview as many households as possible. Usually, about half of the households were at home during the first panel and included in the study. A total of 536 households were interviewed. During the following panels, interviewers were instructed to find the previously interviewed households again. No new households were included during the course of the study. During each panel around 85% of the initial 536 households were interviewed again. In the end, 337 households were interviewed at all four times. These will be included in the present study.
The person selected for the interview had to be the one responsible for water in the household. If the person responsible for the water in the household was absent, it was asked when she/he would be back and the interviewer tried to return at that time. The interviewed person was told that the study would consist of three additional measurements.

Timely design

The complete study design took the form of a longitudinal four-point panel. The study lasted 11 months and measurements were distributed with fairly equal time intervals across the entire time span. The first panel took place at the beginning of the study (beginning of May 2007), the second after 3.5 months (mid August 2007), the third after another 3 months (mid November 2007) and the fourth and last panel took place at the end of the study after another interval of 4 months (mid March 2008). In between the panels, the interventions were applied, except between panels 1 and 2, resulting in two rounds of interventions.

RESULTS

The results are divided into two parts: the first part shows how the two key variables of the behavior change process, SODIS intention and SODIS behavior, developed over time in dependence of the intervention group. This shows the different influence of the two types of interventions. The second part is a deeper analysis of the predictors of SODIS intention and SODIS behavior. Here only data from the last measurement time point will be used to have a high number of people actually knowing and using SODIS. These last analyses will be calculated using multiple linear regressions and it will be controlled for the following demographic variables: education, age, persons per household, children below 5 years, and gender.

Sample description

The interviewed person had a mean age of 45 years (SD = 16), was in 72% of the cases a woman and went 2.7 years to school (SD = 3.2). Households consisted on average of a total of 5.3 persons (SD = 4.9) out of which were 0.7 children below the age of 5 (SD = .90).

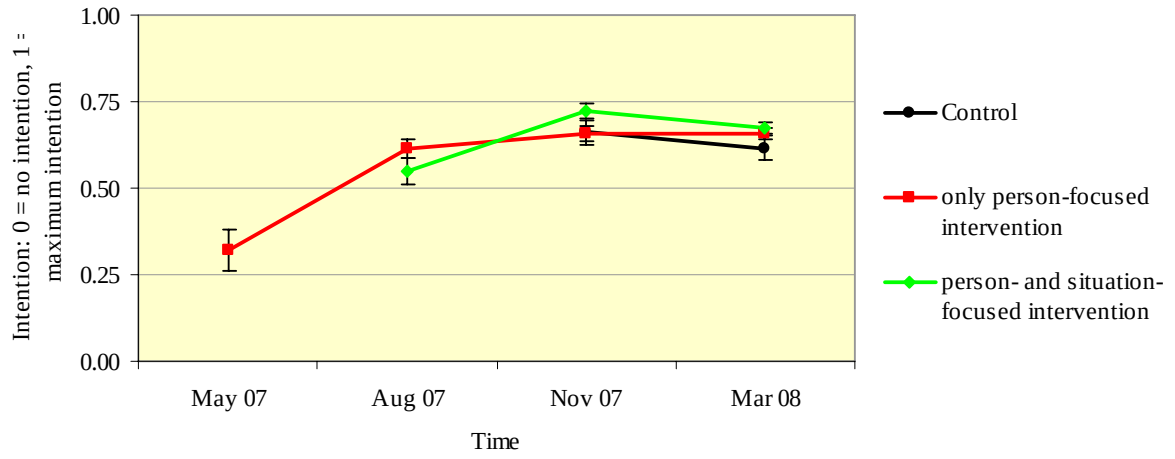
Effectiveness of the interventions

Before analyzing the influence of the interventions, a short overview is given of how many households the three investigation groups contain at which time point. The control group always

contained 42 households. As described earlier, the first intervention took place after the second panel. 86 households out of 295 households had received a prompt or a public commitment (situation-focused intervention). Consequently, 209 households remained in the group with only workshops and/or household visits (person-focused intervention). The second intervention took place after the third panel. There 114 households were provided with a situation-focused intervention out of which only 69 had already been in the situation-focused intervention group before. The person-focused intervention group consequently contained 181 households at panel 4 (see Figure 3).

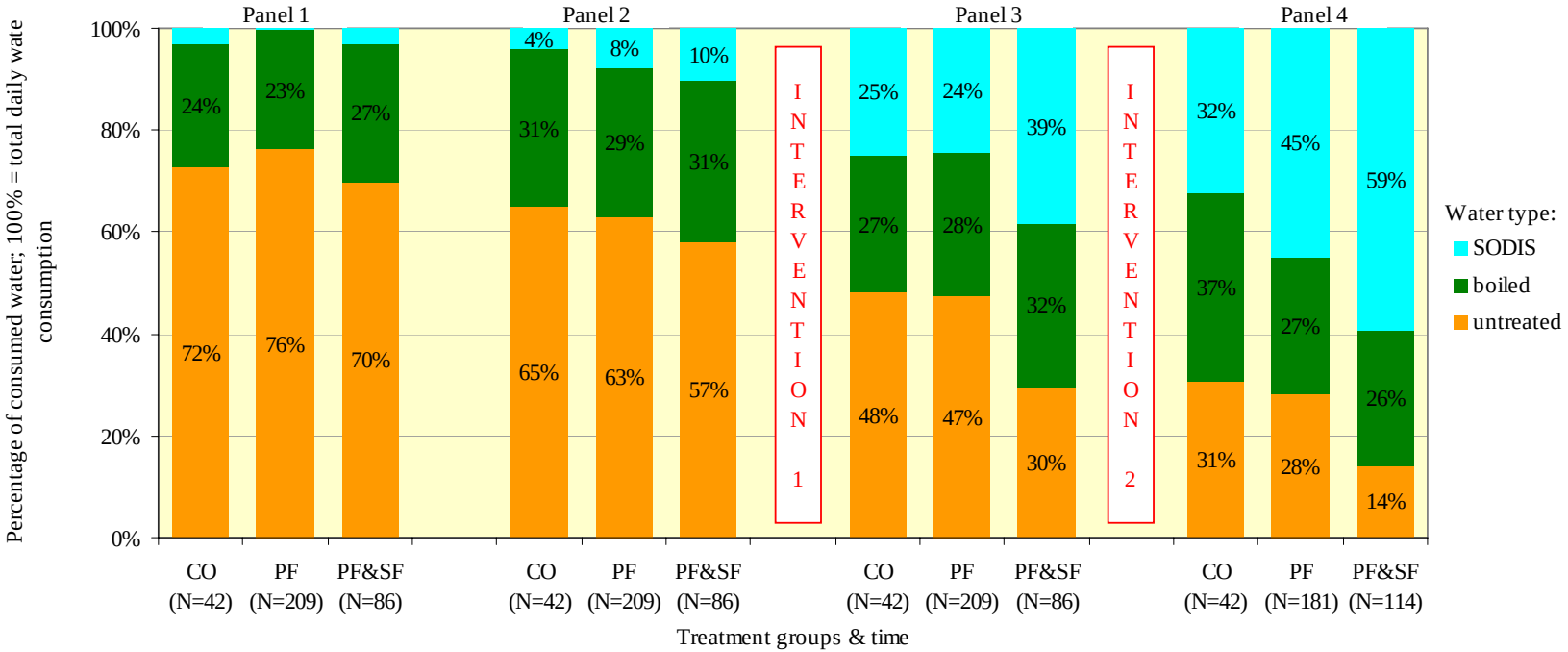
First, the development of the SODIS intention is shown. Since intention was only be possible to measure among people who knew at least a little about SODIS, some data points are missing (N < 10). This is also the reason why no repeated measures analysis can be calculated to estimate the increase over time. Analyses within each time point did not reveal any significant differences could between the two treatment groups and the control group.

Figure 2 – Development of the intention to use SODIS over time for the three different groups.



In the next step, the final outcome of the behavior change process is analyzed – the SODIS water consumption. To provide a more complete picture of water consumption in this context, also consumption of untreated water and the remaining part, boiled water, is shown. The following figure 3 depicts the water consumption pattern of the three different groups across time.
At Panel 1, the water consumption is, as expected for a baseline measurement, very similar for the entire population. Around one third of the total water consumption is boiled water (23-27%), which is mainly used for preparing hot beverages, the remaining part is consumed untreated (70-76%).

Figure 3 – Consumed percentages of the total water consumption of untreated, boiled and SODIS water of the control, person-focused and situation-focused intervention groups over time.



Note: Treatment groups: Co = Control, PF = only person-focused intervention, PF&SF = person- and situation-focused intervention.

At Panel 2, still no differences between the three groups can be observed. This is in line with the expectations, because no intervention had taken place yet. A slight tendency to less untreated water consumption was observed (57-65%), instead some people already took up SODIS (4-10% of total water consumption) and a slightly higher proportion of the water gets boiled (29-31%). These trends over time are significant for untreated water (GLM for repeated measures between the two time points; $F = 31.2$, $p < .001$, $df = 1$), boiled water ($F = 11.6$, $p = .001$, $df = 1$) as well as SODIS water ($F = 23.8$, $p < .001$, $df = 1$). At Panel 3, after the first intervention phase, a lot less untreated water is consumed (30-48%; $F = 66.8$, $p < .001$, $df = 1$). This decrease is significantly stronger for the person- and situation-focused intervention (PF&SF) group than for the other two groups (pairwise comparisons based on estimated marginal means within the GLM; $p < .006$). Instead, all consume more SODIS water than before (24-39%; $F = 110.1$, $p < .001$, $df = 1$). This increase in SODIS water consumption is significantly higher for the PF&SF group compared to the other two ($p < .007$). Boiled water consumption stayed stable. At Panel 4, after the second round of interventions, across the entire sample untreated water consumption dropped further (14-31%; $F = 53.8$, $p < .001$, $df = 1$) and SODIS water consumption increased (32-59%; $F = 52.9$, $p < .001$, $df = 1$). The PF&SF group consumes significantly less untreated water (14%) than the Control (31%; ANOVA, posthoc Bonferroni tests; $p = .006$) and person-focused intervention (PF) group (28%; $p <.001$) as well as significantly more SODIS water (58%) than the Control (32%; $p < .001$) and PF group (45%; $p < .001$). Moreover, the difference between the Control and PF group for SODIS water consumption became significant ($p = .030$). Interestingly, at panel 4 the Control group consumes significantly more boiled water (37%) than the PF group (27%; $p = .004$) as well as the PF&SF group (26%; $p = .004$).
Summarizing, the analysis shows that SODIS water consumption increases most strongly in the PF&SF group, but also in the Control group a remarkable increase of 30% can be observed. An interesting result is that untreated water consumption already decreased after the first panel (interviewer effect). However, only in the PF&SF group it decreased down to an acceptably low percentage of the total water consumption.

Predictors of intention and behavior

The first analysis investigates the influences of factors from the phases problem awareness and persuasion on the behavioral intention to use SODIS. All predictors of intention from the problem awareness and persuasion phases were entered as a first step into a linear regression analysis using a stepwise procedure. The reason to do so was the rather high number of predictors and the explorative character of investigating which factors actually contribute to explain the intention. Moreover, risk of diluting the main effects with entering too many predictors into the model was intended to be reduced. The entry criterion for the predictors was set to a rather weak significance level ($p_{in} = .10$), so no information on marginal effects would be lost. Once entered, variables were not removed anymore from the regression in order not to loose that information. Order of entry will be given with the results. The demographic variables were controlled for in a second block using a forward procedure. In Table 1, the results of the regression on intention are presented. Means, standard deviations and inter-item correlations of the variables of the regression on intention can be found in the Appendix, Table A-2.

Table 1 – Results of the regression on the intention to do SODIS

Predictors of intention	Unstandardized Coefficients	95% Confidence Interval for B		Standardized Coefficients	
	B	Lower Bound	Upper Bound	Beta	Sig.
(Constant)	0.41	0.23	0.59		0.000
Belief Taste	0.22	0.14	0.30	0.28	0.000
Knowledge depth	0.23	0.14	0.32	0.26	0.000
Belief difficulty	0.22	0.03	0.41	0.12	0.020
Affect	0.18	0.06	0.29	0.16	0.004
Importance health	-0.23	-0.46	0.01	-0.09	0.056
Bottle availability	0.07	0.00	0.13	0.10	0.036
Education	-0.01	-0.01	0.00	-0.09	0.052

Note: The order of the predictors in the table is as they entered the regression. Dependent variable: intention to do SODIS. N = 327; adjusted R^2 = 0.35. Not entered into the regression (did not pass p <.1 threshold): problem awareness diarrhea, awareness clean water, causality untreated water – diarrhea, belief health, belief money, belief time, attitude, injunctive norm, subjective norm and of the demographic variables age, persons per household, children below 5 years, gender.

Looking into the results of the regression analysis (Table 1), it has to be noted that the intention to drink SODIS water could not be explained too well (35%). Looking at the predictors which proved to be of importance in determining the intention, the belief about the taste and the knowledge depth are certainly the most important ones (β = .28 and .26, respectively). These two are followed by the affect (β = .16). The belief about the difficulty of preparing SODIS shows still a weak influence (β = .12) as well as bottle availability (β = .10). The other two, importance of health and education, show only very low influences. All other variables did not make it into the regression. Most remarkably, none of the variables of the problem awareness phase showed any important influence on the intention to use SODIS.

The second analysis investigates the influence of the factors from the uptake and habituation phases on SODIS behavior intensity. During the uptake phase particularly situational barriers are assumed to have an influence (perceived behavioral control; see Ajzen, 1991). A positive intention is also assumed to be an important predictor during the uptake phase, being the repository for the indicators of the previous phases (Ajzen, 1991). The habituation phase is represented by forgetting, cognition intensity and perceived habit. These predictors were, like for the intention model, entered first into the regression using the same stepwise procedure (p_{in} = .10, no p_{out}). Order of entry will be given with the results. The demographic variables entered the regressions as a second block in a forward procedure. Only households who consumed SODIS water were included into the analysis. In Table 2, the results of the regression on intention are presented. Means, standard deviations and inter-item correlations of the variables of the regression on behavior intensity can be found in the Appendix, Table A-3.

Table 2 – Results of the regression on the SODIS behavior intensity

Predictors of intention	Unstandardized Coefficients	95% Confidence Interval for B		Standardized Coefficients	
	B	Lower Bound	Upper Bound	Beta	Sig.
(Constant)	0.11	-0.01	0.23		0.086
Perceived Habit	0.31	0.18	0.45	0.27	0.000
Cognition intensity	0.31	0.18	0.45	0.26	0.000
Intention	0.36	0.22	0.49	0.23	0.000
Forgetting	0.16	0.06	0.27	0.15	0.002
Age	0.00	0.00	0.00	-0.17	0.000

Note: The order of the predictors in the table is as they entered the regression. Dependent variable: percentage of consumed SODIS water. N = 288; adjusted R^2 = 0.54. Not entered into the regression (did not pass $p < .1$ threshold): bottle availability and of the demographic variables education, persons per household, children below 5 years, gender.

The results of the regression (Table 2) show that 54% of the variance of the consumption of SODIS water could be explained with the chosen predictors. All predictors from the habituation phase and intention contributed significantly to explain the SODIS behavior. The most important predictor was perceived habit ($\beta = .27$), closely followed by cognition intensity ($\beta = .26$) and intention ($\beta = .23$). A weaker effect was found for forgetting ($\beta = .15$). Bottle availability does not seem to be a limiting factor on behavior in the investigated sample. Interestingly, of the demographic variables age shows a significant, but negative effect on behavior ($\beta = -.17$). That means, the younger the person the higher is the part of SODIS water on the total daily consumption.

DISCUSSION

We have investigated two facets of a SODIS promotion campaign: first, the effect of two types of interventions and second, the factors that are important to achieve successful behavior change. The structure of the discussion will follow these two aspects.

Effectiveness of the interventions

It could be shown that with respect to intention the interventions had no differentiating effects from the control group which "received" only interviews. It seems that the interviews have the same persuasive power as the person-focused interventions (workshops, household visits), because there is always some information on SODIS transmitted during an interview. Then, intention reaches quite quickly a certain positive level; therefore the person-focused interventions did not show additional effects compared to the Control group as one would have expected, because interviews seems sufficient to develop an intention.
In contrast, with respect to SODIS water consumption, there are big differences. The person-focused intervention as well as the person- and situation-focused intervention together induce a higher consumption of SODIS water compared to the control group. The person- and situation-focused interventions together show the strongest increase of SODIS water consumption and the

strongest reduction in the consumption of untreated water. The persuasive messages of the workshops and the promoters have a positive effect, but this effect is intensified by reminders like prompts and public commitments. The increase of SODIS water consumption and decrease of untreated water consumption observed in the Control group may be attributed not only to the interviewer, but also to the radio campaign (which started after the second panel) and the general increased activity level in the area regarding health promotion due to the project. This may also in part explain the suddenly increased boiled water consumption of the Control group towards the end of the study. It seems that people have gained a certain awareness towards treating their water.

Factors influencing intention

Although quite many factors got included into the model predicting behavioral intention, only three factors showed some influence of importance on the behavioral intention. The perception of the taste of the SODIS water and the knowledge about how to prepare it showed a medium influence. The influence of the third important factor, affect, was a little lower. Interestingly, only one of the indicators of problem awareness phase showed a negligible influence on intention (importance health). But all the other more rational beliefs about healthiness, monetary and time costs did not influence the intention to consume SODIS. Only difficulty and bottle availability showed a moderate influence. In general, the mean level of many factors from the problem awareness and persuasion phase was quite positive (Table A-2). This indicates that problem awareness was acquired well during the course of the study or had even already existed before. For the beliefs and attitude regarding SODIS it can also be said that people got convinced about SODIS until the end of the study (that SODIS is easy, not time consuming, healthy, something pleasant etc.). However, the problem awareness and beliefs about SODIS – although positive – are not important for forming a positive intention. It is rather only the belief or perception of the taste, the degree of knowledge and the affect. The two known studies containing comparable analyses of SODIS intention (Altherr et al., 2008; Heri & Mosler, 2008) show some similarities, but also differences. The one study that had some indicators of problem awareness, as well as knowledge included in their model (Altherr et al., 2008) confirms the low influence of problem awareness, but in contrast to the present study, knowledge did not show an influence on intention either. Both studies confirm the importance of affect: Heri and Mosler (2008) used an explicit affect measure and Altherr et al. (2008) with a quite affectively connotated attitude measure. Also, the importance of the cognitive belief about taste on SODIS intention gets support by one of the studies (Heri & Mosler, 2008).
The influence of particularly the taste belief of the SODIS water also has some implications for promotion campaigns. This factor should be targeted most during campaigns promoting SODIS. However, the factors often stressed as being of decisional importance for the people are the ones that did not show an influence. Campaigns usually aim at creating problem awareness and convincing people with arguments about the healthiness, easiness and non-costliness of the SODIS method. It is not said that this should not be done, but taking into account the quite positive mean levels of these factors, it seems that it is quite easily achieved that people have good general problem awareness and a positive set of beliefs about SODIS. For targeting the belief about the taste of SODIS water, during early promotion workshops, tests of SODIS water should be offered to the people to make them aware of its good taste. In addition, as one would expect, the knowledge level of the new behavior SODIS is important for a positive intention to

use it in the future. Consequently, a thorough and constant provision with action knowledge on how to prepare SODIS must be guaranteed, until people have understood and internalized the entire process.

Factors influencing behavior

With respect to the behavioral model, the intention, the perceived habit and cognition intensity are strong predictors of behavior intensity. Forgetting shows a little lower influence. This implies that during campaigns, habit development and regularity of the water consumption should be stressed to increase people's perceived habits. This can be fostered by the situation-focused intervention like prompts and public commitment, which assure a higher cognition intensity and can prevent forgetting due to their permanent presence. Further measures to influence cognition intensity are provided by the Elaboration Likelihood Model (Petty & Cacioppo, 1986), which should be applied for raising this factor, as for example via issue involvement or self responsibility. Tailored interventions which focus on issue involvement as developed by Mosler and Martens (2008) could be used. It could be demonstrated that early adoption of SODIS was predicted by involvement (e.g. vulnerability to and gravity suffering from diarrhea; Moser & Mosler, 2008). The intention should be influenced via the important predictors from the intentional model, which have already been discussed above.
In addition to the variables from the behavior change model, a quite interesting relationship between age and SODIS behavior was found. Apparently, younger people disinfect more water with SODIS than older people. An explanation could be that younger people are more open to an innovation than older people, who have already lived a longer time with their habits and stay with what they know. This circumstance could possibly be used during promotion campaigns, with first targeting younger people.
Overall, SODIS water consumption could be explained quite well (54% of the variance) with the suggested factors. Also, it could be shown that the conceptualization of a separate habituation phase is very useful to fully understand why people treat different quantities of their water with SODIS once they have started. One important goal for future research in this context should be to determine what makes people perceiving a certain habit strength or not, because perceiving a habit is not directly addressable with interventions. A start has been made with including cognition intention and forgetting, however other factors probably have to be considered in addition. Better insight into this important construct can probably facilitate the development of more effective ways to support habit formation. Additionally, it should be thought of indicators that describe the uptake process. Here maybe the inclusion of planning processes that have occurred during uptake could help to bridge the gap (Schwarzer, 2008).

CONCLUSION & LIMITATIONS

Summarizing, the factors derived from the stage model could explain a good part of the SODIS consumption related intention and behavior. The behavior was better explained than the intention.
The factors found influencing the intention provide insight into which particular beliefs must be addressed during campaigns. The belief about the taste and the knowledge depth were interestingly found to be strong predictors of intention. Having a positive intention then, in turn,

influences behavior, together with perceived habit, cognition intensity and forgetting. Here, more research is needed to find other factors that are important during the habituation phase. Moreover, it is assumed that circumstances that were present during the uptake phase could possibly also play a role. However, in this study they were not critical.
A clear limitation of the presented analyses is that it is only a one point snap shot of the behavior change process. No real process analysis was carried out, which would have required the inclusion of the previous time points. It is therefore highly suggested to gather larger samples of longitudinal data with shorter time intervals to have a better database for analyzing the process character of behavior change. A larger sample and shorter time intervals of measurements would provide the possibility of placing groups of individuals along the stages of the process and analyze their progress separately. This would not have been possible with the available data, because for analyzing separate groups, the longitudinal sample size was too small, and the measurements were too far apart from each other to analyze over time causalities. Additionally, it has to be tested if the same relations exist in different circumstances, for example more urban settings.

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APPENDIX

Table A-1 – Item formulations of the items used in the present paper.

Variable name	Item formulation	Scale Study II	Restric-tions
Problem awareness diarrhea children *	Do you think it is a serious disease when a child has diarrhea?	5-point: 0 it's something normal 1 very serious	-
Problem awareness diarrhea self *	How much does it bother you when you have diarrhea?	5-point: 0 doesn't bother me 1 bothers me a lot	-
Awareness clean water	When you drink a glass of water, how much do you bother about if it is clean?	5-point: 0 never 1 always	-
Importance health	How important is it for you to have good health?	5-point: 0 not at all 1 a lot	-
Causality untreated water - diarrhea	Do you think that untreated water can cause diarrhea	5-point: 0 never 1 always	-
Knowledge SODIS	Have you heard of SODIS?	dichotomous: 0 no 1 yes	-
Knowledge depth SODIS	Could you please explain SODIS to me?	5-point: 0 does not know SODIS 1 knows SODIS very well	-
Belief taste SODIS	What do you think about the taste of SODIS water?	9-point: -1 tastes very bad 0 tastes neither good nor bad 1 tastes very good	has to know SODIS
Belief health SODIS	Do you think that SODIS water is good or bad for your health?	9-point: -1 very bad 0 neither good nor bad 1 very good	has to know SODIS
Belief money SODIS	Do you think that SODIS water costs little or a lot of money?	5-point: -1 costs a lot 0 does not cost anything	has to know SODIS
Belief time SODIS	Do you think that preparing SODIS water costs little or a lot of time?	5-point: -1 costs a lot of time 0 does not cost time	has to know SODIS
Belief difficulty SODIS	Do you think that preparing SODIS is difficult?	5-point: -1 very difficult 0 not difficult at all	has to know SODIS
Affect SODIS	Do you like/enjoy preparing SODIS?	9-point: -1 I dislike it a lot 0 I neither enjoy nor dislike it 1 I like it a lot	has to know SODIS
Attitude SODIS	How good or bad do you think is using SODIS?	9-point: -1 it's very bad 0 it's neither good nor bad 1 it's very good	has to know SODIS

Injunctive norm SODIS	What do other people think if you drink SODIS water?	9-point: -1 they think very bad about me 0 they think neither good nor bad about me 1 they think very good about me	has to know SODIS
Subjective Norm SODIS	What do you think or know, how many other people (neighbours) use SODIS?	5-point: 0 (almost) no one 1 (almost) everyone	has to know SODIS
Availability of bottles	Are there sufficient bottles available to prepare SODIS?	5-point: 0 no bottles available 1 always available	has to know SODIS
Intention SODIS	How much water you think you will disinfect with SODIS in the future?	5-point: 0 nothing 1 everything	has to know SODIS
Perceived habit SODIS	Do you think you have the habit to prepare SODIS water?	5-point: 0 not at all 1 a lot	has to consume SODIS
Cognition intensity SODIS	Do you always remember doing SODIS?	5-point: 0 never 1 always	has to consume SODIS
Forgetting SODIS	How often do you have the intention to prepare SODIS, but then you forget it?	5-point: -1 always 0 never	has to consume SODIS
Behavior SODIS	Do you use SODIS?	dichotomous: 0 no 1 yes	-
Behavior intensity SODIS	How much of your water consumption is SODIS water?	0 0% 1 100%	-
Prompt	Did you receive a prompt since the last interview?	dichotomous: 0 no 1 yes	-
Public Commitment	Did you receive a public commitment since the last interview?	dichotomous: 0 no 1 yes	-

* These two items were taken together as scale named problem awareness diarrhea (Cronbach's alpha = 0.62).

Table A-2 – Inter-Item Correlations for the variables of the regression on intention

			Variables in the regression														
Variables in the Regression	*M*	*SD*	Int	KD	PAD	ACW	IH	CUD	BTa	BH	BM	BTi	BD	Aff	Att	IN	SN
Intention (Int)	0.66	0.21	-														
Knowledge depth (KD)	0.66	0.25	.45														
Problem awareness diarrhea (PAD)	0.75	0.08	-.04	-.06													
Awareness clean water (ACW)	0.65	0.17	.21	.16	.09												
Importance health (IH)	0.75	0.08	.01	.16	.16	.28											
Causality untreated water – diarrhea (CUD)	0.71	0.23	.28	.21	.03	.43	.12										
Belief taste (BTa)	0.63	0.26	.46	.38	.01	.20	.05	.24									
Belief health (BH)	0.69	0.17	.39	.34	.09	.31	.15	.25	.52								
Belief money (BM)	-0.02	0.08	.21	.16	.01	.10	.10	.07	.14	.24							
Belief time (BTi)	-0.09	0.13	.15	.11	.00	.10	.12	.31	-.02	.20	.39						
Belief difficulty (BD)	-0.05	0.11	.30	.29	.04	.18	.14	.30	.12	.29	.30	.27					
Affect (Aff)	0.64	0.19	.43	.43	.14	.33	.25	.39	.47	.56	.20	.15	.35				
Attitude (Att)	0.69	0.16	.39	.42	.08	.39	.14	.32	.54	.75	.27	.14	.34	.60			
Injunctive norm (IN)	0.42	0.35	.16	.08	-.03	.07	.00	.02	.32	.14	-.04	-.34	.04	.10	.20		
Subjective norm (SN)	0.23	0.20	.17	.23	.10	.04	.00	-.01	.26	.17	.02	-.29	.05	.26	.25	.36	
Bottle availability (BA)	0.55	0.31	.12	-.05	.02	.26	.10	.28	-.03	.16	.17	.43	.27	.08	.11	-.29	-.39

Note: Means, standard deviations and inter-item correlation of the variables that entered the regression to predict SODIS intention. Grey correlations are not significant; all others are significant at least at .05 level.

Table A-3 – Inter-Item Correlations for the variables of the regression on behavior

Variables in the Regression	M	SD	Variables in the Regression				
			Beh	BA	Int	PH	F
Behavior (Beh)	0.57	0.25	-				
Bottle availability (BA)	0.57	0.30	0.24				
Intention (Int)	0.69	0.16	0.52	0.18			
Perceived habit (PH)	0.62	0.22	0.65	0.26	0.48		
Forgetting (F)	-0.24	0.23	0.47	0.28	0.22	0.50	
Cognition intensity (CI)	0.59	0.21	0.64	0.40	0.47	0.70	0.47

Note: Means, standard deviations and inter-item correlation of the variables that entered the regression to predict SODIS behavior. All correlations are significant at least at .05 level.