Successful promotion of Solar Water Disinfection (SODIS)

Thesis

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Andrea Tamas
from Germany

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Prof. Dr. Hans-Joachim Mosler and Prof. Dr. Heinz Gutscher

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CONTENTS – OVERVIEW

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SUMMARY

The consumption of untreated source water is still among the major causes of diarrhea and child mortality in low income countries. Roughly one third of infant mortality is caused by such waterborne diarrheal diseases (WHO, 2007). To combat this preventable global burden, the Millennium Development Goals (MDGs) have called for halving the proportion of people without sustainable access to safe drinking water and basic sanitation by 2015.

The promotion of household water treatment and safe storage systems (HWTS) represents an effective and realistic method to accelerate health gains to those without reliable access to safe drinking water (WHO, 2007). A variety of technologies for water treatment at household level exist and many are widely used in different parts of the world (e.g. boiling, filtering, chlorination, solar disinfection etc.). According to the World Health Organization (WHO, 2008), solar water disinfection (SODIS) is one of the most promising and accessible technologies for household water treatment. The method consists of exposing water-filled, transparent plastic bottles to full sunlight for about one day. Experiences of efforts promoting SODIS or other HWTS, however, have shown that the uptake of treatment techniques has often been slow and not initiated through information only. Consequently, investigations are needed on people's motivations to use HWTS, to understand how households can be encouraged to take up these new methods, and how their behavior can be changed sustainably (Zwane & Kremer, 2007).

The overall objective of the present work is the investigation of how to successfully promote the consumption of SODIS water. More specifically, questions investigated are: Which are psychological drivers of safe and unsafe water consumption behavior, particularly the consumption of SODIS water? What are reasons for discontinuing water treatment with SODIS? How can the development of a long-term habit be successfully supported with specifically designed interventions? Which type of communication strategy is most cost-effective in terms of reaching people and changing their behavior towards SODIS water consumption during SODIS promotion campaigns?

For understanding the behavior change process, an integrative model based on four behavior change theories was developed. The considered behavior change theories were all stage models, namely the "Transtheoretical model" (Prochaska & DiClemente, 1982, 1983), the "Innovation decision process" (E. M. Rogers, 1983, 2003), the "Model of action phases" (Heckhausen & Gollwitzer, 1987; Gollwitzer, 1996), and the "Health action process approach" (Schwarzer, 1992, 2008). The phases derived are *problem awareness*, *persuasion*, *uptake* and *habituation*, with the first two involving motivational and the latter two volitional processes. These phases are not understood strictly linear, relapses from later to earlier phases may occur. Specific factors of the various stages of the behavior change process were investigated for

understanding the consumption of SODIS, boiled and untreated water. The investigation of the discontinuance of SODIS use was guided by the same model with a special focus on the habituation phase. The mode of operation of two habit supporting interventions, prompt (e.g. De Young, 1993) and public commitment (e.g. Dwyer, Leeming, Cobern, Porter & Jackson, 1993), was investigated using a range of so-called behavior near factors. These represent processes taking place in the habituation phase, and habit supporting interventions are assumed to operate via these factors. Implementation intentions, perceived habit and commitment were the most prominent ones under investigation. The selection of communication strategies was on one hand based on the classification into mass and interpersonal communication strategies (E. M. Rogers, 1995), on the other hand this classification was supplemented by experience driven considerations.

Two data sets are the basis of this thesis. Questionnaire measurements took place during two studies where SODIS was actively promoted in (I) periurban and (II) rural areas of Bolivia. Both data collection designs were longitudinal panel designs with four measurement time points. The time frame, however, of the two studies was different. While Study I had a two months highly active promotion phase and a seven months inactive phase, Study II consisted of eleven months constant but less intensive promotion activities. Study I was designed to investigate the impacts of different communication strategies and the two habit supporting interventions, prompt and public commitment. In addition, due to its inactive phase, it was possible to study the sustainability of the SODIS promotion campaign and reasons for behavior discontinuance. Study II covered a larger area than Study I and was designed for the investigation of the same habit supporting interventions as were used in Study I. Moreover, Study II provided the data to calculate the behavioral model regarding the consumption of SODIS, boiled and untreated water.

The detailed analyses of the complete water consumption pattern at the end of Study II revealed that the more SODIS water is consumed, the lower is the amount of consumed untreated water, whereas the proportion of boiled water is nearly constant with approximately 25% of the total daily water consumption. Of the total investigated sample, only 17% do not use SODIS at all after eleven months of SODIS promotion campaign. However, the prepared amounts vary considerably. Only those 25% of the SODIS users who treat more than 80% of their daily needed water with SODIS, do not or very little consume untreated water. The analyses of the integrated behavior change model for the behaviors SODIS, boiled and untreated water consumption confirm the usefulness of the model, particularly the inclusion of the habit phase. Of the motivational phases, problem awareness does not seem to play such an important role, whereas affective beliefs such as liking and the taste belief are of predictive importance for all water consumption intentions. The behaviors, in turn, are all influenced by the behavioral intentions, which indicates the importance of this transition measure. For two of the three water consumption behaviors, the influence of habit proved to be even stronger than that

of intention, underlining the importance of investigating habit development in addition to motivational processes.

Into the same direction points the analysis of the discontinuance of SODIS use. After a seven months non-promotion phase in Study I, about 55% of former SODIS users have dropped the behavior. In general, these relapsers have lower values than continued users for all factors of the behavior change process. In addition, the further the behavior change process advances, the greater are the differences between relapsers and continuers, and the lower is the level of the factors for relapsers resulting in the largest differences during the habituation phase. It can be reasoned that the causality for people being relapsers lays mainly in the missing habit, which they have not managed to maintain during the inactive phase in contrast to those who stayed users. Interestingly, among relapsers as well as continuers, two different types of relapsers and continuers were identified. Low-value relapsers (referring to the values of the factors of the behavioral model) differ from high-value relapsers mainly in affective beliefs, such as liking and the taste belief, the injunctive norm, intention and cognition intensity. High-value relapsers interestingly have values almost as high as low-value continuers, only differing in the degree of habit. Only high-value continuers seem to be stable and do not show a decrease in critical habit variables over time, whereas low-value continuers still need to strengthen their habit.

The applied habit supporting interventions, prompt and public commitment, are both able to increase chances for people to start using SODIS by 100 to 300%. For the prompt, stable long term effects were shown. Directly after the intervention phase, the interventions are most effective in influencing SODIS uptake. The quantity of water treated with SODIS was explained with a model involving indirect influences of the interventions via behavior-near factors. On implementation intention, both interventions operate in a similar way: activation of the SODIS behavior and initiation of planning processes. Perceived habit to use SODIS is only directly influenced by the prompt. The public commitment, in contrast, does not act as a direct reminder to perform SODIS, because it has not been placed where the behavior was to be executed and it contains too little information. Instead, the implementation intention evoked by the public commitment manifests itself in the habit. Overall, it was shown that prompts and public commitments operate via behavior-near factors and not directly on the behavior itself, when it comes to increase the proportion of SODIS-treated water on the overall water consumption. Initial SODIS uptake, on the other hand, can directly be initiated through these interventions.

When looking at different strategies on how to communicate with the target population, in terms of reaching people and changing their behavior to use SODIS, employed promoters are most successful and have achieved 73% of SODIS users after a two months promotion time period. Opinion leaders – although less effective on the uptake of SODIS (62% SODIS users after two months) – pose the additional potential to stimulate communication between people about SODIS. In contrast, a health fair has stayed beyond expectations in reaching people and does not have a big impact on behavior. Of the investigated sample, 20% have been reached by the health fair and 14% have used SODIS afterwards. One major reason seems to be that a

health fair is only a one-time event. Comparing the costs of the different communication strategies, it appears even less advisable to use a health fair, because of the high costs involved. Paid promoters cost about half of the health fair and opinion leaders are almost of no cost, except for the regular trainings and follow-ups that are needed. Due to the higher effectiveness of the professional promoters in initiating SODIS uptake, a combination of promoters and voluntary opinion leaders may show interesting synergetic effects, save costs, and may be most sustainable during long-term promotion campaigns.

Summarizing, during a SODIS promotion campaign, particular interest should be paid to address the relevant factors of the behavior change process. The SODIS method should be connected to positive affects, and a possibility for tasting the water should be provided. The development of a positive intention and uptake (at least a try out) should be supported. During the following phase of habit development, supporting interventions like prompts or public commitments are easily applicable and widely accepted possibilities. Particularly prompts have a proven positive long-term influence on habituation and the amount of water treated with SODIS within a household. Communication channels should be primarily interpersonal, others like fairs or mass media may be used as supportive sources of information. However, solely applying the latter ones is not likely to show the desired effects on behavior.

In future studies, additional factors for explaining the water consumption behavior should be considered to gain more detailed insight into drivers of this particular type of behavior. Another topic that urgently needs to be addressed is social influence and with it interpersonal communication. The question remains, how people can be motivated to communicate about water treatment, which at the moment is not very frequent.

Finally, some limitations like small sample sizes, the sometimes low number of people who actually received interventions, the long time difference between measurements, particularly in Study II, as well as the specific context of the two studies have to be overcome.

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PROBLEM DEFINITION

More than one third of the people living in developing countries do not have access to save drinking water. Microbiologically contaminated drinking water can cause diarrheal diseases, which are particularly dangerous to children. Roughly one third of infant mortality is caused by such diarrheal diseases, and every day around 6.000 children die due to the direct or indirect effects of diarrheal diseases – in many cases caused by contaminated drinking water. In 2003, the United Nations have included safe drinking water in their list of Millennium Development Goals, with the goal to halve the amount of people with no access to safe drinking water by the year 2015 (United Nations, 2003). This ambitious goal can be reached in two ways: on one hand, new and safe installations (pipes, boreholes, etc.) can be set up; on the other hand, people can be educated not to drink untreated water. Of course, on the long run it surely is a goal to provide safe drinking water from the tap, however, this will still be a long way to go. Household water treatment and safe storage (HWTS) interventions can lead to dramatic improvements in drinking water quality and reductions in diarrheal diseases – making an immediate difference to the lives of those who rely on water from polluted rivers, lakes and, in some cases, unsafe wells or piped water supplies (WHO, 2008).

This thesis has its relevance in the field of the promotion of the household water treatment method SODIS (Solar Water Disinfection) and intends to be a first step into the direction of an integrative analysis of different aspects related to SODIS promotion.

THE SODIS METHOD

This part summarizes all relevant research that has been published and insights that have been gained about SODIS. Different topics will be included, namely, biological studies on the effectiveness on eliminating microorganisms, a short overview about the effects of SODIS on the reduction of diarrhea (health impact), some analyses on economical savings, and a review of studies that have investigated behavioral factors determining SODIS use or analyzed SODIS promotion.

Effectiveness on eliminating microorganisms

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 on solar water disinfection was first conducted by Professor Aftim Acra at the American University of Beirut in the early 1980s (Acra, Karahagopian, Raffoul & Dajani, 1980). Follow-up 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 followed, which assessed and demonstrated the effectiveness of SODIS in destroying diarrhea-causing bacteria (Campylobacter jejuni, Yersinia enterocolitica, enteropathogenic Escherichia coli, Staphylococcus epidermidis, Vibrio cholerae, Salmonella typhimurium, Shigella dysenteriae, Pseudomonas aeruginosa), viruses (Poliovirus), parasites (Giardia spp., Cryptosporidium spp., Acanthamoeba) and fungi (Candida albicans, Fusarium solani; Berney, Weilenmann & Egli, 2006; Berney, Weilenmann, Simonetti & Egli, 2006; Boyle et al., 2008; Conroy, Elmore-Meegan, Joyce, McGuigan & Barnes, 2001; Gaafar, 2007; Heaselgrave, Patel, Kilvington, Kehoe & McGuigan, 2006; Kehoe, Barer, Devlin & McGuigan, 2004; Lonnen, Kilvington, Kehoe, Al-Touati & McGuigan, 2005; MacKenzie, Ellison & Mostow, 1992; McGuigan, Joyce, Conroy, Gillespie & Elmore-Meegan, 1998; McGuigan et al., 2006; Méndez-Hermida, Castro-Hermida, Ares-Mazás, Kehoe & McGuigan, 2005; Smith, Kehoe, McGuigan & Barer, 2000). Only spore forming bacterial species may survive the SODIS disinfection process (Boyle et al., 2008; Lonnen et al., 2005).

Health impact

Regular application of SODIS has the potential to reduce diarrhoeal diseases by up to 50%. Up to date SODIS is used in about 30 countries by more than 2 million people and is recommended by the World Health Organization (WHO, 2008). The health impact of consuming SODIS-treated water was first examined in Kenya in the 1990s. The study 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, Elmore-Meegan, Joyce, McGuigan & Barnes, 1996, 1999, 2001). From 2000 to 2003, the Swiss Tropical Institute conducted an epidemiological study in Bolivia in collaboration with Eawag to assess the health impact of SODIS on children below five. According to the study, SODIS reduced diarrhea incidence by more than 35% (Hobbins, 2003). A health impact study among 100 children in an urban slum in Tamil Nadu revealed that 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), in Uzbekistan by 53-57% (Grimm, 2004; Grimm, 2006) and of about 50% in projects conducted in Nepal, East Lombok and Assam, India (SODIS Reference Center, 2008b).

Cost Benefit Aspects

The mean costs for SODIS implementation in 13 countries, including the costs for bottles and educational material amounted to annually USD 0.75 per trained person. In the following years, users pay on average USD 0.60 per person per year for the application of SODIS, i.e. to replace damaged bottles. The running costs for SODIS application are greatly outweighed by the economic benefits drawn from improved health as a result of reduced diarrhea incidence, i.e. expenditure for medical care decreases, the economic productivity of adults and the school attendance of children increase, which leads to additional benefits.

The health impact assessments in Pakistan, Uzbekistan, Nepal, East Lombok, and India revealed that diarrhea rates of more than 970'000 SODIS users were reduced by about 50% (see above). Therewith, an estimated 2.4 million diarrhea cases could be prevented annually in the project areas. Assuming that treatment of one diarrhea case costs the health sector USD 10 (Haller & Hutton, 2004), more than USD 24 million were saved by the health sector. Moreover, the benefit of an improved economic labor force through improved health is estimated at USD 12 million (Haller & Hutton, 2004). With a total project cost of USD 730'800, the achieved cost-benefit ratio for the health sector amounted to 1:49.

At household level, the cost-benefit ratio is not as dramatic, but still significant: SODIS users in Nepal and Pakistan save on average 32 USD, respective 22 USD, annually per household through reduced costs for medical treatment of diarrhea. In the Kibera Slum of Nairobi, Kenya, one household annually saves 7 USD on average through reduced costs for medical treatment of diarrhea. The annually recurring costs for PET-bottles needed by one household for SODIS application are 2.20 USD in Nepal and Pakistan, and 3.20 USD in Kenya (SODIS Reference Center, 2008c). At the same time, people save money, because no wood or gas for boiling is needed. Data on the benefits of the improved labor force has not been collected at household level.

Promotional Efforts

Because the SODIS method is quite recent, there has been almost no scientific research on its promotion. Nonetheless, since 1995 SODIS has already 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. NGO partners such as the SODIS Foundation (Latin America) regularly report that the promotion of SODIS needs a comprehensive training and promotion process to achieve a significant uptake at user level (Mercado, 2005). 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.

An analysis of the few studies available assessing the effectiveness of SODIS promotion strategies shows that the success rates (percentage of SODIS users) reported in these studies vary greatly. Rainey and Harding (2005) report an adoption rate of only 9% in the course of a four-month follow-up study in Nepal, but the promotional effort here was very limited (one 2-hour training session). Reasons seemed to be perceived barriers (work, culture) on one hand and on the other hand lacking awareness, knowledge and motivation. In contrast, other studies report adoption rates of between 40 and 70% (Kabra, 2005; Mahmood & Lodhi, 2004; Moser et al., 2005; unpublished project reports). However, the promotional effort in these studies was comparably high, consisting of multiple strategies applied simultaneously. Various strategies were post-hoc evaluated, but no systematic comparison between the effectiveness of different promotion strategies was carried out. We found a few studies focusing on investigating which internal factors are important in determining SODIS uptake. One of the studies (Moser et al., 2005) focused on influential factors to use SODIS and found that habit, the behavioral intention and a social factor are amongst the most important ones. Also, the recent study of Altherr, Mosler, Tobias and Butera (2008) rather focused on behavior determining factors and tested a TPB model (Theory of planned behavior; Ajzen, 1991). They found similar results: intention and social influence were important. Additionally, attitude and knowledge were found to have influence on the use of SODIS. On the explicit evaluation of the diffusion process of the innovation SODIS is the one study of Heri and Mosler (2008). There the full diffusion of innovations model (E. M. Rogers, 2003) was tested and different determinants of the amount of water treated with SODIS were found such as the relative advantage of the SODIS method, compatibility with daily habits, availability of PET bottles, descriptive norm and the number of promotion activities a person participated. Furthermore, the amount of consumed untreated water had a negative relationship to the amount of water treated with SODIS. Only one paper (which is also a part of this thesis) so far has investigated the effectiveness of different communication strategies to promote SODIS (Tamas, Tobias & Mosler, accepted). The authors

compared a health fair, professional promoters and community based opinion leaders and found the two interpersonal strategies (promoters and opinion leaders) being much more effective and cost-efficient.

Summarizing, SODIS has proven to disinfect water effectively, to reduce diarrhea incidence by approx. 50% and to save people and governments health costs. Only when it comes to SODIS promotion, the picture gets more diffuse concerning effects and reasons for failure of the applied strategies. Therefore, in the next part, some theoretical backgrounds that are necessary to understand SODIS promotion from a social scientists perspective will be outlined.

THEORETICAL BACKGROUND RELEVANT TO SODIS PROMOTION

This thesis has the goal to provide a broad insight into how to achieve that people use SODIS to treat their water. This involves two theoretical parts to consider: one, which psychological factors influencing behavior (i.e. the uptake of SODIS) are of importance, and two, which promotional strategies work best in changing these factors and the related behavior. So, not a test of one particular theory or model or experimental paradigm will be performed, but various approaches that are related to the topic of SODIS promotion will be briefly outlined. But first of all, a clarification of what "SODIS promotion" implies psychologically must be made.

First, on a community level, the promotion of the technology SODIS in a social environment that has not yet heard about SODIS can be viewed as the diffusion of an innovation. To understand the process of innovation diffusion, a brief overview on Everett M. Rogers' (1983, 1995, 2003) "Diffusion of Innovations" theory will be given. Secondly, on an individual level, SODIS promotion can be understood as a change of an everyday behavior. Correspondingly, models of behavior change must be employed to understand the behavior change process. Thirdly, since it is the aim to change behavior, i.e. to promote the uptake of SODIS, it is important to have an overview about interventions that exist to reach this goal.

Diffusion of innovations

Everett M. Rogers' (1995) "Diffusion of innovations" theory (DOI) is a very comprehensive introduction to the process of innovation diffusion, viewing the process from different angles. Rogers tries to answer the questions of how, why, and at what rate new ideas and technologies spread through cultures. Rogers incorporates four possible influence factors on a general level and searches proof in many real world examples. In principle, the theory states that the adoption of an innovation depends on (1) the perceived attributes of the innovation, (2) the used

communication channels, (3) the nature of the social system, and (4) the time aspect of the entire process.

The first factor, **attributes of the innovation**, is the one most widely studied (e.g. Moore & Benbasat, 1991; Tornatzki & Klein, 1982). Five attributes have been found to explain between 49 and 87% of variance in the rate of adoption of innovations. These are the relative advantage of the innovation over the idea it replaces, the compatibility with existing values and habits, past experiences and needs of the receivers, the complexity or the degree to which the innovation is perceived as difficult to understand and use, the trialability or the degree to which an innovation can be easily tested for effectiveness, and the observability of the outcome of the innovation (E. M. Rogers, 1995, p. 206). Innovations an individual adopts to prevent an unwanted event in the future are classified as "preventive innovations". SODIS is a classic representative of a preventive innovation – it is adopted to prevent diarrhea. These types of innovations encounter particular slow uptake, because the outcome of the innovation is not immediately observable.

Communication channels are most commonly divided into mass media and interpersonal channels (Alcalay, 1983; Griffin & Dunwoody, 2000; E. M. Rogers, 2003; Valente & Saba, 1998). Classical mass media representatives are radio, television, or newspaper. Interpersonal communication involves interpersonal contact between someone who knows something about the innovation and the recipient and is often realized with promoters or opinion leaders. Mass media are viewed as helpful for having positive effects during the early phase of innovation adoption, besides they are able to transmit information to a wide audience, but rarely change behavior. Interpersonal communication is mostly seen as the more effective strategy.

Diffusion of an innovation occurs within a **social system**. The system's norms and the communication structure and intensity between the members of the social system can influence the adoption of innovations. System norms describe what ought to be done (injunctive norms) and what is done (descriptive norms; Cialdini, Reno & Kallgren, 1990; Rhodes & Courneya, 2003). Both norms can completely hinder an innovation to be taken up by a certain population as in the case of boiling in a Peruvian village (Wellin, 1955). Without communication no diffusion occurs and the communication intensity can make a complete difference in the speed of innovation adoption (Rogers & Kincaid, 1981).

The last of Rogers' factors, **time**, is involved in three concepts. First, in the process model of behavioral change, the "Innovation Decision Process", where it is stated that an individual needs time to pass through the stages of the behavior change process. Secondly, individuals have different degrees of innovativeness, and therefore, will adopt an innovation at different speeds. Five categories of adopters are described, ranging from innovators (very early adopters) to laggards (the latest adopters). Thirdly, different innovations have different rates of adoption, which refers to the relative speed with which an innovation is adopted by members of a social system. Nevertheless, the shape of the curve of cumulated amount of adopters over time will more or less be the same for all innovations: an S curve. The faster an innovation gets adopted, the steeper the S curve will be, and vice versa.

Rogers' theory was described in brief, because it provides a very holistic picture of what a diffusion of an innovation can be. Later in this work, it will be gone back to the attributes of the innovation and the norms of the social system, how they were operationalized for the innovation SODIS, and how they contribute to explaining SODIS behavior. More detailed results will be presented on the effectiveness of different communication channels. The innovation decision process will be, amongst other theories, employed to understand the discontinuation of SODIS use.

Models of behavior change

As briefly mentioned in the introductory part of this chapter, SODIS uptake must be understood as a process of behavior change. Therefore, it is important to have a general overview about psychological predictors of behavior, and a short summary on models of behavioral change is presented. Many different theories exist, proposing sometimes different, sometimes similar predictors of behavior. This part only gives an overview. The details about which parts of which theories were used in which way will be described in the corresponding chapter (chapter 1).

Behavioral models can be divided into two approaches: continuous or linear models and stage models. **Continuum models** want to explain an individual's likelihood of performing a certain behavior with combining influential predictor variables in one prediction equation. The individual moves along the proposed continuum of behavior likelihood. Prominent representatives of such theories are the "Theory of planned behavior" (TPB; Ajzen, 1985, 1991), the "Norm activation model" (Schwartz, 1973, 1977) or the "Protection motivation theory" (R. W. Rogers, 1983; R. W. Rogers & Prentice-Dunn, 1997). Such models do not assume any sequence of psychological change, nor do they allow for "jumps" or going back during the course of the behavior change. They imply that it is not important, which behavioral predictor should be first targeted with an intervention and interventions could be applied in any order or also simultaneously as long as they influence the important predictors of behavior (Schwarzer, 2008). Moreover, the behavioral predictors described in continuum models are preceding a behavioral intention, but leave a black box between intention and behavior, the so called "intention-behavior gap" (Sheeran, 2002). Nevertheless, the predictor variables described in these theories are very important for understanding motivational predictors of behavior, for example the concepts of intentions, attitudes, norms or beliefs.

Stage models in contrast describe behavior change rather as a process with certain qualitatively distinct stages an individual has to pass through. The behavior change process is not assumed to be linear; relapses may occur and the process is often described as spiral-like. The probably most famous representative of stage models is the "Transtheoretical model" (TTM; Prochaska & DiClemente, 1982, 1983). The TTM proposes five stages (pre-contemplation, contemplation, preparation, action, maintenance), which are all mutually exclusive and

qualitatively different. Also the already mentioned "Innovation decision process" (IDP; E. M. Rogers, 1983, 2003) proposes five distinct stages (knowledge, persuasion, decision, implementation, confirmation), whereas the "Model of action phases" (MAP; Heckhausen & Gollwitzer, 1987; Gollwitzer, 1996) defines four stages: pre-decisional, pre-actional, actional and post-actional phase. The TTM and the MAP additionally define goals or tasks that mark the transition points between the stages. One model, the "Health action process approach" (HAPA; Schwarzer, 1992, 2008) only differentiates between a motivational and a volitional phase, with the latter including the actual action. Summarizing, although the presented stages of the different models by far are not identical, the process they describe is the same and they could be mapped against each other. One important advantage of all stage models compared with continuum models is the inclusion of a post-intentional phase that intends to close the intention-behavior gap apparent in continuum models. Similar like continuum models, also stage models describe a variety of motivational predictor variables of behavior, which are placed along the different stages. These specific assignments imply that some predictors are prerequisites of others and consequently a sequence of interventions is also implied. Therefore, stage models are often viewed as better applicable in field work, especially in intervention studies when describing differential effects of interventions.

As pointed out already, stage models are advantageous to continuum models. So, in this work behavior will be understood as the process where an individual passes through different phases or stages. To keep the model simple, we propose four areas which an intervention should target: (1) problem awareness (transition from pre-contemplation to contemplation, TTM), (2) persuasion (contemplation & preparation, TTM; knowledge to decision, IDP; pre-decisional & pre-actional, MAP; motivational, HAPA), (3) uptake (action, TTM; implementation, IDP; actional, MAP; action, HAPA) and (4) habit (maintenance, TTM; confirmation, IDP; post-actional, MAP; volitional, HAPA). In later chapters the entire behavior change process or parts of it will be used to explain SODIS behavior. There a more detailed description on which behavior determinants were used, how they were operationalized, and how they influence the behavior will be provided.

Classification systems of 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. The aim of this work is to change behavior directly or indirectly from drinking untreated water to using SODIS. Therefore, it is important to have a general overview about instruments or interventions and their way of functioning scientists have developed and practitioners have already tested to initiate a behavior change, independent of the type of behavior.

Unlike on the topic of behavior change, on the mechanisms of interventions no theory as such exists. Nevertheless, there exist some useful classification systems that also include some

information about what the intervention should achieve or change. A common distinction of interventions is the one between external and internal interventions, or structural and person focused, respectively (De Young, 1993; Frey, Stahlberg & Wortmann, 1990; Homburg & Matthies, 1998; Mosler & Gutscher, 1998; Scheuthle & Kaiser, 2003). Internal interventions are strategies targeted to change conditions lying inside the person, whereas external interventions are targeted to changing situational circumstances to allow for the new behavior. Homburg and Matthies (1998) further distinguish within the person focused interventions between knowledge and norm centered techniques. Structural interventions are further classified into antecedent and consequential stimuli of behavior, i.e. changing conditions preceding or succeeding a behavioral performance (Dwyer, et al., 1999; Geller, 1987, 1989; Mosler & Gutscher, 1998; Schahn, 1993). However, one big drawback of all those classifications is the ignorance of the desired *psychological* effect in the individual according to a psychological model of behavior change. Only a few approaches tried to classify interventions viewed from a person's inside point of view, but the underlying behavioral models are rather reduced in complexity and differ between the classifications (Cook & Berrenberg, 1981; Flury-Kleubler & Gutscher, 2001). One recent publication of Mosler and Tobias (2007a) addressed the mentioned shortcomings and presented a more comprehensive classification, integrating most of the interventions mentioned in older classifications. For this reason, their classification will be presented in more detail in the following.

Mosler and Tobias (2007a) developed a person focused system that understands behavior change as a process where first the behavior execution has to be possible in general, then the goal behavior must be the preferred behavioral alternative by the individual, and finally the person must remember the behavior execution in the appropriate moment. This classification uses a similar behavioral model like the underlying consent found in the formerly presented stage models: developing a preference for a behavior is certainly a motivational process and ends with the intention to perform the behavior, and then remembering the behavior in the crucial moment corresponds to the volitional or post-decisional phase. The intervention strategies on the first level were correspondingly classified 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 make the behavior (im)possible from a person-external point of view, e.g. imposing of fees, subventions, certificates, or new infrastructure. Person-focused techniques point at making the behavior possible from a person's point of view; techniques are information, persuasive communication to convince and motivate, or requests. The second group, behavior supporting techniques, comprises situation-focused and diffusion-focused techniques. Situation-focused techniques can aim at individuals or the social system; they can be passive or active. A passive technique aimed at the individual may be a simple reminder or feedback; actively social would be a public self-commitment to perform the behavior. Finally, diffusion-focused techniques include all strategies that explicitly include the community or social network to diffuse the

innovation. This last category strongly corresponds with what E. M. Rogers (2003) called "communication channels".

In this work, only behavior supporting techniques will be investigated systematically. The reason is that we already knew before conducting our field work that motivating people to try SODIS (behavior generating) is often easy, but maintenance of the SODIS behavior poses a problem. Therefore, we concentrated on the maintenance aspect (habit formation). Of course also behavior generating techniques were applied, only no systematic variation took place to compare different ones. As already mentioned in the part about the "Diffusion of innovations" theory, different diffusion-focused techniques will also be compared.

SUMMARY

During the course of this chapter about the theoretical background that was considered to be relevant for understanding SODIS promotion and uptake, the theory of innovation diffusion was introduced as an integrative overview, various behavior change theories to understand the process were outlined and a classification of behavior change interventions to understand how to influence behavior was presented. Shortly summarizing, it is important to take into account which stage of the behavior change process is crucial for the uptake, i.e. if we need to convince and motivate people for the innovation or if we can directly support their already existing intentions and actions, because they are already convinced. Of equal importance is the social system, its norms and communication structure and last but not least, which communication channels and interventions are used for the promotion of the new behavior. Designing promotion campaigns should particularly pay attention to link the theoretical behavior change process with appropriate measures to influence this process, i.e. select appropriate communication channels and interventions.

In the following chapters, results corresponding to the mentioned topics of interest will be presented. The key factors of the different stages of the behavior change process will be inspected. Target behavior is of course primarily SODIS use and SODIS use intensity, but also the consumption of untreated and boiled water. The two latter behaviors and their determinants will also be investigated to describe the entire water consumption pattern. The last stage of the behavior change process, habit formation, will be more intensively looked at with an analysis of reasons for behavior discontinuance in contrast to continuance after a longer period of time after the introduction of the SODIS method into the community. Into two groups of interventions will be looked closer: behavior supporting intervention techniques and diffusion focused techniques, which are called communication strategies in the following, will be compared regarding their effectiveness and psychological influence. Each of these chapters will contain a more detailed description of the underlying theories and their parts. But before, design, time frame, methodology and a few general descriptive measures of the two field studies will be presented.

Methods

CONTENTS

STUDY I

The complete study design took the form of a longitudinal four-point panel lasting nine months. Measurements took place at the beginning of the study (first panel, end of August 2005), after the first month (second panel, end of September 2005), the second month (third panel, end of October 2005) and then again seven months later (fourth panel, June 2006). The first two months of the study were conceptualized as an active promotion phase, whereas no activities took place during the last seven months. Consequently, the first three panel measurements reflect short-term effects whereas the fourth panel reflects long-term effects after an inactive phase.

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. In periurban areas, water is often delivered by trucks at intervals of between every two days up to only once a week (Figure 1**Fehler! Verweisquelle konnte nicht gefunden werden.**). The origin and quality of the truck water vary unsystematically. In rural areas, some NGO or other organization has often funded a well and water tower, but there is no continuous maintenance of these installations. Additional and widely used water sources in rural areas are manual pumps, which are almost always unsafe (Figure 2). No quality control system exists. It is consequently not advisable to drink untreated water anywhere in Bolivia, no matter where it comes from. Even tap water in the cities can be contaminated.

We selected four periurban (Figure 3) and one rural investigation area (Figure 4). The periurban areas were located in the outskirts of the city of Cochabamba, which is located around 2.500m above sea level in the Andes. In each selected area lived around 150 to 350 households. The houses in the periurban areas were mostly one to two floors high and built of bricks or concrete with metal roofs. The areas had roads and the houses were arranged in block structures with backyards in the middle. Although the four periurban areas were neighboring communities, not much exchange exists between them. The rural area was a village, located 2 hours away from the capital of the municipality, San Julian (near Santa Cruz de la Sierra). The village had a population of around 40 households. Houses were mainly made out clay and roofs out of straw. The houses were arranged quite closely to each other around a big rectangular meadow of the size of a soccer field. The areas were selected with the help of the local NGO (Sacoa), who indicated a village where SODIS was not yet used. Due to high transportation costs in rural areas it was not possible to investigate a second village.

About the percentage of people already knowing SODIS, only rough estimations were available from the NGO for the four periurban areas. From the rural area we already knew that people most probably would already know SODIS from previous radio campaigns.

Figure 1. Water sources in periurban areas: Water truck and water storage.

Figure 2. Water sources in rural areas: hand pump, dirty tap, water tower (left to right).

Figure 3. View of a periurban area of Cochabamba named Calicanto.

Figure 4. View of the village near San Julian named Nucleo 24.

Description of promotion strategies

First, a clarification has to made, how termini are used throughout this thesis: A **promotion strategy or campaign** (synonyms) is that what is done to promote something, i.e. SODIS. The promotion strategy involves the use of a communication channel and the application of an intervention. A **communication strategy** describes how the information reaches the people, i.e. how it is communicated with the target population. For example, via

radio, print media, directly in a group, directly in a 1-to-1 conversation etc. Hence, a communication strategy is always involved, else no contact to the people would exist. An **intervention strategy** is something that is designed to influence the behavior. It can be certain messages or something material, a poster for example. In the case of messages, the intervention is the content that is transported with the communication strategy. For example, rational arguments can be used like 'SODIS is healthy and tasty' or more peripheral messages like 'SODIS is fancy and modern'. Both can be transmitted via the same communication strategy (e.g. radio or a flyer). If something material is given to the people, this can already be the intervention, because if it is kept at a place where it is noticed by the person it can have an influence. Therefore, it has to be considered as a positive (or negative) stimulus. The material can be anything: a poster, sticker, flyer, bottle etc. The basic idea of these studies is that always a combination of different communication strategies and interventions is possible and may have a different influence on the behavior, although not all combinations are useful.

Now coming back to Study I, in three out of the four periurban areas we had selected, a different communication strategy was applied: a health fair, promoters and opinion leaders; the fourth one served as a control group. The theoretical background to these strategies can be found in chapter 4. In the rural area, SODIS continued to be promoted via radio and additionally a bottle center was installed. Additionally, prompts and public commitments were applied as intervention strategies. The theoretical background on those can be found in chapter 3. For the persuasiveness of the promotion strategies it was controlled for by using the same persuasion in all areas (except control area).

Communication strategies

Area 1: Health fair. The health fair was organized in cooperation with the locally working NGO Obispo Anaya. Apart from SODIS, the health fair included other topics such as hygiene, nutrition and medication. It was pre-announced with banner ads and a car with loudspeaker equipment driving through the area, assuring many people would be able to participate. During the health fair, people got to taste SODIS water, illustrated information on SODIS was presented and the antibacterial effects of sunlight were demonstrated. The persuasive arguments were used in conversations with the people who participated in the health fair and prompts as well as a few public commitments were distributed to those interested in SODIS. Later on during the study the prompts and public commitments were also distributed by the interviewer because the health fair did not reach as many people as expected. The health fair was held only once, shortly before the second panel.

Area 2: Promoters. The promoters we selected were trained twice during the study period: shortly after the first panel and again after the second one. The training lasted about two hours each time with the aim of familiarizing them with the persuasive arguments on SODIS and the prompts and later with the public commitments. After each training session, their task was to

visit all interested families in their area, which took about 5 days each time. The promoters were instructed to use the persuasive arguments in their conversations and to distribute the prompts and later the public commitments. They received a regular salary for these days of work.

Area 3: Opinion leaders. The opinion leaders were selected together with the local NGO Obispo Anaya who works on children's health and runs a primary school in the area. The women we chose were described as being greatly involved in the problems of the community as well as in school activities, some had positions as *dirigentes* (which means something like head of the quarter), they were always the most interested in new ideas and respected in the community. Finally, we invited 15 of these women to the training workshop. There we informed them on water quality and diarrhea, on the SODIS method, and trained them with the persuasive arguments. The dates and time frame of the training were similar to those for the promoters. After each training session, they were asked to talk about SODIS to their friends and neighbors using the arguments they had learnt. No payment was made nor were any presents given. The opinion leaders did not work within a limited time frame like the promoters, so they basically worked constantly. In this area, the public commitments and later the prompts were distributed by the interviewers, because it turned out to be impractical to leave them with the opinion leaders.

Area 4: Radio & bottle supply center. Radio spots on SODIS had already been broadcast for some months in the rural area, but the local NGO was aware that people did not use SODIS. During the entire study period, the radio station kept broadcasting the spots as before. Additionally, we started running the bottle supply center. We collected the empty bottles in the nearby town and brought them to the village. They were then distributed free of charge from a fixed place in the centre of the village. The person who maintained the bottle center was trained with persuasive arguments and issued the prompts and later the public commitments when people came to get bottles. People had to come and get the bottles themselves. The bottle center was maintained for the two months between the first and third panels.

Area 4: Control. Only four measurements were made in the control area.

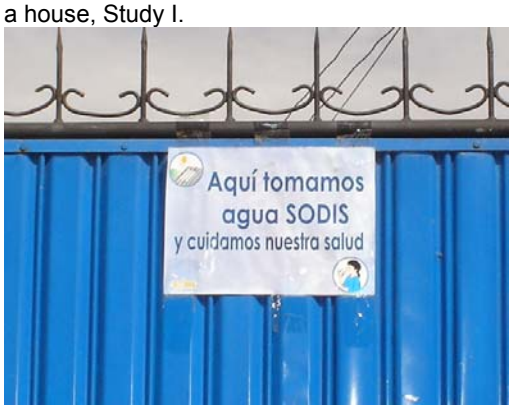
Interventions

Additionally to the different communication strategies, two kinds of habit supporting interventions were applied: a prompt and a public commitment.

The **prompt** (Figure 5) was a big, colorful A3 size poster containing the five steps of doing SODIS and a prominent question: "Have you already put your bottles into the sun today?". It was given away with the instruction to hang it visibly at the place where water is usually prepared. Its function was to remind people and to provide the necessary information of how to do SODIS.

Figure 5. The prompt on a fridge, Study I.

Figure 6. A public commitment outside a house, Study I.



The **public commitment** (Figure 6) was an A4 sized poster with the sentence "In this house we drink SODIS water and look after our health". It also 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.

Persuasion

Apart from the communication and intervention strategies, it also needs a persuasive part with which people should be convinced for the innovation. As a basis we take the Elaboration Likelihood Model of Petty and Cacioppo (1986) and use arguments and peripheral cues. Persuasion will not be varied in our study, which means that all promotion strategies will have the same persuasion strategy. However, one has to be aware of interactions between the type of promotion strategy and persuasion. For example, for the promoters one has to expect a high peripheral cue, because of the competency people attribute to them.

For building the details of the arguments we revert to E. M. Rogers (1995, p. 15) perceived attributes of the innovation, as there are: (a) the relative advantage of the innovation over the idea it supersedes ("SODIS is safe and good for your health"), (b) compatibility with the existing values, past experience and needs of the receivers ("SODIS is practical"), (c) complexity, or the degree to which the innovation is perceived as difficult to understand and use ("SODIS is easy to use"), (d) trialability, or the degree to which an innovation can be tested for effectiveness on a cost or scope-limited basis ("SODIS is economical"), and (e) observability of the outcome of the innovation ("SODIS is good for your health"). Additionally, descriptive norms (E. M. Rogers, 1995, p. 23; Ajzen, 1991) were intended to be addressed as well ("SODIS is already used in many other places").

Measurement

Measurements were realized with questionnaires that were conducted in the form of interviews, because many people in Bolivia cannot read and write. Before the first panel took place, a loudspeaker car drove through all the periurban areas announcing the upcoming interviews, mentioning and describing SODIS in brief. In the rural area, the interviews were pre-announced during a community meeting shortly before. The pre-announcement was highly recommended by the local NGO, since people are wary of strangers. A second reason for using the loudspeaker car in the periurban areas was to create similar percentages of people knowing SODIS in all areas to have the possibility of investigating knowledge dissemination depending only on the promotion strategies. Unfortunately, as can be seen later in the results section of chapter 4, the loudspeaker car did not have the desired effect.

The questionnaires were revised and validated with local experts and the interviewers to ensure identical understanding of the items. Long and short versions of the questionnaire were used. The short one only measured a few demographic variables, whether people had heard about SODIS at all, whether they used SODIS and where they had heard about it (communication channels). The long questionnaire contained additional demographic characteristics, more detailed information on water consumption, psychological variables preceding SODIS use, and the degree of knowledge of SODIS.

Additionally, a social monitoring was applied to about 50% of the families who were in the long questionnaire group. The monitoring was developed to gain more insight into the timely variations of some psychological key factors such as attitude or intention towards SODIS, social norms, SODIS behavior and reasons for not doing SODIS. The monitoring questionnaire was also conducted in the form of an interview and lasted about 10 minutes. It was applied twice a week. It is known that such a high-frequency measurement may have an effect of its own due to reactivity (Landua, 1993). Therefore, the monitoring can be viewed as a separate intervention and will be included as such in the chapter on intervention effects. The complete time series analysis, however, will not be presented within this thesis. It was investigated in a separate work by Inauen (2007).

Interview procedure

During an interview, the interviewer read out the questions to the interviewee. However, it often happened that people did not understand what was meant with a certain questions, therefore, explanations were sometimes necessary. Answers to the questions often were simply "yes" or "no", even when questions were formulated in a way that would require a more differentiated answer (e.g. "How much does it bother you when you have diarrhea?"). The reason is that people are simply not used to scaled answers. Therefore, interviewers had received an extensive training on how to inquire about the strength of a certain statement to find

a differentiated answer. This difficulty resulted in quite varying interview durations ranging from 30 minutes to more than one hour. This procedure applies for both studies.

Operationalization

The operationalization of all variables used in this thesis can be found in Table 1. Since item formulations were mostly identical in studies I and II, details of Study II are also already included. Presented are the name of the measure as it is used in this thesis, the scale type (open, nominal, unipolar or bipolar scale), the item formulation translated as close as possible from Spanish, the scale information including naming of the endpoints for both studies 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 4-point scales for unipolar items and 7-point scales for bipolar items in Study I. In Study II, scales were changed from 4- to 5-point scales for unipolar items and from 7- to 9-point scales for bipolar items. The reason was to achieve more variance of the answers. To have comparable mean values, scales were for both studies rescaled to scores between -1 and 1 if nothing else is mentioned. For Study I, the resulting scale steps are -1 – -0.67 – -0.33 – 0 – 0.33 – 0.67 – 1, for Study II scale steps are -1 – -0.75 – -0.5 – -0.25 – 0 – 0.25 – 0.5 – 0.75 – 1 if nothing else is mentioned. Bipolar scales (negative and positive answer possibilities) covered the entire range from -1 to 1 with 0 representing a neutral answer. Unipolar scales either ranged from -1 to 0 or in most cases from 0 to 1. The coding direction of the unipolar items depends on the content of the item: negative values always indicate that it hinders the behavior, neutral that there is no influence and positive answers indicate supporting conditions for the behavior. For example, a high perceived difficulty is a hindering factor (-1) and no difficulty is a neutral condition for the behavior (0). In contrast, perceiving a high problem awareness is fostering the behavior (1) and perceiving no problem awareness is neutral, but not hindering as such (therefore 0).

In the following, some more details are given to some of the measured items.

Items of problem awareness. The items concerning problem awareness were developed based on our own previous studies (Altherr et al., 2008; Moser & Mosler, 2008) as well as in collaboration with locals and what they though could indicate a Bolivian's perception of problem awareness. The aim was to construct a problem awareness scale. Moser and Mosler (2008) have already aggregated three similar variables into one scale measure; however, internal reliability was low. Therefore, it was intended to cover a wide range of possible problem awareness issues. Four items were initially developed: *problem awareness diarrhea children*, *problem awareness diarrhea self*, *awareness clean water*, and *importance clean water*. In Study II, the item about the *importance of clean water* was changed to the *importance of health*,

Table 1. Item formulations, including demographic variables. Studies I and II.

Variable name	Scale type	Item formulation	Scale Study I	Scale Study II	Restric-tions
Psychological measures					
Problem awareness diarrhea children (Item 1 of scale *Problem awareness diarrhea*)	unipolar 0 to 1	Do you think it is a serious disease when a child has diarrhea?	4-point: 0 it's something normal 1 very serious	5-point: 0 it's something normal 1 very serious	-
Problem awareness diarrhea self (Item 2 of scale *Problem awareness diarrhea*)	unipolar 0 to 1	How much does it bother you when you have diarrhea?	4-point: 0 doesn't bother me 1 bothers me a lot	5-point: 0 doesn't bother me 1 bothers me a lot	-
Awareness clean water	unipolar 0 to 1	When you drink a glass of water, how much do you bother about if it is clean?	4-point: 0 never 1 always	5-point: 0 never 1 always	-
Importance clean water	unipolar 0 to 1	How important is it for you to have clean water?	4-point: 0 not at all 1 a lot	-	-
Importance health	unipolar 0 to 1	How important is it for you to have good health?	-	5-point: 0 not at all 1 a lot	-
Causality untreated water - diarrhea	unipolar 0 to 1	Do you think that untreated water can cause diarrhea	-	5-point: 0 never 1 always	-
Knowledge SODIS	nominal	Have you heard of SODIS?	dichotomous: 0 no 1 yes	dichotomous: 0 no 1 yes	-
Knowledge depth SODIS	unipolar 0 to 1	Could you please explain SODIS to me?	5-point: 0 does not know SODIS 1 knows SODIS very well	5-point: 0 does not know SODIS 1 knows SODIS very well	-
Belief taste - SODIS - boiling - untreated water	bipolar -1 to 1	What do you think about the taste of… - SODIS water? - boiled water? - untreated water?	7-point: -1 tastes very bad 0 tastes neither good nor bad 1 tastes very good	9-point: -1 tastes very bad 0 tastes neither good nor bad 1 tastes very good	SODIS: has to know it
Belief health - SODIS - boiling - untreated water	bipolar -1 to 1	Do you think that… - SODIS water - boiled water - untreated water …is good or bad for your health?	7-point: -1 very bad 0 neither good nor bad 1 very good	9-point: -1 very bad 0 neither good nor bad 1 very good	SODIS: has to know it
Belief money - SODIS - boiling	unipolar -1 to 0	Do you think that… - SODIS water - boiled water …costs little or a lot of money?	4-point: -1 costs a lot 0 does not cost anything	5-point: -1 costs a lot 0 does not cost anything	SODIS: has to know it
Belief time - SODIS - boiling	unipolar -1 to 0	Do you think that preparing… - SODIS water - boiled water …costs little or a lot of time?	4-point: -1 costs a lot of time 0 does not cost time	5-point: -1 costs a lot of time 0 does not cost time	SODIS: has to know it
Belief difficulty SODIS	unipolar -1 to 0	Do you think that preparing SODIS is difficult?	4-point: -1 very difficult 0 not difficult at all	5-point: -1 very difficult 0 not difficult at all	SODIS: has to know it

Variable name	Scale type	Item formulation	Scale Study I	Scale Study II	Restric-tions
Cost-benefit evaluation SODIS	bipolar -1 to 1	How much is it worth to prepare SODIS water?	7-point: -1 it costs a lot more than it's worth 0 costs and benefits are equal 1 it's a lots more beneficial than it costs	-	SODIS: has to know it
Affect - SODIS - boiling - untreated water	bipolar -1 to 1	Do you like/enjoy… - preparing SODIS? - preparing boiled water? - consuming untreated water?	7-point: -1 I dislike it a lot 0 I neither enjoy nor dislike it 1 I like it a lot	9-point: -1 I dislike it a lot 0 I neither enjoy nor dislike it 1 I like it a lot	SODIS: has to know it
Attitude - SODIS - boiling - untreated water	bipolar -1 to 1	How good or bad do you think is… - using SODIS? - boiling water? - consuming untreated water?	7-point: -1 it's very bad 0 it's neither good nor bad 1 it's very good	9-point: -1 it's very bad 0 it's neither good nor bad 1 it's very good	SODIS: has to know it
Injunctive norm - SODIS - boiling - untreated water	bipolar -1 to 1	What do other people think if you drink… - SODIS water? - boiled water? - untreated water?	7-point: -1 they think very bad about me 0 they think neither good nor bad about me 1 they think very good about me	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	SODIS: has to know it
Subjective norm - SODIS - boiling - untreated water	unipolar 0 to 1	What do you think or know, how many other people (neighbours)… - use SODIS? - boil their water? - consume untreated water?	5-point: 0 (almost) no one 1 (almost) everyone	5-point: 0 (almost) no one 1 (almost) everyone	SODIS: has to know it
Descriptive norm SODIS	unipolar 0 to ∞	How many people you know have you seen using SODIS during the last month?	open, numeric	open, numeric	SODIS: has to know it
Availability of - bottles (for SODIS) - combustibles (for boiling)	unipolar 0 to 1	Are there sufficient… - bottles available to prepare SODIS? - combustibles available to boil water?	4-point: 0 no bottles/combustibles available 1 always available	5-point: 0 no bottles/combustibles available 1 always available	bottles: has to know SODIS
Intention - SODIS - boiling - untreated water	unipolar 0 to 1	How much water you think you will... - disinfect with SODIS - boil - consume untreated ...in the future?	4-point: 0 nothing 1 as much as possible	5-point: 0 nothing 1 everything	has to know SODIS
Perceived habit - SODIS - boiling - untreated water	unipolar 0 to 1	Do you think you have the habit to… - prepare SODIS? - boil water? - consume untreated water?	4-point: 0 not at all 1 a lot	5-point: 0 not at all 1 a lot	has to consume the water type
Cognition intensity SODIS	unipolar 0 to 1	Do you always remember doing SODIS?	4-point: 0 never 1 always	5-point: 0 never 1 always	has to prepare SODIS
Forgetting SODIS	unipolar -1 to 0	How often do you have the intention to prepare SODIS, but then you forget it?	4-point: -1 always 0 never	5-point: -1 always 0 never	has to prepare SODIS
Dissonance SODIS	unipolar 0 to 1	How much does it bother you in case you forget preparing SODIS?	4-point: 0 not at all 1 a lot	5-point: 0 not at all 1 a lot	has to prepare SODIS

Variable name	Scale type	Item formulation	Scale Study I	Scale Study II	Restric-tions
Implementation intention	unipolar 0 to 1	How important is it for you to use SODIS?	-	5-point: 0 not at all 1 a lot	has to prepare SODIS
Strength of commitment	unipolar 0 to 1	How committed do you feel to use SODIS?	-	5-point: 0 not at all 1 a lot	has to prepare SODIS
Behavioral measures					
Behavior - SODIS - boiling - untreated water - bought beverages	nominal	Do you… - use SODIS? - boil water? - consume untreated water? - buy beverages/water?	dichotomous: 0 no 1 yes	dichotomous: 0 no 1 yes	-
Behavior intensity - SODIS - boiling - untreated water - bought beverages	unipolar 0 to 1	How much of your water consumption is… - SODIS water? - boiled water? - untreated water? - bought beverages/water?	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): 0 0% 1 100%	Panels 1 to 3: 5-point, Panel 4: 11-point: 0 0% 1 100%	-
Relapse time point	open	When did you stop using SODIS?	open, categorization into the respective month	-	only relapser
Reasons for relapse	open	Why did you stop using SODIS?	multiple open answers, all answers were then grouped into categories	-	only relapser
Intervention checks & measurement indicators					
Communication channels	open	Panel 1: Where did you here about SODIS for the first time? Panels 2 to 4: Where did you here about SODIS after the last interview?	multiple open answers, all answers were then grouped into categories	multiple open answers, all answers were then grouped into categories	-
Number of communication channels	unipolar 0 to ∞	*calculated*, based on the information given in the previous question			-
Prompt	nominal	Did you receive a prompt since the last interview?	dichotomous: 0 no 1 yes	dichotomous: 0 no 1 yes	-
Public Commitment	nominal	Did you receive a public commitment since the last interview?	dichotomous: 0 no 1 yes	dichotomous: 0 no 1 yes	-
Monitoring	nominal	*not asked*	dichotomous: 0 no 1 yes	dichotomous: 0 no 1 yes	-
Number of long questionnaires	unipolar 0 to 3	*not asked*	4-point: 0, 1, 2 or 3	-	-
Demographic variables					
Age	unipolar	How old are you?	open, whole years	open, whole numbers	-

Variable name	Scale type	Item formulation	Scale Study I	Scale Study II	Restric-tions
Education	unipolar	How many years you went to school?	open, whole years. Calculation of years was assisted by the interviewer. University degree = 17 years (12 high school + 5 university)	open, whole years. Calculation of years was assisted by the interviewer. University degree = 17 years (12 high school + 5 university)	-
Number of persons per household	unipolar	How many people are living in your household?	open, numeric	open, numeric	-
Number of children < 5years per household	unipolar	How many children below 5 years of age are living in your household?	open, numeric	open, numeric	-
Job	nominal	Do you follow a regular work?	open, categorization into 0 no 1 yes	-	-
Number of contacts	unipolar	How many people do you know in outside your household, but inside your community?	open, numeric	-	-

Note: The order of the variables follows the behavior change process (see Chapter 1). Intervention related variables are placed after the psychological factors.

because on clean water was already asked with the item about the *awareness of clean water*. Additionally, later in Study II an item about the understanding of the *causality between untreated water and diarrhea* (only panels 3 and 4) was included. How the scale was finally constructed is explained after the operationalization part.

Knowledge depth SODIS. This question required the interviewee to explain the steps of preparing SODIS in a detailed way. These answers were then 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 SODIS knowledge: complete understanding of how to do SODIS and how it works

The knowledge scale does not show equal intervals, because the category 'very little knowledge' does only represent that a person has heard about the existence of SODIS or solar disinfection without actually knowing any facts about it. The scale regarding real knowledge depth is actually conceptualized as a 4-point scale with the presented scale steps but without the step 'very little knowledge'. However, it seemed appropriate to include the 'very little

knowledge' in between 'no knowledge' and 'some knowledge'. Moreover, only few individuals fell into this category (approx. 5-10%). Mostly, if people had heard about SODIS they also knew some details.

In general, our knowledge measure may appear somehow unusual, but there has not been much investigation on the issue of measuring SODIS knowledge. First steps into establishing one have already been taken by Altherr et al. (2008) who have used a very similar measure. The use of only one open question contrarily to classical multiple choice (often used in education tests) or false/true items (e.g. on AIDS knowledge; Carey & Schroder, 2002) and the subsequent categorization by the interviewers were chosen for various reasons. One is that SODIS is basically too easy to allow for numerous questions to assess different knowledge facets. Another one is that people are probably not used to multiple choice questions or judging false/true statements.

Belief measures. The aim was to cover all advantages and disadvantages that people could possibly perceive about a certain water type. Therefore, a wide range of beliefs was covered, mainly inspired by our own studies (Altherr et al., 2008; Heri & Mosler, 2008; Moser & Mosler, 2008) and what people had mentioned at previous occasions as an advantage or disadvantage of the SODIS method. Since it is the aim to have more information on which belief is important for future intervention planning, no scale was constructed.

Cost-benefit. This measure was used during the first study as a kind of summary measure for all cognitively evaluated beliefs. The cognitive beliefs were only introduced at the end of Study I and in Study II.

Affect and attitude. Affect is measured separately, because of the dividing of the attitude concept. Still, attitude was measured additionally, because it is such a prominent concept (Ajzen, 1991) and it was not sure if the separate measures of affect and the cognitive beliefs would be sufficient information.

Norms. Injunctive and subjective norm were conceptualized according to Cialdini's norm concepts (Cialdini et al., 1990; Cialdini, 2003). Additionally, it was assumed that measuring a real descriptive norm (how many other people were truly seen performing the behavior; Park & Smith, 2007) covers a distinct aspect of social normative influence. Of course, also the widely popular theory of planned behavior (Ajzen, 1985, 1991) stresses the importance of norms, however, only focusing on Cialdini's subjective (Ajzen: descriptive) norm factor.

Availability of resources. This is a measure of the perceived behavioral control (Ajzen, 1991), which has already been used before (Altherr et al., 2008).

Intention. This measure is according to almost all behavioral theories a central construct in predicting behavior (Ajzen, 1991) or in stage models marking the change from motivation to action (Schwarzer, 2008) and captures how much a person intends to perform the behavior in the future.

Cognition intensity, forgetting and dissonance. The theoretical reflection can be found in chapter 2. The operationalizations follow the idea to be as close as possible to the phenomenon that is intended to be captured.

Perceived habit. Bamberg (1996) stated the importance of asking the participants if they perceive the behavior as habitual. The present measure of directly assessed perceived habit was recently used by Knussen, Yule, MacKenzie and Wells (2004). However, the problem of operationalizing the habit construct is not yet solved adequately (Klöckner, Matthies & Hunecke, 2003).

Implementation intention. Even though a great number of studies manipulate implementation intentions (Bamberg, 2002; Chasteen, Park & Schwarz, 2001; Sheeran, Webb & Gollwitzer, 2005), it still is not clearly defined how to operationalize this concept appropriately. Rise, Thompson and Verplanken (2003) asked their participants about the planning strength of the action achievement. From different yes or no answers about where and when the specific action was planned, they formed a summation scale to model the strength of implementation intention. So obviously, the planning of an action is the core element which is tried to capture with measuring implementation intention (see also Brandstätter, Lengfelder & Gollwitzer, 2001; Gollwitzer, 1999; Ziegelmann, Luszczynska, Lippke & Schwarzer, 2007). The question used in the present study asks how important it is for the people to do SODIS. Although this question does not follow the tradition of explicitly asking for planning efforts people may have made, it is assumed that if a behavior is viewed as important, some planning processes are active to successfully perform it. Planning processes as they were conceptualized by the previously mentioned authors were viewed as an unknown or too complicated concept within the rural Bolivian population and could therefore not be inquired directly.

Commitment. This factor was operationalized by asking about the strength of the felt commitment. Mosler and Tobias (2007b) assume that the strength of commitment defines how much an individual is committed to perform a certain behavior.

The problem awareness diarrhea scale

The construction of the problem awareness scale using all measured items mentioned above posed some problems. First, factor analyses were conducted (results Table 2) and secondly different variations of the scale were analyzed with reliability analyses (Table 3).

Factor analyses for Study I always result in a 1-factor solution. However, the loading of the item *awareness clean water* is only in the fourth panel >0.5. For the other three panels, the loading is very low. In Study II the picture gets more complicated. For panels 1 and 2, the same two factors were found: items *problem awareness diarrhea children* and *problem awareness diarrhea self* load on one factor and *awareness clean water* and *importance health* on the second one. In panel three, when *causality untreated water – diarrhea* was additionally included, these two factors were found again plus a third one, only consisting of the newly added item. In panel four again *problem awareness diarrhea children* and *problem awareness diarrhea self* loaded on one factor, but the second factor consisted of the *awareness clean water* and the *causality untreated water – diarrhea*. *Importance health* did not belong to one of these two

Table 2. Factor analysis (principal component, mineigen>1) of the items of the problem awareness stage. Rotated (Varimax) component matrices are presented. Studies I and II.

	Study I				Study II								
	P1	P2	P3	P4	P1		P2		P3			P4	
Label	F1	F1	F1	F1	F1	F2	F1	F2	F1	F2	F3	F1	F2
PA1	**.73**	**.69**	**.71**	**.70**	**.82**	.06	**.87**	.13	**.84**	.18	.05	-.01	**.86**
PA2	**.70**	**.73**	**.81**	**.68**	**.80**	.12	**.82**	.01	**.86**	-.01	-.12	.09	**.81**
PA3	.32	.43	.49	**.62**	.12	**.76**	-.12	**.84**	.08	**.83**	.16	**.85**	.05
PA4	**.70**	**.69**	**.70**	**.65**	.05	**.80**	.31	**.64**	.09	**.77**	-.30	.38	.30
PA5	-	-	-	-	-	-	-	-	-.05	-.05	**.96**	**.82**	-.04
Eigenvalue	1.62	1.68	1.90	1.75	1.57	1.00	1.63	1.05	1.74	1.11	1.00	1.71	1.33
% of variance	40	42	47	44	39	25	41	26	35	22	20	34	27

Note: PA1 = Problem awareness diarrhea children; PA2 = Problem awareness diarrhea self; PA3 = Awareness clean water; PA4 = Importance clean water (Study I), importance health (Study II); PA5 = Causality untreated water – diarrhea. Bold numbers indicate factor loadings >0.5. P1 to P4 = Panels 1 to 4. F1 to F3 = Factors 1 to 3.

Table 3. Reliability analysis of the items of the problem awareness stage. Cronbach's alphas are presented. Studies I and II.

	Study I				Study II			
Scale	Panel 1	Panel 2	Panel 3	Panel 4	Panel 1	Panel 2	Panel 3	Panel 4
PA1 to PA5	-	-	-	-	-	-	.36	.51
PA1 to PA4	.48	.53	**.62**	.57	.48	.47	.54	.47
PA1 + PA2 + PA4	.55	.56	**.65**	.52	.43	.55	.51	.48
PA1 + PA2	.48	.53	**.64**	.53	.51	**.66**	**.63**	**.62**
PA3 + PA4	.24	.34	.39	.45	.39	.23	.51	.36

Note: PA1 = Problem awareness diarrhea children; PA2 = Problem awareness diarrhea self; PA3 = Awareness clean water; PA4 = Importance clean water (Study I), importance health (Study II); PA5 = Causality untreated water – diarrhea. Bold numbers indicate Cronbach's alphas >0.6.

factors. In general the picture is different for Study I and Study II. Study I indicates a one-factor solution with three items, whereas Study II points to a two-factor solution with two items each. Different combinations were tested for reliability in a next step.

Cronbach's alphas are in general pretty low and never exceed 0.66. The 5-item scale, which could only be tested for 2 measurement points, performed unsatisfactory (Cronbach's alphas of 0.36 and 0.51). The 4-item scale (without the newly added item *causality untreated water – diarrhea*) and also the three-item solution, which was indicated by the factor analysis of Study I, overall performed also unsatisfactory (7 out of 8 Cronbach's alphas < 0.6). Finally, two two-item scales were tested as they were indicated by the factor analysis of Study II. The one using *problem awareness diarrhea children* and *problem awareness diarrhea self* performed best of all tested solutions, although Cronbach's alphas are still very borderline to be accepted (for Study I between .48 and .64, for Study II between .51 and .66). However, it was a first trial towards reducing the many dimensions measured in these studies and will be used during the further analyses. The other three items, which are now not included in the scale, will be separately included into the analyses.

Design

Since there are different types of measurements (panel, monitoring) as well as different types of promotional strategies (communication strategies and interventions), a detailed overview on all combinations will be given in the following. The complete design of the study is presented in Figure 7, showing which communication strategies were applied when and in which area as well as which of the intervention strategies prompts and public commitment occurred in which area. Also, numbers of households with short and long questionnaires are given as well as households with a monitoring.

Measurement design

Households were selected using a modified random route procedure (Hoffmeyer-Zlotnik, 1997). In contrast to the technique described by Hoffmeyer-Zlotnik, we did not select random intersections, because the areas were not very big. Instead we partitioned each of the periurban areas into four parts and one interviewer started to select each second or third house from the center of each part, depending on how big the total area was. An equal spread of households across areas was ensured with the aid of maps on which all the interviewed households were marked. In the rural area, all households were tried to be interviewed due to the small size of the village.

The person selected for the interview had to be the one responsible for water in the household (in 90% of cases it was a woman). In the periurban areas, she was first asked if she was willing to participate in the long questionnaire. If she refused, we asked for participation at least in the short questionnaire. The interviewed person was told that the study would consist of two additional measurements. Rejection rates were approximately 20% for the long questionnaires and almost 0 for the short ones. In the rural area only long questionnaires were applied. All households where the person responsible for water was at home during the time of the first panel participated in the study. For the second and third panel, the same households were visited. Of the households which initially had only had a short questionnaire in the periurban areas and were willing to participate also in a long one, a long questionnaire was applied (30 changes short to long questionnaire in the second panel, 26 in the third panel). Additionally, new households were included (90 in the second panel, 9 in the third panel). The criterion for both, changing from short to long questionnaire and inclusion of new households was that the interviewed persons had to know about SODIS. The main reasons were to compensate for drop outs and to assure to have households in the study that have actually heard about SODIS, because an investigation of the effects of promotional strategies requires knowing where people had heard about SODIS. In chapter 4 some insight will be provided into differences on SODIS knowledge and use between households in the study since the beginning and those 70 households who joined during the second panel. This procedure of changing short

Figure 7. Complete design of Study I. Includes dates of panels, number of long and short questionnaires, dates of communication activities, number of interventions, and number of households with monitoring.

	1st Panel 01.09.05	Promotion phase I 1 month	2nd Panel 30.09.05	Promotion phase II 1 month	3rd Panel 26.10.05	Inactive phase 7 months	4th Panel 04.06.06
Area 1 peri-urban	N long: 30 short: 69	Health Fair: 25.09.05 Prompts: 26 Public Commitments: 4 Monitoring: 16	N long: 78 short: 55	Prompts: 29 Public Commitments: 10 Monitoring: 46	N long: 84 short: 42	no activities Prompts kept: 25 Public Commitments kept: 1	N long: 90
Area 2 peri-urban	N long: 30 short: 70	Promoters: 15-19.09.05 Prompts: 77 Public Commitments: 1 Monitoring: 12	N long: 48 short: 42	Promoters: 10.-14.10.05 Prompts: 4 Public Commitments: 40 Monitoring: 25	N long: 49 short: 34	no activities Prompts kept: 40 Public Commitments kept: 2	N long: 76
Area 3 peri-urban	N long: 30 short: 67	Opinion leaders: start 06.09.05 Prompts: 7 Public Commitments: 22 Monitoring: 14	N long: 73 short: 44	Prompts: 39 Public Commitments: 8 Monitoring: 38	N long: 85 short: 26	no activities Prompts kept: 18 Public Commitments kept: 10	N long: 87
Area 4 rural	N long: 37 short: 0	Radio; Bottle center: start 05.09.05 Prompts: 35 Public Commitments: - Monitoring: 32	N long: 39 short: 0	Prompts: 9 Public Commitments: 8 Monitoring: 35	N long: 38 short: 0	Radio Prompts kept: 12 Public Commitments kept: -	N long: 32
Area 5 peri-urban	N long: 32 short: 73	Control	N long: 31 short: 64	Control	N long: 31 short: 55	no activities	N long: 84
Total	N long: 159 short: 279	Prompts: 145 Public Commitments: 27 Monitoring: 74	N long: 269 short: 205	Prompts: 81 Public Commitments: 66 Monitoring: 144	N long: 287 short: 157	Prompts kept: 95 Public Commitments kept: 13	N long: 369

Note: For the panel measurements, the starting day is given. Completing the measurements took about 5 days.

to long questionnaires and including new participants was not applied to the control area. Constant drop outs after the first and second panel were very low and mostly related to the short questionnaires. Rates were 7% for long questionnaires and 13% for short ones after the first panel, 6% for long questionnaires and 14% for short ones after the second panel. Households, which where only failed to be visited during the second or third panel were not included in the drop out rate.

After the third panel, the study was declared as finished in all areas and no more activities took place. The fourth panel then was conducted in June 2006. No prior warning was given to the households, and using the same interviewers as in 2005, about 70% of the households could be identified and interviewed again. During the fourth panel, only long questionnaires were applied.

The social monitoring was applied to all households we could get hold of on a regular basis in the rural area. No monitoring was applied in the control area. In the remaining three

periurban areas, after the first panel about 50% of the households with long questionnaires were asked for participation in the monitoring. After the second panel, more households were measured with long questionnaires and proportionally more households of those now having had a long questionnaire were included in the monitoring after the second panel.

Promotional design

During the first month, the prompt was combined with the promoters and the public commitment with the opinion leaders. For the second month of the active phase (after the second panel), the combination was switched to promoters with public commitment and opinion leaders with prompt. In the health fair area it had been planned to distribute both interventions during the entire active phase. In the rural area the same sequence of interventions was applied as in the promoters' area (first month prompt, second public commitment). As can be seen in Figure 7, in some cases the distribution plan did not work out as intentioned. In general, fewer public commitments than prompts were distributed, especially during the first month of activities, where almost no public commitments reached the households.

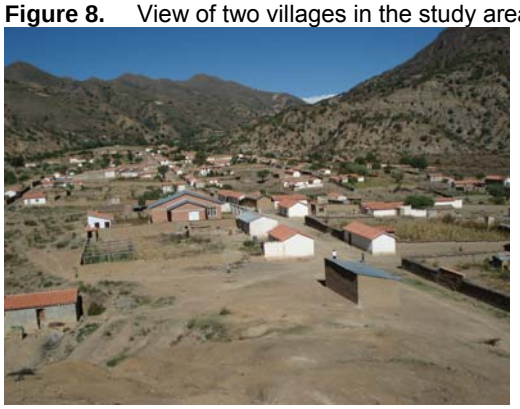
STUDY II

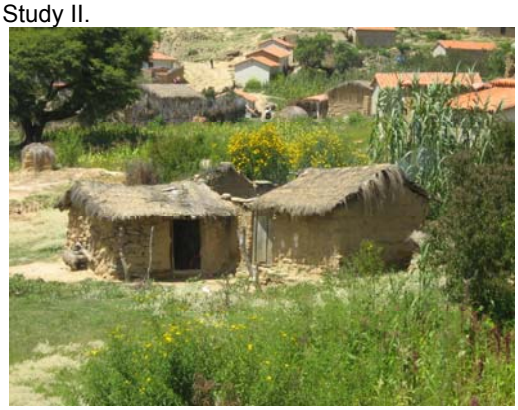
As in Study I, the complete study design took the form of a longitudinal four-point panel. Study II lasted 11 months, but in contrast to Study I, measurements were distributed with equal time intervals across the entire time span. The first panel took place at the beginning of the study (beginning of 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).

Study area

Also the area of Study II was located in Bolivia. Study II was carried out in the department Chuquisaca. 22 villages from the provinces Tarabuco, Presto (approx. 9.000 inhabitants) and Mojocoya (approx. 8.000 inhabitants) were selected (Figure 8). 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. Although we did not carry out water quality tests, it is assumed that the water is 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

Figure 8. View of two villages in the study area of Study II.





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.

Description of promotion strategies

In contrast to Study I, Study II was planned and carried out within a much bigger project involving a lot more actors. The overall project, named "Proyecto Agua Segura y manos limpias (PRASML)" (Project safe water and clean hands), was 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 very dispersed settlement structures. Some so called nuclei exist with a more densely populated village structure.

Within Study II, three areas were selected to separate the different intervention strategies. However, many overlaps of different promotion strategies occurred and it is hardly possible to build 'clean' subgroups where all members received the same promotional strategies.

Communication strategies

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 PRASML project it was intended to have these health volunteers realizing the household visits and educating people about SODIS and hand washing. However, first these health volunteers had to be educated, because they also did not yet know about SODIS. Additionally, during the PRASML project community activities (reunions and workshops), activities in school and a radio campaign (starting after the second panel, August 2007) were planned. The plan was to have three phases of promotion activities in between the four panel measurements. In general, first a workshop had to be held to educate the health volunteers and then the health volunteers had to visit their families. Additionally, in some of the villages where the measurements of Study II took place, intervention materials were intended to be distributed via the health volunteers during the home visits. The communication strategies were not systematically varied in the project. The procedure was as follows:

1st promotion phase: In June 2007 the Foundation SODIS held workshops in the bigger main villages (4 to 5 in each of the provinces) to train the health personnel (nurses) and the health volunteers how to use SODIS and how to wash hands correctly. These workshops lasted one day and included information as well as group work. At the end of the workshop, it was agreed between health personnel and health volunteers to visit each village together with the aim that the official health person (a nurse) officially introduces the program during a community assembly and announces the following home visits by the health volunteer in the weeks after the assembly. This was seen to be necessary, because a nurse has a much stronger authority and expert status. In August 2007, during the second panel, it was found out that the official program introduction into the communities at one of their assemblies had not taken place. This was mainly due to the failure of the health personnel, who broke their given commitment. The health volunteers on the other hand did not carry out the introduction of the program alone, because they probably did not feel competent enough. Consequently, nearly no intervention materials were distributed. Therefore, the procedure was changed during the next two promotion phases.

2nd and 3rd promotion phase: With the experience of the first promotion phase, the workshops of the second and third promotion phase were carried out in each village (not only the main villages) where it was possible to find a date with the health personnel, the health volunteers *and* the community. Additionally to the health personnel and the health volunteers also all interested people from the villages were invited and took part in the 1-day workshop. Moreover, intervention materials were distributed directly to the people. The health volunteers received the instruction to visit those families that were not present at the workshop and also give them the intervention materials. Additionally, during the third promotion phase we personally initiated a distribution of intervention materials in those villages where no date was found to have a workshop. As the results will show, not so many households were reached by the intervention

materials, so the procedure followed during the second and third promotion phase should be improved.

Interventions

The same interventions were applied as in Study I, but this time it was tried to apply them separately in contrast to Study I. Therefore, prompt and public commitments were applied in different areas. The goal was to re-test them in a similar context (Bolivia). However, due to special local circumstances (it was not allowed to hang a poster inside a house) the prompt had to be redesigned. Also the public commitment was adjusted to the new circumstances and changed a little its design.

The **prompt** (Figure 9) was a cuboid made of cardboard of about 15 cm x 15 cm x 30 cm in size. The cuboid had four sides with pictures and information on SODIS. On one side, the five steps of how to do SODIS were displayed. On the second side were photographs of people drinking SODIS water and the sentence "One has to put the bottles with water out into the sun". The third side contained a reminder of hand washing with the sentence "Tell me, which hand are you eating with … and I tell you which face you will have." (referring to the smily and the frowny on the girl's hands) and the fourth side was a calendar, to motivate people to keep the prompt. The cuboid had cords, which enabled the participants to hang the prompt up to the ceiling, but it also could be put on top of some furniture. The handing in of the prompt was accompanied by the instruction that he prompt should be situated at the place where drinking water is normally prepared.

The **public commitment** (Figure 10) was as in Study I 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 was changed to "We are committing us to drink water treated with the SUN" with the aim to have the word "commitment" in the sentence. Like in Study I, it also contained a SODIS logo and 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.

Persuasion

As well as in Study I, the persuasion part was tried to be standardized. A similar set of arguments as in Study I was developed and introduced to the health volunteers. Persuasion will not be varied in this study.

The arguments taken from Study I were: "SODIS is good for your health", "SODIS is easy to use", "SODIS is economical", "SODIS is practical", "SODIS is popular" (similar to Study I). New arguments were "SODIS is natural" (referring to its taste; relative advantage to boiled

Figure 9. The prompt of Study II. Unfolded view and folded view.

Figure 10. The public commitment of Study II.

water, which changes the taste) and "Doing SODIS is pleasant" (referring to the strong influence of affect on intention).

Measurement

Like in Study I, measurements were realized with questionnaires that were conducted in the form of interviews, because many people in Bolivia cannot read and write. Since the areas were very rural and settlements were much dispersed, no pre-announcement was possible as in Study I. Instead, community heads were informed and the interviewer carried an official document approving their work.

The questionnaire was developed on the basis of the questionnaire of Study I and some more items were added. Mostly identical formulations of items were used to assure comparability between the two studies. See also operationalizations, Table 1. The questionnaire was revised and validated with local experts and the interviewers to ensure identical understanding of the items. In Study II only a long version existed. It contained demographic characteristics, detailed information on water consumption, psychological variables preceding SODIS use, boiled water use and untreated water consumption, and the degree of knowledge of SODIS.

Additionally, a social monitoring was applied to about 45 households coming from three different villages. The monitoring was developed to gain more insight into the timely variations of some psychological key factors such as attitude or intention towards SODIS, social norms, SODIS behavior and reasons for not doing SODIS. The monitoring questionnaire was also conducted in the form of an interview and lasted about 10 minutes. It was applied once a week. It is known that such a high-frequency measurement may have an effect of its own due to reactivity (Landua, 1993). Therefore, the monitoring can be viewed as a separate intervention and will be included as such in the chapter on intervention effects. The complete time series analysis, however, will not be presented within this thesis. Its investigation is still in preparation.

Interview procedure and **operationalizations** are already described with Study I.

Design

The overview includes details on the different types of measurements (panel, monitoring) and the different types of promotional strategies (communication strategies and interventions). Although measurements took place in three different provinces, this will not be taken into account in the presentation of the design, because communication strategies and interventions occurred in all three regions. Demographic data do not indicate large differences between these regions (not presented; Tamas, 2008, p.13). The complete measurement and promotional design scheme is presented in Figure 11.

Measurement design

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. Final drop out rates were 2% after the first panel, 2% after the second panel and 14% after the third panel. In total, 63% were interviewed all four times.
As in Study I, the person selected for the interview had to be the one responsible for water in the household (in 70% of cases it was a woman). 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. Rejection rates were low with 0 in 71% of the cases, 1 in 20% of the cases and between 2 and 9 for the rest (the corresponding question was "How many

Figure 11. Complete design of Study II, including dates of panels, number of questionnaires, number of interventions, and number of households with monitoring.

	1st Panel 04.05.07	Promotion phase I 3.5 months	2nd Panel 15.08.07	Promotion phase II 3 months	3rd Panel 15.11.07	Promotion phase III 4 months	4th Panel 23.03.08
Area 1 Prompts	N=95	Prompts: 8 Public Commitments: - Monitoring: 30	N=82	Prompts: 44 Public Commitments: - Monitoring: 30	N=84	Prompts: 44 Public Commitments: 1 Monitoring: 30	N=79
Area 2 Public commit-ments	N=110	Prompts: 1 Public Commitments: 14 Monitoring: -	N=95	Prompts: - Public Commitments: 33 Monitoring: -	N=93	Prompts: - Public Commitments: 54 Monitoring: -	N=86
Area 3 both	N=57	Prompts: - Public Commitments: 1 Monitoring: 15	N=51	Prompts: - Public Commitments: 36 Monitoring: 15	N=54	Prompts: 23 Public Commitments: 26 Monitoring: 15	N=42
Area 4 none	N=274	Prompts: - Public Commitments: - Monitoring: -	N=207	Prompts: - Public Commitments: - Monitoring: -	N=236	Prompts: - Public Commitments: - Monitoring: -	N=231
Total	N=536	Prompts: 9 Public Commitments: 15 Monitoring: 45	N=435	Prompts: 44 Public Commitments: 69 Monitoring: 45	N=467	Prompts: 67 Public Commitments: 81 Monitoring: 45	N=438
Comm. Channels (Total)	N=536	Workshop: 6% Health volunteer: 2% Radio: 4% School teacher: 4% Nurse, doctor: 6% Women's group etc.: - Personal contacts[a]: 3% Other: - None: 78%	N=435	Workshop: 19% Health volunteer: 8% Radio: 53% School teacher: 8% Nurse, doctor: 11% Women's group etc.: 1% Personal contacts[a]: 7% Other: 3% None: 28%	N=467	Workshop: 46% Health volunteer: 7% Radio: 61% School teacher: 17% Nurse, doctor: 21% Women's group etc.: 12% Personal contacts[a]: 26% Investigators[b]: 17% None: 11%	N=438

Note: For the panel measurements, the starting day is given. Completing the measurements took about 10 days.
[a] Personal contacts include: friends, neighbors, family members.
[b] During the third promotion phase, the investigators of Study II went personally to two villages to hand in the intervention materials.

households did you visit without success before this one?"). However, in this measure are also households included where the person responsible for the water in the household was not present.

The social monitoring started in week 30, 2007 (18.07.2007). Three of the larger villages were selected and of each village 15 households were asked to participate in the monitoring.

Promotional design

As described earlier, communication strategies were not varied during the project, it was only checked afterwards, which households received which communication channel. In contrast, interventions were separated and applied in different villages. The areas in this study are therefore defined by the type of interventions: only prompt, only public commitment, both, and

none. The communication channels that occurred in more or less all areas are also shown in the design overview, however, since they are not separately analyzed in this thesis, no detailed information on co-occurrence with the interventions and distribution across the areas are presented. As can be seen in the listing of communication channels, lots of different ones occurred and effects would be hardly separable. Moreover, all the named communication channels also occurred in random combinations.

SAMPLE DESCRIPTION

In the following, a descriptive overview of all used variables of the two studies being part of this thesis is given. Note that the measures given in Table 4 refer to the entire sample available at each time point. Therefore, descriptive measures given with the separate chapters may differ from the ones presented here, because often analyses had to be restricted to sub-samples due to problems with missing values or due to a particular research question. In the following, the complete samples are described according to their demographic data. For Study I, the areas will be compared regarding demographic data, because the analysis of the different communication strategies (chapter 4) is based on the comparability of the four periurban areas.

The descriptive measures of the variables related to consumption of SODIS, boiled and untreated water and their change over time are not further described, they are simply too numerous. They are only presented for a more comprehensive understanding of the development of different facets of the behavior change process. At some points a reference is made to these values, particularly in the final discussion. All descriptive measures can be found at the end of this part in Table 4.

Study I

The following demographic variables were collected and are used for sample description: age, education, number of persons per household, number of children below 5 years per household, gender, job situation and number of personal contacts. Percentages or means are presented in Table 4. If significant differences exist between the four periurban areas, they will be mentioned in the following.

The person responsible for water in the household (interviewed person) was female in 93% of the cases (N=528), the mean age was 38 years (SD=15, N=525), and the mean years of education were 6.9 (SD=4.6, N=520). For education, all four periurban areas differ significantly from each other, except health fair and control. The promoters' area had the lowest education (4.9 years), followed by the control area (6.5 years), the health fair area (7.1 years) and the opinion leader area (9.6 years). The average employment rate was 37% in the periurban areas (mostly vendors, few with formal employment; N=490). In the rural area, almost all people

worked as farmers. For occupation rate, the promoters' area differed significantly from all other areas having the lowest employment rate (15%). The other three areas had employment rates between 43% and 48%. The total amount of people living in one household was 5.0 people (SD=2.0, N=526). Significant differences were found only between the health fair (5.3 persons) and the opinion leader area (4.6 persons); the other two areas had values in between. Each household had on average 0.85 children below 5 years of age (SD=0.95, N=525); no significant differences between the areas. On average, the interviewed person had contact with 2.4 persons outside their own house, but still living within the same community (SD=2.3, N=306) with significant differences between the promoters' area (3.2 persons) and the health fair (2.0 persons) as well as the opinion leaders' area (1.5 persons). The control area had a value in between (2.1 persons).

Overall, the demographics do not show any important differences between the four periurban areas. Particularly important, there is no area having always the lowest or highest values. Therefore, the areas are considered as being comparable for the analyses of chapter 4, but it will also be controlled for the demographic variables whenever possible.

Study II

For Study II, the same demographic variables are presented, except job situation and number of personal contacts. The job situation in rural areas is the same for all households – every family has to do farming, else they would not have food to eat. Therefore, this measure is not presented. Number of contacts was not measured in this study.

The person responsible for water in the household (interviewed person) was female in 71% of the cases (N=536), the mean age was 44 years (SD=16, N=536), and the mean years of education were 2.9 (SD=3.4, N=535). The total amount of people living in one household was 5.1 people (SD=4.3, N=536) and each household had on average 0.7 children below 5 years of age (SD=0.9, N=536).

Compared to Study I, a higher percentage of men were interviewed, although the majority of the water responsible persons is still a woman. The sample was on average a little older and a lot less educated. This is most probably due to the fact that the sample of Study I is mainly from periurban areas and the Study II sample from very rural areas. The indicator on education shows for Study II that 40% did not go to school at all; for Study I it is only 12%. Interestingly, household sizes are the same and also number of children below 5 years is equally low in both samples. However, the mean age indicates that the samples are rather old (especially Study II) and their children are probably already more than 5 years old.

Table 4. Descriptive measures of all four time points. Studies I and II.

	Study I												Study II											
	Panel 1			Panel 2			Panel 3			Panel 4			Panel 1			Panel 2			Panel 3			Panel 4		
Variable name	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**
Problem awareness diarrhea children	159	.68	.29	269	.78	.25	287	.71	.24	369	.77	.21	533	.66	.20	429	.72	.18	465	.73	.15	436	.76	.10
Problem awareness diarrhea self	159	.74	.26	266	.76	.22	286	.77	.20	369	.78	.21	532	.66	.18	434	.71	.19	458	.71	.15	435	.74	.09
Problem awareness diarrhea	159	.71	.22	266	.77	.19	286	.74	.19	369	.78	.17	531	.66	.15	429	.72	.16	458	.72	.13	435	.75	.08
Awareness clean water	159	.53	.36	269	.60	.34	287	.6	.35	369	.58	.31	535	.45	.28	434	.62	.26	465	.69	.21	436	.64	.17
Importance clean water	158	.82	.18	269	.84	.17	287	.82	.16	368	.75	.17	-	-	-	-	-	-	-	-	-	-	-	-
Importance health	-	-	-	-	-	-	-	-	-	-	-	-	535	.78	.16	435	.83	.16	465	.85	.16	437	.75	.08
Causality untreated water - diarrhea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	466	.65	.25	437	.70	.23
Knowledge SODIS (% yes)	438	36%		473	81%		444	98%		369	100%		536	10%		435	41%		466	86%		437	96%	
Knowledge depth SODIS	159	.25	.33	245	.55	.37	277	.79	.22	367	.74	.26	534	.04	.13	418	.16	.26	458	.42	.29	430	.64	.26
Belief taste SODIS	-	-	-	-	-	-	-	-	-	359	.51	.33	45	.41	.33	151	.40	.36	389	.42	.36	416	.62	.27
Belief taste boiling	-	-	-	-	-	-	-	-	-	-	-	-	536	.08	.40	435	.04	.44	464	.12	.44	436	.33	.48
Belief taste untreated water	-	-	-	-	-	-	-	-	-	-	-	-	536	.53	.33	434	.50	.40	466	.48	.48	437	.14	.61
Belief health SODIS	-	-	-	-	-	-	-	-	-	367	.59	.26	50	.65	.20	150	.65	.27	391	.65	.25	418	.70	.17
Belief health boiling	-	-	-	-	-	-	-	-	-	-	-	-	536	.61	.25	435	.64	.33	465	.63	.27	437	.66	.20
Belief health untreated water	-	-	-	-	-	-	-	-	-	-	-	-	536	-.09	.48	433	-.11	.50	465	-.25	.53	436	-.33	.56
Belief money SODIS	-	-	-	-	-	-	-	-	-	-	-	-	51	-.07	.13	150	-.06	.13	391	-.03	.09	415	-.03	.09
Belief money boiling	-	-	-	-	-	-	-	-	-	-	-	-	535	-.16	.18	435	-.18	.22	465	-.14	.20	435	-.14	.15
Belief time SODIS	-	-	-	-	-	-	-	-	-	367	-.13	.20	51	-.15	.14	149	-.13	.18	390	-.09	.15	418	-.09	.13
Belief time boiling	-	-	-	-	-	-	-	-	-	-	-	-	536	-.19	.16	433	-.18	.18	463	-.14	.17	437	-.15	.14
Belief effort SODIS	-	-	-	-	-	-	-	-	-	367	-.14	.20	-	-	-	-	-	-	-	-	-	-	-	-
Belief difficulty SODIS	155	-.22	.30	238	-.05	.14	286	-.05	.16	367	-.07	.17	49	-.18	.20	150	-.12	.21	388	-.11	.19	418	-.06	.13
Cost-benefit evaluation	70	.52	.47	226	.74	.23	286	.69	.27	367	.62	.32	-	-	-	-	-	-	-	-	-	-	-	-
Affect SODIS	61	.55	.29	225	.65	.25	286	.68	.19	367	.54	.32	50	.41	.31	150	.43	.31	390	.48	.30	417	.64	.20
Affect boiling	153	.62	.33	258	.57	.35	284	.58	.31	-	-	-	535	.24	.34	435	.23	.41	467	.37	.35	437	.54	.30
Affect untreated water	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	434	.45	.40	466	.34	.49	435	.07	.62
Attitude SODIS	156	.74	.24	268	.73	.21	287	.77	.20	367	.67	.27	48	.46	.31	151	.56	.30	391	.56	.28	418	.69	.17
Attitude boiling	-	-	-	-	-	-	-	-	-	-	-	-	536	.39	.30	434	.38	.37	465	.44	.33	437	.57	.32
Attitude untreated water	-	-	-	-	-	-	-	-	-	-	-	-	533	.13	.47	435	.18	.50	466	-.02	.57	437	-.11	.64
Injunctive norm SODIS	70	.39	.34	225	.52	.30	286	.48	.32	367	.36	.33	49	.24	.34	148	.33	.33	390	.38	.34	417	.42	.35
Injunctive norm boiling	-	-	-	-	-	-	-	-	-	-	-	-	536	.26	.31	435	.27	.37	466	.33	.33	436	.38	.34
Injunctive norm untreated water	-	-	-	-	-	-	-	-	-	-	-	-	535	.03	.29	434	.08	.32	465	-.01	.35	436	-.02	.45
Subjective norm SODIS	-	-	-	-	-	-	-	-	-	-	-	-	50	.14	.14	150	.18	.18	388	.28	.23	417	.23	.19
Subjective norm boiling	-	-	-	-	-	-	-	-	-	-	-	-	533	.21	.18	433	.24	.14	467	.30	.23	437	.25	.21
Subjective norm untreated water	-	-	-	-	-	-	-	-	-	-	-	-	534	.72	.30	435	.76	.21	465	.63	.23	437	.44	.32
Descriptive norm SODIS	157	0.62	2.07	269	1.74	3.17	287	2.95	4.03	369	1.11	1.75	42	0.38	0.94	114	0.66	1.10	261	2.41	5.15	389	1.54	1.76

	Study I												Study II											
	Panel 1			Panel 2			Panel 3			Panel 4			Panel 1			Panel 2			Panel 3			Panel 4		
Variable name	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**
Availability bottles	158	0.76	0.37	103[a]	.87	.26	32[a]	.95	.15	-	-	-	-	-	-	189	.60	.38	317	.61	.32	400	.55	.31
Availability combustibles	159	0.79	0.31	103[a]	.89	.18	32[a]	.85	.24	-	-	-	536	.56	.28	433	.58	.30	466	.60	.29	437	.54	.30
Intention SODIS	156	.84	.26	236	.83	.28	285	.87	.25	366	.68	.33	37	.39	.25	149	.57	.24	388	.66	.23	418	.65	.22
Intention boiling	159	.72	.34	257	.82	.28	285	.87	.24	-	-	-	536	.42	.17	434	.49	.19	464	.51	.25	437	.51	.22
Intention untreated water	-	-	-	-	-	-	-	-	-	-	-	-	534	.54	.22	435	.54	.23	463	.39	.29	436	.25	.29
Perceived habit SODIS	-	-	-	-	-	-	-	-	-	367	.25	.30	13	.60	.22	93	.48	.28	247	.61	.25	363	.60	.23
Perceived habit boiling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	430	.35	.24	460	.36	.29	436	.45	.24
Perceived habit untreated water	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	435	.64	.25	465	.49	.30	433	.31	.32
Cognition intensity SODIS	16	.50	.30	160	.60	.30	232	.66	.28	367	.38	.39	14	.48	.32	92	.52	.28	246	.64	.25	366	.58	.23
Forgetting SODIS	16	-.52	.34	158	-.33	.29	233	-.29	.23	266	-.56	.35	14	-.29	.24	92	-.38	.27	248	-.29	.22	364	-.24	.23
Dissonance SODIS	16	.40	.28	151	.45	.35	225	.49	.33	350	.24	.29	12	.27	.31	92	.28	.25	233	.32	.23	324	.42	.28
Implementation intention	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	149	.63	.29	389	.64	.28	417	.68	.25
Strength of commitment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	91	.45	.31	247	.42	.32	364	.54	.27
Behavior SODIS I (% yes)	438	5%		472	33%		444	58%		369	38%		536	3%		436	25%		467	54%		438	83%	
Behavior boiling I (% yes)	159	97%		268	96%		287	99%		369	99%		535	90%		434	95%		467	91%		438	96%	
Behavior untreated water I (% yes)	159	54%		103[a]	24%		262	22%		369	33%		536	98%		435	97%		467	84%		438	55%	
Behavior bought beverages I (% yes)	159	25%		103[a]	16%		32[a]	25%		369	55%		529	21%		417	35%		467	17%		438	13%	
Behavior intensity SODIS	159	.01	.07	103[a]	.20	.28	32[a]	.22	.28	369	.15	.23	532	.01	.09	427	.11	.23	467	.33	.35	438	.47	.31
Behavior intensity boiling	159	.58	.34	103[a]	.65	.27	32[a]	.58	.27	369	.64	.27	536	.24	.20	435	.32	.21	467	.34	.26	437	.28	.19
Behavior intensity untreated water	159	.32	.37	103[a]	.09	.18	32[a]	.08	.20	369	.12	.23	535	.74	.26	435	.64	.27	464	.47	.33	437	.25	.31
Behavior intensity bought beverages	159	.09	.18	103[a]	.06	.14	32[a]	.11	.21	369	.10	.17	-	-	-	-	-	-	-	-	-	-	-	-
Age	435	39.1	14.9	466	38.3	15.1	436	38.3	15.0	364	39.3	15.2	536	43.8	16.3	435	44.4	16.1	467	44.0	16.2	438	43.9	16.0
Education	432	6.7	4.7	461	7.1	4.6	429	7.0	4.6	358	6.8	4.7	535	2.9	3.4	435	2.8	3.2	466	2.8	3.4	437	2.8	3.2
Persons per household	436	5.1	2.0	467	5.0	2.0	436	5.1	2.1	364	5.2	2.0	536	5.1	4.3	435	5.1	4.5	467	5.1	4.4	438	5.1	4.5
Children <5y. per household	436	0.8	0.9	467	0.9	0.9	435	0.9	1.0	364	0.8	1.0	536	0.7	0.9	435	0.7	0.9	467	0.7	0.9	438	0.7	0.9
Gender (% female)	438	93%		469	93%		437	93%		365	93%		536	71%		435	73%		467	70%		438	71%	
Job (% yes)	438	34%		469	36%		437	36%		365	35%		-	-	-	-	-	-	-	-	-	-	-	-
Number of contacts	216	2.6	2.5	287	2.4	2.3	282	2.4	2.3	244	2.3	2.3	-	-	-	-	-	-	-	-	-	-	-	-
Prompts (% yes)	-	-	-	474	30%		444	18%		-	-	-	-	-	-	435	2%		467	9%		438	15%	
Public commitment (% yes)	-	-	-	474	6%		444	15%		-	-	-	-	-	-	435	3%		467	15%		438	18%	
No. of communication channels	-	-	-	474	1.39	1.05	444	0.66	0.82	-	-	-	-	-	-	435	0.25	0.52	466	1.13	0.97	437	2.05	1.44
Long questionnaires	159			269			287			369			536			435			467			438		
Short questionnaires	279			205			157			-			-			-			-			-		
Additional households	-			90			9			-			-			-			-			-		
Real drop outs	-			33			30			105			-			10			13			75		

Note: [a] These variables were only measured with those households who joined the study newly or were changed from short to long questionnaires. They have to be interpreted carefully.

Chapter 1

Behavioral models for the consumption of SODIS, boiled and untreated water

CONTENTS

ABSTRACT

The entire water consumption pattern is investigated in the present chapter based on the factors derived from a stage model of behavior change. The model consists of two motivational phases, namely problem awareness and persuasion, and two volitional phases, namely uptake of the behavior and habit development. Intention is viewed as a crucial transition point between the motivational and volitional phases. It is hypothesized that SODIS, boiled and untreated water consumption are driven by different factors of the behavior change process. It is assumed that with the knowledge of those factors, contents of promotion campaigns could be planned much more effectively.

To analyze the water consumption pattern, data from the last panel of Study II is used. Regressions were calculated to predict a) the intentions to use SODIS, boil water and consume untreated water with factors from the motivational phases, and b) the percentage of water consumed of each water type with the behavioral intention and factors from the volitional stages.

The results show that all stages of the behavior change process are involved in predicting intentions and behaviors. However, the problem awareness factors are of much lower importance than the persuasion phase factors. Particularly affective influences show a strong influence on intention in addition to the belief about the taste of each water type. Norms only influence the intention to boil water with a relevant strength. The behaviors are all influenced by the intention, which indicates the importance of this transition measure, and perceived habit. Availability of resources and the indicator of uptake, past behavior, only showed low influence. Additionally, quite strong negative relations between the different intentions as well as the different behaviors of SODIS and untreated water were found.

The analyses confirm the usefulness of the model, particularly the inclusion of the habit phase. Of the motivational phases, problem awareness does not seem to play such an important role. Although some valuable insights could be gained, additional factors should be considered, because particularly the intention towards boiling and the behavior boiling could not be explained very well. Moreover, indicators of the uptake phase are missing. Furthermore, implications for SODIS campaigns are discussed based on the specific factors influencing the different intentions and beliefs.

Keywords: behavior, intention, behavior change process, SODIS, boiling, untreated water

INTRODUCTION

For some decades now, the topic of health behavior has been the focus of many researchers, who studied for example smoking prevention (Prochaska, DiClemente & Norcross, 1992), exercise programs (Fuchs et al., 2005) or changing poor diets (Lippke & Sniehotta, 2003). Often, the adoption of a health preventive behavior is viewed as the only logical answer to a potential health threat (Schwarzer, 2001). This view is mainly based on the doubtful assumption that humans are purely rational driven living beings. However, many studies show that the perception of a health risk alone is a weak predictor of behavior change, i.e. the adoption of a preventive behavior (e.g. Calnan & Rutter, 1988; Luszczynska & Schwarzer, 2003; Schwarzer, 2001). One may only think of the risk of contracting lung cancer due to smoking, obesity due to too much junk food, and many other examples where no action is taken, although risks are perfectly known (Schwarzer, 2001).

The desire to understand the phenomena in the context of health preventive behaviors led to the development of several behavioral models, e.g. the transtheoretical model (Prochaska & DiClemente, 1983) or the health action process approach (Schwarzer, 2008). These models follow the assumption of qualitatively different stages and consequently different mechanisms underlying each stage. Stage models were designed for closing the intention-behavior gap by including those post-intentional factors that seemed to be of importance for behavior change. Moreover, this approach was simply more appealing for designing and understanding the functioning of different interventions.

In the present chapter the behavior change process regarding SODIS water consumption is described in detail, using four different stage models as the basic theoretical approach and combining them. The described stages of the behavior change process also apply of course to the consumption of other types of water, i.e. boiled or untreated water. The statistical analyses first focus on explaining the behavioral intention as the transition point from motivation to action stages and then, in a second step, try to explain the consumption of the three types of water that are consumed in the study areas: SODIS water, boiled water and untreated water. All three types of consumed water are investigated, because they are strongly related to each other, which is also shown during the analysis. Discussion will concentrate on important predictors of intentions as well as behaviors and discuss measures to increase consumption of SODIS or boiled water and decrease the consumption of untreated water.

SODIS behavior change in a stage model

A short introduction to stage models has already been given in the chapter Introduction, particularly outlining the advantages of stage models compared to continuum models. It was concluded that stage models are more appropriate to serve as a theoretical framework to

explain the behavior change process for the present study than continuum models. Not only the emphasis on the stage or phase character of the behavior change process was a decisive factor in favor of stage models, but also the common intention-behavior gap of continuum models, simply ignoring the habit formation process. Several stage models outlined in the chapter Introduction were condensed to a model comprising four different themes of interest. These four topics follow the general idea of stage models, understood as different phases or stages the individual has to pass through. The four topics or stages are: (1) problem awareness (2) persuasion, (3) uptake and (4) habit. Problem awareness and persuasion can be condensed into a motivational phase, where mostly cognitive processes are involved. It is not explicitly stated that being in the problem awareness and persuasion phase has to occur in sequence, processing of both types of information may as well take place in parallel. Uptake and habit are action phases and involve different processes. It has already been suggested by theoretical and empirical evidence that uptake and maintenance of a new behavior have different underlying motivational and volitional processes. While behavior uptake is probably more determined by positive beliefs, attitudes and intentions, as well as initiation processes, for habit development factors like maintenance self-efficacy (e.g. Luszczynska & Schwarzer, 2003), action planning, self concordance of intentions, or integration of feedback may be more important determinants (Lippke, Ziegelmann & Schwarzer, 2004, 2005). Intention is viewed as a transition point between the motivational and action phases. The more a goal intention actually corresponds to one's own wishes and needs, the stronger the goal behavior will be pursued in critical moments. Also, mechanisms of protecting the intention against attractive behavioral alternatives can be a useful strategy (Fuchs et al., 2005).

In the following, the stages are described in more detail, taking the behavior SODIS water consumption as an example and deriving specific factors of each stage. The overlaps of each stage to four common stage models are described. Links to the proposed indicators of the different stages will also be made.

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 (E. M. 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.

Often, stage models do not include this stage or simply depict problem awareness as the prior condition to enter the behavior change process (E. M. Rogers, 1995, p. 163). Only the transtheoretical model has a separate stage for people who have not yet experienced the need or seen the problem: the pre-contemplators. The process of acquiring problem awareness

describes the transition from the immotive pre-contemplation stage to the contemplation process (Prochaska & DiClemente, 1983). A certain amount of motivation to change the behavior is necessary to start dealing with the problem (Prochaska & DiClemente, 1982). Schwarzer (2008) at least involved risk perception as one factor into his first stage (motivational phase).

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.

To gain awareness of the drinking water and diarrhea problem, different possibilities exist. The contamination of drinking water may be perceived directly, for example by having frequent episodes of diarrhea. Then, with simple information, a link can be made between water and diarrhea, and the solution SODIS use can be pointed out. If no diarrhea has been experienced, the dangerous potential of consuming untreated water, its relation to diseases and the solution SODIS can also be directly explained to the person.

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). Finally, mental planning processes can be used to anticipate the future situation (E. M. Rogers, 1995, p. 168).

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

In the most common stage models, the persuasion stage is conceptualized as an important step towards behavior adoption. The innovation decision process (E. M. Rogers, 1995) divides it up into the knowledge stage, which involves the cognitive processes of information seeking, the persuasion stage, which is more characterized by affective thinking, and the decision stage, which describes the actual decision to adopt or reject the new behavior. Also the transtheoretical model (Prochaska & DiClemente, 1983) divides the processes of thinking about adoption of the new behavior and deciding to do so into two separate stages: contemplation and preparation. The model of action phases (Heckhausen & Gollwitzer, 1987) summarizes all consideration processes into one stage, the pre-decisional stage. The decision to act is viewed as the critical step of 'crossing the Rubicon'. The model of action phases separates the subsequent planning process from the decision (pre-actional phase). Finally, the health action process approach (Schwarzer, 1992, 2008) views all these processes as being part of the motivational phase.

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, Meierhofer, Wegelin & Mosler, 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, Tamas, Tobias, Caballero Rodriguez & Guzman Miranda, 2008; Trafimow & Sheeran, 1998). Moreover, the differentiation into cognitive beliefs and affective elements is a lot more useful for evaluating, which aspects of an innovation 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. 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 et al., 1990; Cialdini, 2003). Real observations of people using SODIS will exert an additional influence (*descriptive norm*). 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).

Measures to cognitively convince people of SODIS can be all kinds of information in oral or written form. Addressing the affective dimension of attitude is more difficult and may be realized with relating SODIS to something pleasant. This may be the atmosphere during an information campaign or a joke on a poster. Positive social influence is hard to exert in an environment where people are not yet using SODIS. Here, either local stars or influential persons of a community may be won over to publicly support the SODIS idea and function as role models.

Uptake

Until now, the behavior change process was only marked by motivational mental processes (E. M. 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 et al., 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 (E. M. 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 continue performing the behavior in case of a positive opinion and intention until a certain amount of automaticity and habit has developed. During this phase, the behavior has to be consciously remembered and activated.

Some stage models simply call this stage 'action' (transtheoretical model, Prochaska & DiClemente, 1982; model of action phases, Heckhausen & Gollwitzer, 1987). Rogers (E. M. Rogers, 1995, p. 172) calls this stage implementation stage and the health action process approach (Schwarzer, 2008) post-intentional volitional phase. The main differences to the following maintenance stage are the time span after the decision, and that the behavior has not yet been established as a continued change (Prochaska et al., 1994). Rogers additionally takes

note of the implementation phase phenomenon of re-invention of an innovation. This is, when "the new idea changes and evolves during the diffusion process" (E. M. Rogers, 1995, p. 174). However, this phenomenon will not be investigated here and has been observed only in very rare occasions for SODIS[2].

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, not having time or availability of bottles (*availability of bottles*) may or may not interrupt SODIS use. The amount of cognitive resources each person applies to sustain SODIS use also depends on the initial commitment. Low cognition intensity at this stage often results in forgetting the behavior (Tobias, 2007). Not only using SODIS constantly in the uptake phase is important, but also which part of the daily consumed water is treated with SODIS. During the first try out period, a person can as well decide to only disinfect a small part of the daily consumption with SODIS, which probably makes a difference in habit formation and reflects the initial amount of commitment. This suggests *past behavior intensity* as a predictor of present behavior intensity. However, empirical evidence already suggests that in case of well formed intentions, effects of past behavior on future behavior are weak (Ajzen, 2002a; Bamberg et al., 2003). Moreover, for the current analysis the time span between measurements was fairly long (4 months). Therefore, effects are expected to be rather weak.

To keep SODIS present in people's heads, it is important not to stop with SODIS promoting activities too early. At this stage, content does not really play a role (unless people fall back to the persuasion stage), it may be a better strategy to use many small and individual things that help remembering. Also, the easiness of the trial is important (E. M. Rogers, 1995, p. 16) and can be facilitated by providing the necessary resources (i.e. bottles) in the beginning.

Habit

The last stage is characterized by habit development with habit forming processes being active. These processes are described in more detail in chapter 2, where relapse behavior due to failed habit development is characterized in contrast to continued behavior.

The transtheoretical model defines a time frame for entering the maintenance stage – that is 6 months after action has started (Prochaska et al., 1994) and ends when the problem is solved and the individual has left the process, because no desire to relapse exists anymore (Prochaska & DiClemente, 1982). For Rogers (E. M. Rogers, 1995, pp. 180), the last stage, named confirmation, has a stronger focus on confirming the taken decision and action. This can be realized by seeking reinforcement, or by reducing or avoiding a state of dissonance. In the model of action phases (Heckhausen & Gollwitzer, 1987), the last stage (post-actional phase) is

[2] In Study I, about 5 households used SODIS to heat up their water already before the study. However, these individuals were unaware of the disinfection process.

rather cognitively driven, where intended and achieved goals are critically evaluated. Also, the health action process approach (Schwarzer, 2008) does not explicitly mention habit developing processes in the volitional phase, which includes maintenance. Only cognitive, behavioral and situational processes are mentioned, which correspond more to the previously described uptake stage.

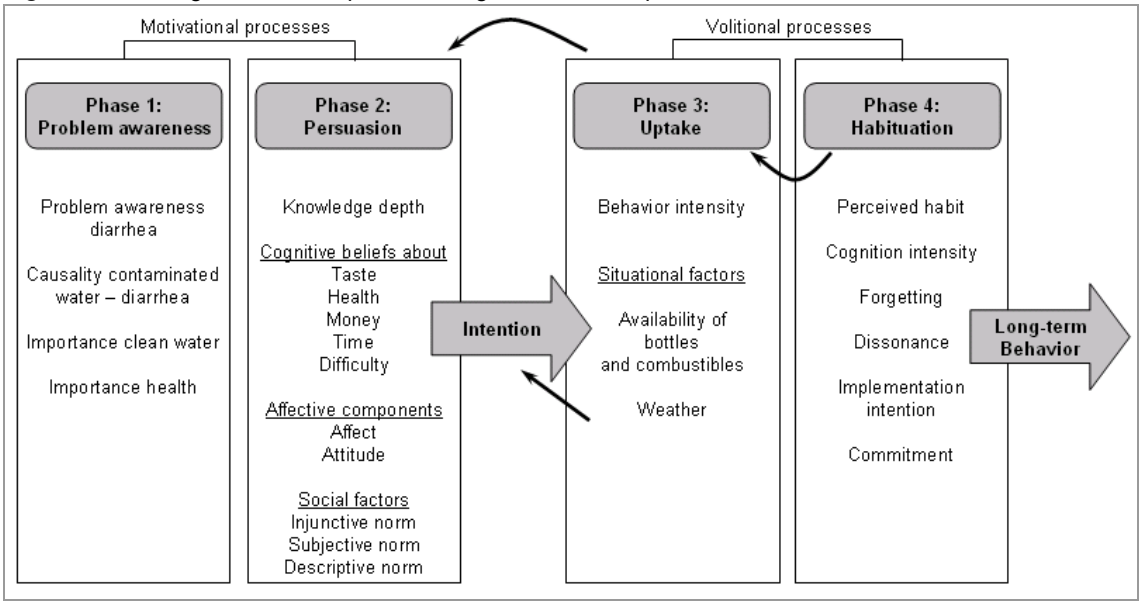
For a long-term use of SODIS, it is important that people primarily do not forget preparing SODIS during their daily life routine or constantly prioritize other things. Also, it is of importance to achieve a positive evaluation in terms of solving the problem initially described, i.e. reducing diarrhea episodes. It is therefore a goal to reduce untreated water consumption and increase SODIS water consumption as much as possible. Else, people will never experience any positive health effects and most likely stop using SODIS after a while. 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). This problem will be discussed in more detail in the chapter about relapse behavior (chapter 2).

Measures to support habit development processes should be introduced on an individual level with memory aids or personalized integration of the new behavior into people's daily routines, so that it gets anchored and related to other daily activities.

Summary

In Figure 12 the entire behavior change process is presented. The topics or stages 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, Abrams, Emmons, Lincoln & Shadel, 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 intentions and behaviors in the water consumption context. These results are hopefully valuable in deriving suitable interventions to promote or hinder the consumption of a certain water type. Therefore, no explicit hypotheses are stated, which factors are of lower or higher importance in predicting intention and behavior. The intentions and behaviors studied here are related to the consumption of SODIS water, boiled water and untreated water. For boiled water, the situational restriction is naturally not the availability of bottles, but the *availability of combustibles*. For untreated water, beliefs about how much time and money it costs are irrelevant, because consuming untreated water does not require any additional time or money and neither does it cause any difficulty.

Figure 12. A stage model to explain drinking water consumption.



Comparing determinants of SODIS, boiled and untreated water consumption

In the previous part, the behavior change process for the adoption of SODIS was outlined. The following analyses, however, will not be restricted to determine predictors of the intention to use SODIS and the SODIS use itself. Also, determinants of the intention and consumption of boiled and untreated water will be analyzed using the same model factors. The main reason is, as already mentioned, that the three water consumption behaviors are related to each other. Thus, if it is possible to decrease the consumption of untreated water, the consumption of treated water (boiled or SODIS) has to increase. Therefore, it is necessary to know all factors involved in the overall water consumption behavior. Additionally, it is assumed that the consumption of the different types of water is determined by different factors, which can have relevance for planning interventions. For example, since SODIS is a new behavior and people got newly convinced about SODIS, problem awareness and beliefs may have a greater impact, while boiling and consuming untreated water are already established behaviors and may only be determined by habit.

Since it was not possible to fit the data into a long-term model analysis (missing cases between time points, too many predictors), only a snap shot from the last measurement will be presented. It is tried to explain intention with predictors from the motivational phases, that is problem awareness indicators and persuasion stage indicators. Additionally, the situational factors may already have an influence in the decision phase (Ajzen, 1991). Behavior intensity is not expected to be strongly directly influenced by indicators of the motivational phases, since these exert their influence via the behavioral intention. One exception are the situational

circumstances that can particularly in the case of barriers have direct influence on behavior. Also, the belief about the difficulty of the behavior performance can influence behavior directly (Ajzen, 1991; Schwarzer, 2008). Those two factors will be included into the behavioral model in addition to behavioral intention and the factors from the uptake and habit stages.

METHODS

The explanatory influence of the indicators of the motivational stages on intention and the influence of intention and the factors of the volitional stages on the three water consumption behaviors, SODIS, boiled and untreated water, will be calculated using data from the last panel of Study II. A detailed description of the study area, participants' characteristics as well as all operationalizations can be found in the overall Methods part of this thesis.

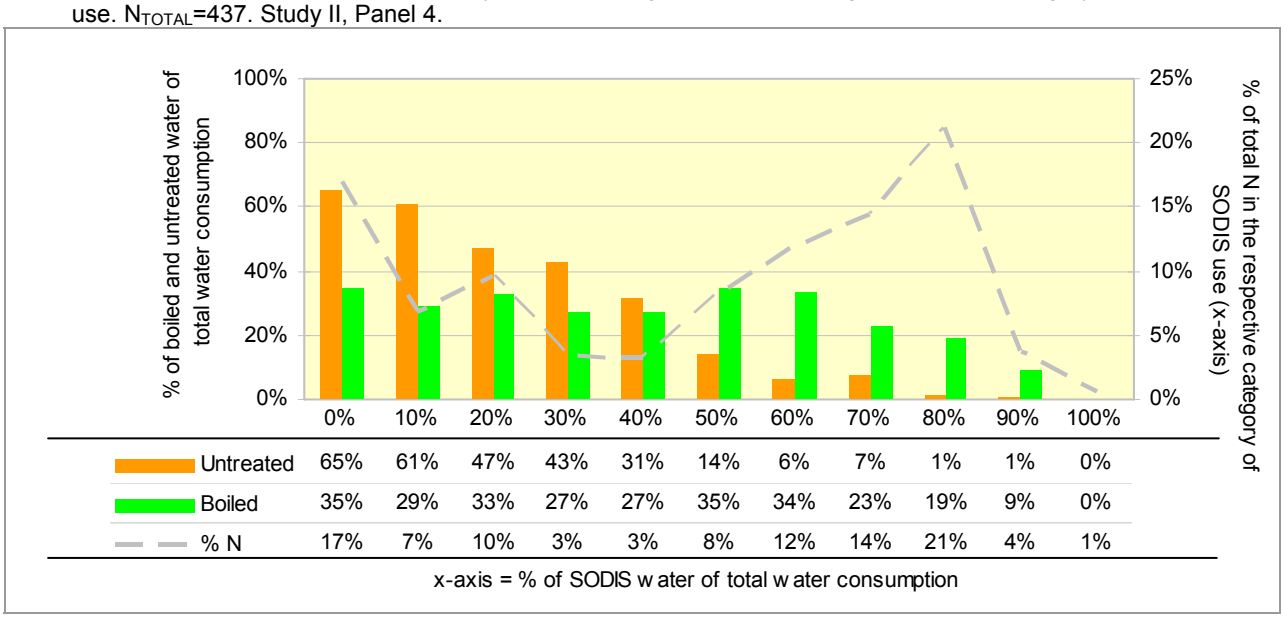
RESULTS

The results part consists of three analyses: 1) a brief analysis on the inter-relations of the three intentions and behaviors related to water consumption, 2) the explanation of the behavioral intentions to consume SODIS treated, boiled or untreated water with three separate linear regressions of factors from the motivational stages, and 3) the explanation of water consumption of SODIS, boiled and untreated water with linear regressions of factors previously described in the action phases on the percentages of SODIS treated water, boiled water and untreated water. Into the intention models, only those cases were entered, who new about the respective water type. Since everybody knew boiled and untreated water, this is only relevant for the selection of households for the SODIS intention model. Similarly, into the water consumption models only those entered, who consumed the respective water type. This was relevant for the selection of cases for the SODIS behavior model and also for the untreated water model, since some people stopped consuming untreated water.

Relations between behavioral intentions and behaviors SODIS, boiling and untreated water consumption

This part gives an overview of the inter-correlations of the three intentions to consume SODIS, boiled and untreated water and the three corresponding behaviors using correlation analyses. Additionally, the overall water consumption pattern is presented (percentages of which type of water are consumed by the population; Figure 13).

Figure 13. Water consumption pattern of untreated and boiled water, dependent on the amount of water that is treated with SODIS. Additionally, the percentages of total N are given of each category of SODIS use. N_{TOTAL}=437. Study II, Panel 4.



The intentions regarding the two treatment behaviors, to do SODIS and to boil water, are only weakly correlated with each other (r=.15, p=.003, N=418). In contrast, their correlations with the intention to consume untreated water are higher. The correlation of the intention to consume untreated water with the intention to boil water is still rather low (r=-.29, p<.001, N=436), whereas the correlation with the intention to use SODIS is of medium intensity (r=-.48, p<.001, N=418).

When looking at the behavior intensities, the percentages of SODIS, boiled and untreated water on the total water consumption, the picture is a bit different. Boiling behavior correlates at a medium level with the two other behaviors (both r=-.30, p<.001, N=437). In contrast, a very strong relation was found between untreated water and SODIS behavior (r=-.81, p<.001, N=437). Note, that in this analysis also zero-amounts were included. That means, if someone did not consume a certain water type, it was coded with zero. Thereby, the relations of the amounts of consumed water could be analyzed in the entire sample.

Summarizing, it seems that the introduction of SODIS most strongly influenced untreated water intention and consumption, and had a weaker impact on boiled water intention and consumption. This perfectly meets the desired effect of SODIS promotion campaigns.

The above presented assumption is also supported by the graphs of the overall water consumption pattern (Figure 13). The data points of the graphs of boiled and untreated water consumption were calculated based on how much SODIS water a person consumes (x-axis, 10% steps). An additional graph gives the number of people in each category of % SODIS water consumption. Analyzing the graph, it is clearly visible that with increasing SODIS water

consumption, untreated water consumption decreases. When people treat around 60% of their water with SODIS, almost no untreated water is consumed anymore. After that point, the increased SODIS water consumption reduces the amount of water that is boiled. Boiled water consumption is relatively stable for SODIS water consumption percentages of 0 to 60%. Looking at the amount of people in each category of percentage SODIS water consumption, two peaks are observable. Either people treat no or very little amounts of water with SODIS or 50% to 80% with a clear maximum at 80%. It seems that 60 to 80% SODIS water, 20 to 30% boiled water and around 5% untreated water is an optimum, which is preferred by almost 50% of the interviewed sample.

Predictors of the behavioral intention

In this part, influences of factors from the areas of problem awareness and persuasion on behavioral intentions to use SODIS, to boil water and to consume untreated water are investigated. Problem awareness comprises the specific awareness of the diarrhea problem, the awareness of clean water, the importance of health and the understanding of the causality between contaminated water and diarrhea. Those four variables are identical for all three behavioral intentions. Persuasion comprises the topics of knowledge about the target behavior, specific cognitive beliefs, a general affective belief, attitude, social factors and situational barriers. Specific knowledge was only included for the SODIS behavior, because for boiling it is known that people have the knowledge on how to boil water and untreated water does not require special knowledge. The specific beliefs about taste and health of the respective water type were included for all three behaviors. The beliefs about monetary and time related costs do only make sense for the two behaviors that can require money and time costs. For consuming untreated water consequently these two beliefs were not measured. The same applies for situational barriers: for untreated water an additional situational barrier like the bottles for preparing SODIS and combustibles for boiling water, does not exist. Only for the SODIS behavior the belief perceived difficulty was included. Of the social factors, the descriptive norm was only included for SODIS water consumption, because, at least in the beginning of the study, nearly every household consumed untreated and boiled water. Although this changed over time, the measure was not included later on.

All predictors of intention from the problem awareness and persuasion stages 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 three different intentions. 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 entered afterwards as a second block in a forward procedure into the regression. As already mentioned above, only households who knew SODIS entered into the regression on the intention to use SODIS. The total amount of interviewed households in the fourth panel of Study II was 438. Boiling water and consuming untreated water was known to everybody, here the slightly lower number of Ns are caused by missing values of one of the factors (list-wise deletion).

First, descriptive measures (means, standard deviations and correlations with the dependent variable intention) of all variables of the regression models are presented in Table 5. Correlations between the independent variables are not presented, but were calculated and checked for problematically high correlations. The highest correlation found in the matrix of the SODIS related variables was 0.75 between the belief about the taste and attitude, in the boiling correlation matrix the highest correlation was 0.58 between the beliefs about money and time, and in the untreated water correlation matrix the highest correlation was 0.84 between the belief about the taste and the affect.

The dependent measure intention has the highest value for using SODIS (M=.65), followed by the intention to boil water (M=.51). The lowest value shows the intention to consume untreated water (M=.25). These values are highly significantly different from each other (p<.001).

The four indicators of the problem awareness stage are the identical measures for all three behavioral intention models, therefore means and standard deviations are very similar (only varying due to the slightly different sample sizes). The mean values in general indicate quite a high level of problem awareness (M>.64). Correlations with the behavioral intentions are only significant for the awareness of clean water (r_{SODIS}=.22, r_{Boiled}=.11, $r_{Untreated}$=-.18) and the awareness of the causality between contaminated water and diarrhea (r_{SODIS}=.33, r_{Boiled}=.13, $r_{Untreated}$=-.30), not for the problem awareness of diarrhea and the importance of health.

SODIS knowledge depth is at a satisfactory level (M=.67) and shows a medium correlation with the intention to use SODIS (r=.44).

People belief that SODIS water is quite tasty and healthy (M=.62 and .70, respectively). These two beliefs correlate with medium intensity with the intention to use SODIS (r=.46 and .41, respectively). Boiled water is judged less tasty (M=.33), but almost equally healthy as SODIS water (M=.66). Untreated water in contrast is judged slightly unhealthy (M=-.33) and only a little tasty (M=.14). The correlations of those two beliefs with the intentions are all significant and range from .21 to .68. The mean values of the beliefs about time and money regarding SODIS use and boiling water as well as the belief about the difficulty of using SODIS are all nearly 0 (means from -.03 to -.15), which means that neither SODIS nor boiling are perceived as costly regarding money and time, neither is SODIS perceived as very difficult. Correlations with intention for SODIS are rather low (from .14 to .31) but significant, whereas for boiling correlations are not significant.

The affect towards SODIS water as well as the attitude are positive and of about the same level like intention (M=.64 and .69, respectively). Correlations with intention are of

Table 5. Descriptive statistics of all factors of the motivational stages for SODIS, boiled water and untreated water. Means (*M*) and standard deviations (*SD*) as well as the Pearson correlation coefficients (*r*) of the intentions to consume SODIS, boiled and untreated water with all factors from the motivational phase of the behavior change process, and demographic variables are presented. Study II, Panel 4.

	SODIS (N=404) [a]			Boiled (N=429)			Untreated (N=429)		
Factor	***M***	***SD***	***r***	***M***	***SD***	***r***	***M***	***SD***	***r***
Intention	.65	.22	.	.51	.22	.	.25	.29	.
Problem awareness diarrhea	.75	.08	.00	.75	.08	-.04	.75	.08	.02
Awareness clean water	.65	.17	.22	.64	.18	.11	.64	.17	-.18
Importance health	.75	.08	.04	.75	.08	.07	.75	.08	-.02
Causality contaminated water - diarrhea	.71	.23	.33	.70	.23	.13	.70	.23	-.30
Knowledge depth SODIS	.74	.20	.45	-----	-----	-----	-----	-----	-----
Belief taste	.62	.27	.46	.33	.48	.46	.14	.62	.68
Belief health	.70	.17	.41	.66	.20	.21	-.33	.56	.55
Belief money	-.03	.09	.21	-.13	.15	-.08	-----	-----	-----
Belief time	-.09	.13	.14	-.15	.14	-.04	-----	-----	-----
Belief difficulty	-.06	.13	.31	-----	-----	-----	-----	-----	-----
Affect	.64	.20	.51	.54	.30	.31	.07	.63	.68
Attitude	.69	.17	.42	.57	.32	.32	-.12	.64	.66
Injunctive norm	.42	.35	.20	.38	.34	.24	-.02	.45	.51
Subjective norm	.23	.19	.20	.25	.21	.32	.44	.32	.32
Descriptive norm	1.5	1.8	.21	-----	-----	-----	-----	-----	-----
Availability bottles / combustibles	.55	.31	.09	.54	.30	-.10	-----	-----	-----
Age (years)	44	16	-.06	44	16	.03	44	16	.02
Education (years)	2.8	3.3	-.06	2.8	3.2	-.03	2.8	3.2	-.07
No. of persons per household	5.2	4.6	-.06	5.1	4.5	.03	5.2	4.5	-.01
No. of children <5y. per household	0.8	0.9	.06	0.7	0.9	.01	0.7	0.9	.00
Gender (0=m, 1=f)	0.72	0.45	.04	0.72	0.45	.02	0.72	0.45	.03

Note: Grey correlation coefficients are not significant at p<.1 level. ----- = not measured for the respective type of water.
[a] Except: descriptive norm N=371, availability bottles N=386.

medium intensity (*r*=.51 and .42, respectively). For boiling, affect and attitude are a bit lower and again at a very similar level like intention (*M*=.54 and .57, respectively) with a moderate correlation with intention (*r*=.31 and .32, respectively). For untreated water, affect and attitude are clearly lower with attitude even having a negative value (*M*=.07 and -.12, respectively). Interestingly, correlations with the intention to consume untreated water are twice as high as for boiling (*r* =.68 and .65, respectively).

The injunctive norm (i.e. the reputation of the respective water type) is positive, but rather low for SODIS (*M*=.42) and boiling (*M*=.38), and neutral for untreated water (*M*=-.02). Particularly for boiling, the low value of reputation is rather surprising, because boiling water is necessary to have hot beverages and is practiced by virtually every household. Correlations to intention are rather low for SODIS and boiling (*r*=.20 and .24, respectively), but of medium intensity for untreated water (*r*=.51). The mean values of the subjective norms unveil some interesting misjudgment, it seems that people are not able to correctly estimate the proportion of people who use SODIS, boil water or consume untreated water. Especially for SODIS and boiling the subjective norm is very distinct to reality. People estimate that only around 23% (corresponds to *M*=.23) of all people use SODIS, but according to the data 83% did so. For boiling the discrepancy is similar – according to the estimated subjective norm, 25% boil their

water, in contrast to 96% who actually stated to boil water. For untreated water the estimated subjective norm (44%) is not so different to reality (55%). Nevertheless, correlations of subjective norm with intention were significant, but of lower intensity for SODIS (r=.20) and boiling (r=.24) than for untreated water (r=.51). The 'reality measure' descriptive norm, which was only asked for SODIS, shows that on average only 1.5 other households were observed using SODIS. The correlation with the intention to use SODIS is the same as for subjective norm (r=.21).

Bottles for SODIS and combustibles for boiling were judged as medium available (M=.55 and .54, respectively). These values did only marginally correlate with intention (r=.09 and -.10, respectively).

Finally, none of the demographic variables correlated significantly with any of the three intentions. For a description of the mean values of the sample see the overall Methods chapter.

Table 6 shows the results of the three linear regressions on the three different intentions. As additional information, in Table 7 the explained variances of intention of different blocks of variables are presented separately. The calculations presented in Table 7 were done to get a better impression, which groups of factors explain bigger parts of the variance of the three intentions.

In general, it has to be noted that the intentions to drink SODIS and boiled water could not be explained very well (39% and 29%, respectively). The explained variance of the intention to consume untreated water is much better with 57%. The factor blocks that contributed most for all three intentions were the different beliefs as well as affect and attitude. Additionally, the problem awareness factors and SODIS knowledge contributed to explain SODIS intention. To explain the intention to boil and to consume untreated water, the social variables contributed too. Comparing the three regression models, some commonalities are observable. First, the taste of the water seems to be of importance for all three water types. For the intentions to consume boiled and untreated water it even is the most important predictor with quite a strong influence (β=.38 and .29, respectively). For the SODIS intention it is the third most important predictor (β=.17). Another factor influencing all three behavioral intentions is affect. For SODIS intention, affect is the strongest predictor (β=.30), for boiled and untreated water the effect is weaker (β=.13 and .15, respectively). Another group of factors that is somehow consistent across the three behaviors are the social factors. However, here for boiled and untreated water, the subjective norm shows an influence on intention (β=.21 and .11, respectively), whereas for SODIS the injunctive norm plays a role (β=.12). Slight differences between the three models are found for the influence of factors from the problem awareness stage. SODIS and boiling intention are both slightly positively influenced by the understanding of the causality between contaminated water and diarrhea (β=.09 and .12, respectively). Oddly enough, the importance of health shows a slight negative influence on SODIS intention (β=-.10). The intention to

Table 6. Standardized betas of stepwise regressions of factors of the motivational stages on the behavioral intentions of using SODIS, boiling water and consuming untreated water. Study II, Panel 4.

Block	Factor	SODIS [a]	Boiled	Untreated
1	Problem awareness diarrhea			
	Awareness clean water			
	Importance health	5: -.10 *		
	Causality contaminated water - diarrhea	6: .09 *	3: .12 **	
2	Knowledge depth	2: .22 ***	-----	-----
3	Belief taste	3: .17 **	1: .38 ***	1: .29 ***
	Belief health			3: .17 ***
	Belief money	4: .11 **		-----
	Belief time			-----
	Belief difficulty		-----	-----
4	Affect	1: .30 ***	4: .13 **	5: .15 *
	Attitude			2: .23 ***
5	Injunctive norm	7: .12 **		
	Subjective norm		2: .21 ***	4: .11 **
	Descriptive norm		-----	-----
6	Availability bottles / combustibles	8: .07 (*)		-----
7	Age (years)			
	Education (years)	-.07 (*)	-.07 (*)	
	No. of persons per household			
	No. of children <5y. per household			
	Gender (0=m, 1=f)			
	Tolerance [3]	all >0.62	all >0.85	all >0.28
	VIF	all <1.61	all <1.17	all <3.56
	R^2	0.408	0.299	0.574
	Adj. R^2	0.394	0.291	0.569
	N	404 [a]	429	429

Note: Presented are the standardized betas of the final model of a stepwise linear regression (Blocks 1 to 6) on intention. Input threshold was p=.1, no out threshold was set (that means, once a factor had passed the threshold, it stayed in the calculation, independently whether it became insignificant later on or not). The demographic block 7 entered after the other blocks in a forward procedure. The number preceding each standardized beta refers to the step the factor became included into the model. Each column represents one regression. Significance levels of standardized betas: *** p<.001, ** p<.01, * p<.05, (*) p<.1. Empty cells indicate that the respective factor in the respective regression has not met the .1 threshold to enter the model. ----- = no data is available for that factor at that certain time point.

[a] Except: descriptive norm N=371, availability bottles N=386. All missing values were replaced with mean values for the regressions.

Table 7. R squares of separate regressions of the different blocks of factors on the behavioral intentions of using SODIS, boiling water and consuming untreated water. Study II, Panel 4.

Block	SODIS	Boiled	Untreated
Block 1	.114 ***	.026 *	.092 ***
Block 2	.198 ***	-----	-----
Block 3	.281 ***	.230 ***	.519 ***
Block 4	.280 ***	.128 ***	.510 ***
Block 5	.076 ***	.117 ***	.320 ***
Block 6	.008 (*)	.009 *	-----
Block 7	.022 ns	.003 ns	.005 ns

Note: Block 1 – Problem awareness diarrhea, awareness clean water, importance health, causality contaminated water - diarrhea. Block 2 –- SODIS knowledge depth. Block 3 – Beliefs taste, health, money, time and difficulty. Block 4 – Affect, attitude. Block 5 – Injunctive, subjective and descriptive norm. Block 6 – Availability of bottles (SODIS) and combustibles (boiling). Block 7 – demographic variables. Presented are the R squares of each block on intention, being tested with a separate regression. All factors of a block entered simultaneously into the regression. Significance level is given: *** p<.001, ** p<.01, * p<.05, (*) p<.1. However, it is not adjusted to the number of regressions calculated and may therefore be interpreted with caution. ----- = no data is available for that factor at that certain time point.

[3] Tolerance and VIF are indicators of the collinearity statistics of a linear regression. Tolerance values should not fall below 0.2 (Menard, 1995) and VIF, which is its reciprocal, consequently not above 5. Other authors even state a value not greater than 10 as acceptable for a VIF and consequently for tolerance values greater 0.1 are acceptable (Myers, 1990).

consume untreated water was not influenced by problem awareness related factors. Further influences among the beliefs were found for the belief about the costliness of SODIS on SODIS intention (β=.11) and for the belief about the healthiness of untreated water on the intention to consume untreated water (β=.17). Moreover, the intention to consume untreated water is influenced quite strongly by the attitude towards untreated water (β=.23). Another important predictor of the SODIS intention is how well the person knows about preparing SODIS (knowledge depth; β=.22). Furthermore, a very slight influence was found for the factor bottle availability (β=.07). Among the demographic variables, only education shows a tendency to negatively influence SODIS and boiled water intention.

Predictors of behavior

The second part of the analyses investigates the behavioral models for SODIS, boiled and untreated water consumption. The factors predicting behavior intensity are taken from the later stages of the behavior change process, uptake and habit. The uptake phase is represented by the past behavior intensity of each behavior and the habit phase by the perceived habit. Additionally, the situational barriers and the perceived difficulty are assumed to have an influence (real and perceived behavioral control; see Ajzen, 1991) as well as the intention as the repository for the indicators of the previous phases (Ajzen, 1991). These predictors were, like for the intention models, 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 the respective water type were included into each analysis, resulting in different Ns for each of the three behavioral models. The Ns were additionally reduced by approximately 40 households due to the inclusion of past behavior.

First, descriptive measures of all independent and dependent variables are presented in Table 8 (means, standard deviations and correlations with the dependent variable behavior). Correlations between the independent variables are not presented, but were calculated and checked for problematically high correlations. The highest correlations found in all three correlation matrices, of the SODIS, boiling and untreated related variables was found between the intention and perceived habit. For SODIS, the correlation was 0.51, in the boiling correlation matrix 0.61, and for untreated water 0.59.

The dependent measure intensity of consumed water shows that the highest part of consumption is water treated with SODIS (*M*=.58), followed by untreated (*M*=.47) and boiled water (*M*=.28). These values cannot be compared directly, because the sample is partly a different one for each water consumption behavior due to the exclusion of households who do not consume a certain type of water from the respective regression.

Table 8. Descriptive statistics of all factors of the action stages for SODIS, boiled water and untreated water. Means (*M*) and standard deviations (*SD*) as well as the Pearson correlation coefficients (*r*) with the percentage of consumed water treated with SODIS, boiling or consumed untreated water of all factors from the action stages of the behavior change process and the demographic variables are presented. Study II, Panel 4.

	SODIS (N=307)			Boiled (N=370)			Untreated (N=202)		
Factor	***M***	***SD***	***r***	***M***	***SD***	***r***	***M***	***SD***	***r***
Behavior	.58	.24	.	.28	.18	.	.47	.28	.
Belief difficulty	-.05	.11	.35	-----	-----	-----	-----	-----	-----
Availability bottles / combustibles	.57	.30	.26	.55	.30	.06	-----	-----	-----
Intention	.70	.17	.55	.52	.21	.54	.42	.25	.61
Past behavior	.38	.36	.05	.34	.27	.23	.52	.33	.21
Perceived habit	.63	.21	.66	.47	.24	.54	.54	.23	.71
Age (years)	44	16	-.17	44	16	.23	45	17	.01
Education (years)	2.9	3.3	.03	2.8	3.3	-.05	2.8	3.0	-.06
No. of persons per household	5.2	4.1	-.11	5.2	4.8	.02	5.1	4.7	.06
No. of children <5y. p. household	0.8	0.9	.05	0.7	0.9	-.12	0.7	0.9	-.02
Gender (0=m, 1=f)	0.71	0.45	.02	0.7	0.5	.02	0.70	0.46	.09

Note: Grey correlation coefficients are not significant at p<.1 level. ----- = not measured for the respective type of water.

As for the entire sample knowing SODIS, also for the subsample that uses SODIS, the SODIS behavior is not perceived as difficult (*M*=-.05). Nevertheless, a substantial correlation with SODIS behavior exists (*r*=.35). Similarly, judgments on the availability of bottles and combustibles by SODIS users and boiling subsamples are the same as for the entire sample. Bottles are more or less available (*M*=.57) as well as combustibles (*M*=.55). A correlation with the behavior only exists between bottle availability and SODIS behavior (*r*=.26).

Past water consumption of SODIS and boiled water is quite similar at about the current level of boiled water (*M*=.38 and .34, respectively). This indicates a strong increase in consumed SODIS water and a slight decrease of boiled water. Past consumption of untreated water also decreased slightly from a mean value of 0.52. Correlations with current behavior are low for boiled and untreated water (*r*=.23 and .21, respectively), and even insignificant for SODIS water (*r* =.05).

The perceived habit is of medium intensity with SODIS habit having the highest value and habit to boil water the lowest (M_{SODIS}=.63, M_{Boiled}=.47, $M_{Untreated}$=.54). Correlations with behavior are quite high (r_{SODIS}=.66, r_{Boiled}=.54, $r_{Untreated}$=.71).

In contrast to the intention models, the demographic variables show some significant correlations to the water consumption behaviors. Age is negatively related to SODIS water consumption (*r*=-.17) and positively to boiled water consumption (*r*=.23). Moreover, the total number of persons per household shows a slight negative correlation with SODIS water consumption (*r*=-.11) and number of children below five years of age to boiled water consumption (*r*=-.12).

Table 9 shows the results of the three linear regressions on the three different behaviors. In Table 10 the explained variances of each factor on each behavior is examined separately.

Table 9. Standardized betas of stepwise regressions on the behavioral indicators percentages of consumed water treated with SODIS, consumed boiled water and consumed untreated water. Study II, Panel 4.

Block	Factor	SODIS	Boiled	Untreated
1	Belief difficulty		-----	-----
	Availability bottles / combustibles	3: .10 *	3: .14 **	-----
2	Intention	2: .28 ***	1: .37 ***	2: .29 ***
3	Past behavior		4: .09 *	3: .14 **
4	Perceived habit	1: .50 ***	2: .30 ***	1: .52 ***
5	Age (years)	-.20 ***	.18 ***	
	Education (years)			
	No. of persons p. HH			
	No. of children <5y. p. HH			
	Gender (0=m, 1=f)	-.07 (*)		
	Tolerance	all >0.71	all >0.61	all >0.64
	VIF	all <1.42	all <1.63	all <1.56
	R^2	0.542	0.429	0.578
	Adj. R^2	0.534	0.421	0.572
	N	307	370	202

Note: Presented are the standardized betas of the final model of a stepwise linear regression (Blocks 1 to 4) on the behavioral indicator. Input threshold was p=.1, no out threshold was set (that means, once a factor had passed the threshold, it stayed in the calculation, independently whether it became insignificant later on or not). The demographic block entered after the other blocks in a forward procedure. The number preceding each standardized beta refers to the step the factor became included into the model. Each column represents one regression. Significance levels of standardized betas: *** p<.001, ** p<.01, * p<.05, (*) p<.1. Empty cells indicate that the respective factor in the respective regression has not met the .1 threshold to enter the model. ----- = no data is available for that factor at that certain time point.

Table 10. R squares of separate regressions of the different blocks of factors on the behavioral indicators percentages of consumed water treated with SODIS, consumed boiled water and consumed untreated water. Study II, Panel 4.

Block	SODIS	Boiled	Untreated
Block 1	.157 ***	.004 ns	-----
Block 2	.301 ***	.294 ***	.370 ***
Block 3	.002 ns	.052 ***	.046 **
Block 4	.433 ***	.290 ***	.506 ***
Block 5	.051 **	.065 ***	.016 ns

Note: Block 1 – Difficulty, availability of bottles (SODIS) and combustibles (boiling). Block 2 – Intention. Block 3 – Past behavior. Block 4 – Perceived habit. Block 5 – demographic variables. Presented are the R squares of each block on the behavioral indicator, being tested with a separate regression. All factors of a block entered simultaneously into the regression. Significance level is given: *** p<.001, ** p<.01, * p<.05, (*) p<.1. However, it is not adjusted to the number of regressions calculated and may therefore be interpreted with caution. ----- = no data is available for that factor at that certain time point.

In general, explained variance for the SODIS and boiling behavior models is better than it was for the corresponding intention models (53% and 42%, respectively). For untreated water a very similar portion of the variance of the behavior as for the intention could be explained (57%). The factors that contributed most to all three behaviors were intention and perceived habit. Additionally, for SODIS the perceived barriers were of importance. No or little contribution was made by past behavior and by the demographic variable block.

The explained variances are directly reflected by the calculated regression coefficients. Intention and perceived habit have the strongest influence on all three behaviors. For SODIS and untreated water consumption, perceived habit is the strongest predictor (β=.50 and .52,

respectively), whereas for boiled water consumption intention is the strongest predictor (β=.37). The situational barriers, bottles for SODIS and combustibles for boiling water, show a slight influence on both behaviors. The more bottles or combustibles are available, the more water is treated with SODIS or boiled, respectively (β=.10 and .14, respectively). The perceived difficulty did not show any influence on SODIS behavior. As expected, past behavior did not show a big influence on current behavior. For SODIS behavior, no relation was found (as there was already no correlation). This is not very surprising, because SODIS behavior was targeted to be changed with the interventions and not based on past behavior intensity. For boiled water as well as for untreated water a weak influence was found (β=.09 and .14, respectively), which reflects that boiled and untreated water consumption were not as strongly changed by the interventions and still a relation to past behavior existed. An interesting and rather unexpected influence was found for age on SODIS and boiled water consumption. On SODIS behavior, a negative influence was found (β=-.20), which means that younger people disinfect more water with SODIS. Contrarily, on boiling a positive influence of age was found (β=.18), which indicates that older people prefer boiling a larger proportion of their water.

DISCUSSION

The structure of the discussion will follow the structure of the results, so at first, influences on behavioral intentions are discussed, and secondly influences on water consumption behavior in view of implications for future interventions. Finally, the findings will be integrated into the behavior change model.

The intention models

Although quite many factors got included into the models predicting the three different behavioral intentions, two common factors that influence all three intentions could be found: the belief about the taste of the water and the affect towards its consumption. It can be generalized that these two factors always play a role when people form their intentions about which water they intend to consume in the future. In contrast, the other more rational beliefs about monetary and time costs, healthiness and difficulty as well as the preceding problem awareness have a much lower influence spectrum.

Only for untreated water a relation between the health belief and the intention exists. This is a rather interesting finding, because campaigns often emphasize how healthy SODIS and boiled water is, instead of stressing how *un*healthy untreated water is. Complementing this interesting relationship, the understanding of the causality between contaminated water and the occurrence of diarrhea only positively influences the intentions of SODIS and boiling, but not negatively the intention to drink untreated water (as one could easily have expected).

Consequently, during campaigns both aspects have to be addressed, because they cover distinct information (correlations are only between .26 and .39) and influence different intentions.

Another slightly important belief is the one about the monetary costs of SODIS. This seems natural, because the costs of a new behavior first have to be assessed. Then the behavior is more likely to be preferred if it is evaluated as being of low costs. Interestingly, for the intention to boil the costs – although rated slightly higher than those of preparing SODIS – do not play a role. Probably boiling is viewed as a necessary behavior (to have hot beverages), and therefore performed independently of its costs.

The beliefs about difficulty and time costs are not of importance for building the intention to use SODIS or boil water. Also not crucial for the forming of the behavioral intentions are the resources needed to perform the behavior (bottles for SODIS and combustibles for boiling). It seems that at this stage, resource availability is not yet considered.

As already mentioned, only the belief about the taste and the affect are universal predictors of all three behavioral intentions. Moreover, for SODIS intention the affect and for the other two intentions the belief about the taste is also the most important predictor. This finding is consistent with the one of Heri and Mosler (2008), who found affect being the most important predictor of SODIS intention. The consistent influence of affect and taste belief also has some implications for promotion campaigns. These two factors should be targeted most during campaigns promoting SODIS (and boiling) and discouraging people to consume untreated water. However, the factors often stressed as being of decisional importance for the people are the ones that did not show such universal influences. 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 and also boiling. Consequently, the implication would be to specifically target the belief about the taste of all water types and the affective connotation towards each water type, because these are the main driving factors of the behavioral intentions. The mean values of both indicators for untreated water allow for further interventions changing the currently neutral evaluation of taste and affect of untreated water into negative ones. Interestingly, the taste of untreated water and the affect towards consuming it are very closely related (r=.84). In contrast, the taste and affect of SODIS are already quite positively evaluated and would not pose such a potential for improvement. Moreover, it seems easier to relate the consumption of untreated water to the feeling of unpleasantness, indicating its unsecure origin or the possibility of fecal contamination by humans and animals, for example. Here the relationship between the intentions should be used, because a lower intention towards untreated water correlates with a higher intention to consume SODIS water. For boiled water, not much intervention potential is seen to improve the belief about its taste, because boiled water in reality does not taste very well. On top of it, taste is by far the strongest predictor for boiling intention.

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.

Furthermore, it is interesting to note that for the 'old' behaviors, boiling and consuming untreated water, the perceived subjective norm is important, whereas for the new behavior SODIS the reputation (injunctive norm) influences the intention. This, although the injunctive and subjective norms for all three behaviors are pretty low, and the subjective norms do not reflect real percentages of users among the population, particularly for SODIS use and boiling. It can only be suspected that for the old behaviors reputation does not matter anymore, but one gets influenced by what others seem to do. In contrast, the new behavior SODIS first has to get established and people are more influenced by what they think that others think about it. The reason why these two norms are rated so low may as well be based in a misunderstanding of the items. This issue should be investigated further and in case of really low reputation of SODIS (and boiling), interventions increasing this factor should be thought of (e.g. famous role models).

The behavioral models

Comparing the three behavioral models, as expected the intention and the perceived habit are strong predictors of behavior intensity. The stronger the intention to use SODIS, boil water or consume untreated water and the stronger the person perceives her/his own habit towards each of these three behaviors, the more water of the respective water type is consumed. For SODIS and untreated water consumption, perceived habit is the stronger predictor, whereas for boiled water consumption it is the intention. This implies that during campaigns, habit development and regularity of the water consumption should be stressed to increase people's perceived habits. Since lowering the perceived habit of untreated water consumption may be difficult, focus should be laid on increasing the perceived habit of SODIS and boiled water consumption. The intentions should be influenced via the important predictors from the intentional models (see above).

Additional, but much weaker influence on behavior is exerted by the available resources for preparing SODIS and for boiling water (bottles and combustibles). The more easily these resources are available, the more water is treated with SODIS or is boiled. Structural interventions would be helpful to have these resources at hand when people have formed a positive intention and are ready to act. Another way to make those resources available would be to point out ways and means for people to organize bottles or combustibles themselves. However, still 50% of the people claimed at the end of the study that one or more bottles were missing, which reduces the possible amount of water that can be treated with SODIS. Unfortunately, the situation about bottle availability was not explicitly investigated. The

perceived difficulty of SODIS does not have an influence on the behavior, and in general, SODIS is not perceived as being very difficult.

As expected, past behavior does not predict current behavior for SODIS and only shows weak influence on boiled and untreated water consumption. The long time-span between the measurements (4 months) and the interventions that were targeted to influence the water consumption behaviors and uncouple it from past practices are likely to have caused these weak relationships. An additional, quite interesting relationship between age and the behaviors was found. Apparently, younger people disinfect more water with SODIS and older people boil more water. For untreated water consumption, no relationship was found. 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, boiled water consumption could be partly explained (42% of the variance), as well as SODIS and untreated water consumption (53% and 57% of the variance) with the suggested factors. Other factors probably have to be considered in addition to those presented.

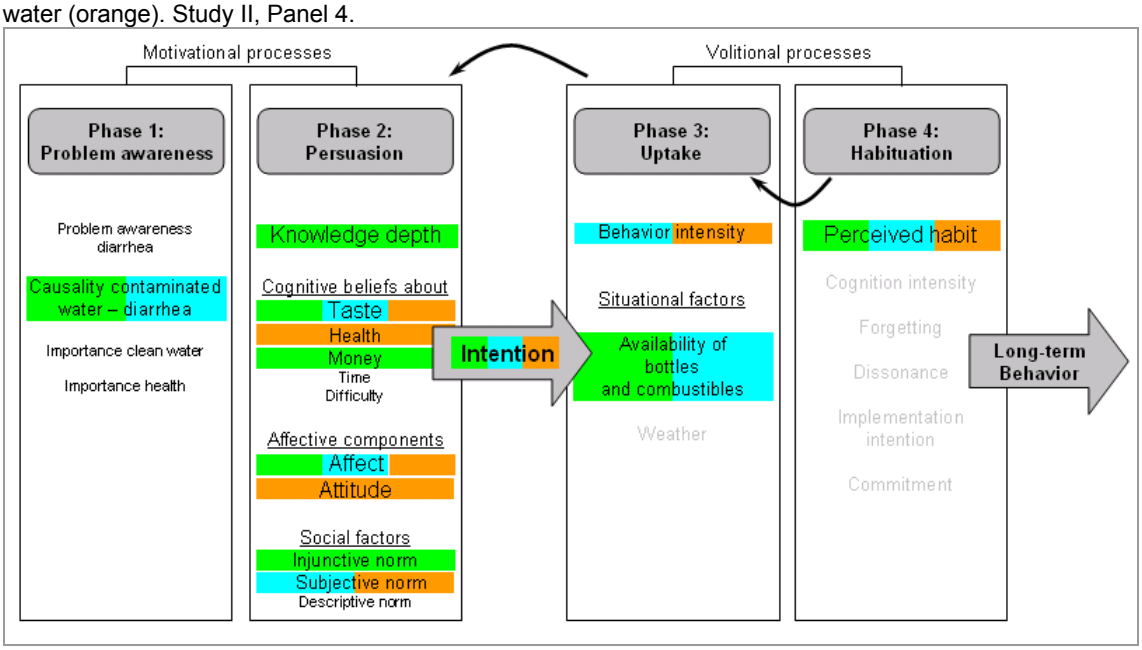
Integration of the intention and the behavioral models into a stage model

In the following, the stage model of Figure 12 is presented again in Figure 14 now highlighting the found predictors of the intentions towards SODIS use, boiling and consumption of untreated water (motivational phase) as well as the found predictors of the three corresponding behaviors (volitional phase).

The highlighting of influence factors in the model shows that factors from all topics of the behavior change process are involved in predicting the intentions and behaviors. The intentions were only weakly influenced by one factor from the problem awareness phase and strongly by factors from the persuasion phase. The behaviors were influenced by all hypothesized factors from the uptake and habit phase.

For SODIS intention, this is consistent with what was expected. Problem awareness was assumed to have existed already before the study. Instead, the persuasion stage factors played the dominant motivational role. As long as the behavior is not yet completely habitual, all the cognitive processes are active and cognitive beliefs, affects, action knowledge and social evaluation processes that in turn form the intention are easily accessible. Later on, it would be expected that those factors are not salient anymore. 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

Figure 14. Predictors of intention and behavior SODIS water (green), boiled water (blue) and untreated water (orange). Study II, Panel 4.



Note: Smallest type size = indicators that never have shown an influence, medium type size = indicators that have shown low influence, large type size = indicators that have shown medium influence, very large type size = indicators that have shown a strong influence. Green background = influence on SODIS, blue background = influence on boiling, orange background = influence on untreated water. Grey type color = not included in the models calculated in the present chapter.

an explicit affect measure and Altherr et al. (2008) with a quite affectively connotated attitude measure. Also, the importance of cognitive beliefs about taste and money on SODIS intention, as well as the injunctive norm influence gets support by one of the studies (Heri & Mosler, 2008).

For the intentions to boil and consume untreated water, it is interesting to see that they are also explained by factors from the motivational phase, which was not expected with such strength. Apparently, due to the process of changing drinking water habits with the introduction of SODIS as a new alternative, also for the old behaviors, beliefs were activated and changed. A complete analysis of the entire change process (i.e. analyzing all points of measurement) would be interesting, but would go beyond the scope of this chapter. At this point it shall only be referred to the descriptive statistics already presented in the overall Methods chapter. There it can be seen that those variables predicting the extent of intention towards boiling and untreated water consumption indeed have been changed during the course of the study into the desired directions (more positive evaluation of boiling and more negative evaluation of untreated water). This is particularly true for untreated water, where more drastic changes were observed. Additionally, the intentions towards untreated and SODIS water are related much stronger to each other than the intentions towards boiled and SODIS water.

Presumably, this is also the reason why the untreated water intention could be explained much better than the boiled water intention, where 70% of the variance was not explained with the factors of the motivational phase. Probably, boiling intention predicting motivations were not

accessible with the applied measures. Also, the intention to use SODIS could be explained better than the intention for boiling. Somehow, the model factors from the motivational phase are not sufficient for explaining the intention of boiling behavior. Other factors, addressing the necessity component related to boiling water may serve better in explaining its intention.

A similar relation of explained variances and consequently predictive power of the model is found for the three behaviors: the boiling behavior model had the lowest value in explained variance (42%), the other two had equally higher explained variances (53% and 57%). Again, SODIS and untreated water consumption are related much stronger to each other than to boiled water consumption. Overall, the factors of the volitional phase of the stage model explain behavior quite well and their strengths of influences indicate that perceived habit and intention are crucial factors. The need for consideration and operationalization of a separate habit phase is therefore confirmed and should be tested further in the context of water consumption behavior. One important addition 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. More 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. In the presented model, only past behavior was included, but as already discussed above, this logically does not explain future behavior when behavior change campaigns are taking place and the time difference between measurements is large. Here maybe the inclusion of planning processes that have occurred during uptake could help to bridge the gap (Schwarzer, 2008).

Finally, the low explained variance of boiling behavior indicates that the model factors do not provide such explanatory power for boiling behavior. Like already mentioned for the intention towards boiling, other relevant factors addressing the necessity aspect of boiling should be investigated.

One additional factor not included in the current model but suggested by several authors is the concept of self-efficacy (Bandura, 1982; Schwarzer, 1992, 2008). Self-efficacy is said to have influence on intention *and* behavior (Schwarzer, 2001). On the other hand, the concept of self-efficacy, dealing largely with the difficulty to perform a behavior, is already incorporated in the concept of perceived behavioral control (Ajzen, 2002b). The parallel between self-efficacy and perceived behavioral control concerning their effect on intention, as well as on behavior, support Ajzen's view. However, perceived difficulty and 'real' difficulty, which together form the amount of perceived behavioral control were measured and included and did not show very strong impacts. One other factor one could think of is the perceived compatibility with existing habits (Heri & Mosler, 2008). However, such a factor would only apply for a new behavior, because old behaviors can be assumed to fit with existing habits.

CONCLUSION & LIMITATIONS

Summarizing, the factors derived from the stage model could explain a good part of the water consumption related intentions and behaviors. The behavior could be better explained than the intentions. Especially for boiling, additional factors not yet included in the model have to be thought of. Explained variances for the boiling intention is rather unsatisfactory, for the behavior it is acceptable.

The negative correlations that were found between SODIS and untreated water intentions, as well as between the two behavior intensities, suggest that promotion campaigns addressing the increased use of SODIS *and* the decreased consumption of untreated water at the same time, pose a higher potential for success. Additionally, the factors found influencing intentions provide insight into which particular beliefs must be addressed to influence which intention. The belief about the taste of the water and the affect were interestingly found to be strong and water type independent predictors of intention. Having a positive intention then, in turn, influences behavior, together with perceived habit. Here, more research is needed to untangle the predictors of perceived habit. Moreover, it is assumed that circumstances that were present during the uptake phase could possibly also play a role. However, they have to be investigated and operationalized with following research.

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 (as that of Study I).

Chapter 2

Why do people stop using SODIS?

CONTENTS

ABSTRACT

In this chapter households having stopped using SODIS after a long inactive period of time, named relapsers, are compared with households which have continued with SODIS use after the same long inactive period of time, named continuers. Relapsers and continuers are not only investigated as such, but as it had been already tried by Fuchs (1997), different subtypes were hypothesized. Those subtypes were assumed to differ mainly in their intention to use SODIS and the degree of cognition intensity (cognitive presence of the topic SODIS). Further, it was investigated how relapsers, continuers and their subtypes can be characterized using a range of factors from the stages of the behavior change process. It was assumed that differences would occur mainly among the factors of the action stages.

For analyzing relapsers and continuers, data from measurement time point 3 and 4 of Study I were used. Cluster analyses were employed for finding relapser and continuer subtypes, and variance analyses for comparing them afterwards regarding the different factors.

In the comparison of overall relapsers and users it was shown that for all factors of the behavior change process relapsers had lower values than users. The difference pattern of these factors shows that the further the behavior change process advances the greater are the differences between relapsers and users, and the lower is the level of the variables for relapsers. It can be reasoned that the causality for people being relapsers lays mainly in the missing habit, which they obviously did not manage to maintain in contrast to those who stayed users.

Similar to Fuchs typology (1997), two relapser and two user subtypes could be identified. A low and a high relapser as well as a low and a high user were found. The classification ‘low’ and ‘high’ relates directly to the mean level of the factors of the behavior change process. Low relapsers stopped using SODIS early compared to high relapsers, and therewith show a similar behavior like Fuchs’ relapser types. In addition, low relapsers show quite a range of differences to high relapsers in psychological factors. Not only were variables used for identifying the subtypes, intention and cognition intensity, different as hypothesized, but also one central belief (taste), the affective connotation, injunctive norm, and dissonance. High relapsers interestingly have values almost as high as low users, only differing in the degree of habit. Under the assumption of an underlying threshold of habit being critical for behavior performance, it is argued that low users are at risk of becoming high relapsers if no measures are taken. Only high users seem to be stable and did not show a decrease in critical habit variables between the two measurement time points. However, also high users do not yet perform SODIS automatically, because their cognition intensity is still very high, and forgetting still occurs.

In the further discussion, the different subtypes are placed along the behavior change process and possible interventions for each type are highlighted.

Keywords: relapse, continuance, solar water disinfection, intervention

INTRODUCTION [4]

Preface. The idea for the following analysis was inspired by the situation we found in the fourth panel of Study I, when we went back to Bolivia for the long term evaluation. The situation it is referred to is the almost equal numbers of people still using SODIS and having stopped SODIS use. This kind of distribution gave the statistical opportunity and raised curiosity to closer analyze the differences between those who continued using SODIS and those who stopped it. The ones who continued with SODIS are labeled 'continuers' and those who stopped are named 'relapsers'.

In the previous chapter, the predictors of the behavioral intention and behavior intensity were analyzed to describe the behavior change process until the point where a habit starts to develop. However, it was not analyzed what happens when a habit does not develop and people finally stop the behavior. Experiences from health psychology have shown that it is not a given fact that someone, who knows about the obvious advantages of a certain preventive behavior and has even already tried out this behavior, actually continues doing so forever (e.g. Fuchs et al., 2005). Often, it is not a conscious decision against a certain behavior, it is rather guided by partly unconscious factors (Scheirer, 1990). Everyday behaviors like water consumption in contrast to more complex (health) behaviors like alcohol abstinence pose even more potential to be widely unconscious.

Since some decades, the topic of health behavior change is the focus of many researchers. At the same time, these researchers started to wonder why people dropped out of their health prevention programs or resumed with a health risky behavior. Drop out rates for example for exercise and sport programs can be as high as 60% (Fuchs, 1997; Pahmeier, 1994). As a consequence, stage models for explaining (health) behavior change were inspired or developed (e.g. the transtheoretical model [Prochaska & DiClemente, 1982, 1983]; the health action process approach [Schwarzer, 2008]) as it was already laid out in the previous chapter. These stage models about health behavior change aimed at closing the intention-behavior gap with the inclusion of not only motivational processes, but also the action phase. Moreover, some of these stage models explicitly include maintenance of a behavior as a separate stage, acknowledging that performing a behavior does not necessarily mean life-long continued performance of the same.

The behavior change process regarding SODIS has already been described in detail in chapter 1. Therefore, the present chapter only focuses on the habit phase and described more

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in detail (which was not done in the previous chapter). However, also factors from the earlier stages will be used to investigate differences between continuers and relapsers.

Additionally, Fuchs (1997) has presented a typology of people who continue with a behavior and those who relapse, which will be laid out as well. The analyses of this chapter will focus on finding different types among SODIS relapsers and continuers, and then describe them using the different variables from the behavior change process.

The habit stage of the behavior change process

Being in the habit stage, it is said that the individual performs the behavior, i.e. SODIS, with a certain continuity and despite of hindering situational factors. Then after some time a new habit will develop. But what factors it depends on and how long it takes exactly until a new habit has developed is not answered clearly by today's behavior change research (Tobias, 2007, p. 109). This problem will be discussed more in detail in the following part.

As just mentioned, factors and time frame of habit development are not defined clearly by existing research. However, different assumptions exist, and first it will be reflected about time frames.

Pavlov stated 1927 that in the context of classical conditioning – which can also be viewed as a type of behavior change – after 6 stimuli without reinforcement the relation between stimulus and reflex is deleted (Pavlov, 1927). In the context of reinforcement learning it was stated that after approximately 14 days an optimum is reached (Tolman & Honzik, 1930, p. 267). Others rely more on the frequency of the behavior execution than on time frames. However, the range is quite wide. From 12 to 15 behavior executions without a given time frame (Breckler & Wiggins, 1989), via at least 10 repetitions and a frequency over time of at least twice a month (Ronis, Yates & Kirscht, 1989) to daily or at least weekly performance in stable circumstances (Ouellette & Wood, 1998). According to these researchers, a SODIS habit would be established after one month, because SODIS is a behavior that has to be performed every 1 or 2 days.

In contrast to those very specific statements on what it needs to develop a habit, Rogers assumes that like the period of time that is needed for a person to take over an innovation, also the period of time that is needed to develop a habitual behavior depends on the innovation and the person itself (E. M. Rogers, 2003, p. 191). One aspect rarely mentioned is that uptake of a behavior and maintenance of that behavior may possibly be completely different processes (Rothman, 2000). Rothman refers to the fact that many individuals frequently manage to start new behaviors, but periodically fail to maintain them. This is taken as a hint that there must be different mechanisms behind these two processes. Moreover, the habit component that has been added to the theory of planned behavior, although conceptualized only as the past behavior intensity, is able to predict behavior continuance somehow better than intention and

perceived behavioral control alone (Ronis et al., 1989; Bamberg et al., 2003; Ouellette & Wood, 1998). So maybe, the time frame depends on the innovation or even on the individual.

If the behavior is not already during the uptake phase prevented from being performed in the future due to negative evaluations of motivational factors, other performance hindering factors come in during the habit phase. For example, simply *forgetting* the behavior, low *cognition intensity* (i.e. the intensity with which 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. High cognition intensity is important for the transition from the uptake phase to the habit phase and it prevents forgetting the behavior. The less habitual a behavior is, the more it has to be cognitively active to prevent forgetting (Logan, 1980; Tobias, 2007). If the behavior is not activated, chances that it will be performed despite of the existence of old habits are low, unless it is related to a very positive affective component (which is not expected to be the case for water treatment). If then additionally 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). The degree of perceived dissonance depends on the goals the person has defined for her/himself beforehand. 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). In the context of habit development, some authors also stress the importance of how strongly people themselves perceive they are performing the behavior habitually (*perceived habit*; Bamberg, 1996; Knussen et al., 2004; Verplanken & Orbell, 2003).

Additionally, in order to not to forget the new behavior, the correct moment for behavior execution has to be detected. For example, doing SODIS has to be remembered when the person is at home and not at work. Furthermore, it has to be remembered how the behavior is to be performed (e.g. the five SODIS steps). The more salient key situations are defined, the more likely the possibility to perform the behavior will be recognized, and the more likely is behavior execution (Marsh, Hicks & Hancock, 2000). Habitual behavior has the characteristic that it is performed despite of changing circumstances and emerging difficulties (Fuchs et al., 2005). To support people in remembering when and how to perform the behavior, memory aids are a possible intervention. In the present study, some households had received prompts to support remembering the SODIS behavior in the correct situation and to provide information on how to perform it. A detailed description of these prompts and their mode of operation can be found in the general Methods chapter (design) and in chapter 3 (mode of operation).

Summarizing, the main question that is intended to be answered with the current chapter is: Which are the factors that make the difference between continuers and relapsers, including time as well as motivational and volitional factors? It is not precisely stated to which stage of the behavior change process an individual falls back when relapsing after some time of behavior performance. It is suspected that the motivational factors at the stages of problem awareness and persuasion (i.e. beliefs, attitudes, knowledge etc.) are not very different between relapsers

and continuers, because all people have already passed through those two stages, got convinced about SODIS and have at some point started using it. The main differences that are hypothesized to exist between continuers and relapsers will probably be found at the action stages. It is hypothesized that relapsers have a lower intention to do SODIS as the key transition point to the uptake phase. Furthermore, it is assumed that relapsers have had lower behavior intensity already before they have dropped out, because of to the influence of past behavior[5]. Unfortunately, the assumption on previous behavior cannot be tested due to missing data. Further it is assumed, that relapsers have a lower cognition intensity concerning the SODIS behavior, forgetting is much higher than for continuers and forgetting is not perceived as very dissonant. At this stage it should have had an influence if people previously had received a memory aid (prompt). Furthermore, people who do not consume SODIS water must naturally consume a different type of water. It is unclear, whether relapsers use an alternative disinfection method (e.g. boiling) or if they drink more untreated water[6].

Different types of 'continuers' and 'relapsers'

Often it is only distinguished between those who stop with a certain behavior and those who continue. Fuchs' research (1997), which is related to sports program compliance, however, suggests a more than dichotomous view. He identified four types in his study on participation behavior in a sport intervention: two types of continuers and two types of relapsers. The overall continuers are distinguished into continuers and fluctuaters, and relapsers into early and late relapsers.

Continuers participate continuously in the sports program and show a behavior intensity of about 90%. Also **fluctuaters** are in some sense continuers, but show more interruptions. Their behavior intensity is about 68%. **Early relapsers** show the behavior for two weeks and then drop out. Among all four types, early relapsers have the highest degree of self-determination and the lowest degree of introjection. This implies that early relapsers choose their behavioral goals according to their own needs, emotions and interests, and are not responsive to other people's expectations. They are probably the ones that realize quickly that the chosen sports program does not meet their expectations, and draw the appropriate consequences (Fuchs et al., 2005). Finally, there are **late relapsers**, who encounter their relapse after approximately six weeks. They show an inclination to externally determined behavior and rather low self-determination, and appear to be the complete opposite to the early relapsers. The long period of time late relapsers are actually showing the sport behavior is a hint

[5] In chapter 1, the influence of past behavior was non-existent for current SODIS behavior. However, it is assumed that the interventions that had been taken place had a stronger effect than the length of the interval between measurement time points, because it is known that people behave very constant under constant circumstances. Therefore, it can be assumed that the past behavior could have had an influence on relapse or continuing, because no intervention had been taking place between those two measurements compared in the present chapter.

[6] Although in the previous chapter it was found that SODIS water consumption is strongly negatively related to untreated water consumption, in this analysis the case could possibly be different, because the study area is mostly periurban and not rural. Water consumption patterns are known to be different between periurban and rural areas.

that extrinsic motivation or social-contextual conditions can actually trigger a longer performance, but eventually are not sustainable (Ryan & Deci, 2000).

Fuchs and colleagues (2005) argued that this taxonomy may be transferable to other behaviors. However, one may have doubts on the comparability of a sports activity to an every day water treatment behavior. Further doubts arise about the control mechanisms of the variables used for characterizing the two relapsers, self-determination and introjection. These may be of importance when it comes to such a complicated behavior like following regular sports activities. Here it is assumed that an everyday behavior is not dependent on general, stable personality traits. Instead, it is assumed that everyday behavior is rather guided by topic related and stage specific factors which were laid out in the previous chapter in the description of the behavior change process. Therefore, the idea of different sub-types among relapsers and continuers from Fuchs is kept and will be tested, but different criteria will be investigated. The crucial factors that make the difference between becoming a real long-term SODIS user or one that drops out after a while are hypothesized to be factors of the later stages of the behavior change process. Therefore, two of those key variables will be used: intention and cognition intensity[7]. Moreover, the relapse pattern over time in the present study is a rather continuous one and does not indicate a clear early or late type. For SODIS use, fluctuation cannot be estimated, because people had not been continuously monitored like in Fuchs study. Due to this lack of information, it would simply not be possible to establish the same categories like Fuchs and do a subsequent characterization with other variables.

Typing with intention and cognition intensity

As it was just mentioned, due to the nature of the present data it is not possible to actually replicate Fuchs' types. Therefore, two variables of the behavior change process were selected to serve as the basis for a cluster analysis and the identification of different types among relapsers and continuers. In the following a brief explanation will be given, why those two variables were chosen.

As it was explained in the description of SODIS within the behavior change process, it is hypothesized that the critical stages for relapse or continuing to use SODIS are the action stages of the behavior change process.

The successful transition between motivational and action stage, however, is marked by a high **intention**. The behavioral intention can be described as an aim or decision to act in a specific way. According to the theory of reasoned action (Fishbein & Ajzen, 1975) and the theory of planned behavior (Ajzen, 1985, 1991), intention is the proximal cause of behavior.

[7] In the last chapter, perceived habit was found to be very dominant in predicting behavior. Cognition intensity is used instead of perceived habit in the present chapter, a) because perceived habit is quite a general variable and was only used in the previous chapter, because cognition intensity was not measured for boiling and untreated water consumption (only perceived habit was measured for all three water types), and b), cognition intensity has a strong to very strong relation (correlation) to perceived habit and seems to be its dominant predictor (analyses not presented). In any case, perceived habit is still included in the close-up of the relapser and continuer types.

Once there is an opportune situation to show the favored behavior, the behavioral intention gains strength and guides the action until the goal is achieved (Heckhausen & Kuhl, 1985). This does not mean that every behavior is operated by a preliminary intention; for example habitual and reflexive actions are automatic and initiated through a situation, not through an intention (Heckhausen, 1991). Many studies investigating different behaviors have shown a good predictive power of intention on behavior (e.g. Ajzen, 1991; Bamberg et al., 2003; Bamberg, 2002; Kaiser & Gutscher, 2003), although often the so-called intention-behavior gap remains (that is the residual part of the variance, often >50%, that cannot be explained with intention). The underlying assumption for using intention to discriminate different relapser types and continuer types is the suspicion that among non-users (relapsers), non-intenders and intenders are distinguishable (Schüz, Sniehotta, Mallach, Wiedemann & Schwarzer, 2009). This distinction implies quite different actions or interventions for preventing relapse and is therefore of interest. Also, among continuers may exist some with a lower and others with a higher intention, manifesting itself in a lower or higher behavioral intensity. It is expected that intention is more important for differentiating between relapser types than between continuer types.

Cognition intensity, the second cluster variable, was described previously as being important for a constant behavior performance during the time before a real habit is established. A high cognition intensity prevents forgetting and facilitates the correct processing of situational cues. Other key processes at the action stages like planning processes, implementation intentions, self-efficacy, which are investigated by other authors (e.g. Schwarzer, 2008), also imply a certain amount of cognitive conscious processing. In the current analysis it is suspected that cognition intensity for relapsers is rather low, but differences are observable, probably depending on when people stopped using SODIS. The longer it was ago, the lower the cognition intensity should be. For continuers, it is hypothesized that there exist different groups related to cognition intensity: those who are performing the behavior still under strong cognitive control should have a high cognition intensity and those that have already reached fully the habit stage should have a lower cognition intensity. It is expected that cognition intensity is more important to differentiate between the continuers than between the relapsers.

METHODS

The differences between relapsers and continuers will be investigated using data from Study I. Relapse occurred between panels 3 and 4, therefore data from those two panels will be looked at to test the stated hypotheses. Study procedures, the interventions and participants' characteristics as well as all operationalizations can be found in the overall Methods part of this thesis.

RESULTS

The results part consists of two major analyses: first, finding different relapser and continuer types. This will be realized with two separate cluster analyses – one for the relapsers to identify relapser types and one for the continuers with the aim to identify continuer types. In a second part, the found types 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. Finally, on some selected factors an insight about their change over time will be given.

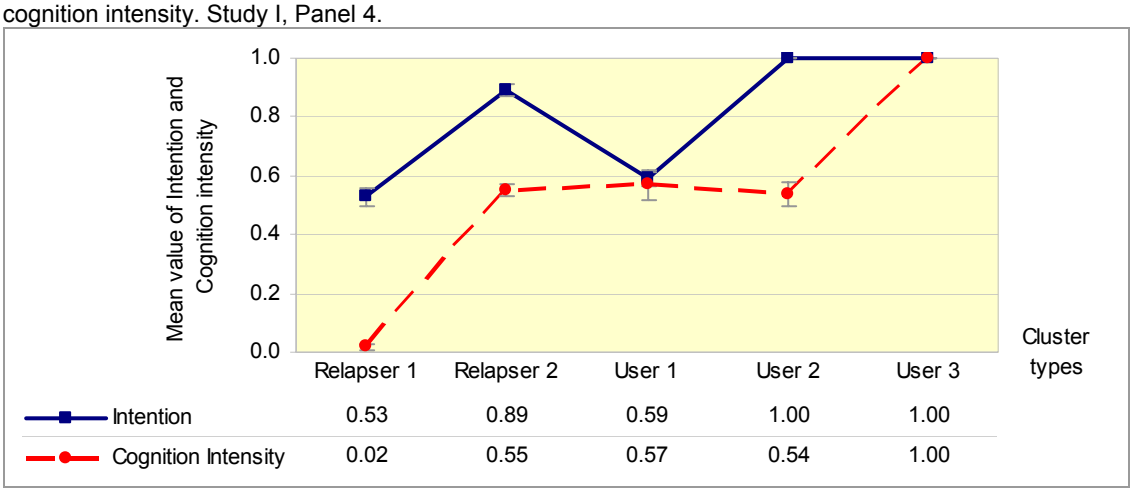
166 relapsers and 123 SODIS continuers entered the analyses. As **relapsers** those households were categorized that were not using SODIS in the fourth panel. All those who reported using SODIS in the fourth panel were classified as **continuers**, independently if they had been using SODIS at the third panel or if they started afterwards during the inactive phase.

Identification of relapser types and continuer types

A cluster analysis was run including all relapsers. The number of clusters was set free. A two-step-cluster analysis using intention and cognition intensity measured at time point 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 confirms that the clusters are well distinguishable. Both discriminant analyses, for relapsers and continuers, revealed 100% of correctly classified cases. For relapsers, the discriminant analysis resulted in one canonical discriminant function with a *Wilks' lambda* of 0.23 ($\chi^2(2)=220.23$, $p<.001$). For continuers, two canonical discriminant functions were found with a *Wilks' lambda* of 0.07 ($\chi^2(4)=357.92$, $p<.001$) for the first one.

The cluster profile, consisting of the mean values of each cluster for the two cluster variables, is presented in Figure 15. Cluster subtypes that were found in the two cluster analyses can be described as follows. Relapser type 1 has a medium level of intention, but never thinks about SODIS. Relapser type 2 has higher levels of both variables: a medium cognition intensity and a quite high intention. Continuer type 1 is the 'medium' type – medium intention and medium cognition intensity. All cases of continuer type 2 have the maximum intention, but only a medium cognition intensity. It appears to be a similar pattern like relapser 2. Finally, continuer type 3 has a maximum intention and a maximum cognition intensity. The five types will be characterized further in the next section, when variables from the entire behavior change process are analyzed separately for the five types and relapsers vs. continuers together.

Figure 15. Cluster profiles of the two relapser clusters and the three continuer clusters by intention and cognition intensity. Study I, Panel 4.



Characterization of relapsers, continuers and their subtypes

Descriptives 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. Mean differences were analyzed with variance analyses (between the subtypes), t-tests (relapsers vs. continuers) and chi-square tests in case of non-ordinal data. Between continuer type 1 and continuer type 2, only two factors showed a significant difference: the cluster variable intention (means see Figure 15, $p<.001$) and the belief about the costliness of the SODIS method ($M_{Continuer1=}.66$, $M_{Continuer2=}.78$, $p=.003$). A lot more differences, particularly for the variables of the habit stage, were found between continuer type 3 compared to the other two. Due to their similarity, at this step it was decided to unite continuer types 1 and 2, resulting in a final solution with two relapser types and two continuer types, which will be described more detailed in the following. All means and standard deviations as well as significance values of the variance analyses comparing the now only four subtypes with each other and t-tests comparing overall relapsers and continuers are found in Table 11.

Comparing overall relapsers and continuers it is clearly visible from Table 11 that continuers have significantly higher values than relapsers for nearly all psychological factors at all stages of the behavior change process. For the motivational factors, problem awareness and persuasion, significant differences between relapsers and continuers for the following factors were found: problem awareness concerning diarrhea, awareness and importance of clean drinking water, SODIS knowledge depth, beliefs about the healthiness, costliness, effort as well as difficulty of (doing) SODIS and injunctive as well as subjective norm. These differences vary between 0.04 and 0.15 on a scale ranging from 0 to 1. Larger differences (> 0.15) were found for belief about the taste of SODIS water, cost-benefit evaluation, affect as well as attitude

Table 11. Descriptive statistics of factors of the behavior change process including the two cluster variables and demographic variables. Values are presented separately for the two relapser and the two continuer types as well as for total relapsers and total continuers. Study I, Panel 4.

	Groups												Significance tests [a]						
	Relapser 1 (r1)		Relapser 2 (r2)		Continuer 1 (c1)		Continuer 2 (c2)		Relapser total (r)		Continuer total (c)		r1-r2	r1-c1	r1-c2	r2-c1	r2-c2	c1-c2	r-c
Factor	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**p**	**p**	**p**	**p**	**p**	**p**	**p**
PA Diarrhea	.77	.20	.78	.15	.79	.16	.86	.15	.77	.18	.82	.16			*		(*)		*
Aw. clean water	.60	.29	.56	.26	.65	.30	.63	.30	.58	.28	.64	.29							(*)
Imp. clean water	.76	.17	.71	.17	.78	.17	.79	.17	.74	.17	.79	.16				(*)	*		*
Knowledge depth	.72	.29	.81	.23	.83	.18	.88	.16	.75	.27	.86	.17	(*)	**	***				***
Belief taste	.41	.40	.61	.20	.63	.24	.70	.22	.50	.34	.66	.23	***	***	***				***
Belief health	.54	.33	.64	.19	.67	.16	.70	.16	.58	.29	.68	.16	(*)	**	**				**
Belief time	-.14	.20	-.13	.21	-.11	.16	-.11	.16	-.14	.20	-.11	.16							
Belief money	.67	.17	.68	.16	.72	.17	.73	.13	.68	.17	.73	.15			(*)				**
Belief effort	-.16	.21	-.13	.20	-.10	.17	-.09	.16	-.15	.21	-.10	.16							*
Belief difficulty	-.10	.20	-.06	.16	-.03	.13	-.01	.04	-.08	.18	-.02	.10		(*)	**				**
Cost-benefit	.59	.31	.66	.27	.71	.27	.83	.18	.62	.29	.77	.24		*	***		**	(*)	***
Affect	.47	.32	.60	.17	.67	.19	.75	.16	.52	.28	.71	.18	**	***	***		**		***
Attitude	.61	.30	.67	.13	.77	.18	.84	.17	.63	.25	.80	.17		***	***	*	***		***
Injunctive norm	.31	.30	.49	.29	.41	.32	.53	.30	.38	.31	.47	.31	**		***				*
Subjective norm	.07	.13	.13	.15	.19	.20	.28	.24	.10	.14	.23	.23		**	***		***	*	***
Descriptive norm	0.6	1.2	1.1	1.5	1.70	1.95	2.4	2.5	0.8	1.4	2.0	2.2		**	***		***		***
Intention	.53	.31	.89	.20	.79	.23	1.00	.00	.68	.32	.89	.20	***	***	***		*	***	***
Untreated water	.15	.28	.18	.30	.06	.13	.03	.07	.16	.29	.05	.11			*	*	**		***
Boiled water	.72	.28	.71	.30	.52	.19	.42	.15	.72	.29	.47	.18		***	***	***	***		***
SODIS water	-	-	-	-	.38	.16	.51	.15	-	-	.44	.17	-	-	-	-	-	***	-
Cognition intensity	.02	.09	.55	.21	.55	.26	1.00	.00	.25	.30	.76	.29	***	***	***		***	***	***
Forgetting	-.78	.28	-.70	.33	-.42	.27	-.24	.21	-.74	.31	-.34	.26		***	***	***	***	**	***
Dissonance	.12	.19	.24	.24	.37	.30	.63	.20	.17	.22	.49	.29	*	***	***	**	***	***	***
Perceived habit	.09	.18	.20	.27	.43	.23	.64	.27	.14	.23	.52	.27	*	***	***	***	***	***	***
Age	39.0	15.9	40.3	15.3	38.1	14.4	38.2	12.4	39.5	15.6	38.2	13.5							
Education	7.3	4.9	6.3	4.7	7.83	5.01	6.8	4.6	6.9	4.9	7.4	4.8							
Persons per HH	4.8	2.0	5.0	2.0	5.40	1.87	5.6	2.0	4.9	2.0	5.5	1.9							*
Children <5y p. HH	0.8	0.9	0.9	0.9	.91	1.00	0.8	1.0	0.8	0.9	0.8	1.0							
Gender (% ♀)	93%		91%		97%		87%		92%		93%								
Job (% yes)	43%		18%		33%		36%		33%		34%		**						
No. of contacts	5.7	2.8	6.6	3.1	5.80	2.62	6.8	2.9	6.1	3.0	6.2	2.8							
N	96		70		67		56		166		123								

Note: The two orange marked factors are the cluster variables. PA – Problem awareness. Aw. – Awareness. Imp. – Importance. HH – Household. M – mean, SD – standard deviation.

[a] The presented significance values are from post-hoc Bonferroni analyses. For the comparison relapsers total vs. continuers total (d-u) t-tests were calculated. In case of the variables gender and job, chi-square tests were calculated. *** p<.001, ** p<.01, * p<.05, (*) p<.1. All empty cells are non-significant.

towards doing SODIS, and intention. However, all those differences are less than one scale step (1 scale step = 0.33). Additionally, the descriptive norm shows that continuers know on average more than twice as many other people also using SODIS compared to relapsers. The behavioral indicators show that relapsers consume 11% more untreated water than continuers, but also boil a bigger proportion of their water (difference 25%). The indicators from the last stage of the behavior change process, habit, show much bigger differences than those previously mentioned. Differences between relapsers and continuers are at least one scale step

(between 0.32 and 0.51) for cognition intensity, forgetting of SODIS, the perceived dissonance in case of forgetting, and perceived habit.

Comparing the two relapser types with each other, relapsers type 2 have higher values for all those factors that show significant or even only a trend to significant differences between the two relapser types: SODIS knowledge, beliefs about the taste and healthiness of SODIS, affect towards SODIS, injunctive norm, intention, cognition intensity, dissonance, and perceived habit. The highest differences were those of the belief about the taste of SODIS water (ΔM=0.20), the injunctive norm (ΔM=0.18) and the two cluster variables (intention: ΔM=0.36; cognition intensity: ΔM=0.53). Another, very interesting difference is that of relapsers type 2 only 18% have a job, whereas of relapsers type 1 43% have a job (average 33%). According to the values of the psychological factors, one could call relapsers type 1 ‘low relapsers’ and relapsers type 2 ‘high relapsers’.

The comparison of the two continuer types only shows significant differences for subjective norm (ΔM=0.09), intention (ΔM=0.21), and the habit indicators cognition intensity (ΔM=0.45), forgetting (ΔM=0.18), dissonance (ΔM=0.26), and perceived habit (ΔM=0.21). Continuers type 2 have for all those variables more positive values. They also consume significantly more SODIS water than continuers type 1 (ΔM=13%). Interestingly, the consumption of untreated water does not differ (3 and 6%). Instead, continuers type 1 consume 10% more boiled water; however, this difference is not significant. No differences in demographic variables were found. Like for the relapser types, a low and a high subtype of continuers was found. Continuers type 1 will be ‘low continuers’ and continuers type 2 ‘high continuers’ in the following.

Comparing the relapser types with continuer types, it is apparent from Table 11 that low relapsers differ from both continuer types in quite many aspects. In contrast, high relapsers compared with the two continuer types, only differ in many aspects from high continuers. The difference to low continuers, however, is limited to behavioral and habit factors. High relapsers consume more untreated water (ΔM=12%), but also more boiled water (ΔM=19%) than low continuers, as well as they forget SODIS more often (ΔM=0.28), feel less dissonance (ΔM=0.13), and have a lower perceived habit (ΔM=0.23). Interestingly, intention is even higher and cognition intensity the same for high relapsers compared to the low continuers (not significant; ΔM=0.10 and 0.00, respectively). In fact, for many variables not only relapsers together have lower values than continuers together, but a clear overall sequence of the four subtypes is found: low relapsers < high relapsers <= low continuers < high continuers with the exception of injunctive norm and intention.

Regarding the habit supporting interventions, prompt and public commitment, in 2005 future continuers and future relapsers did not receive different amounts of prompts or public commitments (see Table 12, average 58% for prompts and 26% for public commitments).

Table 12. Descriptive statistics of the interventions of Study I in 2005 and 2006, monitoring and long questionnaire. Values are presented separately for the two relapser and the three continuer types as well as for total relapsers and total continuers. Study I, Panel 4.

	Groups						Significance tests [a]						
	Low relapser (r1)	High relapser (r2)	Low continuer (c1)	High continuer (c2)	Relapser total (r)	Continuer total (c)	r1-r2	r1-c1	r1-c2	r2-c1	r2-c2	c1-c2	r-c
Factor	**M**	**M**	**M**	**M**	**M**	**M**	**p**	**p**	**p**	**p**	**p**	**p**	**p**
Prompt 2005	49%	76%	58%	50%	60%	54%	**				*		
PC 2005	18%	30%	30%	30%	23%	30%							
Prompt 2006	24%	30%	42%	38%	27%	40%		(*)					*
PC 2006	4%	1%	6%	7%	3%	7%							
No. of comm. channels	3.1	3.3	3.5	3.4	3.2	3.4							
Monitoring	35%	54%	48%	32%	43%	41%	(*)				(*)		
No. of long questionnaires	1.6	1.9	2.1	2.0	1.7	2.0		*					*
N	96	70	67	56	166	123							

Note: M – mean. PC – Public commitment.
[a] The presented significance values are from post-hoc Bonferroni analyses (no. of communication channels, no. of long questionnaires) or chi-square tests (all other factors). The threshold for significance level of chi-square tests was adjusted according to number of tests calculated (Sachs, 1978, p. 369). For the comparison relapsers total vs. continuers total (d-u) t-tests were calculated for no. of communication channels and no. of long questionnaires. ** p<.01, * p<.05, (*) p<.1. All empty cells are non-significant.

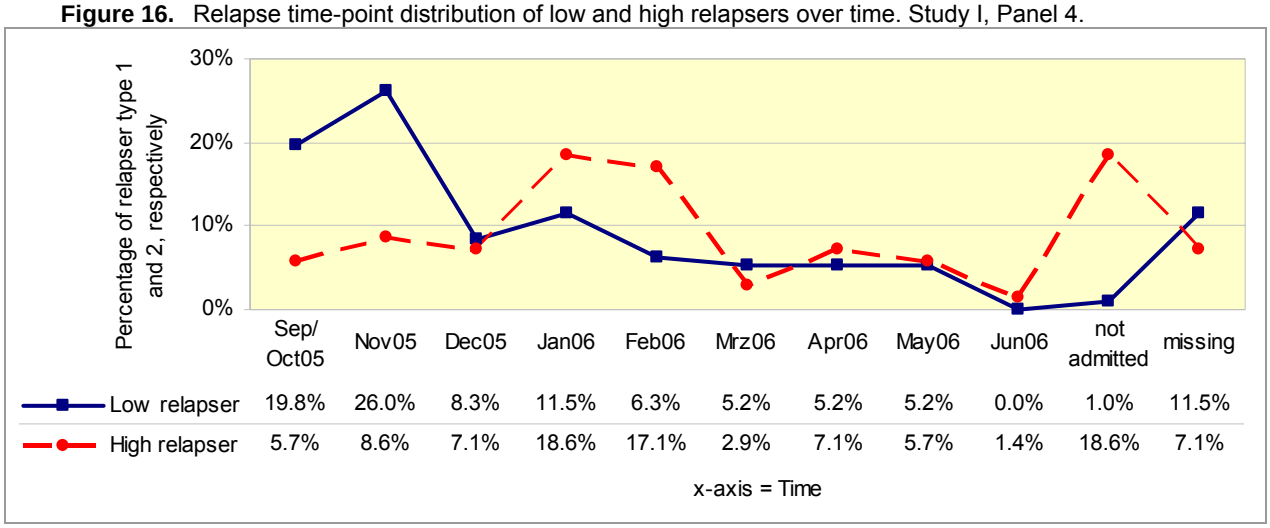
However, a higher percentage of continuers in the fourth panel still had their prompts (40%) compared to relapsers (27%). The reason for not having the prompt anymore was in 85% of the cases because it was torn up or dirty. The public commitment almost nobody kept until 2006, also in 88% of the cases because it was torn up, wet or dirty. Other reasons for not having the prompt or public commitment anymore were that people gave it away as a present, they moved house and forgot it or that it simply had been lost. One possible influence on people continuing to use SODIS may have been the long questionnaires: future continuers had a slightly higher average amount of long questionnaires in 2005 than the relapsers. Number of perceived SODIS communication channels and having been in the monitoring group did not have an influence on continuing or stopping SODIS use.

Comparing the types within the groups of relapsers and continuers, one interesting result was found: high relapsers had received substantially more prompts (76%) and have the highest percentage of people who were in the monitoring group in 2005 (54%) compared to he low relapsers (prompts: 49%, monitoring: 35%) and to continuers (prompts: 57%, monitoring: 42%).

Change over time of relapsers, continuers and their subtypes

So far, relapsers and continuers and their sub-types have been characterized using all available data from the fourth panel. However, information is still missing on what actually happened between the end of the active phase (third panel) and the fourth panel. Unfortunately, not much information is available, only the time point of when relapsers stopped using SODIS

Figure 16. Relapse time-point distribution of low and high relapsers over time. Study I, Panel 4.



and reasons for relapse were inquired retrospectively. For all other factors, a simple comparison of the values of the third and the fourth panel must be sufficient.

The key criterion for characterizing relapsers relating back to Fuchs is presented next: the time-point relapsers had actually stopped using SODIS. Figure 16 shows the distribution of relapsers type 1 and 2 along a time axis from September 2005 to June 2006.

Two peaks are clearly distinguishable between relapser types. Whereas 46% of low relapsers stopped using SODIS either already during the active study phase (September/ October 2005) or shortly after (November 2005), 36% of high relapsers stopped using SODIS in January or February 2006. Additionally, 19% are found among high relapsers under the label ‘not admitted’. Those are people who stated in the questionnaire that they were still using SODIS and therefore the information on a relapse time point is not available. Nevertheless, they also stated that they did not treat any amount of water with SODIS, therefore they got classified as relapsers. It can be assumed, that they have just recently stopped using SODIS and may even take it up again later. However, at the time of the fourth panel they were relapsers and most of them belong to the high relapser group. For 10% of the cases the information about the relapse time point is simply missing. To simplify the classification, it seems that the line for separating the two peaks of early and late relapsers is in December 2005. Classifying all relapsers until end 2005 as early and all of the year 2006 as late relapsers, 61% of all valid cases of low relapsers are early relapsers, and 77% of all valid cases of high relapsers would be late relapsers. A chi-square test on relapser type (low vs. high) by relapse time point (early vs. late) shows highly significant results ($\chi^2(1, 149)=21.6$, $p<.001$).

Reasons for relapse were assessed with an open question and categorized (Table 13). Similar percentages of low and high relapsers named the reasons no time (30 and 37%), bad

Table 13. Reasons for relapse of low and high relapsers. Study I, Panel 4.

Reason	Low relapser	High relapser	Chi-square test (p)
No time	30%	37%	
Bad weather	15%	16%	
No bottles	13%	20%	
Forgot	23%	17%	
Boils or buys water	26%	9%	**
Evacuation	4%	10%	
Doubts / taste	6%	0%	
Other	8%	4%	
Missing	22%	24%	
N	96	70	

Note: * p<.05. All empty cells are non-significant.

weather (15 and 16%), no bottles (13 and 20%), forgetting (23 and 17%), evacuation (4 and 10%), and that they had doubts about the effectiveness of the SODIS method or did not like the taste (6 and 0%). Other reasons included travels, that no water was available or that they were busy with moving. Only the reason that people boil or buy water instead of using SODIS was significantly named more often by the low relapsers (26 and 9%). Interestingly, no-one of the high relapsers had mentioned doubts or bad taste, this was mentioned only by low relapsers. Unfortunately, of 23% of relapsers no answers were available.

For completing the characterization of relapsers and continuers, of some selected variables values of the third panel (that is, before the relapsers have become 'relapsers') are presented. Particularly, for the variables that have shown larger differences between relapsers and continuers at the fourth panel, it seems to be of interest if they already had had lower values for relapsers, when they were still using SODIS at the time of the third panel, and if the change between the third and fourth panel is found to be significant.

Table 14 shows the values of those variables of the third panel that had differences greater than 0.15 between relapsers and continuers at the fourth panel, except the belief about the taste of SODIS water and perceived habit, which were not measured at the third panel. In general, only very few significant differences were found between relapsers and continuers. Only attitude and the dissonance in case of forgetting SODIS were already more positive among the continuers at the third panel. No significant differences were found within relapsers and within continuers. Only low relapsers had a significantly lower cost-benefit evaluation than high continuers and knew by trend less other people using SODIS (descriptive norm). So, over all no relevant differences were found at the time of the third panel. The general level of all variables is quite highly in favor of using SODIS (high mean values).

Analyses of significance of the change over time, calculated separately for the two relapser types and the two continuer types using dependent t-tests, revealed highly significant negative changes between third and fourth panel among the low relapsers for affect ($t(57)=3.52$,

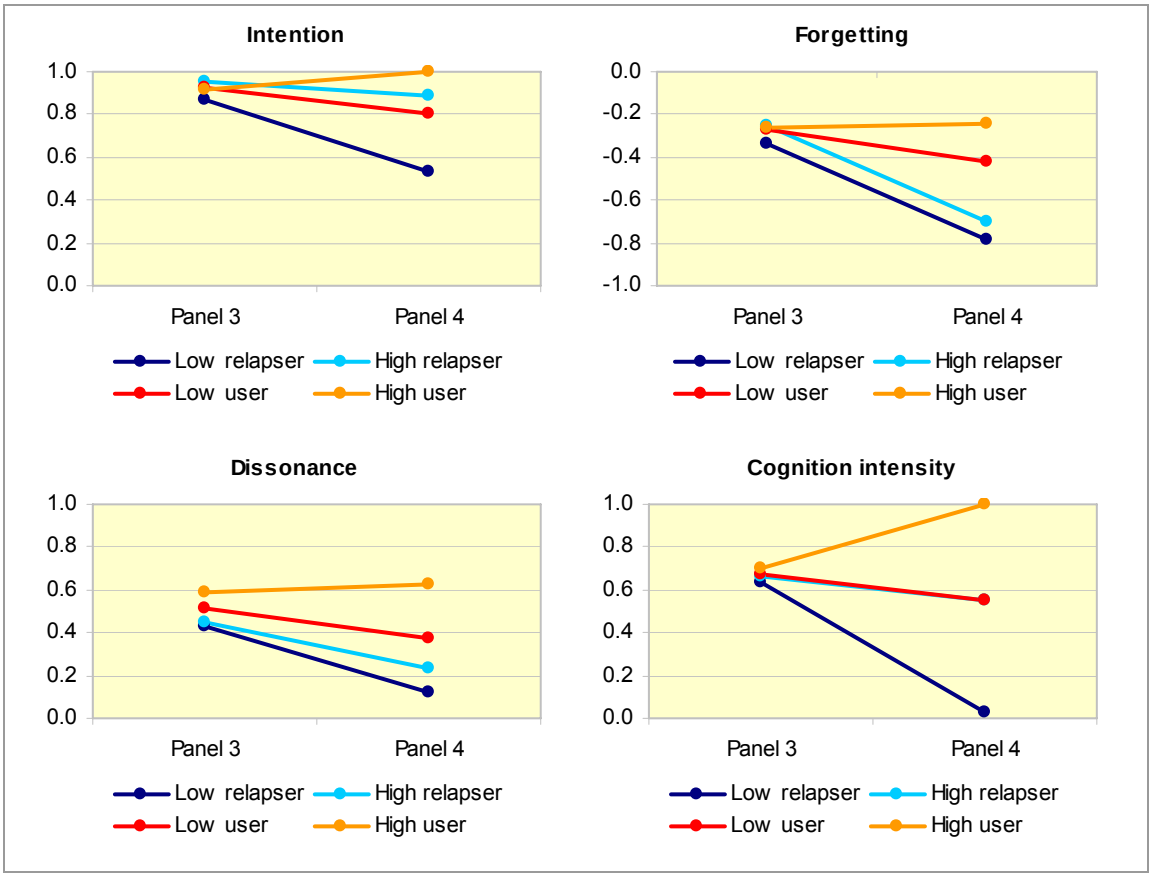
Table 14. Descriptive statistics of some factors of the behavior change process, measured at the 3rd panel. Values are presented separately for the two relapser and the two continuer types as well as for total relapsers and total continuers. Study I, Panel 3.

	Groups												Significance tests [a]						
	Low relapser (r1)		High relapser (r2)		Low continuer (c1)		High continuer (c2)		Relapser total (r)		Continuer total (c)		r1-r2	r1-c1	r1-c2	r2-c1	r2-c2	c1-c2	r-c
Factor	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**p**	**p**	**p**	**p**	**p**	**p**	**p**
Cost-benefit	.65	.27	.74	.22	.72	.26	.80	.27	.70	.25	.75	.26			*				
Affect	.66	.18	.68	.23	.71	.19	.73	.17	.67	.20	.72	.18							(*)
Attitude	.75	.23	.75	.19	.81	.20	.84	.18	.75	.21	.82	.19							*
Descriptive norm	2.1	3.1	3.4	4.8	2.5	3.2	4.0	4.3	2.7	4.1	3.2	3.8			(*)				
Intention	.87	.24	.96	.15	.92	.19	.91	.22	.91	.20	.92	.20							
Cognition intensity	.64	.28	.66	.27	.67	.32	.70	.28	.65	.27	.69	.30							
Forgetting	-.34	.20	-.26	.23	-.27	.23	-.26	.23	-.30	.22	-.27	.23							
Dissonance	.43	.33	.45	.32	.52	.33	.59	.32	.44	.33	.55	.32							*
N	58		53		58		42		111		100								

Note: M – mean, SD – standard deviation.
[a] The presented significance values are from post-hoc Bonferroni analyses. For the comparison relapsers total vs. continuers total (d-u) t-tests were calculated. *** p<.001, ** p<.01, * p<.05, (*) p<.1. All empty cells are non-significant.

p=.001), attitude (t(57)=2.55, p=.014), descriptive norm (t(57)=3.38, p=.001), intention (t(57)=7.12, p<.001), cognition intensity (t(46)=13.80, p<.001), forgetting (t(29)=6.07, p<.001), and dissonance (t(40)=5.10, p<.001). For high relapsers also most of the factors showed a significant decline between third and fourth panel, except intention and cognition intensity (the two cluster variables; affect: t(52)=2.76, p=.008; attitude: t(52)=2.28, p=.027; descriptive norm: t(52)=3.60, p=.001; forgetting: t(48)=6.19, p<.001; dissonance: t(45)=3.63, p=.001). For low continuers, all habit factors and intention show a significant decline (intention: t(55)=3.63, p=.001; cognition intensity: t(50)=2.75, p=.008; forgetting: t(50)=2.97, p=.005; dissonance: t(46)=2.71, p=.009), whereas for high continuers only the descriptive norm shows a significant decline (t(41)=2.19, p=.034). For the two cluster variables, intention and cognition intensity, a significant increase could be detected (intention: t(41)=-2.55, p=.015; cognition intensity: t(38)=-6.54, p<.001). The changes of the variables of the habit phase as well as for intention are for better illustration presented in Figure 17.

Figure 17. Development of intention, cognition intensity, forgetting and habit between 3rd and 4th panel. Graphs are presented separately for the two relapser and the two continuer types. N=211. Study I, Panels 3 and 4.



DISCUSSION

In the discussion, relapsers, continuers and their subtypes will be characterized using all presented data and they will be related to Fuchs types and to the stages of the behavior change process. Finally, some recommendations for possible interventions will be given.

Relapser or continuer?

This part contrasts overall relapsers against overall continuers, before it will be looked at the subtypes of relapsers and continuers.

Summarizing description of results. The results have shown that relapsers have significantly lower values than continuers for almost all factors along the behavior change process. Starting at the first stage with problem awareness and knowledge about SODIS, continuing with the cognitive beliefs, affect, attitude and intention at the second stage, and ending with cognition intensity, forgetting, dissonance and perceived habit at the action stage, a similar pattern is observed. Looking closer, there are two aspects apparent: first, differences

between relapsers and continuers are smallest on the problem awareness stage. Factors on the persuasion stage already show larger, but still rather small differences (less than one scale step), and finally on the habit stage the differences are largest (greater than one scale step). The second aspect refers to the mean level of the factors. The mean level of the factors on the problem awareness stage is quite high for relapsers *and* continuers (close to the scale step before the maximum one). On the persuasion stage most cognitive belief factors (time, money, effort, difficulty, cost-benefit) as well as attitude and intention have also quite high mean levels. However, some factors at the persuasion stage, such as the beliefs about taste and health as well as the affect are as low as the middle of the scale for the relapsers. Alarmingly low for both groups, relapsers and continuers, are the norm factors: injunctive and subjective norm are in the lower half and lower quarter of the scale, which implies that SODIS among relapsers *and* continuers has quite a low reputation and that people underestimate the proportion of other people in their community using SODIS. Also the descriptive norm, that is how many other people a person knows using SODIS, is very low for relapsers with a value of less than one. The lowest mean values, however, were observed for the habit factors for relapsers. These mean values are between the lowest and the next to lowest scale point for all four habit factors, cognition intensity, forgetting, dissonance, and perceived habit. Additionally, relapsers have a slightly lower number of persons per household. The behavioral indicators show a much higher consumption of boiled water by the relapsers (72%; continuers 47%), but boiling does not compensate not using SODIS completely. Untreated water consumption is higher for relapsers with 16% compared to 5% among the continuers.

Summarizing, the difference pattern between relapsers and continuers on the psychological variables shows that the further the behavior change process advances, the greater the differences between relapsers and continuers, and the lower is the level of the variables for the relapsers. It can be reasoned that the causality for people being a relapser lays mainly in the missing habit, which they obviously did not manage to maintain in contrast to those who stayed continuers.

The point just being made – the missing *maintenance* of the habit – is backed up by the results of the previous panel. These results clearly show that relapsers had equally high levels of all indicators that seem to have become crucial in determining the destiny as a relapser or continuer, namely the critical factors of the persuasion stage (cost-benefit evaluation and affect), descriptive norm and two of the three habit factors (cognition intensity and forgetting). Only attitude and dissonance are slightly lower for relapsers already in 2005. The almost equal values for relapsers and continuers at the third panel on one hand do not give hints, why a certain person went the one way or the other. On the other hand, those results show that relapse is not pre-determined by initially lacking problem awareness, negative beliefs or low initial habit intensity. The results contrariwise indicate that relapsers have started at the same point like 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 and indicated. Support for the possible usefulness of habit supporting interventions is already given by the fact that those people who still had their prompt in 2006 were more likely to still be a continuer. The results in general show that there is high intervention potential among relapsers to make them staying continuers.

Until now, relapsers and continuers were compared globally. In the next part, the focus will be laid on the question whether all relapsers show the same relapse pattern and whether all continuers show the same stability, and finally give some more ideas on how the subtypes can be addressed with further interventions

Low or high relapser, low or high continuer?

The effort to find sub-types of relapsers and continuers was inspired by Fuchs' (1997), who found early and late relapsers, fluctuating and constant continuers. In contrast to Fuchs, in the present study two psychological variables to find different types of relapsers and continuers were used: intention and cognition intensity. Two different relapser types and three different continuer types were found and confirmed with statistical analyses. Looking at the psychological factors, it appeared to be useful to unite two of the continuer types, which resulted then in two relapser types and two continuer types. Those four types, labeled low and high relapser, low and high continuer relating to the mean level of the psychological factors will be characterized in the following.

The relapser types

Summarizing description of results. In general, both relapser types are aware of the diarrhea and water problem, have acquired enough knowledge about SODIS and also have a positive opinion about SODIS. Only the taste is valued less positively by the low relapser than by the high relapser. This may be the reason that the low relapser also affectively likes it less to do SODIS than the high relapser, and for him SODIS has quite a low reputation. Nevertheless, attitude and the other beliefs are as positive as those of the high relapser. Quite apparent is the low descriptive norm of the low relapser – he only knows on average 0.6 persons using SODIS (almost 70% do not know anyone using SODIS) compared to 1.1 persons in the high relapser group. Although the low relapsers' intention is a lot lower than that of the high relapser, it still has a medium level. More informative are the habit indicators – the low relapsers never think about SODIS (cognition intensity), almost never feel any dissonance in case they forget SODIS, and do almost not perceive any habit. In contrast, the cognition intensity of the high relapsers is at a medium level, and dissonance and perceived habit are twice as high as those of the low relapsers. Water consumption is similar for low and high relapsers, they consume equal amounts of untreated and boiled water. Interestingly, 43% of low relapsers have a regular job,

which is more than twice as many people as in the high relapser group, and the highest percentage among all. The high relapsers are for almost all indicators between low relapsers and low continuers, but mostly being closer to low continuers than to low relapsers. Despite all those differences in the fourth panel, differences between the two relapser types had not yet been visible in the third panel. Both relapser types had equally positive values at that time point. Both relapser types have experienced a significant decrease of the crucial factors between third and fourth panel. Only intention and cognition intensity did not decrease for high relapsers in contrast to low relapsers. Low relapsers have stopped using SODIS early compared to high relapsers. Until the end of 2005, 61% of low relapsers had already stopped, but only 23% of high relapsers. High relapsers stopped mainly in January / February 2006 (36%), and another 19% were not even admitting to the fact that they had stopped using SODIS. High relapsers have been favored by the distribution of the prompts – 76% had received a prompt in 2005, which is more than any other group (average ca. 55%). However, in 2006 equal percentages of both relapser types have kept the prompt until then. Compared to low relapsers, high relapsers also have been more often in the monitoring group, by trend even more often than continuers. As the main reason for relapse by one third of the people it was mentioned that they do not have time. No time can have different meanings, but mostly it is meant that people have to work, even informal work, or leave very early in the morning for the market and therefore no time seems to be left to prepare the SODIS bottles. Further reasons are – equally mentioned by low and high relapsers – bad weather, no bottles available, that it was forgotten and some other minor reasons. The only reason indicating a difference is that the low relapser mentions more often than the high one boiling or buying water was the reason for stopping to use SODIS.

Summarizing, low relapsers show differences to high relapsers for quite a range of factors. Not only the cluster variables intention and cognition intensity were different, as hypothesized, but also one central belief (taste), the affective connotation, injunctive norm, dissonance, and perceived habit. High relapsers have values almost as high as low continuers, only differing in attitude, forgetting, dissonance, and perceived habit from low continuers.

The differences between low and high relapsers indicate that **low relapsers** have taken an early and conscious decision against using SODIS. Maybe, the perception of the taste has not been positive enough, has caused a less positive affect and a lower overall intention, and therefore the decision was taken to boil or buy water instead. Additionally, among friends and neighbors, almost nobody was known who used SODIS and could have exerted a positive influence. Probably due to missing information, SODIS was rated as not being very socially favorable (because nobody seemed to be using it). Boiling or buying water may also have been more convenient for the high percentage of employed persons. Since the decision was taken quite early without a long period of time of trying to develop a habit, it is only logical that the habit is basically non-existent. Unfortunately, untreated water consumption was not reduced to zero, however, the untreated water consumers are not the same ones who gave boiling or buying water as a reason to stop SODIS use.

Relating back to Fuchs' (1997) relapser types, low relapsers correspond clearly with the early relapser type of Fuchs and colleagues (Fuchs, 1997; Fuchs et al., 2005). Fuchs had described his early relapsers as those who decided within 2 weeks consciously and rational driven against the behavior (sports exercise), because it did not appear to be appropriate for them and to fit with their goals and expectations. The low relapsers of this study have also tried out the behavior for a short while and then stopped rather early due to a combination of affective, rational and social driven considerations.

According to the behavior change process, low relapsers have fallen out of the process (Prochaska & DiClemente, 1982; E. M. Rogers, 2003) after the third phase. However, they have kept a high problem awareness and still think positively about SODIS. To get low relapsers to use SODIS in the future, it has to be inquired more precisely, which are the hindering reasons for not using it. Maybe SODIS really is not suitable for low relapsers, or it may also be possible that solutions to the seemingly hindering factors can be found on an individual basis.

High relapsers, on the other hand, according to most of the factors of the behavior change process, could also have been low continuers. It seems they have tried to develop a habit for quite some time, probably because they had quite a high level of initial external support from the previously received prompts, the monitoring and social support (descriptive norm). High relapsers in contrast to the low ones still show some signs of habit, it did not vanish completely. They even think as often as low continuers about SODIS, but naturally report to forget it more often and to perceive SODIS as less habitual. The nature of high relapsers in comparison to low continuers suggests a threshold of habit before it leads to behavior. Only when habit rises over a certain threshold, behavior gets performed (Inauen, 2007; Tobias, 2007). 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.

High relapsers of this study are in various aspects similar to Fuchs' late relapsers. Fuchs' late relapsers are described as strongly extrinsically motivated and having externally introjected behavioral goals. However, high external support can lead to a low degree of anchoring of the behavior in the self system and increased chances of relapse (Ryan & Deci, 2000). High relapsers of this study have also stopped the behavior execution rather late and have had strong external motivational cues in form of prompts, the monitoring and a higher descriptive norm. However, high relapsers had 'lost' a high proportion of their external cues (prompts, other people who do SODIS). It can be argued, that either high relapsers had felt that they *should* do SODIS because of all the external cues, but did not really *want* it, and as soon as all the cues disappeared this feeling has vanished. Another explanation, which seems more plausible and is also supported by the still very high values of the motivational factors, the intention and the cognition intensity, is that high relapsers have *relied* on the external cues to remind them and as they slowly disappeared they *forgot* doing SODIS more and more often. Although they still have a positive motivation, including a high intention, and still think about SODIS sometimes, this does not trigger behavior execution due to the missing dissonance, and in consequence, SODIS is perceived as less habitual.

Relating back to the behavior change process, high relapsers have gone back to the start of the action phase, actually being very ready to perform the behavior, because the transition condition – high intention – is met. They just seem to need a small external push into the right direction. For example, dissonance could be induced with a commitment intervention (Brehm & Cohen, 1962; Heckhausen, 1991), forgetting prevented with prompts or other reminders (Mosler & Tobias, 2007a), and cognition intensity increased with anything increasing the presence of the topic. This could be for example a social intervention, which would have additional positive influence on the currently rather low injunctive and subjective norms. However, it has to be made sure that the motivation at some point gets internalized to not fall back to old habits when the external cues are gone.

Concerning Fuchs' types only one remark must be made: the time frame for classifying as early relapsers seems necessary to be redefined much longer (1-2 months) in the case of the every day behavior SODIS than for sports exercises as described by Fuchs (2 weeks).

The continuer types

Summarizing description of results. Both continuer types are, like relapsers, aware of the diarrhea and water problem, have acquired enough knowledge about SODIS, have equally positive opinions about SODIS, think both that SODIS has a medium reputation (injunctive norm), and know both around 2 other people also using SODIS. The estimation of the subjective norm is significantly lower for low continuers, but not much. Differences between low and high continuers start with the intention, and manifest among all four habit variables. Intention is still high for low continuers and at a maximum level for high continuers. Low continuers only think about SODIS on the same medium level like high relapsers in contrast to high continuers, who always think about SODIS. Consequently, low continuers forget SODIS more often than high continuers and feel less dissonance. Additionally, they also perceive that they are performing SODIS less habitual. However, the levels of forgetting, dissonance, and perceived habit of low continuers are higher than those of high relapsers as already pointed out in the relapsers' description. At the behavioral level, low continuers treat less water with SODIS than high continuers (38% compared to 51%), but boil more water instead. Remaining untreated water consumption is equal for both and around 5% of the total water consumption. Looking back to the third panel, both continuer types had equally positive values for all variables, also for the habit variables. Particularly for the habit variables and for intention, low continuers showed a significant decrease, whereas high continuers showed an increase in intention and cognition intensity and stayed stable for forgetting and dissonance. Consequently, high continuers are the only type of all who showed no decrease of the critical tested habit variables. Regarding external influences, low and high continuers almost do not show differences. The same percentage of both had received prompts and public commitments in 2005, and only 12-16% have lost the prompt until 2006, resulting in 40% who still have the prompt in their house. Only the percentages of households having been in the monitoring group showed a slight difference

– only 32% of high continuers have been in the monitoring group compared to 48% of low continuers.

Summarizing, low continuers differ from high continuers only for intention, the habit factors and in consequence, low continuers treat 13% less water with SODIS. Interestingly, low continuers compensate 10% of not using SODIS with boiling water instead. This is an interesting and sensible combination of the target and an alternative behavior, which was also found for high continuers, who still boil 42% of their water. Boiling instead of using SODIS was of course already observed for relapsers, who boil significantly more of their water than continuers (72%). However, in case of low continuers, the combination of SODIS and boiling leads to the advantage that almost no untreated water is consumed anymore (only 6%). For high continuers it can be assumed that the behavioral level of SODIS is not increasable anymore, because a part of the daily water consumption will always be boiled water due to its use in tea and coffee. Nevertheless, it cannot be concluded that both, low and high continuers, have reached a stable state of healthy water consumption, because of the characteristics of the crucial behavioral factors.

The strong differences between low and high continuers for intention and habit factors indicate that **low continuers** may not yet have reached such a stable level of using SODIS (and complementing it with boiling). Particularly critical is the sometimes only small difference to the high relapsers, which suspects that although low continuers for the time being are above the formerly described threshold with their habits, and therefore perform the behavior, they may as well easily fall below, and would sooner or later stop using SODIS. Underpinning this assumption, a negative development between the third and fourth panel has already been observed for forgetting and dissonance, and this development is suspected to continue with time.

Low continuers cannot be related to Fuchs' flucturer, because it was not measured if they had been constantly using SODIS between the third and fourth panel, or of irregularities have occurred. Moreover, Fuchs does not describe his continuer types with psychological factors, he only mentions the degree of regularity as a criterion.

Placing low continuers within the behavior change process, they are clearly situated in the action phase. To prevent low continuers from becoming high relapsers, the same interventions are indicated as already mentioned for high relapsers. Although forgetting, dissonance and perceived habit of low continuers are still more in favor of using SODIS than for high relapsers, they could need some strengthening. Cognition intensity and social factors are equally low for both, low continuers and high relapsers, anyway.

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 been stable since the third panel. According to Fuchs, high continuers are the classic continuers who start a behavior and simply continue. However, relating 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 'save' from relapses. The high degree of cognition intensity is only necessary during the process of establishing a new habit, because then it prevents early relapses as it has been observed for the relapsers. However, the goal is to establish a behavior as truly habitual and mostly automatic, and then only low cognitive resources would be necessary (Oullette & 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 the fully habitual behavior, because their cognition intensity got lower. 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 does not get forgotten anymore, then no more dissonance is needed. In the situation of high continuers, it is recommended to keep track if they keep 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 model and opinion leader to support spreading of SODIS behavior to the other types. This would not be an explicit intervention on high continuers, but would still ensure continuance of SODIS use due to the newly acquired function.

CONCLUSION & LIMITATIONS

The presented approach of not only characterizing relapsers and continuers as such, but looking for differences also within these two groups has proven to produce some very valuable insights. The placement of different subtypes along a theoretical model of the behavior change process gives additional hints of critical points that have to be considered when future interventions are designed to get relapsers back to use SODIS and to prevent continuers from relapse. Particularly interesting in this context is the finding that within relapsers and within continuers differences are partly larger than between certain subtypes of relapsers and continuers, which implies quite different approaches for relapser subtypes and continuer subtypes. Another valuable finding is the fact that all types have more or less had equally high levels at the third panel, and therefore it should be generally possible to find appropriate interventions for all. Furthermore, the results indicate that for all types, interventions should rather aim at habit formation and social support than on more information about SODIS or persuasion on certain convictions or beliefs as it is often done.

A clear **limitation** of this analysis is the missing data of what happened between the two analyzed time points. Only the time point of stopping SODIS use and reasons were assessed retrospectively with open questions. More measurement time points with shorter time intervals would probably have provided a better insight into what actually happened in those seven months between the two measurements. However, applying questionnaires itself would have been an intervention and maybe relapser would not have been observable in the same 'natural' pattern as it was possible now.

Chapter 3

Influences of prompts and public commitments

CONTENTS

ABSTRACT

This chapter investigates the effects of the interventions prompt and public commitment on SODIS behavior. SODIS behavior will be divided into the uptake process and then, once people started using SODIS, the determinants of the quantity of consumed SODIS water will be investigated. It is assumed that the interventions show direct effects on SODIS uptake. Furthermore, other situational variables such as communication activities, monitoring and demographic characteristics were also included to control for them. Quantity of SODIS water was first tried to be explained directly with the same variables, however, it was already hypothesized that SODIS water quantity would be influenced by psychological behavior-near factors. Perceived habit, implementation intention, commitment and an alternative behavior (untreated water consumption) were employed to explain SODIS water quantity over time.

For the calculation of the SODIS uptake model, data from studies I and II was used. SODIS water quantity was only measured in detail in Study II.

Results show that the applied interventions, prompt and public commitment, were able to increase chances for people to start using SODIS. For the prompt, stable long term effects could be shown. Directly after the intervention phase, the interventions were most effective in influencing SODIS uptake. The quantity of water treated with SODIS was better explained with a model involving indirect influences of the interventions via behavior-near factors. It was found that the prompt influences implementation intention and perceived habit directly and both of these factors in turn influence SODIS behavior intensity. The influence path for public commitment was somehow different. Public commitment only influenced implementation intention directly, which then influenced perceived habit, which in turn influenced SODIS behavior. Commitment turned out to be an unreliable predictor. The alternative behavior consuming untreated water was reduced down to the point where it could not be included in the model calculation anymore.

It is argued that on implementation intention both interventions operate in a similar way: activation of the goal behavior and initiation of planning processes that lead to an implementation intention that is related to the target behavior. Perceived habit was only directly influenced by the prompt, because the public commitment did not fulfill the precondition of acting directly as a reminder on habit: it was not placed where the behavior was to be executed and it contained too little information. Instead, the implementation intention evoked by the public commitment manifested itself in the habit.

Finally, some limitations like the small sample size, the sometimes low number of people who actually received the interventions or the time difference between measurements are discussed.

Keywords: prompt, public commitment, perceived habit, implementation intention, solar water disinfection, intervention

INTRODUCTION

In this chapter, the effects of the applied behavior supporting techniques will be studied in detail. In both studies, prompts and public commitments had been applied. They were chosen for various reasons: First, prompt and public commitment are expected to function in a generally similar way, but nevertheless have interesting differences: a prompt is a passive technique aimed exclusively at the individual, whereas a public commitment is more active and above all a social technique (Mosler & Tobias, 2007a). Second, both prompt and public commitment, are fairly well studied regarding their design, applicability and effectiveness. Third, both are easily applicable to the setting of a developing country. In the next parts, studies that have investigated the effects of prompts and public commitments on behavior are presented. Then the modes of operation of prompts and public commitments are outlined, and two behavioral models are developed.

Prompts

Prompts are external memory aids, understood contrary to internal memory aids (e.g. mental rehearsal; Tobias, 2007). They point out to an individual that a certain behavior has to be executed in a specific moment (Mosler & Tobias, 2007a). Hence, well-designed prompts should refer to both aspects, i.e. what has to be done and when it must be done (Tobias, 2007). Usually, prompts are designed as posters, stickers or signs with a request to execute a specific behavior. In order to function as a memory impulse, a prompt should be noticeable, situated where it is highly visible, and it should be comprehensible to the target population, which behavior is requested to be performed (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; Johnston, Hendricks & Fike, 1994), to reduce littering (e.g. Baltes & Hayward, 1976; Hansmann & Scholz, 2003; Reiter & Samuel, 1980) and to minimize the number of graffiti attacks (Craw, Leland, Bussell, Munday & Walsh, 2006). In his meta-analysis, De Young (1993) concluded that a prompt can be an effective memory aid. Some studies, however, yielded little (Witmer & Geller, 1976) or no effects of prompts on behavior (Geller, 1981). One reason may be that prompts often contain not only a request for a specific behavior, but additional information on the consequences of the behavior or other persuasive messages (e.g. Geller, 1981). The effects of prompts could therefore be confounded with other intervention effects. Furthermore, these persuasive messages could also have been less accepted by subjects than a simple request for executing a behavior. In general, for a prompt to be effective, it seems to be crucial that it is formulated in a way that avoids reactance (Brehm, 1966) and that it is located at the place where the behavior is intended to be performed (Hopper & McCarl Nielson, 1991). Practical advantages of prompts are their easy application to

a whole population, the low production costs compared to other interventions and the high acceptability by all different kinds of target groups (Thyer & Geller, 1987).

Public commitment

A commitment is an oral or written promise of an individual or group to perform a certain behavior (Abrahamse, Steg, Vlek & Rothengatter, 2005; DeLeon & Fuqua, 1995). There are two forms of commitment: private and public. Commitment is private, if the promise to execute the behavior is given privately, whereas public commitment includes the announcement of the pledge to the community. In the review of Dwyer and colleagues (1993), public commitment yielded increases in recycling behavior (Wang & Katzev, 1990; Burn & Oskamp, 1986) and energy conservation (Shippee & Gregory, 1982; Katzev & Johnson, 1983). Mosler, Gutscher and Artho (2001) successfully used public commitment during a driving speed reduction campaign.

A public commitment can be implemented in different ways. The names of persons, who committed themselves, can for example be published on a notice board or in a local newspaper (Shippee & Gregory, 1982). Burn and Oskamp (1986) used sticker, which people put on their front doors containing the information about the behavior they promised to show. This strategy implicates that the favored behavior is visible for the environment and therefore can be observed by the public. Also De Young (1993) comments in his meta-analytic review that public commitment can be a very effective intervention technique. It is rated as very reliable and initiates a fast behavior change. Most notably, this strategy enhances sustainable changes (Schultz, Oskamp & Mainieri, 1995).

The modes of operation of prompt and public commitment [8]

The mode of operation of prompts and public commitments comprises different aspects, namely accessibility and implementation intentions, perceived habit, the felt commitment, and social norms. These factors (except for social norms) can be described as 'behavior-near' factors, because according to the stage models of behavior change they are post-intentional factors acting at the habit stage of the model and are directly preceding behavior (for a detailed description of the behavior change process, see chapter 1). In contrast, pre-intentional factors can be called behavior-distant factors. The behavior-near factors and social norms, which are relevant for the present analysis, as well as the hypothesized influences of prompt and public commitment on these factors, will be described in the following.

Accessibility and implementation intentions. A prompt can simply remind a person to perform a certain behavior. During this process, prospective memory is supported and

[8] This part of this chapter is in preparation for publication: Huber, A. C., Tamas, A., Mosler, H.-J. & Meyer, B. (paper in preparation). The modes of operation of prompts and public commitment: A field study in Bolivia.

accessibility of the behavior is increased. Several studies have shown the positive effect of a prompt on the performance of the prospective memory (Einstein & McDaniel, 1995; Ellis, 1996; Mäntylä, 1996). These positive performance effects are already visible in childhood (Meacham & Colombo, 1980). Also, De Young (1993) reasoned that a prompt gets effective the moment it is displayed due to activation processes. Therefore, it can very fast enable a behavior performance, however, the moment the prompt is removed, the effect may also decrease very fast. So, prompts can function as a cue stimulus and increase the accessibility of a specific behavior. If, in addition, the prompt is interpreted by the individual as a request to perform the behavior, a positive implementation intention develops (Tobias, 2007). Sheeran and colleagues have investigated the connection between goal activation, implementation intention and behavior performance (Sheeran, Webb & Gollwitzer, 2005; Sheeran, Milne, Webb & Gollwitzer, 2005). They found evidences that implementation intentions only show effects on behavior if the target behavior was activated before. It was also shown that participants who formed an implementation intention significantly required less time to perform the action expressed in the intention in comparison to participants without an implementation intention. Furthermore, they could prove that the effect is even stronger when the target behavior was activated by priming the participants. There was no effect found when the behavior was not at all activated. Additionally, Aarts, Dijksterhuis and Midden (1999) found out that with the formation of an implementation intention the mental accessibility of a situational cue stimulus (i.e. a prompt) is increased and this simplifies again the activation of the favored behavior.

Not only the prompt, but also the public commitment can affect the strength of implementation intentions. Gollwitzer (1999) stated that a commitment to a behavior is required to form an implementation intention. In other words, the target person has to feel committed before she/he can express an implementation intention. Creating a commitment is exactly what a public commitment does: urge the participants to commit themselves to show a certain behavior. Therefore, the requirement to subsequently form an implementation intention is given. Moreover, Gollwitzer (1999) showed within his research that a strong commitment adds power to the relation between implementation intention and behavior. Therefore, it is important to emphasize that the target group needs to stick to the planned behavior instead of leaving a broad tolerance to perform the action (Gollwitzer, 1999). A public commitment also influences the process of planning a behavior and planning is an important requirement to form an implementation intention (Dahlstrand & Biel, 1997; Tobias, 2007).

Habit. A habit is a goal-oriented behavior with the characteristic that it is shown automatically when the situation occurs (Aarts & Dijksterhuis, 2000a; Bargh & Gollwitzer, 1994). It is important to note that a habit is not an automatic behavior, as for example inborn reflexes. According to Aarts and Dijksterhuis (2000b), the most important difference is that a habit is goal-oriented, which means that a certain behavior has repeatedly lead to a successful goal achievement. Many researchers have found a strong effect of habit on behavior choices in their studies (e.g. Bamberg, 1996). Already Triandis (1977, 1980) incorporated habit to explain

behavior in his “model of the attitude-behavior relation”. In this model, he claims that the stronger a habit of a particular behavior, the higher the probability that a person acts in a certain way. Also Oullette and Wood (1998) state that habits can arouse a behavior with minimal cognitive cost.

Due to its ability to act as a situational stimulus, prompts can directly influence habit. Situational stimuli easily activate the accessible mental structures of future behavior, and lead to the initiation of a behavior without a deliberate evaluation of the decision or a planning process (Aarts et al., 1998). Consequently, prompts can initiate a habit. Dahlstrand and Biel (1997) define sub-steps, which an individual has to pass to change a certain habit. The first step is the activation of the relevant action. The authors assume that the stronger and more precisely the target behavior is activated, the more likely a habit is generated. Prompts are so-called cue stimuli which, when they are placed accurately, catch people’s eyes every day. Due to the daily observation of the prompt and its presented information, people get primed to the target behavior. Therefore, a constant activation of the goal takes place, which encourages the formation of a habit. To achieve such an ongoing and constant impact, a good prompt should neither loose its topicality nor its material quality (De Young, 1993). However, one has to be aware of habituation effects. Two studies of Goschke and Kuhl (1993, 1996) reported no effects of prompts, probably due to habituation to the constant presence of the prompt.

Also the intervention strategy public commitment can affect behavior via habit. In various field studies, public commitments were operationalized with posters that were displayed outside houses (e.g. Mosler & Tobias, 2007b; Inauen, 2007). Since the poster is visible for the participants, for example every time they enter the house, the public commitment helps them to remember the behavior. Through this daily confrontation, the public commitment can, like a prompt, act as an external cue stimulus, activate the relevant behavior, and initiate a habit (Aarts et al., 1998; Dahlstrand & Biel, 1997).

Social norms. When prompts are displayed in public, chances are higher that a target person performs the requested behavior if other persons already performing the behavior are present. Aronson and O'Leary (1982-1983) found that while being alone, only 20% of the people followed the request of the prompt, whereas with the presence of one other positive model already 50% performed the behavior and with two models present two thirds complied with the request. Private prompts are not expected to be related to social influence.

The effect of publicity that was shown with the previously mentioned study makes the link to the functioning of public commitments. According to DeLeon and Fuqua (1995), a public commitment leads to negative social consequences if the commitment displayed in the public is not converted into actual behavior. It is expected that due to social pressure, the external norm gets internalized by the individual. So, public commitment acts like a strong internal control and is therefore seen as an explicit pledge to a certain behavior (Katzev & Pardini, 1988). A particular effect of a public commitment is that persons will perceive others’ commitments. If behavior execution of others is hard to observe, public commitments will facilitate the generation

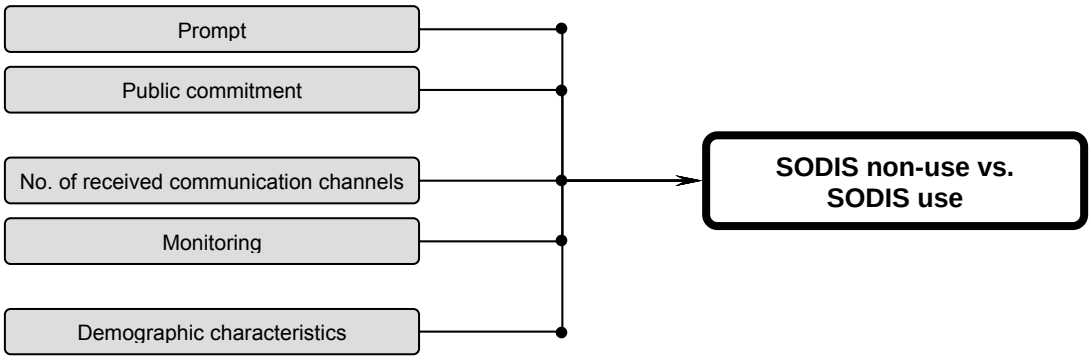
of external ideal norms, which may then influence behavior selection processes through the cognitive component.

Commitment. Heckhausen (1991) defines commitment as a bond with the goal of an actor. A person acts self-committed if an action or decision is enunciated. The willingness to show the behavior increases even more when the person's intention is expressed publicly (Wenninger, 2000). As the underlying mechanism, it is assumed that individuals form implementation intentions due to commitment (Cialdini, 2001). It is argued that commitment affects planning processes, out of which implementation intentions emerge (Tobias, 2007). As soon as a person feels committed, the chances are higher that a situational cue stimulus like a prompt can urge the person to act (Mosler & Tobias, 2007b). It is assumed that a certain initial level of commitment already develops, when the procedure of handing over the prompt is designed in a way that it has to be explicitly accepted into the household by the target person (as it was done in our studies). Another mechanism of influencing behavior via commitment is the emergence of dissonance. If a person feels committed to a certain behavior, but does not act accordingly, cognitive dissonance should develop (Brehm & Cohen, 1962; Heckhausen, 1991). According to Festinger's theory of cognitive dissonance (Festinger, 1957), the individual will seek reduction of dissonance either via behaving consistently with the commitment or via rejection of the activated goal. In the case of voluntary public commitment, it is not expected that a person will reject the goal behavior he/she has committed him/herself to beforehand. So, it is most likely that the felt commitment induced by the public commitment positively influences the behavioral outcome, either via the dissonance mechanism or via implementation intentions. For the intervention public commitment, it is assumed that the felt commitment is even stronger due to the normative aspect of the commitment, especially when the target behavior can be easily observed.

Behavior – uptake or intensity?

In the previous section, the effects of prompt and public commitment directly on behavior or via the behavior-near factors on behavior were described. Now, a closer look will be taken on the dependent variable behavior. As already described in the general introduction about stage models of behavior change, the decision to try out a behavior is often seen as the end point of the motivational phase, where problem awareness and positive attitudes were developed (TTM; Prochaska & DiClemente, 1983; IDP; E. M. Rogers, 2003; HAPA; Schwarzer, 2008). In many stage models, action and maintenance are separate stages. It is therefore assumed that the underlying processes of the uptake of a behavior (action) and the continuous performance (maintenance) are different. Therefore, the analysis looks separately into the uptake of the behavior and its predictors on one hand, and the behavior intensity and its predictors on the other hand.

Figure 18. The SODIS uptake model.



The uptake model

The impact of prompts and public commitment on the uptake will be investigated using a very straightforward model where the effect of the interventions on SODIS use is directly investigated, without difficult underlying moderation of behavioral variables. This is to get an impression, whether behavior actually changed amongst those people who had received a prompt or public commitment in comparison to those who did not. No internal psychological factors were included in this analysis. Only other situational influences were included, to have at first a simple estimation of the direct impacts of the interventions prompt and public commitment when taking into account all other activities, namely the communication activities and the monitoring. Additionally, demographic variables were included in this model to see if some of the effects on behavior are moderated by any of the stable demographic characteristics. The final uptake model is displayed in Figure 18.

The behavior intensity model

As it was already described in the part on the modes of operation of prompt and public commitment, the two interventions operate on the stages of behavior execution and habit formation of the postulated behavior change model. Therefore, a model including the described factors implementation intentions, perceived habit and commitment will be tested. Although it was stated that prompts and public commitment also operate via social norms, these will not be included in the model. Norms are known to be a rather pre-decisional factor and to display themselves via behavioral intentions (Ajzen, 1991; for empirical evidence e.g. Bamberg et al., 2003; Michie, Dormandy, French & Marteau, 2004; Kaiser & Gutscher, 2003). Apart from the psychological behavior-near factors already described, there exist always one or more alternatives to a certain behavior. Maybe specific alternative behaviors exist, but there is at least always the possibility to not perform the target behavior. According to Mosler and Tobias

(2007b), the performance of a specific behavior not only depends on the preference of the behavior, but also which alternative behaviors are remembered by the target person. This implicates that an alternative behavior can operate as a distraction from the target behavior if it is remembered first. Hence, the repeated performance of an alternative behavior must have a negative influence on the execution of the target behavior. Of course, the alternative behavior is also determined by all the factors that apply for the target behavior (implementation intentions, habit etc.). However, for investigating the target behavior itself and the modes of operation of interventions that were designed to influence the target behavior and its behavior-near factors (and not of the alternative), it is assumed to be sufficient to include only the alternative behavior itself as the valid final manifestation of all its preceding factors.

Finally, a certain behavior and its determining factors do not develop out of the air, they often depend on their past status. Therefore, the modes of operation of prompt and public commitment will be investigated taking into account previous dispositions of the behavior and its behavior-near predictors. Particularly the direct influence of past on current behavior has been investigated by several studies and past behavior has been found to be a predictor of the future behavior (Ajzen, 1991; Bagozzi, 1981; Bentler & Speckart, 1979; Fredricks & Dossett, 1983; see Ouellette & Wood, 1998, for a meta-analytic review). Additionally, it is assumed that past behavior via habit influences future behavior, because repeated performance of a behavior leads to habituation (Ronis et al., 1989). However, contradicting evidence was found by a study of Bamberg et al. (2003), who did not find the mediating effect of habit between past and future behavior. In the same study, also the direct relation between past and future behavior was not found in the case of an intervention between the two time points. In the following model both possibilities will be tested.

The final model is displayed in Figure 19.

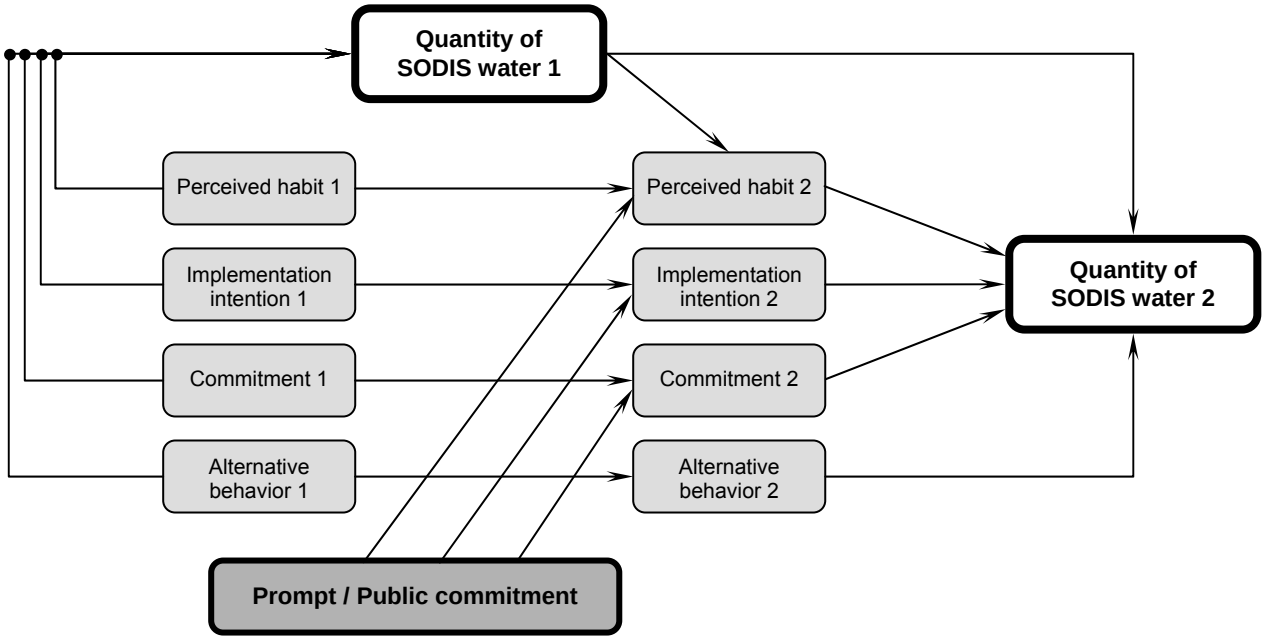
METHODS

The effects of the interventions on the uptake of SODIS will be investigated using available data from both studies. The data from all measurements that were taken after an intervention period will be analyzed separately for each time point.

The effects of the interventions on the quantity of SODIS use will be analyzed using data from Study II of the two measurements which had taken place after an intervention phase. The behavioral model will also be calculated with these data.

Study procedures, the interventions prompt and public commitments, participants' characteristics as well as operationalizations are already described in the overall Methods section of this thesis.

Figure 19. Model of the mode of operation of prompts and public commitment on SODIS behavior intensity.



RESULTS

The section examining the effects of prompts and public commitments consists of the two parts mentioned already in the introduction: SODIS uptake and quantity of use. First, with binary logistic regressions the effects of prompts and public commitment on the uptake of SODIS were calculated. As dependent variable served the dichotomous SODIS use variable (SODIS non-use vs. SODIS use). Second, with a linear regression on SODIS use quantity, the direct effects of prompts and public commitment were tested. In a last analysis, the two models of the mode of operation of prompts and public commitments on SODIS behavior intensity were tested using path analysis.

Influences on SODIS uptake

This part investigates the direct effects of the prompt and the public commitment on SODIS uptake. The dependent variable is SODIS non-use (0) vs. SODIS use (1).

Study I

The effects of prompts and public commitments were tested using a binary logistic regression on the dependent variable SODIS behavior (non-use vs. use). Main independent

variables were whether a household had received a prompt or a public commitment. The interaction of both interventions could not be tested for the second and third panel, because only very few households had actually received both interventions together during one intervention time point (second panel N=5, third panel N=16), resulting in one cell with 0 cases and some cells having very low frequencies for the crosstabulation prompt x public commitment x SODIS use. Further important predictors of SODIS behavior that could not be ignored were the communication activities, which were entered for simplicity only as the number of perceived communication channels, and the monitoring. The model of the fourth panel is slightly different to those of the second and third panel[9]. Here not only the current situation was of interest and entered as independent variables (still having a prompt or public commitment, communication channels perceived between third and fourth panel), but also what had happened before (having had a prompt, public commitment and their interaction, number of communication channels perceived until the third panel).

The main predictors of SODIS use, prompt and public commitment, were entered first into the analysis (block 1). In a second block, number of communication channels and monitoring were entered. The reason was to separate the effects on behavior in terms of explained variance and significance of the contribution (chi-square statistics) of the interventions from the rest. Additionally, it was controlled for demographic variables (age, education, persons per household, children below 5 years, gender, job yes/no, and place (periurban vs. rural)). These seven variables were only entered into the model in case a significant influence was found. This was realized with a stepwise forward procedure. The reason to do so was the rather low number of cases in some of the models and the resulting risk to dilute the main effects with entering too many predictors into the models. Only households with a long questionnaire were included into the analysis, because only very few of the households with short questionnaires had actually received prompts and public commitments. For panel 4 – because then only long questionnaires got applied – those households were excluded who had had only short questionnaires before.

First, descriptive statistics are displayed in Table 15, followed by the results of the regression Table 16.

The descriptive statistics show that at each time point a higher percentage of SODIS users have prompts in their house. For public commitment this is only true for the third panel. During the active phase of the Study I (panels 2 and 3), SODIS user have heard from more channels about SODIS, a higher percentage is in the monitoring group, SODIS users have lower education, and a higher percentage of them lives in the rural area, all in comparison to the SODIS non-user. Additionally, in the third panel, a lower percentage of SODIS users have a job compared to the non-users. This still tends to be true for the fourth panel; additionally, SODIS users are more likely to be female. Regarding all other indicators, SODIS users and non-users do not differ from each other during the fourth panel.

[9] The fourth panel of Study I was measured after a seven months promotion-inactive period of time. For the detailed design of Study I, see general methods chapter.

Table 15. Descriptive statistics of Study I. Received interventions, other activities and demographic variables separately for SODID non-user, SODIS user and the entire sample. Study I, Panels 2, 3 and 4.

Time	Indicator	SODIS non-user	SODIS user	Total	Test of significance between non-user & user	
2nd Panel	*N*	*127*	*106*	*233*		
	Prompt (% yes)	21%	65%	41%	$\chi^2(1)=$	45.83 ***
	Public commitment (% yes)	6%	11%	8%	$\chi^2(1)=$	2.60
	Prompt & Public commitment (% yes)	0%	4%	2%	$\chi^2(1)=$	4.88 *
	No. of comm. channels (*M* / *SD*)	0.91 / 0.23	2.08 / 1.02	1.45 / 1.06	F (1; 231)=	101.60 ***
	Monitoring (% yes)	13%	42%	27%	$\chi^2(1)=$	25.00 ***
	Age (*M* / *SD*)	37 / 15	39 / 14	38 / 15	F (1; 231)=	1.48
	Education (*M* / *SD*)	7.8 / 4.5	6.1 / 4.7	7.0 / 4.7	F (1; 231)=	7.40 **
	Persons per household (*M* / *SD*)	5.0 / 1.9	5.1 / 2.0	5.1 / 1.9	F (1; 231)=	0.18
	Children < 5 years (*M* / *SD*)	1.1 / 1.0	0.9 / 1.0	1.0 / 1.0	F (1; 231)=	1.63
	Gender (% women)	91%	91%	91%	$\chi^2(1)=$	0.00
	Job (% yes)	38%	31%	35%	$\chi^2(1)=$	1.13
	Place (% rural)	6%	23%	13%	$\chi^2(1)=$	14.70 ***
3rd Panel	*N*	*68*	*210*	*278*		
	Prompt (% yes)	9%	34%	28%	$\chi^2(1)=$	16.50 ***
	Public commitment (% yes)	6%	29%	23%	$\chi^2(1)=$	15.39 ***
	Prompt & Public commitment (% yes)	0%	7%	5%	$\chi^2(1)=$	5.13 *
	No. of comm. channels (*M* / *SD*)	0.54 / 0.63	0.96 / 0.94	0.86 / 0.89	F (1; 276)=	11.64 **
	Monitoring (% yes)	12%	61%	49%	$\chi^2(1)=$	50.69 ***
	Age (*M* / *SD*)	37 / 15	38 / 14	38 / 14	F (1; 276)=	0.15
	Education (*M* / *SD*)	8.8 / 4.8	6.9 / 4.7	7.4 / 4.7	F (1; 276)=	7.90 **
	Persons per household (*M* / *SD*)	5.1 / 2.1	5.2 / 2.0	5.1 / 2.0	F (1; 276)=	0.15
	Children < 5 years (*M* / *SD*)	0.9 / 1.1	1.0 / 1.0	1.0 / 1.0	F (1; 276)=	0.74
	Gender (% women)	90%	93%	92%	$\chi^2(1)=$	0.97
	Job (% yes)	51%	28%	34%	$\chi^2(1)=$	12.54 ***
	Place (% rural)	3%	16%	13%	$\chi^2(1)=$	7.62 **
4th Panel	*N*	*92*	*98*	*190*		
	Prompt before (% yes)	59%	62%	61%	$\chi^2(1)=$	0.25
	Public commitment before (% yes)	32%	38%	35%	$\chi^2(1)=$	0.81
	Prompt & PC before (% yes)	29%	34%	32%	$\chi^2(1)=$	0.41
	Prompt now (% yes)	27%	45%	36%	$\chi^2(1)=$	6.45 *
	Public commitment now (% yes)	3%	9%	6%	$\chi^2(1)=$	2.81 (*)
	Prompt & PC now (% yes)	3%	7%	5%	$\chi^2(1)=$	1.43
	No. of comm. channels before (*M* / *SD*)	3.22 / 2.01	3.58 / 1.76	3.41 / 1.89	F (1; 188)=	1.80
	No. of comm. channels now (*M* / *SD*)	0.24 / 0.45	0.16 / 0.39	0.20 / 0.43	F (1; 188)=	1.50
	Monitoring before (% yes)	52%	46%	49%	$\chi^2(1)=$	0.74
	Age (*M* / *SD*)	39 / 14	39 / 13	38 / 14	F (1; 188)=	0.00
	Education (*M* / *SD*)	7.4 / 4.9	7.5 / 4.9	7.4 / 4.9	F (1; 188)=	0.01
	Persons per household (*M* / *SD*)	5.1 / 2.0	5.5 / 2.0	5.3 / 2.0	F (1; 188)=	2.30
	Children < 5 years (*M* / *SD*)	0.9 / 0.9	0.9 / 1.0	0.9 / 0.9	F (1; 188)=	0.04
	Gender (% women)	88%	95%	92%	$\chi^2(1)=$	2.89 (*)
	Job (% yes)	40%	29%	34%	$\chi^2(1)=$	2.86 (*)
	Place (% rural)	16%	11%	14%	$\chi^2(1)=$	1.04

Note: *** p<.001, ** p<.01, * p<.05, (*) p<.1. PC = Public commitment.

The logistic regressions show that at the time point after the first intervention (second panel), households having a prompt in the house have a significant 158%[10] increased chance to

[10] This percentage is calculated based on the Exp(B) value of the logistic regression. The value Exp(B) equals to: odds after a unit change of the predictor (e.g. prompt: yes=1) / original odds before unit change of the predictor (e.g. prompt:

use SODIS compared to those households without a prompt (Exp(B)=2.58). The public commitment also has a positive effect and increases the chance to use SODIS by 70% (Exp(B)=1.7). However, this value is not significant, probably mainly due to the fact that there are only 19 households who actually received a public commitment until the second panel. As expected, number of perceived SODIS communication channels and the monitoring also show a significant influence on SODIS use probability. None of the demographic variables show an influence. The overall explained variance of the model is 49%, of which prompt and public commitment contribute 29%. The classification for both groups, non-user and user, is correct in >50% of the cases with an overall of 79% correctly classified cases.

After the second round of interventions, the influence of the prompt on SODIS use is about the same as after the first round of interventions. The chances to use SODIS with a prompt were increased by 147% compared to not having a prompt (Exp(B)=2.47). However, this value only shows a tendency to significance (p=.08). Stronger than the prompt, the public commitment significantly raises the probability of using SODIS by 243% (Exp(B)=3.43). Again, number of perceived SODIS communication channels and the monitoring show a strong influence, as it was expected. Of the demographic variables, education becomes significant with a small negative value, which means having one year more education makes a household 17% less likely to use SODIS (Exp(B)=0.93). The overall explained variance of the model is a bit lower than in the previous model (37%), with prompt and public commitment contributing the major part (25%). Classification is still correct for both SODIS behavior groups in >50% of the cases; overall 81% are correctly classified.

After the seven months without activities (fourth panel), 69 families still owned the prompt they previously received, but only 12 still had the public commitment. Whether a prompt or public commitment had been received during the intervention phase in 2005, does not have an influence on current SODIS use. The important factor is (at least for the prompt), whether the household still has it or not. Still having the prompt raises the probability of using SODIS with almost the same strength as before (Exp(B)=2.46) and is the only significant predictor in the model of the fourth panel. Consequently, the overall explained variance of SODIS uptake is only 9%. Interestingly, classification is still >50% correct for both SODIS behavior groups with an overall correct classification of 60%.

Study II

The same analysis as for Study I was then calculated with the data from Study II. Here we only have two measurement points after an intervention had taken place: the third and the fourth panel (see description of study design, chapter Methods).

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no=0). The interpretation is as follows, given an Exp(B) value of 2.58 for the predictor prompt: The chance of a household that has a prompt of also using SODIS are 2.58 times higher than the chance of a household that does not have a prompt at home (adapted from Field, 2005, p. 241). The Exp(B) value can also be transformed into a percentage: (Exp(B)-1)*100. Then the value of 2.58 translates into: The chance of a household that has a prompt of also using SODIS is increased by 158%.

Table 16. Effects of prompts and public commitment. Binary logistic regression on SODIS use. Study I, Panels 2, 3 and 4.

					95% C.I. for Exp(B)	
Time	**Included**	**B**	**SE (B)**	**Exp(B)**	**Lower C.I.**	**Upper C.I.**
2nd Panel	Block 1: Method=enter					
	Prompt	0.95	0.38	2.58 *	1.24	5.39
	Public Commitment	0.53	0.57	1.70	0.56	5.19
	Note block 1: ΔR^2=0.29 (Nagelkerke). Model $\Delta\chi^2(2)$=54.40, p<.001.					
	Block 2: Method=enter					
	Number of communication channels	1.37	0.25	3.94 ***	2.42	6.42
	Monitoring	0.78	0.40	2.18 *	1.00	4.76
	Note block 2: ΔR^2=0.20 (Nagelkerke). Model $\Delta\chi^2(2)$=50.58, p<.001.					
	Block 3: Method=forward					
	Age, education, persons per household, children < 5 years, gender (masculine=low), having a job, place (periurban=low): not significant					
	Constant	-2.84	0.39	0.06 ***		
	Note final model: N=233, R^2=0.49 (Nagelkerke), Classification 79% correct. Model $\chi^2(4)$=104.98, p<.001.					
3rd Panel	Block 1: Method=enter					
	Prompt	0.90	0.51	2.47 (*)	0.91	6.75
	Public Commitment	1.23	0.59	3.43 *	1.08	10.92
	Note block 1: ΔR^2=0.25 (Nagelkerke). Model $\Delta\chi^2(2)$=41.23, p<.001.					
	Block 2: Method=enter					
	Number of communication channels	0.42	0.21	1.51 *	1.00	2.29
	Monitoring	2.07	0.43	7.93 ***	3.39	18.53
	Note block 2: ΔR^2=0.10 (Nagelkerke). Model $\Delta\chi^2(2)$=34.21, p<.001.					
	Block 3: Method=forward					
	Age, persons per household, children < 5 years, gender (masculine=low), having a job, place (periurban=low): not significant					
	Education	-0.08	0.03	0.93 *	0.87	0.99
	Note block 3: ΔR^2=0.02 (Nagelkerke). Model $\Delta\chi^2(1)$=4.92, p=.027.					
	Constant	0.36	0.35	1.43		
	Note final model: N=278, R^2=0.37 (Nagelkerke), Classification 79% correct. Model $\chi^2(5)$=80.36, p<.001.					
4th Panel	Block 1: Method=enter					
	Prompt before	-0.06	0.51	0.94	0.35	2.54
	Public Commitment before	0.22	0.97	1.24	0.19	8.26
	Prompt x PC before	-0.46	1.02	0.63	0.09	4.64
	Prompt now	0.90	0.41	2.46 *	1.11	5.44
	Public Commitment now	0.72	0.76	2.06	0.47	9.06
	Note block 1: ΔR^2=0.07 (Nagelkerke). Model $\Delta\chi^2(5)$=9.48, p=.091.					
	Block 2: Method=enter					
	No. of communication channels before	0.12	0.10	1.13	0.93	1.36
	No. of communication channels now	-0.46	0.42	0.63	0.28	1.43
	Monitoring before	-0.46	0.41	0.63	0.28	1.42
	Note block 2: ΔR^2=0.02 (Nagelkerke). Model $\Delta\chi^2(3)$=4.25, p=.235.					
	Block 3: Method=forward					
	Age, education, persons per household, children < 5 years, gender (masculine=low), having a job, place (periurban=low): not significant					
	Constant	-0.28	0.34	0.76		
	Note final model: N=190, R^2=0.09 (Nagelkerke), Classification 60% correct. Model $\chi^2(8)$=13.73, p=.089.					

Note: The presented estimates (B and exp(B) statistics, significance level), are those of the final model for each time point. Dependent variable SODIS Non-Use(0) vs. SODIS Use(1) at each time point. *** p<.001, ** p<.01, * p<.05, (*) p<.1. C.I. = Confidence interval. All available cases at each time point were included (without short questionnaires).

Main independent variables were again whether a household had received a prompt or a public commitment. No interactions could be calculated, because during the third panel it was not intended to have prompt and public commitment distributed together (and it also did not occur, Table 17). During the fourth panel, it occurred that 20 households had received both, prompt and public commitment. However, the distribution of the crosstabulation prompt x public commitment x SODIS use did not allow for the test of the interaction (too many (almost) empty cells). Actually, the test of the direct effect of the public commitment on SODIS uptake would also not have been possible for the fourth panel, because one cell of the crosstabulation public commitment x SODIS use had no cases (see Table 17, 4th panel: 0% of the SODIS non-user had a public commitment). So, basically if a household had a public commitment, the odds of that household also using SODIS were 100%. However, this made it impossible to estimate the Exp(B)[11]. Therefore, one case that had a public commitment was manually set to be a SODIS non-user. Other predictors used in the analysis were the same as for Study I: number of communication channels, monitoring and demographics (age, education, persons per household, children below 5 years, gender). Having a job and place were not necessary, because everyone was in one way or the other busy with farming and all lived in the same type of area (rural). As before, the first block entering was the two interventions, followed by a forced entry of number of communication channels and monitoring, and at last the demographics block entered using a stepwise forward procedure (reason as described above).

First, descriptive statistics are displayed in Table 17, followed by the results of the regression in Table 18.

For both time points a higher percentage of the SODIS users than of the non-users have a prompt or a public commitment in-/outside their house. Also, SODIS users have heard from more channels about SODIS. For the third panel, additional differences between SODIS user and non-user are that SODIS user are a bit younger, show a trend to have higher education and have more children below 5 years of age. In the fourth panel, SODIS user families show a trend to have a higher number of persons per household.

The results of the regressions show an equal influence of prompt and public commitment at the time of the third panel. The prompt increases the chance of SODIS use compared to having no prompt by 178% (Exp(B)=2.78), and the public commitment by 103% (Exp(B)=2.03), both significant. Additionally, the number of communication channels becomes a highly significant and strong predictor, and raises chances of SODIS use by 236% per additional communication channel (Exp(B)=3.36). Monitoring does not have a significant influence on

[11] The calculation of the Exp(B) which is the core information of the logistic regression, follows this equation:

Δodds=Exp(B)=odds after a unit change of the predictor / original odds before unit change of the predictor

Now, both odds values entering this equation are calculated from:

probability of the event (e.g. SODIS use) / probability of the non-event (e.g. SODIS non-use)

Consequently, if the probability of the non-event equals 0, the last equation cannot be calculated (more details see Fields, 2005, pp. 240). Therefore, one can set one case to the non-event to have a non-zero probability of the non-event. This does not change the overall pattern of the relation between event (SODIS use) and predictor (intervention), but allows estimation of the logistic regression.

Table 17. Descriptive statistics of Study II. Received interventions, other activities and demographic variables separately for SODID non-user, SODIS user and the entire sample. Study II, Panels 3 and 4.

Time	Indicator	SODIS non-user	SODIS user	Total	Test for significance between non-user & user	
3rd Panel	*N*	*212*	*253*	*465*		
	% SODIS of total water consumption	0%	60%	33%	-	
	Prompt (% yes)	5%	13%	9%	$\chi^2(1)$=	9.53**
	Public commitment (% yes)	8%	21%	15%	$\chi^2(1)$=	14.34***
	Prompt & Public commitment (% yes)	0%	0%	0%	–	
	No. of communication channels (*M* / *SD*)	0.65 / 0.77	1.53 / 0.94	1.13 / 0.97	F (1; 463)=	117.68***
	Monitoring (% yes)	7%	10%	9%	$\chi^2(1)$=	1.98
	Age (*M* / *SD*)	46 / 16	42 / 16	44 / 16	F (1; 463)=	5.54*
	Education (*M* / *SD*)	2.5 / 3.1	3.1 / 3.6	2.8 / 3.4	F (1; 463)=	3.63(*)
	Persons per household (*M* / *SD*)	5.2 / 6.0	5.1 / 2.4	5.1 / 4.4	F (1; 463)=	0.50
	Children < 5 years (*M* / *SD*)	0.6 / 0.8	0.8 / 0.9	0.7 / 0.9	F (1; 463)=	6.87**
	Gender (% women)	67%	74%	71%	$\chi^2(1)$=	2.37
4th Panel	*N*	*74*	*362*	*436*		
	% SODIS of total water consumption	0%	57%	47%	-	
	Prompt (% yes)	4%	17%	15%	$\chi^2(1)$=	8.52**
	Public commitment (% yes)	0%	22%	19%	$\chi^2(1)$=	20.34***
	Prompt & Public commitment (% yes)	0%	6%	5%	$\chi^2(1)$=	4.28*
	No. of comm. channels (*M* / *SD*)	1.57 / 1.23	2.15 / 1.46	2.06 / 1.44	F (1; 434)=	10.40**
	Monitoring (% yes)	7%	10%	9%	$\chi^2(1)$=	0.73
	Age (*M* / *SD*)	46 / 18	44 / 16	44 / 16	F (1; 434)=	0.87
	Education (*M* / *SD*)	2.3 / 3.1	2.9 / 3.2	2.8 / 3.2	F (1; 434)=	2.28
	Persons per household (*M* / *SD*)	4.3 / 2.4	5.3 / 4.8	5.1 / 4.5	F (1; 434)=	3.39(*)
	Children < 5 years (*M* / *SD*)	0.6 / 0.9	0.8 / 0.9	0.7 / 0.9	F (1; 434)=	2.24
	Gender (% women)	77%	70%	71%	$\chi^2(1)$=	1.41

Note: *** p<.001, ** p<.01, * p<.05, (*) p<.1.

SODIS use, neither does any of the demographic variables. Explained variance of the behavior is very low when only prompt and public commitment are in the model (8%) and only rises to an acceptable level (30%) when number of communication channels and the monitoring were also included in the model. Overall classification is good with 83%, however, of one SODIS behavior category only 52% are classified correctly (which is only 2% above chance).

The model of the fourth panel looks a bit different. The same predictors become significant, but the influence strengths changed. Prompts now increase the chance for SODIS use by 362% (Exp(B)=4.62) and public commitment even by a tremendous 1783% (Exp(B)=18.83). However, as was mentioned before, the calculation of the odds for public commitment was only artificially made possible and the confidence interval of Exp(B) ranges from 2.56 up to 138.37, which reflects the high uncertainty of the Exp(B)-value for public commitment. Therefore, to be on the safe side, the lower confidence interval value (2.56) is used for further interpretation.

Number of communication channels still is a significant predictor, but not such an important one anymore, and raises the chance of using SODIS by 37% per communication channel (Exp(B)=1.37). As for the third panel model, again neither monitoring nor the demographic variables show any significant influence. Explained variance even for the

Table 18. Effects of prompts and public commitment. Binary logistic regression on SODIS use. Study II, Panels 3 and 4.

Time	Included	B	SE (B)	Exp(B)	95% C.I. for Exp(B) Lower C.I.	Upper C.I.
3rd Panel	Block 1: Method=enter					
	Prompt	1.02	0.46	2.78 *	1.13	6.84
	Public Commitment	0.71	0.34	2.03 *	1.04	3.96
	Note block 1: ΔR^2=0.08 (Nagelkerke). Model $\Delta\chi^2(2)$=28.77, p<.001.					
	Block 2: Method=enter					
	Number of communication channels	1.21	0.15	3.36 ***	2.51	4.50
	Monitoring	-0.65	0.45	0.52	0.22	1.25
	Note block 2: ΔR^2=0.22 (Nagelkerke). Model $\Delta\chi^2(2)$=90.48, p<.001.					
	Block 3: Method=forward					
	Age, education, persons per household, children < 5 years, gender (masculine=low): not significant					
	Constant	-1.20	0.18	0.30 ***		
	Note final model: N=465, R^2=0.30 (Nagelkerke), Classification 73% correct. Model $\chi^2(4)$=119.25, p<.001.					
4th Panel	Block 1: Method=enter					
	Prompt	1.53	0.66	4.62 *	1.26	17.00
	Public Commitment	2.94	1.02	18.83 **	2.56	138.37
	Note block 1: ΔR^2=0.13 (Nagelkerke). Model $\Delta\chi^2(2)$=34.67, p<.001.					
	Block 2: Method=enter					
	Number of communication channels	0.32	0.11	1.37 **	1.11	1.69
	Monitoring	0.03	0.57	1.03	0.33	3.17
	Note block 2: ΔR^2=0.03 (Nagelkerke). Model $\Delta\chi^2(2)$=9.96, p=.007.					
	Block 3: Method=forward					
	Age, education, persons per household, children < 5 years, gender (masculine=low): not significant					
	Constant	0.60	0.24	1.83 *		
	Note final model: N=436, R^2=0.16 (Nagelkerke), Classification 83% correct. Model $\chi^2(4)$=44.64, p<.001.					

Note: The presented estimates (B and Exp(B) statistics, significance level) are those of the final model for each time point. Dependent variable SODIS Non-Use(0) vs. SODIS Use(1) at each time point. *** p<.001, ** p<.01, * p<.05, (*) p<.1. PC = Public commitment. C.I. = Confidence interval. All available cases at each time point were included.

final model is low (16%), with the predictors prompt and public commitment contributing most to it (13%). Correct classification is not possible, all cases were classified into the same category.

Influences on the quantity of water disinfected with SODIS (Study II)

In the previous part, the effects of prompts and public commitment on the uptake decision of SODIS have been analyzed, now it also is important to know, how much SODIS water is disinfected once a person uses SODIS, and how this was influenced by the interventions. The criterion for how much water is disinfected is expressed in the percentage of SODIS water on the total drinking water consumption. Only data from Study II can be analyzed, for Study I, water consumption was not asked in such a detailed way.

First, a linear regression on the percentage of SODIS water on total water consumption was calculated. The same predictor variables as for the logistic regression on SODIS non-use

Table 19. Effects of prompts and public commitment. Linear regression on % SODIS water on total water consumption. Study II, Panels 3 and 4.

					95% C.I. for B	
Time	**Included**	**stand. β**	**B**	**SE (B)**	**Lower C.I.**	**Upper C.I.**
3rd Panel	Block 1: Method=enter					
	Prompt	.01	0.01	0.05	-0.09	0.10
	Public Commitment	.06	-0.03	0.04	-0.11	0.04
	Note block 1: ΔR²=0.003. Model ΔF(2)=0.41, p=.663.					
	Block 2: Method=enter					
	Number of communication channels	.03	0.01	0.02	-0.03	0.04
	Monitoring	-.05	-0.04	0.05	-0.14	0.06
	Note block 2: ΔR²=0.003. Model ΔF(2)=0.38, p=.686.					
	Block 3: Method=forward					
	Age, education, persons per household, children < 5 years, gender (masculine=low): not significant					
	Constant		.60 ***	0.03	0.55	0.66
	Note final model: N=253, R²=0.006, adj. R²=-0.01. Model F(4)=0.34, p=.813. *Collinearity statistics: all Tolerance values >0.80, all VIF values <1.25*					
4th Panel	Block 1: Method=enter					
	Prompt	.12 *	0.08	0.04	0.00	0.15
	Public Commitment	.09 (*)	0.05	0.03	-0.01	0.11
	Note block 1: ΔR²=0.04. Model ΔF(2)=6.96, p=.001.					
	Block 2: Method=enter					
	Number of communication channels	-.11 *	-0.02	0.01	-0.04	0.00
	Monitoring	.05	0.05	0.05	-0.05	0.14
	Note block 2: ΔR²=0.02. Model ΔF(2)=3.12, p=.046.					
	Block 3: Method=forward					
	Education, children < 5 years, gender (masculine=low): not significant					
	Age	-.19 ***	0.00	0.00	0.00	0.00
	Persons per household	-.12 *	-0.01	0.00	-0.01	0.00
	Note block 3: ΔR²=0.04. Model ΔF(2)=8.56, p<.001.					
	Constant		0.74 ***	0.05	0.64	0.84
	Note final model: N=362, R²=0.10, adj. R²=0.08. Model F(6)=6.300, p<.001. *Collinearity statistics: all Tolerance values >0.75, all VIF values <1.34*					

Note: The presented estimates (stand. β, significance level and B statistics) are those of the final model for each time point. Dependent variable: % SODIS water on total water consumption at each time point. *** p<.001, ** p<.01, * p<.05, (*) p<.1. PC = Public commitment. C.I. = Confidence interval. All available cases that used SODIS at each time point were included.

vs. use (prompt, public commitment, number of communication channels, monitoring, and demographics) were used. Like before, they entered the regression in three blocks. Only households that used SODIS were included in the analyses. The results of the regression are presented in Table 19.

The first regression, for the third panel, does not contribute at all to explain the variance of the percentage of SODIS water on the total drinking water consumption. None of the entered predictors becomes significant; also the overall model is not significant.

The regression for the fourth panel looks a little better with 10% explained variance of the dependent variable and a significant model. Prompts show a significant, but not very strong

influence on percentage of consumed SODIS water (β=.12). The influence of the public commitment is negligible (β=.09). Number of communication channels shows a slight negative influence (β=-.11), which is a bit bewildering. Of the demographic variables, interestingly age and persons per household show a negative and significant influence (β=-.19 and -.12, respectively).

Overall, it is expected that other variables would be much better predictors of the intensity of the SODIS behavior and that the interventions prompt and public commitment did not influence behavior intensity directly, but via those variables. Therefore, in the following the models of the mode of operation of prompts and public commitments on SODIS behavior intensity will be tested.

The modes of operation of prompts and public commitments (Study II)

Of the total sample, 179 cases were analyzed. These subjects were the ones who took part in both, the third and the fourth panel, and used SODIS at both points in time. Using SODIS was a necessary criterion for the analysis of the mode of operation of the interventions, because the behavior-near constructs require using SODIS to answer the questions concerning the behavior-near variables properly.

Before calculation of the models, descriptive statistics are displayed. Table 20 shows all means, standard deviations and correlations for all model variables for both points of time, before and after the interventions took place. The target behavior, namely to disinfect the drinking water with SODIS, is already relatively high before the interventions and reaches a mean of 0.63 (*SD*=.24). The results also indicate a slight increase of the behavior-near constructs after the interventions, except for the alternative behavior, which decreases as expected, indicating that after receiving an intervention less people consume untreated water. Correlations between the measures within one time point are higher than those between the two time points. The table also shows that at the time of the second survey, 20% (35) of the households had the prompt displayed in their house and 29% (52) families had hung up the public commitment on their front door.

The now following two models were developed with the SIMPLIS command language and path analyses were calculated using LISREL 8.54 (Jöreskog & Sörbom, 2003). A path analysis is a method of structural equation modeling to test theoretical relationships between observed (measured) variables. Within a path model, it is possible to analyze direct and indirect effects of variables (Jöreskog & Sörbom, 1993). Due to the fact that the applied questionnaire data had ordinal scales, the weighted least squares algorithm for polychoric correlations including the asymptotic covariance matrices was employed (Jöreskog & Sörbom, 1993, 1996).

Table 20. Means (M), standard deviations (SD) and correlations for variables before (1) and after (2) the interventions. N=179. Study II, Panels 3 and 4.

			Correlations								
Variables	**M**	**SD**	**SB1**	**PH1**	**II1**	**C1**	**AB1**	**SB2**	**PH2**	**II2**	**C2**
SODIS behavior (SB) 1	.63	.24	.								
Perceived habit (PH) 1	.62	.25	0.59	.							
Implementation intention (II) 1	.75	.21	0.49	0.60	.						
Commitment (C) 1	.40	.33	0.05	0.35	0.33	.					
Alternative behavior (AB) 1	.28	.26	-0.53	-0.49	-0.57	-0.01	.				
SODIS behavior (SB) 2	.61	.22	0.07	0.11	0.10	0.19	-0.04	.			
Perceived habit (PH) 2	.63	.21	0.05	0.06	0.12	0.09	-0.07	0.71	.		
Implementation intention (II) 2	.75	.19	-0.05	0.02	0.06	0.13	-0.01	0.58	0.58	.	
Commitment (C) 2	.54	.27	-0.18	-0.05	0.00	0.19	0.08	0.49	0.50	0.48	.
Alternative behavior (AB) 2	.19	.25	-0.07	-0.05	-0.18	0.02	0.20	-0.71	-0.65	-0.50	-0.42
Prompt (P)	20%										
Public commitment (PC)	29%										

Note: SODIS behavior, habit, implementation intention, commitment and alternative behavior range from 0 to 1. Prompt and public commitment is the proportion of households that received a prompt or public commitment between the third and fourth panel. Grey correlations are not significant at p<.1 level.

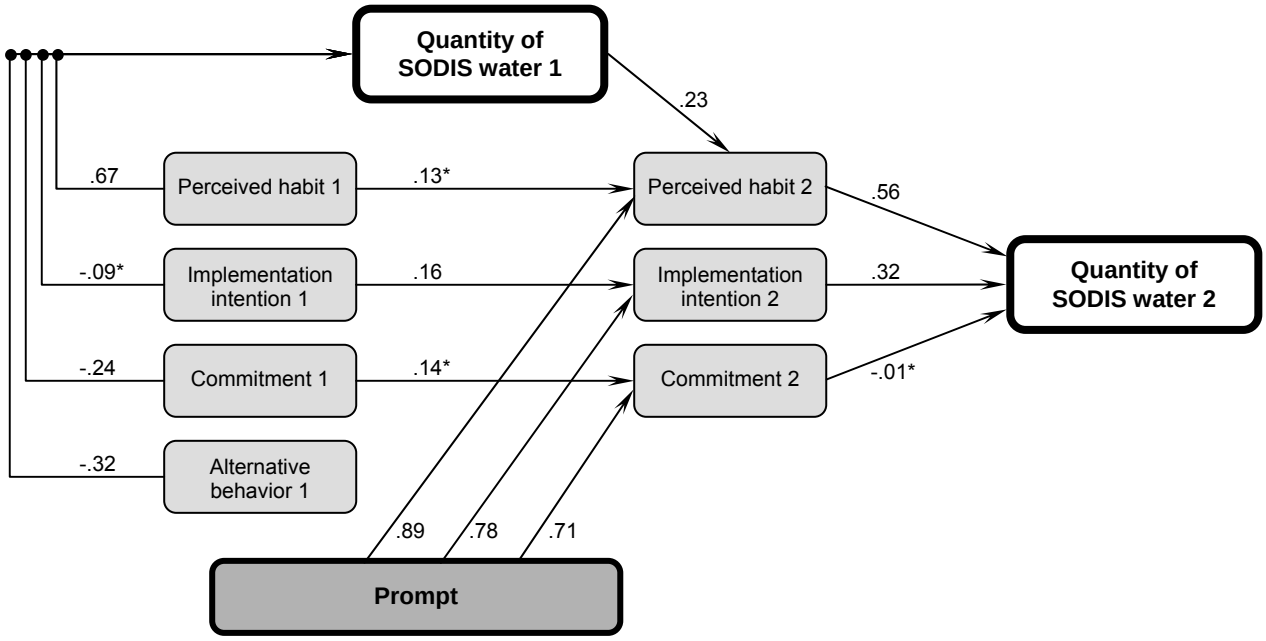
During the analyses, the error variances of the independent variables were allowed to covary in order to obtain an acceptable model fit. We are aware of the fact that this procedure deviates from a strict hypothesis-testing approach. However, we deem it appropriate to use an explorative strategy employed in the present analyses. Jöreskog and Sörbom (2003) state that even though error covariances do not exist by default, error variances are allowed to covary if covariations can be explained adequately. In the present analyses, the four error variances of the independent variables habit, strength of implementation intention, strength of commitment, and alternative behavior are likely to covary, because the constructs were measured with the same instrument and all are behavior-near constructs.

The fit between the data and the path model is expressed with five fit indices: chi-square (χ^2), degrees of freedom (*df*), root mean square error of approximation (RMSEA), goodness-of-fit (GFI) and adjusted goodness-of-fit index. A good model fit is assumed if the χ^2 is not more than three times as high as the *df* (compare Schermelleh-Engel, Moosbrugger & Müller, 2003, for heuristics on the assessment of model fit). The RMSEA indicates the degree of difference between the predicted and the obtained covariance structures. Usually, a RMSEA value should be less than .08 to be acceptable. The GFI estimates the amount of explained variance by the model, and the AGFI adjusts this estimate. Both of these values should be over .95 to indicate a good fit (see also Browne & Cudeck, 1993; Jöreskog & Sörbom, 1996).

The prompt model

At first, the model was calculated for the intervention prompt. Unfortunately, satisfactory model parameters for the original hypothetical model (see Figure 19) were not reached. For this reason, the model had to be readjusted. On that account, LISREL suggested further paths that

Figure 20. The mode of operation of prompts over two points in time: Path model with standardized path coefficients. Study II, Panels 3 and 4.



Note: The numbers 1 and 2 refer to the time point 1 = before the intervention (3rd panel of Study II), 2 = after the intervention (4th panel of Study II). * = not significant. Explained variances: $R^2_{(\text{Quantity of SODIS water 1})}$=.59, $R^2_{(\text{Quantity of SODIS water 2})}$=.56, $R^2_{(\text{Habit 2})}$=.81, $R^2_{(\text{Implementation intention 2})}$=.56, $R^2_{(\text{Commitment 2})}$=.63. Model fit indices: χ^2=41.74, *df*=21, RMSEA=.076, GFI=.99, AGFI=.98.

increased model fit. The model with the best fit being as similar as possible to the hypothesized model is displayed in Figure 20. To reach adequate model parameters, the variable alternative behavior 2 (after the intervention) had to be eliminated, as well as the path from behavior 1 to behavior 2. The error covariances of the independent variables habit 1, implementation intention 1, commitment 1, and alternative behavior 1, which are not displayed in favor of simplicity, ranged from -.66 to .71.

All relations between the variables are shown in Figure 20, which displays the model parameters for changing behavior with a prompt. All path coefficients, except those with an asterisk, display a significant t-value at the 5% level. The amounts of explained variances of the dependent variables as well as the model fit indices are stated in the bottom line. The model fit is found to be satisfactory according to the above-mentioned criteria.

As can be seen in Figure 20, 59% of the behavioral variance at the first measurement time can be explained. The behavior before the intervention is significantly affected by habit (.67), the alternative behavior (-.32), and by the strength of commitment (-.24). Contrary to the hypothesis, the strength of commitment has a negative effect on behavior. Furthermore, the model shows that the strength of implementation intention does not show a significant influence

on SODIS behavior. As predicted, the SODIS behavior before the intervention positively influenced the habit after the intervention (.23). The path coefficients between the three behavior-near constructs from the first to the second measurement time exhibit small values, and only the path between the first and second strength of implementation intention (.16) reaches significance.

The intervention technique prompt significantly influenced all three behavior-near constructs positively as hypothesized: habit 2 (.89), strength of implementation intention 2 (.78), and strength of commitment 2 (.71). Two of the three variables of the second time point, habit and implementation intention, affect the target behavior 2 in a positive way (.56 and .32, respectively). The effect of the commitment 2 on SODIS behavior 2 – after the intervention prompt – was reduced to -.01 and not significant. The explained variance of the target behavior after the interventions reached 56%.

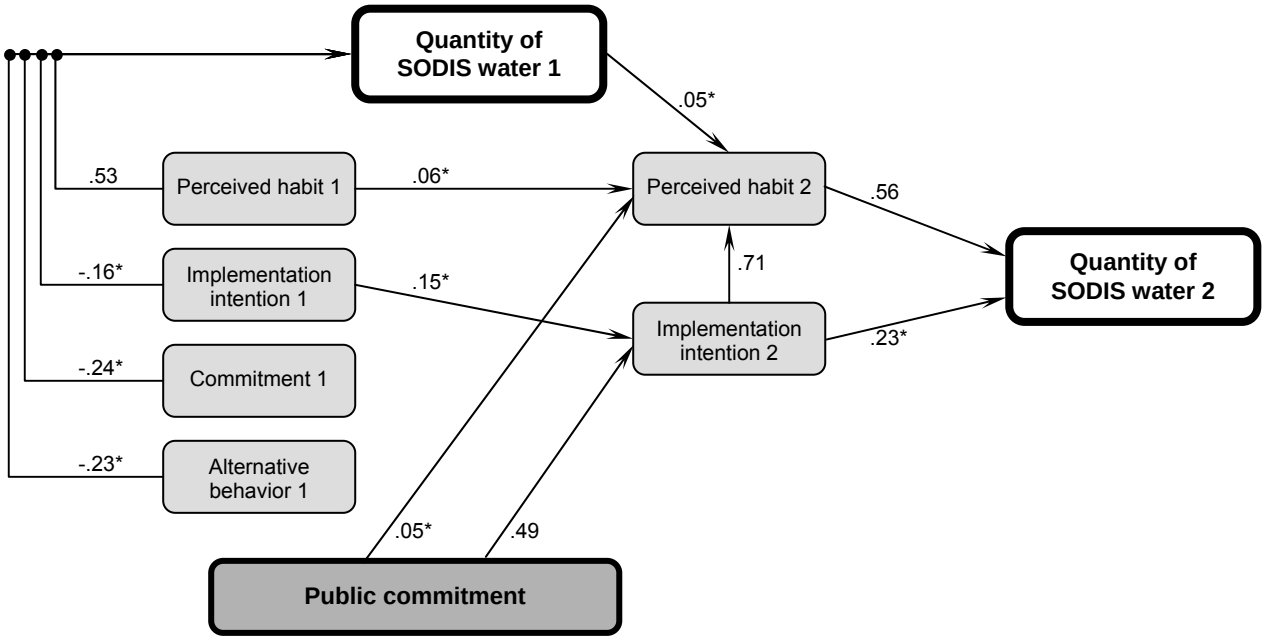
The public commitment model

In a second analysis, the model showing the mode of operation of public commitments was calculated. Again, the originally assumed model as displayed in Figure 19 did not fit to the data. The model showing the modes of operation of the intervention public commitment also had to be readjusted. The model that reached the best model parameters and was as similar as possible to the original model is shown in Figure 21. To reach a better model fit, the public commitment model also had to be reduced by the constructs alternative behavior 2 and the path from the SODIS behavior before the intervention to the behavior after the intervention. In addition to the previous model of the prompt intervention, the commitment 2 after the intervention had to be eliminated. Furthermore, an extra path between the implementation intention 2 and habit 2 after the intervention had to be inserted. As in the previous analysis, the error variances of the independent variables habit, strength of implementation intention, strength of commitment, and alternative behavior at the first measurement time were set freely by the program and were allowed to covary. The covariances, again not displayed in favor of simplicity, reached values between -.66 and .64.

The model fit is found to be good. The goodness-of-fit statistics provide a chi-square of 16.66 with fourteen degrees of freedom. The RMSEA of .033 is below the .05-threshold for a good model fit. The descriptive indices of overall model fit also indicate a good fit (GFI=.99 and AGFI=.99).

As for the prompt model, habit shows a significant influence on SODIS behavior 1 before the implementation of the public commitment (.53). All other behavior-near constructs did not reach significant influences on behavior at the 5% level for time point 1. Nevertheless, the explained variance of SODIS behavior 1 reached 57%. Interestingly, behavior 1 did not have a significant influence on habit 2 after the intervention as it was the case for the prompt model. The path coefficients between the two remaining behavior-near constructs from the first to the second measurement time again exhibit small values, and none of the two reaches significance.

Figure 21. The mode of operation of public commitments over two points in time: Path model with standardized path coefficients. Study II, Panels 3 and 4.



Note: The numbers 1 and 2 refer to the time point 1 = before the intervention (3rd panel of Study II), 2 = after the intervention (4th panel of Study II). * = not significant. Explained variances: $R^2_{(Quantity\ of\ SODIS\ water\ 1)}$=.57, $R^2_{(Quantity\ of\ SODIS\ water\ 2)}$=.55, $R^2_{(Habit\ 2)}$=.55, $R^2_{(Implementation\ intention\ 2)}$=.25. Model fit indices: χ^2=16.66, *df*=14, RMSEA=.033, GFI= .99, AGFI=.99.

In fact, time point 2 is in the case of the public commitment model completely detached from the predictors of time point 1.

The public commitment affected the strength of implementation intention 2 significantly (.49), which in turn had a strong influence on habit 2 (.71). Furthermore, habit 2 after the intervention strongly affected the target behavior 2 (.56). The strength of implementation intention 2 did not significantly influence the SODIS behavior after the intervention. In all, 55% of the variance of the target behavior 2 after the implemented public commitment was explained.

DISCUSSION

At first, a brief summary of the results on SODIS uptake and SODIS water quantity will be presented. The main part of the discussion will then focus on the effects and modes of operation of prompts and public commitments

SODIS uptake

Throughout the two studies and across almost all measurement points, SODIS uptake was positively influenced by having a prompt. In Study I and the third panel of Study II, a family

which had a prompt in the house had increased chances of about 150% to use SODIS. In the fourth panel of Study II, this chance increased to even 360%. Most amazing was to still detect the influence of the prompt in the fourth panel of Study I, when already seven months of inactivity had passed. This result is clearly a strong sign in favor of prompts, because a), the prompt has shown to have the potential to stay a long time in a household (in comparison to the public commitment, which was reported to be torn down by wind and weather) and b), if the prompt is there, it also has a proven impact. These results suggest that no habituation has taken place and the effect did not decrease. Rather, it is assumed that between the prompt and the behavior SODIS a strong link has emerged and people got primed to the target behavior.

In those cases, where enough public commitments had been actually distributed to calculate their impact on SODIS uptake (Study I, only panel 3; Study II, panels 3 and 4), they also exhibited a good influence on SODIS uptake. Chances to use SODIS when a public commitment was hung outside the house were increased by factor 100 to 250% (most conservative estimation). Unfortunately, the long term influence could not be estimated (Study I, panel 4), because not enough public commitments had survived the 7 months interval.

Taken together, prompts and public commitment were able to explain parts of the uptake behavior. However, the amount of explained variance due to prompt and public commitment varied quite a bit. In Study I during the active phase, 25 to 30% were explained, in contrast to the fourth panel after the seven months break where only 7% of the behavioral variance was explained. In Study II, the part of variance explained by prompt and public commitment never exceeded 13%, which was only half as much as for Study I. One reason is seen in the difference of time intervals between the intervention and the measurements. Whereas in Study I panels 2 and 3 took place between one and three weeks after the intervention phase, in Study II the interval may have been as long as four months. This would also explain the low value for Study I, panel 4, because there the interval was seven months. It is assumed that at first the try-out behavior is quite quickly directly initiated by having a prompt or public commitment. Later on, other internal factors develop and therefore the direct influence declines.

Further influence on SODIS uptake was as elicited in both studies by the number of communication channels – one communication channel more from where people had heard about SODIS increased the chances of using SODIS by the 200 to 300% after the first phase of interventions, and by approx. 50% after the second phase of interventions. For detailed effects of the different communication strategies, see chapter 4. The monitoring only in Study I showed a strong influence on SODIS uptake, chances to be a SODIS user were increased by 100 to 700%. In Study II however, no influence of the monitoring on SODIS uptake was found. Maybe here the frequency made the difference: in Study I the monitoring had taken place twice a week, whereas in Study II only once a week. No relevant influence of demographic characteristics was found.

Quantity of water disinfected with SODIS

The direct investigation of the effects of prompts, public commitments, other activities and demographic characteristics on SODIS use intensity of those people who had already started using SODIS showed that the dependent variable, quantity of water disinfected with SODIS, could not be explained very well. The brief analysis using data of Study II, panels 3 and 4 showed explained variances of 6% and 10%, respectively. Prompt and public commitment gained only low influence, stronger predictors were actually age and persons per household in a negative way. Overall, with only external predictors, it could not be explained why some households treat 100% of their drinking water with SODIS and others only 25%. It is assumed that prompts and public commitment do not directly influence the behavioral intensity, but elicit their impact via other, rather internal factors, which will be discussed next.

The modes of operation of prompts and public commitment

As seen in the analysis discussed above and as it was confirmed by the models on the mode of operation of prompts (Figure 20) and public commitment Figure 21, once a household has started to use SODIS, no or only low direct influence of prompts and public commitment on behavior seems to take place. Instead, the influence is mediated by the behavior-near factors.

Direct influence paths of prompts and public commitments

In its final operational model the **prompt** influences all three behavior-near factors that were employed to predict behavior intensity as it was hypothesized: habit, implementation intention and commitment. The prompt influences habit most strongly, because it has the power to act as a situational cue. A situational cue in turn can activate mental structures of a future behavior, which can lead directly to a goal performance without any act of planning (Aarts et al., 1998). A positive influence of the prompt on implementation intention was also found, which indicates that the target behavior is activated by the prompt and the development of a corresponding implementation intention is initiated. Furthermore, also the expected influence on commitment was found in the model. Prompts, as situational stimuli, helped people to remember the target behavior and therefore seemed to have made them feel more committed to act.

Public commitment in contrast did only influence implementation intention (less than the prompt), not habit. As expected, the public commitment poster creates the feeling of being committed within the target group and therefore an important condition for forming an implementation intention is given (Gollwitzer, 1999). Moreover, receiving a public commitment poster influenced certain processes of planning the target behavior and exactly these processes are required during the action of forming implementation intentions (Tobias, 2007). Now, the

question is why the public commitment poster did not influence peoples' habit as it was expected. These expectations were based on the fact that the poster would act similarly to the prompt, because it was displayed on the front door where it was visible for the family and the community. However, this effect could not be observed and the public commitment did not seem to act like a cue stimulus. Possibly, the poster helped people to remember, but failed to provide the important information on what exactly has to be done (Tobias, 2007). Furthermore, Tobias (2007) stressed the importance of the place where a prompt is displayed. A prompt seems to be more influential and helpful for remembering the target behavior if it is presented at the place where the action itself has to take place. For the example of preparing SODIS, the most advisable places to display a prompt are the kitchen or the backyard next to the fountain where the water is normally filled into the bottles. Summarizing, it is assumed that the public commitment poster was placed wrong and contained too little information about the target behavior itself in order to operate as a cue stimulus and influence habitual behavior.

In a next step it will be looked at the entire structure of the two models on the modes of operation of prompts and public commitments, particularly how behavior is influenced by the behavior-near constructs.

The structure of the behavioral model and indirect influences of prompts and public commitments

At time point 1, confirming the hypotheses, SODIS behavior was very positively influenced by habit and negatively by the alternative behavior untreated water consumption. Unexpectedly, commitment showed a negative influence and implementation intention none at all. At time point 2, SODIS behavior was again very positively influenced by habit, but also moderately by implementation intention. Commitment on the other hand changed its moderate negative influence on behavior to no influence after the intervention in the prompt model, and even had to be eliminated in the public commitment model. The alternative behavior had to be removed from both models for time point 2.

The constant effect of **habit** on behavior was expected and had already been repeatedly reported by other authors (Aarts & Dijksterhuis, 2000b; Ajzen & Madden, 1986; Fishbein & Ajzen, 1975; Oullette & Wood, 1998).

Regarding the **implementation intention**, it is assumed that at the first time point the participants had not yet formed a correct implementation intention towards the goal behavior. Although implementation intention already at time point 1 shows a rather high value (Table 20), it seems that people were neither already committed nor their goal – to do SODIS – was correctly activated (Gollwitzer, 1999; Triandis, 1977, 1980). As expected, the **prompt** activated the correct goal and helped to remember which behavior had to be performed (Sheeran, Webb

& Gollwitzer, 2005). Further, the target group at this point in time felt more committed than in the beginning before the intervention (M_1=0.40 vs. M_2=0.54, compare Table 20). The correctly activated goal and the increased commitment towards the target behavior have probably led to the formation of a goal oriented implementation intention, which then affects the actual behavior (time point 2; Gollwitzer, 1993, 1999).

In case of the **public commitment**, which also had a positive influence on implementation intention, in contrast to the prompt model, for time point 2 the implementation intention did not become a significant predictor of the behavior 2. Instead, a new path had to be introduced into the public commitment model, drawing an influence of implementation intention 2 on habit 2, which has – as already discussed – a positive influence on behavior 2. In other words, the public commitment provoked a behavior change not directly via habit, but via the strength of implementation intention that influenced habit. This finding was not expected, but will be explained in the following. Aarts and Dijksterhuis (2000b), for example, claim that the process of forming an implementation intention is very similar to the process of developing a habit (Aarts & Dijksterhuis, 2000a; Bargh & Gollwitzer, 1994). Concerning the formation of an implementation intention, researchers assume that the mental accessibility of a situational cue stimulus is increased and consequently simplified (Aarts et al., 1999). The behavior stated in the implementation intention can also evoke a habit when it is performed repeatedly over time and with positive results (Oullette & Wood, 1998). It is assumed that in case of the prompt, the path implementation intention on habit could not emerge due to the already existing direct influence of the prompt on habit. In case of the public commitment, no direct influence on habit was found as discussed above. It is assumed that the similarity of the factors, habit and implementation intention, had to manifest itself differently, namely in the explicit influence of implementation intention 2 on habit 2.

The negative effect of the strength of **commitment** on behavior for the first time point will be discussed next. After analyzing the distribution of these two variables (see Table 21), it is clear that a great number of families (marked yellow), who disinfect 75% or almost all of their water with SODIS, do not feel very committed to do so. For these people, a commitment perhaps indicated a feeling of external obligation. However, since they were already using SODIS quite intensively, they did not feel externally obliged (and committed), but internally motivated. Already at time point 1, they showed the behavior due to their own motivation and not because of an external commitment. Further, it should always be taken into account that it may be problematic to survey certain psychological constructs in other cultures. Maybe the participants did not understand the question about feeling committed, or they understood it in a wrong way.

Although the strength of commitment increased slightly over time, it still did not influence the target behavior after the intervention in the prompt model and even had to be removed from the commitment model, because no relation to other variables was found. This finding could indicate that the other two variables, habit and strength of implementation intention, at time

Table 21. Crosstabulation of commitment 1 and behavior 1, frequencies. Study II, Panels 3 and 4.

Strength of commitment 1: Do you feel committed to do SODIS?	Target behavior 1: How much SODIS water do you and your family drink?					
	(almost) nothing	around 25%	around 50%	around 75%	(almost) 100%	Total
no	1	8	5	28	8	50
a little	0	11	18	8	3	40
some	0	7	11	12	5	35
sufficient	0	2	12	16	8	38
a lot	0	1	7	7	1	16
Total	1	29	53	71	25	179

point 2 have together a greater explanatory power on the behavior and therefore exclude the strength of commitment. Further, it could be supposed that, like at the first measurement time, the feeling of commitment has a different meaning for this certain target group or was misunderstood by them.

The removal of the **alternative behavior** 2 from both models was due to the fact that the consumption of untreated water decreased and a great percentage (80%) consumed almost no untreated water at the second time point. However, this does not necessarily mean that the people were treating more water with SODIS instead. There were still other opportunities to treat drinking water, for example boiling or chlorinating. However, the participants who still show the alternative behavior at time point 2 are too few to have an influence on the target behavior as on behavior 1. As a consequence, the alternative behavior could not be fitted into the model.

Another change to the original model is the elimination of the direct influence of behavior 1 on behavior 2. This elimination indicates that the past behavior collected before the intervention has no direct effect on the future behavior after the intervention. Only a small indirect effect of the past behavior on the future behavior via habit remained in the prompt model. In the public commitment model this relation between time point 1 and 2 did not become significant. All in all, this is seen to be an effect of the great time difference between the two surveys (4.5 months) and the promotion activities that had taken place in between[12]. The same explanation applies to the low values for the relations between the past and the future values of the behavior-near constructs. Only in the prompt model the past implementation intention slightly influenced the future implementation intention. Even though other authors (e.g. Bamberg et al., 2003) did find stronger influence, they tested pre-intentional (behavior-distant) variables like attitude, perceived behavioral control and social norm in contrast to the test of behavior-near constructs as in the present study. Those behavior-distant factors may be more stable under changing circumstances and therefore a relation over time is more likely to be found. Moreover, with the present study it was intended to change the behavior-near factors with the

[12] The same non-relation has already been observed in chapter 1, see there for a more detailed explanation.

interventions. Therefore, it also seems logical that almost no relation remained between time point 1 and 2. A strong relation would only make sense in the case of stable situational circumstances (see also Bamberg et al., 2003).

Summarizing, the explained variances of the final target behavior were 56% in the prompt model and 55% in the public commitment model, respectively, which are good values. Concerning the mode of operation of the prompt, it could be shown that the prompt influenced all three behavior-near factors. Therefore it can be stated that a prompt operates positively on the formation of a habit and an implementation intention and develops a feeling of commitment towards the target behavior. Subsequently, the formed implementation intention and habit evoke the performance of the goal behavior. Thus, the prompt operates simultaneously in two ways: implementation intention or habit on behavior. The mode of operation of the public commitment was found to be different. The public commitment seems to initiate an implementation intention towards the target behavior, but not directly a habit. Instead, the implementation intention then facilitates the formation of a habit, which then in turn affects the behavior. So, the public commitment only has one mode of operation: implementation intention on habit on behavior. The role of the factor commitment, however, remains unclear, see limitations.

CONCLUSION

It has been demonstrated that the applied interventions prompt and public commitment were able to increase chances for people moving from a pre-action to an action stage in the behavior change process, i.e. to start using SODIS. For the prompt, it could be shown that even on the long term (after 7 months) it was still effective. Directly after the intervention phase the intervention itself was very dominant in predicting SODIS uptake. After a while, other factors also seem to become important and the interventions had lower predictive power of SODIS uptake. When it comes to predicting the amount of water that is treated with SODIS once a person started using it, prompt and public commitment do not directly contribute to an explanation anymore. Instead, the influence is more indirect, via the behavior-near factors.

The presented models indicate that the prompts and public commitments operate in different ways, although both influence the target behavior successfully. Of the three behavior-near factors investigated, habit, implementation intention and commitment, habit plays the most central role in influencing behavior before and after the interventions. Only the prompt affected habit directly, whereas the public commitment operated through the implementation intention and influenced habit only indirectly. The implementation intention was also influenced by the prompt and in the prompt model affected the goal behavior directly. So, the prompt shows two direct ways of influencing behavior: via implementation or habit, whereas the public commitment

has only one, more indirect one, which necessarily involves both factors, implementation intention and habit. Furthermore, the results of the present study show that both intervention strategies evoked a decrease of the alternative behavior drinking untreated water, which can also be seen as a success in terms of reduced chances to contract diarrhea for the targeted people.

LIMITATIONS & OUTLOOK

Specific limitations for this analysis are the sometimes low number of people who actually received the interventions. Therefore, for example, it was not possible to estimate the long term effects of public commitments. Reasons are that intervention materials in our studies are distributed by field worker in a close-to-normal manner to also test the practicability of the materials. This routine, however, is very vulnerable to unforeseen complications, and it cannot be guaranteed that the number of distributed intervention materials reaches the number that was actually planned and would have been more adequate for statistical analyses. In Study I, it occurred that in the beginning people liked the prompt a lot more than the public commitment, because the prompt was a bigger poster and they were allowed to keep it inside (they liked it for decoration). Only during the second phase of interventions (before the third panel), we addressed this problem with giving more restrictive instructions to the field workers about where to distribute which material. Nevertheless, testing the long-term effects failed for the public commitment, because after 7 months only very few of them were not yet destroyed by wind and weather. In fact, we were surprised that there were still enough prompts in the houses to actually run a test on their long-term effects. In Study II, a very disperse area, it was simply unclear if the families received any material at all, if they used it for a different purpose, lost it or threw it away. It was simply impossible to control the field workers. For future studies in the field, it is recommended to plan the distribution of the interventions even better; however, with the resources we had we already did the most possible.

This insecurity when planning the distribution of intervention materials together with organizational difficulties particularly in dispersed areas caused another problem: the long time difference between the panels in Study II. The long interval had a particularly negative effect on the calculation of the two models on the mode of operation of prompts and public commitments, because here long-term data was involved. But it simply had to be made sure that there was actually enough time to have the intervention materials distributed by the field workers, therefore measurements had not been planned with shorter intervals in Study II.

Particularly disadvantageous for the model calculations on the modes of operation of prompt and public commitment was the small sample size that was found amongst SODIS user across two measurement points. One rather unsatisfactory solution to the problem would be to also include people who do not yet use SODIS. However, this option poses the problem that

one would need to survey habit and commitment of people who do not yet perform the behavior and would need to foresee or imagine their habit and commitment, which is doubted to produce valid answers. Increasing the sample size already from the beginning may sound like the simplest solution, but here the available resources represent a hard limit, since it is not a question of mailing a few more questionnaires out to addresses taken from the phone book, but to employ additional interviewers for several weeks.

A further difficulty of the present study is the role of the strength of commitment. After all, the effects of this construct have remained unclear and it could only be speculated about it. Thus, it is recommended that further research may operationalize this factor differently and investigate beforehand in a given setting how this construct is understood.

Despite those limitations, it was possible to demonstrate the potential and also the problems of prompts and public commitments in the field. It was shown that they were accepted, and that they have a positive influence, even in the long term. Prompts after all scored a bit better in the analyses. It is therefore recommended to have either both interventions in combination (although this effect still has to be investigated) or if this is not possible, to give a preference to prompts. This recommendation is underpinned by the fact that habit is such an important factor, but only the prompt influenced it directly. Furthermore, prompts are more durable, because they are used indoors. In general, the understanding of how intervention strategies operate may lead to more efficient planning and maybe completely new ideas of how to improve intervention materials.

Chapter 4

Effects of different communication strategies

CONTENTS

ABSTRACT

Three different communication strategies were systematically applied during Study I in the periurban areas. Two interpersonal strategies had been selected, one using professional promoters and the other one using local people from the community as opinion leaders. The third strategy applied was a centralized strategy, namely a health fair, which carries characteristics of interpersonal and mass communication strategies. Those three approaches are compared with each other and the control groups. Indicators of the effectiveness of the communication strategies are SODIS knowledge, SODIS use and effectiveness of the strategies in reaching people.

Data used for this analysis comes from all four measurement time points of Study I of the periurban areas. The rural area had to be excluded because the applied communication strategies were too confounded with each other. The same applies for Study II.

In terms of reaching people and changing their behavior to use SODIS, the strategy of employing promoters was most successful. Opinion leaders – although less effective – pose a good potential to stimulate communication between people about SODIS. Working with opinion leader instead of promoters or a combination of both is rated as being more economic and more long-term effective. In contrast, the health fair stayed beyond expectations and did not have a big impact on behavior. Reasons are that only a small portion of the people was reached with the health fair and it was only a one-time event. Further discussion includes the costs of the various promotional activities, limitations and some recommendations for future projects.

Keywords: Promoters, opinion leaders, health fair, Bolivia, solar water disinfection

INTRODUCTION [13]

An analysis of the few studies available on SODIS promotion shows that the success rate (percentage of SODIS users) varies greatly. Rainey and Harding (2005) report an adoption rate of only 9% in the course of a four-month follow-up study, but the promotional effort here was very limited (one 2-hour training session). In contrast, other studies (Kabra, 2005; Mahmood & Lodhi, 2005; Moser et al., 2005) report adoption rates of between 40 and 70%. However, the promotional effort in these studies was comparably high, consisting of multiple strategies applied simultaneously. The core problem of information about past SODIS promotion activities is the lack of systematic approaches. In the rare case that an evaluation regarding applied communication strategies has taken place, the strategies were only evaluated post-hoc, often various strategies are applied simultaneously, and effects are confounded. But often no valuable evaluation takes place at all. Until now there is no accordance among practitioners in the SODIS promotion context, which would be a sensible, economic, and sustainable combination of communication strategies in a certain cultural background.

During the two studies which are the basis of this thesis, different communication strategies were applied. However, only Study I was conceptualized as a systematic comparison of three different communication strategies. In Study II the approach was less systematic and many different communication strategies were applied simultaneously, so the information would be too confounded with each other. Therefore, the focus is on the results of Study I. The communication strategies tested in this study will be presented in the following. They were derived on the basis of their applicability in the field, integrating what is known from theory and the field. Taking into account the experiences of our local partners, we found it useful to supplement the common classification of promotional strategies into mass media and interpersonal communication channels (e.g. E. M. Rogers, 1995, p. 194) by adding a third category that we entitled *centralized communication*.

Classical mass media such as radio or TV are not studied here for two reasons: firstly, many studies on effectiveness of classical mass media already exist, showing that they often do not change the actual behavior of the majority of people (e.g. Alcalay, 1983; Griffin & Dunwoody, 2000) and only influence the early adopters of an innovation (Valente & Saba, 1998). Secondly, from field experiences it is known that personal contact seems to be very important in SODIS promotion. Therefore, the study concentrated on interpersonal communication and the new category, centralized communication.

Interpersonal communication channels have a great potential to change behavior because they allow effective persuasive communication (E. M. Rogers, 1995, p. 18). In addition, they can change contrary attitudes and encourage implementation intentions due to the process

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of social exchange (Gierl, 1987). The effectiveness of the social exchange process depends to a certain extent on the similarity of the exchange partners (homophily; Lazarsfeld & Merton, 1954). Similar social, economic, and educational status between the interaction partners makes interpersonal communications more effective (E. M. Rogers, 1995, p. 286; Petty & Wegener, 1998). For example, Levy-Storms and Wallace (2003) investigated the promotion of mammography and found that informal (more homophilous) channels had a greater impact on implementation intentions and behavior. In the SODIS promotion context, interpersonal communication is typically realized by heterophilous agents (promoters making household visits). These promoters have the advantage of being experts in the topic they are promoting, they can be easily trained to work continuously with their clients, and NGOs usually report high success rates with them. A disadvantage is the great effort needed to reach people. A way of realizing homophilous communication is to use opinion leaders (or block leaders; Katz & Lazarsfeld, 1955), but this approach has never been tested for SODIS promotion. Opinion leaders are persons from inside a social system (community) with high social status and a high openness to innovations. Examples of the successful engagement of opinion leaders can be found in Kelly et al. (1991) on the promotion of AIDS-preventive behavior, or Burn (1991) on the promotion of recycling. Advantages of working with opinion leaders include, besides more effective communication, better suitability in dispersed areas where employed promoters are impractical due to long distances and lack of supervision. Limitations of opinion leaders could be their 'working' hours and the availability of targeted people (Passanisi, Prout, & Holm, 2001), or their lower motivation to promote the innovation because of being unpaid. In addition, their knowledge may not be as profound as that of the promoters, and they are difficult to control because they work on a voluntary basis. Nonetheless, if the opinion leader approach turned out to work with SODIS in the field, it would probably give NGOs a very low-cost and low-effort promotional strategy. Therefore, the opinion leader approach was introduced and tested in Study I to compare it with the traditional promoters approach. It is expected that the promoters are very effective in disseminating knowledge and changing behavior. However, effects are only expected to persist as long as they are actively promoting SODIS. The opinion leaders may achieve lower and slower changes, because they do not have such an expert status. But in contrast to the promoters, SODIS should then be embedded more strongly in the social system and consequently this approach should be more sustainable in the long term.

Apart from classic mass media and classic interpersonal approaches, in the field context communication strategies are used, which were not clearly classifiable to one or the other approach. These 'field' strategies hold elements of both approaches, interpersonal and mass media communication, and have some additional characteristics. These strategies can be best described as a centralized way of communication and comprise all types of fairs and partly community reunions. Due to the popularity of fairs, their frequent application (Moser & Mosler, 2008), and because not much is known about the effects of fairs, a health fair as a third communication strategy was included into the study. The main feature of the new category, named centralized communication, is the combination of different elements. Similar to mass

communication, one can reach many people at once, but also the persuasive power of the social exchange process is used during the interpersonal communication that takes place between the exhibitors and the visitors of the fair. However, the communication is probably rather brief and in a public context (usually at a central spot in the community, therefore "centralized communication"). Therefore, the fair is expected to be less effective than household visits (promoters) or the communication within a social system (opinion leaders). A very particular characteristic of the centralized communication is that fairs do not take place very frequently (approximately only once in six months). So unlike any other of the communication strategies, this is a one-time communication and therefore its effect over time may not be very strong. The health fair is expected to have an influence on knowledge, but little effect on behavior. The lower effect on behavior would have two reasons: One, the interpersonal communication taking place is not expected to be very detailed, and it is therefore less effective; two, the health fair is only a one-time event. So even if people try out SODIS, this effect is expected to be weakened quickly with time. An open question is the range of coverage of a health fair.

Summarizing, two interpersonal promotional strategies, promoters and opinion leaders, and a centralized communication strategy, health fair, will be systematically compared with each other and a control group. Measures are the effects on SODIS knowledge, SODIS use and the achieved coverage of the activities. The following hypotheses can be stated:

(1) Promoters have stronger short-term effects than opinion leaders on SODIS knowledge and use.

(2) Opinion leaders have stronger long-term effects than promoters on SODIS use.

(3) The health fair has lower effects on SODIS use than both interpersonal strategies, especially on the long-term.

Additionally, the question whether the health fair has the same or a different coverage compared to the promoters and opinion leader approaches will be answered.

METHODS

The comparison of the three promotional strategies and the control group will use data from the periurban areas of Study I, panels 1 to 4. The first three panel measurements reflect short-term effects whereas the fourth panel reflects long-term effects after an inactive phase. A detailed description of the study area, the communication strategies as well as all operationalizations can be found in the overall Methods part.

RESULTS

The demographics do not show any important differences between the four areas (Methods chapter). Especially important, there is no particular area with permanently the lowest or highest values. Therefore, the areas are considered as being comparable, but it will also be controlled for the demographic variables during the analyses.

The main analyses will concentrate on a description of the effects of the different promotional strategies using the four indicators: percentage of people who knew about SODIS, depth of SODIS knowledge, adoption rate of SODIS (percentage of users) and communication channels where people heard about SODIS. The effects of the interviewer will be addressed separately in the last part of the results section.

SODIS knowledge

Whether people had heard about SODIS or not was investigated by only using those households that were included in the study since the first panel (consequently, N declines over time due to drop outs), because the selection criterion for later inclusion was that people had to know about SODIS. Both types of questionnaires (short and long) contained that information and were included in the analysis. Within one panel (one point in time), the percentages of the different areas are compared with pair-wise chi-square tests. For exact and mean percentages, see Table 22.

The results show, that although it was intended to create similar percentages of people knowing SODIS before the study with the use of the loudspeaker car, percentages in fact varied quite a lot between the areas at the time of the first panel. The promoters' area had the lowest percentage of people who knew SODIS (7%) and differed significantly from all other areas (all $p<.001$, $\chi^2(1)>19.1$). The other areas (health fair, opinion leaders, and control) had percentages of between 32% and 51% with one significant difference between health fair and opinion leaders' area (32% compared to 51%; $p=.007$, $\chi^2(1)=7.361$). Testing for the relation to demographic variables, we found that the more years of education a person had, the more likely he or she was to have already heard about SODIS ($p<.001$, $F(1)=29.4$). This relation is clearly reflected by the opinion leader area (most years of education → highest percentage of people knowing SODIS) and the promoters' area (vice versa).

Already at the time of the second panel a ceiling effect occurred, as all areas with promotional activities had very high percentages of people who knew about SODIS of between 86% (opinion leaders) and 99% (health fair). Only the control area had a significantly lower value (56%; all $p<.001$, $\chi^2(1)>19.1$). At the end of the active phase at the time of the third

Table 22. Percentages of people knowing SODIS over time for each promotional strategy. Study I, Panels 1 to 4.

Communication strategy	1st Panel		2nd Panel		3rd Panel		4th Panel	
	%	N	%	N	%	N	%	N
Health fair	$32\%_{a}$	98	$99\%_{a}$	88	$99\%_{a}$	78	100%	50
Promoters	$7\%_{b}$	99	$91\%_{ab}$	74	$100\%_{a}$	66	100%	49
Opinion leader	$51\%_{c}$	90	$86\%_{b}$	85	$99\%_{a}$	79	100%	59
Control	$37\%_{ac}$	104	$56\%_{c}$	93	$95\%_{a}$	83	100%	74
Mean / Total	31%	391	82%	340	98%	306	100%	232

Note: Percentages in one column which do not share the same subscripts differ from each other at least at p<.05 in a pair-wise chi-square test. Since it was necessary to calculate six chi-square tests to assess the differences between all four groups within one panel in a pair-wise way, the corresponding threshold to define the significance p-level was adjusted (Sachs, 1978, p. 369).

panel, almost every household had heard about SODIS and the percentages varied only between 95% and 100%.

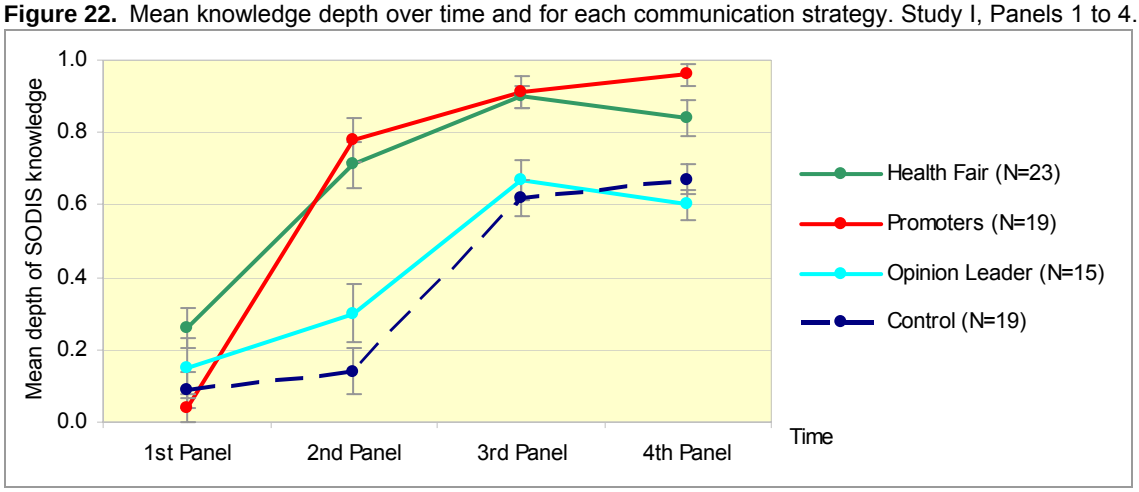
In summary, all promotional strategies were clearly effective in informing people more quickly compared to the control area.

Knowledge depth

The more qualitative indicator *depth of knowledge* was analyzed with a General Linear Model (GLM) for repeated measures. This method allows the simultaneous investigation of group, time and interaction effects. A drawback is that a GLM model requires complete data sets, so only cases with data from all four time points were used. Thus, the number of cases was much lower, but a calculation with the complete dataset (all information available, only long questionnaires) showed very similar mean values. The finally calculated model contained a total of 76 cases and included all demographic variables as covariates (age, education, occupation, number of persons in the household, number of children below 5 years of age in the household, and gender). Additionally, the number of people a person knows within the same community but outside the house was included, because having more social contacts could cause a better knowledge level due to increased exchange possibilities. The development of knowledge depth over time and for each promotional strategy is shown in Figure 22.

The promotional strategies have a strong direct group effect ($p<.001$, $F(3)=20.2$), whereas time shows a somewhat weaker direct effect on the depth of knowledge ($p=.021$, $F(3)=3.3$). Also, an interaction between both could be observed ($p<.001$, $F(9)=8.2$). Of the demographic variables, only the number of children below 5 years of age showed a slight significant direct effect ($p=.026$, $F(1)=5.2$). None of the demographic covariates showed an interaction effect with the time factor. Pair-wise comparisons of promotional strategies (post-hoc Bonferroni method based on estimated marginal means) confirmed what can already be seen in Figure 22: the health fair and promoters' areas form one group on a generally higher level and

Figure 22. Mean knowledge depth over time and for each communication strategy. Study I, Panels 1 to 4.



differ significantly (p<.012) from the opinion leader and control areas, which form a second group on a lower level. Pair-wise analyses between the four time-points (post-hoc Bonferroni method based on estimated marginal means) also confirm the visual presumption: the overall increase of knowledge is highly significant until October 2005 (p<.001), and then the level remains stable until June 2006.

In summary, quite a high level of knowledge depth was reached after the two months of promotional activities, and this level remained stable until the fourth panel seven months later. Although the final level was quite high, clear differences were evident between the promotional strategies. Whereas the health fair and the promoters almost reached a 'very deep' level, the opinion leader and control group only achieved a 'deep' level. The late "take off" of the control and opinion leader groups – the knowledge depth only started to increase remarkably after the second panel – is especially noteworthy.

SODIS use

The most important aim of the study was – besides informing people about SODIS – to get people to use SODIS to treat their water. This information was gathered with the long and the short questionnaires. Table 23 lists the percentages of SODIS users across areas and time.

At the beginning of the study, the opinion leader area had a slightly higher percentage of SODIS users than the other periurban areas (11% compared to 3% in all other areas), but pair-wise chi-square tests showed no significant differences. Similar like for the level of knowledge, at the time of the first panel also for SODIS use a positive relation to the education level existed (p<.001, F(1)=12.2).

Table 23. Percentages of people using SODIS over time for each communication strategy. Study I, Panels 1 to 4.

Communication strategy	1st Panel		2nd Panel		3rd Panel		4th Panel	
	%	N	%	N	%	N	%	N
Health fair	$3\%_a$	98	$14\%_a$	132	$48\%_a$	125	$39\%_a$	90
Promoters	$3\%_a$	99	$47\%_b$	88	$73\%_b$	81	$47\%_a$	74
Opinion leader	$11\%_a$	90	$33\%_b$	96	$62\%_{ab}$	92	$41\%_a$	70
Control	$3\%_a$	104	$13\%_a$	92	$29\%_c$	85	$20\%_b$	83
Mean / Total	5%	391	25%	408	52%	383	37%	317

Note: Percentages in one column which do not share the same subscripts differ from each other at least at p<.05 in a pair-wise chi-square test. Since it was necessary to calculate six chi-square tests to assess the differences between all four groups within one panel in a pair-wise way, the corresponding threshold to define the significance p-level was adjusted (Sachs, 1978, p. 369).

After one month of activities, the user percentages of the areas with the various promotional strategies differed greatly from each other. Promoters produced a good increase to 47% users, and opinion leaders had a more moderate influence and reached 33% users. Only the health fair resulted in a fairly low percentage (14%). Except for the health fair percentage, the other two values differed significantly from the control area ($p<.01$, $\chi^2(1)>10.8$), which reached 13%. The same order of user-percentages as for the second panel was found for the third panel: the promoters' area had the most users (73%), next was the opinion leaders' area (62%), which was followed by the health fair area (48%) and the control area (29%). All the promotional strategy areas, including the health fair area, now differed significantly from the control area (health fair $p=.007$, $\chi^2(1)=7.256$, the others $p<.001$, $\chi^2(1)>18.819$). Additionally, the high percentage of the promoters' area differed significantly from the health fair area ($p=0.001$, $\chi^2(1)=12.4$). In summary, until October 2005 a clear order of the promotional strategies in terms of SODIS user percentages was visible: the promoters were more effective than the opinion leaders, which were more effective than the health fair in terms of getting people to start using SODIS. Interestingly, the control area without any promotional activities also showed a considerable number of users (29%). This finding will be discussed later.

Now, when looking at user percentages at the fourth panel in June 2006, it can be clearly seen that quite many people stopped using SODIS. The percentages went down to 39-47% in the areas and down to 20% in the control area. The differences between the areas of previous promotional activities and the control area were still significant (health fair $p=.008$, $\chi^2(1)=7.0$; promoters $p<.001$, $\chi^2(1)=12.7$; opinion leaders $p=.005$, $\chi^2(1)=7.9$; all comparisons with the control area), but no more significant differences were found in between the areas which previously had promotional strategies. So, overall the promotional strategies showed their effects compared to the control area, but there were no differential effects between the various activities. No relation of SODIS user percentages to the demographic variables were found for the second, third and fourth panel.

Communication channels

To compare the perceived communication channels with the applied promotional strategy, communication channels were assessed openly. Table 24 presents percentages of the various communication channels separately for each promotional strategy and time point. Named communication channels were the promotional strategies themselves (health fair, promoters and friends/neighbors to measure opinion leader influence), the loudspeaker car, the interviewers and other sources (radio, TV, institutions, schools). Unsurprisingly, the interviewers were named by nearly everyone, but often other sources were also named. Therefore, the percentage of those who communicated *only* with the interviewers (and no other source) was included in Table 24. Additionally, the percentages of households which had no SODIS related communication at all were also included.

Asking where people had first heard about SODIS during the first panel had the main goal of checking if the loudspeaker car did have an impact or not. The results show that people had heard about SODIS mainly from other people, from radio or TV or a range of other sources. The loudspeaker car as the source of the first-time-knowledge was only mentioned on average by 8% (N=31), although there were still almost 70% of the people who had never heard about SODIS before the study (and theoretically would have been the target population for the loudspeaker car). Since the amount of people who had heard about SODIS from the loudspeaker car was so small, we refrained from investigating the effects of the loudspeaker car on SODIS knowledge depth or SODIS use. Basically, the loudspeaker car did not have any remarkable influence. The other sources named during the first panel will not be further interpreted, because the time span was about the last 10 years before the study and this information therefore can not be viewed as reliable.

To judge the effectiveness of the promotional strategies, it is of interest to know how many people heard about SODIS via the applied promotional strategies. The percentages after one month (second panel) showed relevant differences: while in the health fair area only 20% had heard of SODIS during the health fair, in the promoters' area 81% had contact with the promoters. In the opinion leaders' area, 46% of the people heard about SODIS via friends or neighbors. Communications within the social network in this area were clearly the result of the opinion leaders' work, because such communications were very low in the other areas (2-3%). While 46% was a good result for the opinion leaders as the least controllable promotional strategy, only 20% for the health fair was surprisingly low. One would expect such a big event to reach more people in the community. So it is not surprising that among the areas with a promotion campaign, the health fair area had the highest percentage with no communication at all (27%) as well as the highest percentage of those who had heard about SODIS only from the interviewers (45%). After the second month of promotional activities (third panel), the percentages relating to communication channels showed results similar to those after the first month: the promoters worked very constantly and reached 73%, and the communications due to

Table 24. Percentages of communication channels over time and for each promotional strategy. Study I, Panels 1 to 4.

Time	Communication strategy	Communication Channel: Loud-speaker Car	Health Fair	Pro-moter	Friend/ Neigh-bor	Other Source	only Inter-viewer	None	N
1st Panel	Health Fair	5%	-	-	21%	22%	-	57%	98
	Promoters	4%	-	-	7%	7%	-	84%	99
	Opinion Leader	16%	-	-	41%	34%	-	31%	90
	Control	8%	-	-	20%	24%	-	54%	104
2nd Panel	Health Fair	-	**20%**	3%	2%	5%	45%	27%	132
	Promoters	-	1%	**81%**	3%	16%	10%	8%	88
	Opinion Leader	-	2%	0%	**46%**	18%	27%	15%	96
	Control	-	5%	0%	2%	2%	65%	**26%**	94
3rd Panel	Health Fair	-	-	0%	2%	7%	32%	**60%**	125
	Promoters	-	-	**73%**	1%	6%	2%	23%	81
	Opinion Leader	-	-	0%	**39%**	24%	10%	38%	92
	Control	-	-	0%	2%	1%	9%	**88%**	85
4th Panel	Health Fair	-	-	-	8%	3%	-	89%	90
	Promoters	-	-	-	0%	0%	-	100%	74
	Opinion Leader	-	-	-	7%	3%	-	90%	70
	Control	-	-	-	1%	1%	-	98%	83

Note: Calculation of percentages is based on the total number of interviewed households per area. Percentages are rounded off. Empty cells mean that this type of communication channel did not exist for that time point and promotional strategy area. Bold numbers mark the communication channels that were applied and therefore expected for the corresponding promotional strategy area and time point. Multiple answers were possible; row sums may therefore exceed 100%.

opinion leaders showed that 39% learnt about SODIS within their social network. Only in the health fair area almost no communication channels were named, because – as planned – the health fair was not repeated a second time. So, once again we found the highest percentage of people without communication (60%) and only interviewer communication (32%) in the health fair area. Not much communication took place in the control area: most people mentioned no communication channel or only the interviewer.

When the fourth panel took place seven months later, almost no communication channels were named in all areas. As expected, no activities had taken place, but no communication had occurred within the social network either. For the opinion leader area it was a rather disappointing fact to realize that although we had managed to trigger communication within the social network, nothing remained after seven months.

Effects of the interviewer

The effects of the interviewer shall be investigated in more detail, because of the rather large amount of households that joined the sample during the second panel. In addition – and probably the more urgent matter to clarify – there is a considerable amount of households who have heard about SODIS only from the interviewers. Firstly, the new households from the second panel will be used in comparison to the households who were in the study since the

beginning to compare for sensitization due to interviewing. Secondly, the households who had heard about SODIS from the interviewer only and those who mentioned other sources will be compared with each other.

First, it is distinguished between first (*old* households) and second panel (*new* households) as entry points into the study. At the second panel, an analysis of variance revealed a slightly but significantly higher knowledge depth of the old households compared to the new households (M_{old}=0.54 [0.36], M_{new}=0.35 [0.37], N=192, p=.001, F(1)=11.97). This difference did not exist anymore at the time of the third panel (M_{all}=0.77 [0.22], N=192). In the case of SODIS use, chi-square tests were calculated, comparing percentages of SODIS user at each time point separately for the two groups, new and old households. Already in the second panel, no significant difference could be found, both groups had a similar percentage of SODIS users of about 25% (N=408).

The second analysis compared those households who heard from SODIS only from the interviewer (*onlyInt*) with those who mentioned other sources as well (*other*). Households who did not mention any communication channel are not included in this analysis. For the second panel, knowledge depth was clearly higher for those having heard about SODIS not only from the interviewer, but from other sources as well ($M_{onlyInt}$=0.64 [0.37], M_{other}=0.40 [0.31], N=153, p<.001, F(1)=18.1). At the time of the third panel, knowledge depth was equally high for both groups (M_{all}=0.79 [0.21], N=136). Looking at SODIS user percentages, only 18% of the households who had only heard from the interviewer about SODIS also applied SODIS, in contrast to 42% SODIS user in the "other" group (N=329, p<.001, $\chi^2(1)>21.7$). Also for the third panel the same picture was found: households who heard only from the interviewer were less likely to use SODIS ($f_{onlyInt=}$56%, f_{other}=79%, N=179, p=.001, $\chi^2(1)>10.5$).

Summarizing, the households who were one month longer in the study showed a slight sensitization effect on SODIS knowledge, but not on SODIS behavior. Furthermore, the interviewer did have an impact on SODIS knowledge and use (the effects found in the control area), but this effect was clearly lower than that of the promotional strategies as sources of information.

DISCUSSION

The following discussion compares the effectiveness of the different promotional strategies for the knowledge and use of SODIS. Our conclusions obviously hold only for a setting similar to the one in which they were tested.

Interpersonal communication

Until the end of the active phase of the study (third panel), both, opinion leaders and promoters, informed everyone in the sample about SODIS. The promoters reached people very well (81% during the first month, 73% during the second month) and opinion leaders triggered communications with moderate success within the social network (46% during the first, 39% during the second month). As hypothesized (hypothesis 1), a difference could be found when looking at short-term knowledge depth: promoters transferred information on SODIS better than opinion leaders. Also as hypothesized (hypothesis 1), promoters were more effective in influencing SODIS use in the short term and attained a figure of 73% of SODIS users compared to 62% in the opinion leader area. When looking at the long-term effects (fourth panel), percentages of SODIS users dropped to 47% for promoters and 41% for opinion leaders, and the difference had become insignificant. Clearly, SODIS did not become better embedded in the social system with the opinion leaders than with the promoters over the long term, as expected (hypothesis 2). The main reason seemed to be a lack of communication within the social network; it was only observed during the active phase in the opinion leader area. The low connectedness within the social network (each person only knew two other people on average outside the household within the same community) probably explains both the poor communication and that the opinion leaders in general did not make a greater impact. Another reason for the lower impact of the opinion leaders compared to the promoters may be people's insecurity about the trustworthiness of the innovation. People seemed to find 'official' information more convincing as regards the innovation (in our case that SODIS really disinfects water). This was confirmed by the opinion leaders themselves, who reported that some people they talked to doubted that the SODIS method worked and sought confirmation when the interviewers walked around to distribute the reminders. So, a part of the effects in the opinion leader area is certainly due to the interviewers serving as 'confirming experts' for the people and distributors of the reminders. Without the distribution of these reminders that serve as situational cues in the households, a lower effect on behavior would probably have been found.

Centralized communication

A comparison of the health fair with the interpersonal communication strategies reveals big differences between the two approaches. While at least 39% of the people heard about SODIS as a result of an interpersonal communication strategy, only 20% of our sample participated in the health fair. So clearly, the coverage range of the health fair is lower than that of the interpersonal strategies. Nevertheless, the percentages of informed people and knowledge depth were very high, at the same level as in the promoters' area. Probably the high knowledge was caused by the additional, unplanned impact of the interviewers in the health fair area. However, since it is impossible to disentangle the effects of health fair and interviewers in

the health fair area, we cannot clearly state if the health fair really would have achieved lower knowledge than the interpersonal strategies, as hypothesized. When looking at the user percentage after one month, a clear difference to the interpersonal communication strategies can be seen. The health fair area did not have more users than the control area (14%, which represents the interviewer effect) while in the interpersonal areas at least 33% of the people used SODIS. Only later, user percentages in the health fair area also increased more strongly than in the control area, but the interviewers were actively involved at that time (distributing reminders). The decision to involve the interviewers was made with the goal in mind to help the people with their water treatment. Although we cannot exclude delayed effects of the health fair, it would account for only those 20% who actually participated in it. Confirming our original hypothesis (hypothesis 3), the health fair area showed the lowest percentages of SODIS users of all promotional strategies areas at the end of the active phase. An explanation for the low participation rate (which was rather unexpectedly low to us too) is maybe the fact that people on average only know two other people outside her/his household. So maybe motivation to go to a primarily social event where he/she will meet other people is probably low.

As it has been observed for the interpersonal communication strategies, in the fourth panel also in the health fair area SODIS user percentages dropped down to a slightly lower level than in the areas with interpersonal strategies (39%). However, this difference was not significant.

In summary, interpersonal strategies were more effective than the centralized strategy. The centralized strategy did not reach as many people and did not change behavior well, while the interpersonal strategies were successful in both respects. Moreover, the applied centralized strategy (health fair) was the most expensive promotional strategy (music, animator, food for staff, advertising, prizes for competitions), while the opinion leaders were very inexpensive, and the two weeks of employing the promoters cost about half of the health fair. To us, the centralized strategy health fair as a method to reach people as it was suggested by our local partners seems to be questionable, at least the way it was organized in this study (which is the way NGOs do it) and in this kind of periurban setting we found. Maybe a more participatory approach in organizing such an event would have had the power to get more people attracted and involved, but here it needs further research.

For the interpersonal strategies, promoters are more effective than opinion leaders in the short term, but there is no difference between these two interpersonal communication strategies in the long run. The strengths of opinion leaders are their ability to trigger social network communication and their low costs, whereas the strengths of the promoters are their better quality in informing people, their higher perceived expertise and their higher practical skills in distributing additional materials. A clear drawback is the higher cost of their salaries. In our view, it would be worth to further investigate the opinion leader approach and to develop strategies that give them a more 'official' appearance. A combination of promoters and opinion leaders may perhaps show interesting synergetic effects and save costs. This combined approach could

start with promoters *and* opinion leaders working together and only later would the latter take over full responsibility. Alternatively, the expert promoters could be chosen directly from within the community. This combination would also be very practical for field application, because the training does not require much effort and should be applied for a longer time period to have real long-term effects on behavior. In fact, the strength of interpersonal contact is also reflected by the impact the interviewers had in the control area (and later in the health fair area), because conducting interviews is nothing else than having an interpersonal contact with the people. Therefore, we would like to emphasize the importance of further studies on how these interpersonal strategies could be improved in terms of optimizing costs *and* effects.

LIMITATIONS

A clear limitation is the different community sizes and the almost unavoidable irregularities of the sample size due to drop-outs and the enlargement of the sample in the second panel. The percentages of people who knew about SODIS before the study were also quite different. Only when we were in the field we realized that the opinion leaders are not very effective in distributing the reminders. So we had to take advantage of the interviewers, because the reminders were an important part of the promotional strategies. The interviewers had to be involved again when we realized that the health fair had such a low impact. There was also a strong general interviewer effect – in the control area a maximum of 29% used SODIS – but it would be ethically questionable to forbid an interviewer to tell the interviewed person more about SODIS (a method that could possibly save their children's lives) if she/he were interested in knowing more.

Even if the list of limitations appears to be long, the results shed some interesting light on the advantages and disadvantages of the different strategies. In addition, it was our intention to investigate these strategies in the field as close to NGO reality as possible, because that is where we hope the results will be used. Although the absolute level of SODIS use is probably not correct, the relation between the promotional strategies should be. We think that interviewer effects in all areas were similar or even lower in the areas where the promotional strategies worked well (opinion leader and promoters), so one should discount the effects of the control area on SODIS knowledge and behavior from those of the promotional strategies. This should reveal realistic results in terms of absolute level of SODIS knowledge and user percentages that can be achieved with the promotional strategies alone (without interviewers). We hope to have shown that although the promoters may not reach 73% of users on another occasion, they will probably be more successful than opinion leaders and also more successful than a health fair, if all are applied in similar periurban areas. However, to overcome some of these limitations and gain more insight into the promotional strategies presented here in different contexts, more field studies are needed on this topic.

Discussion

CONTENTS

INTRODUCTION

During the course of this thesis, data were gathered from two field studies and various results were presented with the goal to investigate SODIS promotion. Viewing angles were determinants of drinking water consumption (chapter 1), reasons for interrupted SODIS use (chapter 2), effects of prompts and public commitments (chapter 3), and effectiveness of different communication strategies (chapter 4).

In the last part of this thesis, previously presented results will be summarized and linked to each other. The frame for this last discussion is, as laid out in the overall introduction, the stages of the behavior change process. Although the structure reminds to chapter 1 where the behavior change process was investigated explicitly, information on the parts of the process stemming from other chapters will be added. Finally, as a summary, a 'perfect' SODIS promotion campaign will be described based on the presented results.

THE BEHAVIOR CHANGE PROCESS AND SODIS PROMOTION – THE INVESTIGATION

Factors influencing water consumption in Bolivia were investigated. The majority of the water consumed is either SODIS treated, boiled or untreated water. Bought water is usually only consumed during special occasions (weekends, get-togethers, events etc.). Consequently, determinants of the consumption of the three dominant water types were looked into: SODIS, boiled and untreated water. Each of the three water types is interpreted as a separate behavior and analyzed as such. Additionally, their inter-relations are laid out. The theoretical basis for deriving factors influencing the behaviors was a stage model of behavior change. The model consists of four topics or stages: (1) problem awareness (2) persuasion, (3) uptake, and (4) habit. Problem awareness and persuasion can be condensed into a motivational phase, where mostly cognitive processes are involved. Uptake and habit are stages of the action phase, and involve different processes. Problem awareness includes aspects related to: diarrhea problem awareness, awareness of clean water, importance of clean water, importance of, and the understanding of the causality between untreated water consumption and diarrhea. Persuasion comprises a wide variety of factors, such as: action knowledge, cognitive beliefs (about the taste, health impact, time costs, money costs, effort, difficulty, and cost-benefit evaluation), the affect, attitude, and normative influences.

During the uptake phase, the individual starts the new behavior. Resource availability, such as bottles for SODIS or combustibles for boiling, and situational circumstances become important. In case an individual moves on to the habit phase, processes of habit development are active. They can be represented with the perceived habit, the degree of implementation

intention, commitment and cognition intensity, frequency of forgetting, and felt dissonance in case the behavior gets forgotten.

Intention is viewed as a crucial transition point between the motivational and volitional phase. Behavior intensity is the outcome of the process. Problem awareness and persuasion do not have to be sequential, but may also process in parallel. Predictors of intentions towards each of the water types and predictors of each water consumption behavior were analyzed.

A comparison of relapse behavior with continued SODIS application including again all phases of the behavior change process tries to find out retrospectively, at which stage of the process relapsers failed to continue.

Effects of different applied interventions and communication strategies on SODIS uptake and percentage of SODIS water of the total water consumption are investigated.

THE DEVELOPMENT OF A POSITIVE INTENTION

In the following, the factors of the motivational phase will be separately looked at to derive their importance for future SODIS promotion campaigns. These aspects were analyzed regarding their power to positively influence the behavioral intention, which is a crucial factor for individuals to proceed to the action phase of the behavior change process.

Problem awareness

In chapter 1 it was shown that only one of the indicators of problem awareness, the understanding of the causality between untreated water consumption and diarrhea, showed an influence on the intention to use SODIS and the intention to boil water. However, this influence was rather low. When looking at the descriptive statistics, problem awareness already existed quite strongly within the populations before the start of both studies, as it was measured in both first measurements before any campaigns had started. The only variable, which actually showed a positive development over time, was the awareness if the consumed water is clean or not, but this indicator in turn shows no influence on any of the intentions. Also, the analysis of relapse behavior of chapter 2 showed that those, who stopped using SODIS, still had a high problem awareness and did not differ much from the continuers.

Summarizing, problem awareness already was prevalent among the investigated populations and does not influence intention (e.g. Calnan & Rutter, 1988; Luszczynska & Schwarzer, 2003; Schwarzer, 2001). Consequently, problem awareness does not need to be targeted with particular emphasis during SODIS promotion campaigns. However, it should be made sure that it really exists with the desired strength, for example with a baseline questionnaire. Maybe, also some more detailed (qualitative) information about the understanding of problem awareness could be gathered to get an impression about 'black spots'

within people's understanding of problem awareness. Some authors have experimented with the induction of fear via risk awareness information (Maddux, Brawley & Boykin, 1995; Ruiter, Abraham & Kok, 2001), but scaring people into healthy behaviors has not shown to be very effective (Ruiter et al., 2001).

SODIS knowledge

The percentage of people who knew about SODIS during both studies quickly reached nearly 100%. Already after one campaign phase, more than 80% knew about SODIS. This percentage was achieved independently of the applied communication strategy, as shown in chapter 4. Only interviews alone already resulted in around 40 to 50% of people being informed about SODIS after two rounds of interviews.

Once people have heard about the SODIS method, the more details they know about how to prepare SODIS water, the higher is their intention towards using it. This relation, which was found in chapter 1, implies that a focus should be laid on the provision with sufficient action knowledge until people have internalized the SODIS preparation process. The time span depends on people's knowledge preceding a promotion campaign. Therefore, the knowledge level has to be checked from time to time. In the periurban areas of Study I, for example, the knowledge level was higher already in the beginning and also at the end of the campaign compared to the rural areas of Study II. Once people have reached a sufficiently high level of SODIS knowledge, this aspect can be slowly removed from campaigns to avoid reactance (Brehm, 1966; Brehm & Brehm, 1981). Studies have shown that in the beginning, repetition and confirmation of existing attitudes or already given information result in an increased persuasive effect of the messages. More than five repetitions of the same message, however, may result in a more negative attitude due to reactance, distorted processing of information and generating of contrary arguments. The number of possible repetitions before negative effects take place may vary with the complexity and familiarity of the message and if variations of the message are used or not (Olson & Zanna, 1993; Petty & Wegener, 1998).

In the analysis of Study I in chapter 4, a good knowledge depth was shown to be better achieved with expert communication strategies. Health fair and professional promoters caused an almost perfect knowledge of the SODIS preparation process, whereas opinion leaders as well as interviews alone only lead to a good SODIS knowledge level. However, this level can still be viewed as sufficient to properly prepare SODIS, concluding that independently of the communication strategy enough knowledge gets transferred to the targeted population. In a rural setting (Study II, descriptives), it seems to take longer to inform everyone sufficiently about the SODIS process. Moreover, the initial knowledge level was lower than in the periurban population.

Even if SODIS promotion campaigns stop, the knowledge level stays fairly stable, independently from which source it had been acquired before. Although relapsers showed in

chapter 2 a lower knowledge level than the users, the level of knowledge was still quite high even among the relapsers. Hence, it is not assumed that knowledge played a role in causing relapse behavior. Instead, continuers may have had the SODIS preparation process more salient in mind, because they were still using SODIS and therefore were able to remember also the small details.

Cognitive and affective components of attitude

Chapter 1 shows clearly that among the cognitive beliefs, the belief – or in case of real consumption an evaluation – about the taste of the consumed water seems to be extremely important for the formation of the intention, independently of the water type. The tastier the water is perceived, the more of it is consumed. For the two water types, boiled and untreated water, which have been consumed by the population since a long time, taste is even the most important driver of intention. It can be assumed that the influence of taste is lower for SODIS due the fact of shorter experience people have had with SODIS water. Instead, the most important predictor of SODIS intention is the affective component of attitude. For boiling and untreated water intention, the effect of affective components also exists, but is somewhat lower. The intention towards untreated water additionally is determined by the overall attitude. Other aspects, such as more rational beliefs about the healthiness, difficulty, monetary and time costs of the water types do not show such universal influences on the intentions. Only the monetary costs show a low influence on SODIS intention, despite the fact that SODIS was generally evaluated as being very economic. For untreated water, additionally to the taste, also the belief about the healthiness of the water is quite important. For boiled water, none of these cognitive beliefs is predicting the behavioral intention. The belief about the taste and affect are the two water type independent predictors of intention.

Looking into the development of the cognitive and affective beliefs over time in the descriptive statistics of Study II, it is clearly visible that those factors that showed some influence on the intentions were also the ones that had changed over time during the promotion campaigns. It can be assumed that they have been made salient by the promotion campaigns (Conner & Armitage, 1998; Fishbein & Ajzen, 1975). The perception about the taste of SODIS and boiled water improved quickly for boiled water and somehow delayed and weaker for SODIS water, whereas the taste for untreated water was evaluated worse over time as well as the untreated water was judged less healthy. For SODIS water and untreated water, the affect shows a very similar development at about the same level like the belief about the taste. For boiled water, the affect also improves over time, but at a more positive level than the taste. The changes of affect and attitude towards SODIS seem to be stronger in the rural than in the periurban population, where it already starts at a more positive level.

The relapser analysis of chapter 2 also indicates the importance of the taste, because amongst all cognitive beliefs the greatest difference between relapsers and continuers was

found for the taste of SODIS water. A particular low perception of taste was found for early relapsers, so it can be argued that the low perception of taste has caused a lower intention, and in consequence a quick decision was taken to stop using SODIS. Also for the affect and attitude towards SODIS, the differences between relapsers and continuers were around the same order of magnitude as for the belief about the taste of SODIS water. Like for the taste belief, a low affect towards SODIS co-occurs with early relapse behavior. Attitude is lower for relapsers than for continuers, independently of an early or late relapse time point.

The impact of these findings on SODIS promotion is twofold: 1) taste and affect are important. It has to be quickly established that SODIS water tastes good and a positive affect has to be stimulated, else people are at risk to stop using SODIS. The taste belief could be targeted with the provision of tasting SODIS water possibilities during workshops, home visits et cetera. If bottles are provided, they should be cleaned well, because sometimes the taste of the previous content is still prevalent in the bottle. The taste aspect should be repeatedly mentioned during campaigns, maybe with a slogan or something alike. Targeting the affect is more difficult and subtle. Maybe the fun aspect can be emphasized during the promotion campaigns, and the existing medium relation between the taste belief and affect can be used. To-date, SODIS promotion often focuses primarily on emphasizing problem awareness and arguments about the healthiness, easiness and non-costliness of the SODIS method instead of the taste and the affect.

The second implication for promotion campaigns is that not only the direct predictors of SODIS water intention can be targeted, but also the ones predicting untreated water intention. A lower intention towards untreated water correlates with a higher intention to consume SODIS water. Since the taste and affect of SODIS are already quite positively evaluated and do not pose such a potential for improvement, it seems sensible to relate the consumption of untreated water to a feeling of unpleasantness. Taste and affect for untreated water consumption are strongly related to each other. The unsafe origin of untreated water or the possibility of fecal contamination by humans and animals can be pointed out, which would additionally influence the health belief. For boiled water, not much intervention potential is seen to improve the belief about its taste, because boiled water in reality does not taste very well. On top of it, taste is by far also the strongest predictor of the boiling intention.

Social factors

Overall, social factors do not play such a dominant role in influencing people's intentions towards water consumption as it was found out in chapter 1. Only on the intention towards boiling, subjective norm shows a medium influence. For untreated water intention, also a higher perceived subjective norm influences the intention, but only weakly. For SODIS water intention, the injunctive norm shows a weak influence. Interestingly, subjective norm values are unrealistically low for boiled and SODIS water. This indicates that people are completely

misjudging the amount of other people who boil water or use SODIS. For SODIS use, the mean subjective norm estimation of the percentage of people using SODIS in the community is 23% – in reality 83% reported using SODIS. For boiling, the discrepancy is even larger – the subjective estimate was 25% of people boiling water in contrast to 96% who reported doing so. Only for untreated water consumption the estimate was with 44% only 11% below the real percentage.

The misjudgment especially for boiling is bewildering, because boiling is a behavior people have already performed before the study and one would expect that everyone is aware that all others also boil parts of their water. For SODIS the misjudgment is more understandable, because it is a very recent behavior and maybe has not yet reached publicity. This assumption is supported by the low descriptive norm. Additionally, misperceptions of social norms seem to be a common phenomenon (Park & Smith, 2007), but the discrepancy can also be in the other than the observed direction (Borsari & Carey, 2003). The assessed injunctive norms, conceptualized as the reputation of SODIS, boiled and untreated water, were also found to be comparably low (in comparison with the cognitive beliefs for example) and showed a medium positive level for boiled and SODIS water and a neutral level for untreated water.

The development of the normative factors over time also indicates the relative non-importance of those norms, because only the subjective norm of untreated water consumption decreased remarkably. The others changed only slightly over time. The analysis of reasons for relapse in chapter 2 shows a significantly lower subjective and descriptive norm for relapsers. The injunctive norm only differs marginally.

In any case, the influence of the norm factors on intention was found to be rather low, so it is questionable, if it makes sense to further investigate the reasons, why these norms are rated so low. In general, the norm influence in other studies varies from no influence to only medium influence (for reviews see Ajzen, 1991; Armitage & Conner, 2001), depending on the behavior. However, Cialdini et al. (1990) noted that norms have to be salient to show an influence on behavior. Since water consumption is a rather private behavior, maybe the social norms have not been salient at the time of measurement. This would also explain the heavy misjudgment of the subjective norm. Maybe with stressing norms explicitly during campaigns, a lower discrepancy and an influence on intention can be achieved. For example, assessing in a work group who is consuming which water type helps to make norms salient and perceivable. Injunctive norms, i.e. the reputation of SODIS and boiling water, can be addressed with famous role models, for example. If it is possible to make these norms salient with special promotion activities, then an influence on intention should be found.

PREDICTING BEHAVIOR

In the following, the factors influencing behavior are discussed. The results analyzed within the behavior change process will be integrated with the findings about influence paths of interventions. The main target is to derive ideas for future interventions.

Intention

According to a range of researchers, intention is a key construct of the behavior change process. The various cognitive and affective evaluations that took place during the motivational phase manifest in the behavioral intention. The intention marks the transition to action (e.g. Schwarzer, 2008; Ajzen, 1991). Intention is described as the conscious plan to use physical and psychological resources to perform the behavior in the near future, and is viewed as a proximal cause of behavior (Ajzen, 1991). Although no-one denies the existence of the intention-behavior gap, the importance of intention cannot be denied either. A commonly drawn conclusion of many researchers is that it needs additional constructs to achieve a better explanation of observed behavior, but that intention cannot be ignored.

In the analyses of the behavior change process, intention functioned as a dependent variable and was tried to be explained with the previously described factors of the motivational phase. Secondly, intention was used as a predictor to explain behavior. These two roles of intention will be looked at separately.

In chapter 1, intention towards all types of water consumption behavior was tried to be explained with problem awareness factors, amount of action knowledge, cognitive and affective beliefs, and social influence. Comparing the explained variances of the intentions towards SODIS use, boiling water and consuming untreated water, it is apparent that the intention to boil water was least explainable. Only 29% of the variance it could be accounted for with the used variables, in contrast to 39% for the intention towards SODIS use and 57% for the intention towards untreated water consumption. However, boiling water is a necessary behavior for having hot water, and therefore a factor measuring this need-component would add explanatory power. Untreated water intention was surprisingly well explained. This indicates that the measured factors are the ones that influence the intention to a large part and that they had been mentally accessible for the individuals. This is supported by the change of these factors that has taken place during the time period of the study. For SODIS intention, actually a higher explained variance was expected, because it was assumed that as long as the behavior is not yet completely habitual, all cognitive beliefs, affects, action knowledge and social evaluation processes that in turn form the intention are easily accessible.

The two available studies for SODIS that tested very similar intention models (Altherr et al., 2008; Heri & Mosler, 2008) achieved higher explained variances for SODIS intention,

although the authors used quite similar factors in their models (62% and 52%, respectively). In the study of Altherr et al. (2008), the affect played a much stronger role, and in the study of Heri and Mosler (2008), a factor measuring the compatibility with daily tasks and habits added additional predictive power to their model. From the results of the current study it can be learnt, that some other factors have to be considered in addition to those presented.

However, studies on various other topics have also reported explained variances of intention of only roughly 30 to 50% (Corbett, 2002; De Groot & Steg, 2007; Knussen et al., 2004; Tonglet, Philips & Read, 2004). A review of the explanatory power of TPB variables on health related behaviors also found only an overall explained variance of 41% (Godin & Kok, 1996, cf. Conner & Armitage, 1998).

Intention as a predictor of behavior intensity performed well for all three water consumption behaviors that were investigated. For boiled and SODIS water consumption, the intention accounted for around 30% of the behavioral variability, for untreated water consumption 37%. For boiling water, intention was the most important predictor, for SODIS and untreated water the second most important. During the course of the study, the intention developed quite positively over time in the investigated rural population (Study II). In contrast, the intention in the studied periurban population (Study I) was already very high since the beginning of the promotion campaigns and only decreased after active SODIS promotion had stopped. Interestingly, the analysis of relapse behavior in chapter 2 revealed that only early relapsers suffered from a strongly decreased intention, whereas late relapsers as well as those who continued using SODIS after the end of the SODIS campaign kept their high intention. However, with the present data the question about the direction of the causality between intention decrease and early relapse cannot be answered.

Summarizing, intention seems to serve quite well as the bottleneck between the influences from the motivational phases on one side, and translating them into action and influencing the behavior on the other side. The explained variances are within the range what can be expected from previous research. Nevertheless, it should be worked on investigating additional factors on both sides of the intention.

Within promotion campaigns, targeting intention can be consequently achieved with targeting those factors that in turn influence intention. Direct influence could be realized with asking people to set a fixed amount of (SODIS) water they want to consume. However, this type of intervention would aim more at the commitment and implementation dimensions, which are rather considered being part of the habit phase, which are investigated in chapter 3.

Resource availability

Necessary resources for using SODIS are bottles, and for boiling water combustibles. The influence of resource availability on intention and behavior was investigated for SODIS and boiling within chapter 1. The results show that for forming of a positive intention, resource availability is not considered by the individual. Only when the behavior is started to be performed, it gains some influence. However, the observed influence was rather low. In general, resources for SODIS and boiling were judged as being widely available in the periurban areas, but more or less available in the rural areas. At the end of the Study II, still 50% of the people claimed that one or more bottles were missing, which reduces the possible amount of water that can be treated with SODIS. Structural interventions would be helpful – at least in the beginning – to have these resources at hand when people have formed a positive intention and are ready to try the behavior. Once the SODIS is accepted as such, other ways of organizing bottles can be pointed out to the people, and help can be provided that people can finally organize bottles or combustibles themselves.

The habit factors

During the course of the different chapters of this thesis, different habit indicators have been used. The behavioral models of chapter 1 used perceived habit, which is a very general indicator of habit. This was used to have the same predictor for all three water consumption behaviors. The relapsers' habit in chapter 2 was investigated using additionally cognition intensity, forgetting and dissonance, while the closer examination of the interventions' mode of operation on behavior in concert with the habit factors in chapter 3 looked at the roles of perceived habit, implementation intention, and strength of the felt commitment. The next part of the discussion will focus on the importance of all these constructs for behavior.

According to the analyses of chapter 1, **perceived habit** explains roughly 30% of the consumption of boiled water, 40% of the consumption of SODIS water and 50% of the consumption of untreated water. Moreover, it is the strongest predictor of the consumed amount of SODIS and untreated water (for boiling it is the intention). The analysis of relapse causes in chapter 2 has also shown a strong difference between relapsers and continuers regarding perceived habit. Knowing that perceived habit is such an important predictor of behavior intensity, it can be assumed that a successful increase of the perceived habit would also stimulate SODIS use. Moreover, the two structural models of chapter 3, calculated for investigating the effects of the interventions prompt and public commitment on behavior, have shown the important direct effect of perceived habit on behavior. In addition, these models have revealed the *mediating* influence of perceived habit between the interventions, implementation intention and the amount of consumed SODIS water. It is therefore evident that habit plays a

key role among the behavior-near factors in influencing behavior. An additional role seems to be the 'collection' of the influences of other habit related factors, as it has been observed for implementation intention in the model testing the mode of operation of public commitments in chapter 3. Here probably more research is needed to find determinants that cause people perceiving a habit towards a certain behavior. Particularly, the link to the other three habit phase indicators, cognition intensity, forgetting, and dissonance, which have not been included in the models, should be investigated. Maybe, perceived habit can function as a 'collector' of habit stage related information, like intention is the ‘collector’ of factors from the motivational phase. In view of how easily perceived habit can be acquired with a simple question, it could be used for developing tailored interventions depending on the amount of already perceived habit. As the models of the mode of operation of prompts and public commitments have shown, particularly prompts are strongly influencing habit formation. Additionally, other habit supporting interventions could be developed, for example private commitment (see Mosler & Tobias, 2007a).

The habit factors **implementation intention** and **commitment** were only investigated within the models of the mode of operation of prompts and public commitments in chapter 3. According to these analyses, next to perceived habit, implementation intention is also an important factor for influencing SODIS use intensity. Prompts influence behavior not only via perceived habit, but also via implementation intention. For public commitments, the implementation intention is even more important for eliciting their influence on behavior, because they do not directly influence perceived habit. Instead, public commitments operate via implementation intentions which in turn influence perceived habit. They do not influence habit directly, because they miss the characteristic of an effective cue stimulus: they do not contain the necessary action information and they are not placed at the place where the action is carried out (Tobias, 2007).

The commitment factor performed a bit ambiguously in the models of the modes of operation of the interventions. Before the interventions, it showed a slight negative influence on SODIS behavior, after the interventions it did not show any relation to SODIS behavior, although it was influenced by the intervention prompt. From the public commitment model, it had to be removed due to strange behavior. One explanation may be the inappropriate measurement of this factor. It is suspected that either the question imposed an uncomfortable feeling of obligation and reactance occurred causing the negative influence on behavior, or the question was completely misunderstood due to cultural specialties.

Both, implementation intention and commitment, only seem to influence behavior after they had been specifically activated, for example by an intervention. In the calculated models, at time point one of the model, no influence of implementation intention on behavior was found and commitment even had a slight negative effect in one of the models. So, it seems to be of particular importance to target these factors with interventions to have them exerting their influence on behavior. Interestingly, implementation intention and commitment only increased

marginally due to the interventions, however, the influence on behavior changed. The explanation is probably that only due to an intervention the correct goal gets activated and helps forming a goal-directed implementation intention.

Influencing implementation intention positively has been successfully achieved by the both applied interventions prompt and public commitment. Therefore, these two are also recommended to be used during future campaigns. Other implementation intention supporting techniques like using formalized verbal implementation intention sentences ("In situation X I will do Y"; Gollwitzer, 1999) have to be tested locally, if people understand the concept. It was tried in Study II to use this kind of intervention to support the development of goal-directed implementation intentions. However, already during the culture compatibility check with local experts before the study, the concept was not well understood and it was recommended to drop this type of intervention.

The other three habit related factors, **cognition intensity**, **forgetting** and **dissonance** have been only investigated within the analysis of causes for relapse behavior in chapter 2. All three factors show large differences between relapsers and people who continued SODIS use. Moreover, these are the factors that have changed most dramatically between the time point before the relapse and the one after (time frame 7 months). Forgetting increased, dissonance and cognition intensity decreased. This applies to both types of relapse behavior, early (low) and late (high) relapse, as well as the low user type. Only high (supposedly stable) users were not affected by the change of these three habit factors. The implications are that relapsers did not manage to maintain their acquired habit, and therefore at some point stopped using SODIS. Also low users seem to be at risk to stop using SODIS soon. The causality between relapse and the change of the habit factors has been made, because these are the ones among all factors from the behavior change process that show the largest differences between relapsers and users *and* the strongest negative change. Even within the overall population (that means, even including continuers), in the descriptive statistics the development of these factors over time shows a remarkable decline after the promotion campaign phase had ended. Before, all factors were at a good medium level. This level was the same for the rural and the periurban population, only in the rural population a measurement a long time after the end of the campaign phase had not taken place. It can be assumed, that a similar change pattern of the three habit indicators also within Study II would be observable if another measurement would be carried out now.

Possible interventions could be dissonance inducing methods like commitment interventions (Brehm & Cohen, 1962; Heckhausen, 1991), preventing of forgetting with reminders (prompts). Cognition intensity could be targeted with anything that helps keeping the SODIS topic present in people's heads.

Overall, the need for including a separate habit phase with specific indicators when trying to understand the complete behavior change process has been overwhelmingly confirmed with the presented results regarding habit. There is still work to do to find out more about the

presented aspects of habit, which are the most important factors, and how they are exactly related to each other. It is highly recommended to focus on these issues during following research. Also, the relation of how habit develops under different circumstances and in response to different intervention strategies, respectively, has to be investigated. A first step was taken with showing that prompts and public commitments operate at least via some of these habit aspects, but many more steps have to be taken. This is particularly stressed, because often only one or two aspects of habit are studied, and consequently not much is known about interactions between all of these factors. Especially, cognition intensity, forgetting and dissonance measures are seldom found in empirical studies. Another aspect that lacks a certain state-of-the-art is the measurement of these habit factors. Some operationalizations of the variables were 'only' developed with an idea about what was intended to capture, and which could be the most appropriate and understandable formulation of the variable.

WATER CONSUMPTION BEHAVIOR

Naturally, when conducting a field study together with local institutions on the promotion of SODIS, the most important and most valued success indicator is the behavior. The goal is to promote SODIS use. As consequence, the outcome is often expressed in the percentage of SODIS user after certain promotion campaigns had taken place. However, as we found during the course of Study I, knowing the percentage of SODIS user is only one side of the success indicators. The other two sides are: *how much* water is treated with SODIS? And: do people still consume *untreated* water? On the development of these two behavioral indicators will be focused in the last part of the discussion.

As the relation of psychological factors to the behavior of SODIS use has already been discussed, the focus shall be now on the suspected influence of all applied external cues: interventions and communication strategies. But first, the development of the water consumption behavior will be described over time as an indicator of the general effect of the promotion campaigns.

Campaign effects

The promotion campaigns that were applied during both studies can be described as a mixture of different communication strategies, situational cues (habit supporting interventions) and more or less standardized persuasion. In both studies, interpersonal and centralized communication strategies were applied, in Study I in a controlled design and only one strategy at a time, whereas in Study II application was rather randomly and confounded. Therefore, in Study II people received information about SODIS via a higher number of different communication channels. The two applied interventions, prompts and public commitments, were

the same in both studies, only varying in their design. In Study I, both interventions were applied in parallel to all communication strategies, in Study II they were tried to be applied to separate groups. Overall, in Study I, a higher percentage of the investigated population had received an intervention compared to Study II. The persuasive messages were mostly identical.

In Study I, in two evaluative panels during the time of promotion campaigns (panels 2 and 3), SODIS use was only measured dichotomous. Therefore, only one part of the success indicators can be presented. SODIS user percentages increased clearly over time as long as there was active SODIS promotion. The starting point was 5% SODIS users at the first panel. After one month of active SODIS promotion, 37% used SODIS, and after another month of promotion, 64%. After seven months without promotion activities, 43% were still using SODIS. In the control group, which did not receive active SODIS promotion, user percentages of 13% and 29% (after the first and second month, respectively), and 20% in the long-term analysis 7 months later were observed. The numbers of the control area of Study I indicate roughly the effect and potential of the interviews. Study II does not provide such a clear data basis for estimating the interviewer effect. Coming back to Study I, in the first panel, the overall consumed SODIS water averaged across all people (including control group) was 1%. For the next two panels, unfortunately, data is missing. After the seven inactive months, still 15% of the total water consumption was SODIS water. Untreated water was initially consumed by 54% of the population. This percentage declined to 22% during the time of the SODIS promotion campaigns, and rose again up to 33% after the campaigns had stopped. However, the overall amount of consumed untreated water was fairly low with 12% of the total water consumption (32% at the beginning of the study).

In Study II, information on percentages of SODIS users *and* percentage of the amount of SODIS water used, are available for all measurements. Initially, 3% of the population used SODIS. At the second panel, 3.5 months later, already 25% used SODIS, although almost no promotion activities had taken place. This result is assumed to be to a large part caused by the interviewer. After 3 months with active SODIS promotion, 54% of the people used SODIS and in the last panel, after another phase with active SODIS promotion, 83% stated they were using SODIS. The percentage of SODIS treated water in the first panel was, as in Study I, 1% of the total water consumption, rose first to 11%, then to 33%, and finally reached 47% in the overall measured population. Untreated water consumption was admitted by 98% of the population before the study. The percentage of people consuming untreated water declined over time to only 55%, who were still consuming untreated water at the end of Study II. The steepest decline was observed between the before-last and last measurement. It seems that first people had started using SODIS, and only delayed in time they had stopped drinking untreated water. The amount of consumed untreated water depends strongly on the amount of SODIS water: the more SODIS water, the less untreated water gets consumed. An optimum of the total water

consumption patters seems to be: 60 to 80% SODIS water, 20 to 30% boiled water and around 5% untreated water, which is preferred by almost 50% of the interviewed sample in Study II.

These percentages state the success of the applied promotion campaigns in both studies. In the following, more detailed information is discussed on the different applied elements of the promotion campaigns: communication strategies and interventions.

Effects of different communication strategies

In chapter 4, the analysis of the effectiveness of different communication channels in Study I has shown the superiority of employing expert promoters compared to opinion leaders or a health fair in obtaining quick and large changes regarding SODIS use. The promoters were most effective in reaching people and convincing them to use SODIS. However, their long term impact was only insignificantly larger than that of the opinion leaders. The opinion leaders interestingly also initiated quite large changes regarding SODIS use. Although the percentage of people using SODIS was lower due to the opinion leaders in comparison to the promoters, the impact was impressive in the sense that the opinion leaders worked voluntarily and only caused very little costs. They therefore achieved the best cost-effect ratio of all communication strategies. Moreover, opinion leaders had a positive effect on interpersonal communication about water among the people of a community. This effect is clearly attributable to the opinion leaders, because in the areas where other communication strategies were applied, people did not name their peers as a source of information. The type of big event communication strategy, which was tested with a health fair, did not show the desired impact. Costs were twice as high as employing the promoters, but the participation rate was only 20% among the interviewed sample. Consequently, the impact on behavior was very modest, if not non-existent. The long term effect of the health fair cannot be estimated, because a confound with promotion efforts carried out by the interviewers occurred in the respective area.

Summarizing, it seems that interpersonal communication strategies have a stronger impact on SODIS behavior compared to the centralized strategy health fair. They are more effective in reaching people and have a better potential to change people's behavior, while the health fair, like it is already known from mass media communication (e.g. Alcalay, 1983; Griffin & Dunwoody, 2000), may have the potential to inform people, but not to change their behavior. This is at least true in the periurban setting where these communication strategies were studied. One major characteristic of the investigated areas was the low number of peers people had within their community. Maybe in a more connected community, a more participatory approach for organizing a health fair would have the power to get more people attracted and involved, but here it needs further research.

In chapter 3, ignoring the nature of the communication channel from which an individual received information about SODIS, it was found for both studies that each additional communication channel increased the chances of using SODIS between 37 and almost 300%. The effect of additional communication sources providing information about SODIS was much stronger after the first phase of promotion campaigns (in Study I 294% and in Study II 236% increased chance of using SODIS) than the second campaign phase (51% and 37%, respectively). The long-term analysis of Study I showed neither an effect of recently perceived SODIS communications, nor a residual effect of previously perceived SODIS communications on SODIS use. The latter fact is also confirmed by the analysis of relapse behavior in chapter 2: overall relapsers and continuers, as well as their subtypes, did not shown any differences regarding previously perceived number of communication channels.

Consequently, it seems to be important to start a promotion campaign with massive communication, using various communication channels simultaneously. Once people have been reached, it seems not so important anymore or even slightly contradictory to have many different information sources. However, also for the start of a campaign, it is assumed that the amount of perceived communication channels can be increased infinitely. The relation between number of communication channels and chances of using SODIS is not linear anymore above a limit of 4 to 5 different communication channels (result of an earlier analysis of the dataset of Study I; Tamas, 2006, p. 17), i.e. it is not possible to use 10 different communication channels and expect increased chances of SODIS use of 3000%.

Effects of situational cues – prompts and public commitments

In both studies, two different situational cues were applied: prompts and public commitments. Their direct effects on SODIS uptake and amount of water treated with SODIS were analyzed in chapter 3.

If a household had received a prompt, chances of using SODIS were increased by approximately 150 to 350%; the public commitment reached an effect of about 100 to 250% increased chance of SODIS use. In Study I, prompts have shown a very constant effect of about 150% increased chances for SODIS use if the family possessed a prompt, even in the analysis of the long-term effect. In Study II, the effect of the prompt increased over time from 150 to 350% of increased chance of SODIS use. The public commitment also showed a strong increase in its effect on SODIS use during Study II. At the end of Study II, the households having a public commitment were 100% SODIS user. But at that point, within the entire population 83% were using SODIS.

In Study I, the effect of the public commitment did not occur until the end of the second phase of SODIS promotion activities. Before, it seems that too few households had actually received the public commitment and hung it outside their houses. One reason may have been –

as it was reported by those who distributed intervention materials – that people liked the prompt a lot more, and as soon as they had realized that also prompts existed, they preferred to have a prompt instead of the public commitment. Secondly, maybe it was asked too much too early – to hang a commitment outside their house already at the beginning of the study. However, this problem was only observed in the periurban areas of Study I.

The long-term effect of the public commitment could not be tested either, because people reported that it was torn down by wind and weather. So, it seems the prompt has a higher potential to stay a long time in a household, and if the prompt is there, it also has an impact on SODIS use. The results of the long-term analysis also show that previously applied interventions do not have an effect on later behavior. This is in line with expectations for the effectiveness of situational cues. The relapser analysis in chapter 2 supports the importance of situational cues, because a) only 27% of relapsers still had a prompt in their household compared to 40% of continuers, and b), late relapsers had the highest 'loss' of prompts. It is argued that they have relied on the prompt as a reminder, but once the prompt was lost, they forgot doing SODIS and became high relapsers. One central characteristic of high relapsers is their readiness to act in terms of psychological variables: high problem awareness, high motivation, and high intention, but missing external cues initiating behavior execution.

Prompts and public commitments seem to exert their influence on the decision to use SODIS. Once people use SODIS, only weak direct influences on the amount of water treated with SODIS were found. A prompt directly increases the percentage of SODIS water of the total water consumption by 12% and a public commitment by 9%. This effect was only found in one of the two analyzed measurements of Study II in chapter 3. It rather seems that on behavior intensity prompts and public commitments operate via other factors. These are the behavior-near factors of the habit stage of the behavior change process, as previously described. Prompts indirectly influence SODIS behavior intensity via perceived habit and implementation intention, whereas public commitments only influence implementation intention, which in turn influences perceived habit, and therefore influences the SODIS behavior. The strengths of the influences of prompts and public commitment on the behavior-near factors are of medium intensity for public commitments, and of strong intensity for prompts. It can be concluded, that prompts have a stronger influence on SODIS behavior intensity than public commitments. This is not very surprising, since prompts are better situational cues, because they are placed at the location of behavior execution and contain all necessary information to perform the behavior correctly (Tobias, 2007).

SUMMARY, OR: A 'PERFECT' SODIS PROMOTION CAMPAIGN

The behavioral factors and elements of the SODIS promotion campaigns that have shown to be important for SODIS use can be summarized as follows:

- Among the cognitive beliefs, the belief about the taste of the water is important for forming the intention towards all water consumption behaviors.
- The same applies for the affective component of attitude – people form their intention largely based on their affect towards a certain water type.
- Intention is a central mediator between motivational factors and behavior.
- Resources such as bottles are only slightly important and only when SODIS is used.
- Separately taking into account the habit factors adds significant insight to understanding behavior intensity and occurrence of relapse.
- Among the habit factors, perceived habit plays a central role.
- Interpersonal communication is more effective and less costly than centralized communication.
- Increased number of communication channels increases the chances of people using SODIS, but only in the beginning of a promotion campaign (up to 4 or 5 different channels).
- Prompts are easily applicable interventions, they are accepted, people keep them for quite a long time, and they show constant short- and long-term effects on the decision to use SODIS. Moreover, they positively influence behavior intensity via the habit factors implementation intention and perceived habit.
- Public commitments are possibly less accepted in a periurban population, but also show comparable short-term influences on the decision to use SODIS. However, they do not last as long as the prompts due to their outside use. As the prompts, also public commitments influence behavior intensity, but only via implementation intention, not via perceived habit.

In the following, these influences are illustrated using a small example of a promotion campaign designed according to the presented results.

Every promotion campaign, no matter if promoting a product or a behavior, should be adapted to the situation. Consequently, the first indispensable step towards developing an effective campaign always should be an analysis of the current circumstances. What has been the first panel measurement in the two studies of this thesis, should ideally take place longer before the start of the promotion phase to have the opportunity using the information from the first panel measurement to plan the contents of the promotion campaigns. For example, if people already effectively treat their water with a certain method and do not consume untreated

water at all, no SODIS promotion campaign is needed in terms of public health improvement. Important aspects are:

a) the level of problem awareness,
b) if SODIS is known already or not and to which degree,
c) in case SODIS is known, what are people's opinions (cognitive and affective beliefs),
d) their intentions, and
e) their habits.

The water consumption pattern should also be assessed as detailed as possible. Further useful information should be collected about their communication practices, media usage and the like.

Given, for example, the situation that people consume a large amount of untreated water, value untreated water quite positively, mostly do not know about SODIS, the area is rural and a part of the people live very dispersed, but it has a popular radio station in the area, as it was found in the beginning of Study II. In this case, a good strategy would be to have information events in the communities to:

a) introduce the project officially, ideally with health officials,
b) to assure support from community leaders,
c) to find out, who already knows SODIS and who could be possible opinion leaders, and
d) to assure that all have understood the general problem and to make people familiar with SODIS (*knowledge aspect*).

Participatory workshops, as they have been performed by the Foundation SODIS in Study II, have received a good feedback. The information event should be definitely complemented by

a) a taste comparison between untreated, boiled and SODIS water (*belief taste all water types*),
b) a fun factor instead of only providing information (*affect all water types*),
c) explicitly discuss the problem of recontamination due to missing cup washing practices (Rufener, Mäusezahl, Mosler, & Weingartner, submitted), and
d) brainstorm where to get *bottles* from.

During the workshops, attractive *prompts* should be given to the people, but not without explaining extensively what they are for and where they have to be placed.

Quite immediately after the workshops, employed expert *promoters* should go and visit as many households as possible. The promoters should

a) make sure that people know the SODIS process well,

b) give them bottles to start if needed,
c) assure the prompt is used correctly, and
d) should fix the next visit.

It is recommended, that the promoters start with the most interested people, who have been identified at the workshops, and convince them to take the role as *opinion leaders*. The idea is that after a while the opinion leaders take over more and more of the task of the promoters, and the promoters become more and more redundant. This should also increase the general exchange among people in a community, because the opinion leaders are community locals. How long this process should take to have a thorough continuation of the promotion by the opinion leaders has to be tested. Once opinion leaders have been identified, they can be brought into the process by first accompanying the promoters to learn from them. Opinion leaders should be rewarded, however not monetary, but symbolically with small incentives (presents) and official credentials.

In parallel, a radio campaign could be launched, ideally in with the official support of the Ministry of Health (*number of communication channels*). The radio campaign should contain

a) a fun part (*affect*),
b) the information of how long SODIS bottles should be exposed (the most important aspect of *knowledge*),
c) and a note that already so-and-so many people in village XY use SODIS (to increase the *subjective* and the *injunctive norm*, and to increase social exchange among people).

One could also think about having a contest between villages. If enough resources are available, school campaigns could also be included, because teachers are often viewed as authorities and older kids are sometimes responsible for water in the family. However, the effect of including schools still has to be tested.

Looking at the design of a promotion campaign over time, the massiveness of the initial communication should be switched after a while to more targeted actions. If radio campaigns had taken place or events or contests, they should be slowly removed after a few months, preferably before the promoters get fully replaced by the opinion leaders (the time frame, however, is unclear and has to be investigated). Targeted actions mean interpersonal communications, either with small (community) meetings and/or household visits. Focus should be laid on *habit* forming interventions like prompts or public commitments or others which should increase *cognition intensity* to prevent *forgetting*. Assistance in planning when and where to prepare SODIS and to define a responsible person should help to develop a goal-directed *implementation intention*. Ideally, the responsibility of supervision and continuing of SODIS use and hygiene is then embedded in the community and largely in the hands of the opinion leaders.

Moreover, every 2-3 months, an evaluation should take place to adjust the campaign strategy to the stage of the behavior change process people are in. Last but not least, it is always advisable to have a true control group to prove the effectiveness of the applied measures. If it is a goal to systematically compare the effects of different strategies, it should be assured that they are applied in a standardized procedure. The campaigns should last at least one year or even longer.

LIMITATIONS & OPEN ISSUES

The results clearly shed some light on water consumption behavior in general and SODIS use as one possible water type in particular. The behavior change process was investigated and possible determinants for the consumption of different water types were found. Recommendations on future SODIS promotion campaigns were given.

However, there is still a range of open questions and studies to carry out. Some limitations already have been pointed out at the end of the chapters 1 to 4. First, these are shortly summarized, and then additional open issues are pointed out.

Limitations

For chapter 1, it would have added insight into the behavior change process if a real process analysis would have been carried out. However, shorter time intervals of measurements would have been needed to better investigate relations over time. Chapter 2, the analysis why people stopped using SODIS, in principle suffers from the same circumstance: the missing information about what happened between panels 3 and 4 of Study I. However, applying questionnaires itself would have been an intervention and maybe relapsers would not have been observable in the same 'natural' pattern as it was possible in chapter 2.

A specific limitation for the analysis of the effects of the intervention materials (chapter 3) is the sometimes low number of people who actually received the interventions. This was caused by unforeseen irregularities during the distribution of the interventions. Therefore, it was not possible to estimate the long term effects of public commitments.

The comparison of the three communication strategies with the control area (chapter 4) was limited by the different community sizes and the almost unavoidable irregularities of the sample size due to drop-outs and the enlargement of the sample. The percentages of people who knew about SODIS at the beginning of the study were also quite different. Moreover, the interviewers had to be involved in distributing the prompts.

In general, the results have been calculated using two different samples: a periurban and a rural one. These samples are different in some of their characteristics, especially in their education, their lifestyle and their initial level of SODIS knowledge. Nevertheless, results from both studies were combined. On one hand, this adds valuable insights into the results, on the other hand in later studies the results calculated with a periurban sample should be confirmed with a rural sample and vice versa.

Another limitation related to the two different samples this thesis is based on, is the change of the measurement scale from 4- to 5-point for unipolar items and 7- to 9-point for bipolar items. This seemed necessary to achieve more variance of the answers. To have comparable mean values, scales were for both studies rescaled to scores between -1 and 1, however, it cannot be excluded that some of the differences between Study I and II are due to the different scales. Therefore, studies I and II were not directly comparable with each other.

There are also some validity insecurities regarding the operationalizations of some habit indicators. For example, based on the results of chapter 4, it is suspected that the variable commitment was not well understood by the people (or not in the intended sense).

Open issues

All the different communication channels that were used in Study II could be investigated much more in detail. Unfortunately, a strong confounding of the different active communication channels was observed, therefore an analysis with the present data would be limited in validity. Future field studies could more systematically investigate the effects of radio, workshops, home visits, school activities and others, which would be very valuable input to practitioners not only in the field of SODIS promotion.

Another topic that urgently needs to be addressed is social influence and how this could be used in a positive way. Obviously, a non-separable part of the social influence is the interpersonal communication. Especially in a rural context, where every neighbor is certainly always looking and interested in what the other neighbors are doing, and where exchange of information via verbal channels is indispensible, because newspapers are non-existent, social influence is certainly of importance. We know that during the both studies presented in this thesis, it was not talked very frequently about SODIS. However, people do talk and the question is, how talking about SODIS can be facilitated, and if an influence on behavior takes place. Here, suitable theoretical communication models as well as empirical investigations are missing.

Another issue in the context of SODIS promotion is not only the analysis of SODIS behavior, but as it was already tried in chapter 1, analyzing the entire water consumption pattern and its predictors. There are more studies needed. For defining campaign effectiveness in the sense that people's health gets improved, it is important to achieve that untreated water

consumption is reduced to a minimum. The reason is of course that no matter if people consume SODIS water, if they also still consume untreated water, the positive health impact of SODIS is severely weakened. More effort should be made to find out the important drivers of untreated water consumption. If it is only the lack of an alternative, SODIS promotion campaigns can further concentrate on SODIS promotion. The high correlations between the two water consumption behaviors already indicate that the lack of a suitable alternative is an important driver for untreated water consumption, however more data is needed.

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CURRICULUM VITAE

Andrea Tamas
Born 9th September 1977 in Leipzig, Germany
German Citizen

Professional experience

since Nov 08	**Postdoc Position** Swiss Federal Institute for Aquatic Science and Technology (Eawag), Department Water and Sanitation in Developing Countries (Sandec)
Aug 04 – Oct 08	**PhD Thesis** Swiss Federal Institute for Aquatic Science and Technology (Eawag), Department Systems Analysis, Integrated Assessment and Modelling (Siam)
Apr 04 – Jul 04	**Research Assistant** University of Zurich, Department of Social Psychology
Apr 03 – Aug 03	**Internship** Institute of Work Research and Organizational Consulting (Zurich, Switzerland)
Sep 99 – May 03	**Student Research Assistant and Diploma Thesis** Max-Planck-Institute for Human Cognitive and Brain Sciences (Leipzig, Germany)
Sep 99 – Dec 99	**Internship** Advice Centre for Adolescents and Families, Youth Welfare Office (Leipzig, Germany)

Education

Apr 09	**PhD in Psychology** University of Zurich, Faculty of Arts, Department of Psychology Supervision: Prof. Dr. H.-J. Mosler (Eawag), Prof. Dr. Heinz Gutscher (University of Zurich) Title: Successful promotion of solar water disinfection (SODIS)
Oct 03	**Diploma in Psychology** University of Leipzig, Faculty of Biology, Pharmacy and Psychology Diploma Thesis: The 4-finger-Stroop: A variation of the colour-word-interference-task – validation study with functional Magnetic Resonance Imaging (fMRI)

Jan 03	**Certified Trainer** for "Coaching in social psychological based communication trainings" Psychologisches Zentrum GbR (Leipzig, Germany)
Jun 96	**Abitur** Wilhelm-Oswald-Gymnasium (Leipzig, Germany)

Various

Languages	German (Mother tongue) English (fluent) Spanish (fluent)
Memberships	IAESTE Student Network Switzerland IPU (Initiative Psychology in Environmental Issues) IAPS (International Association for People Environment Studies)

Publications (peer reviewed)

in prep	Tamas, A., Meyer, J. & Mosler, H.-J.: Predictors of treated and untreated water consumption in Bolivia (in: *Integrative Psychological and Behavioral Science*)
in prep	Huber, A. C., Tamas, A., Mosler, H.-J. & Meyer, B.: The modes of operation of prompts and public commitment: A field study in Bolivia.
submitted	Mosler, H.-J., Contzen, N., Kraemer, S. & Tamas, A.: Factors affecting informal interpersonal communication about a health innovation: disseminating solar water disinfection in Zimbabwe (in: *Critical Studies in Media Communication*)
submitted	Tamas, A. & Mosler, H.-J.: Why do people stop treating their contaminated drinking water with solar water disinfection (SODIS)? (in: *Health Psychology*)
accepted	Tamas, A., Tobias, R. & Mosler, H.-J.: Promotion of Solar Water Disinfection: Comparing the effectiveness of different strategies in a longitudinal field study in Bolivia (in: *Health Communication*)
2008	Mosler, H.-J., Tamas, A., Tobias, R., Caballero Rodriguez, T. & Guzman Miranda, O.: Deriving interventions on the basis of factors influencing behavioral intentions for waste recycling, composting and reuse in Cuba (in: *Environment and Behavior*, 40(5), 522-544)

Conferences

2009	Tamas, A. & Mosler, H.-J.: SODIS Promotion – Investigating the behavior change process (Paper at the *Disinfection 2009*, Atlanta, U.S.A.)
2008	Tamas, A.: Investigating interpersonal communication behavior as a precondition of sustainable diffusion of an innovation (Paper at the *20th IAPS International Conference*, Rome, Italy)
2008	Tamas, A.: Successful long-term adoption of SODIS – evaluating different commitment interventions in rural Bolivia (Paper at the *XXIX International Congress of Psychology*, Berlin, Germany)
2008	Tamas, A., Huber, A. C. & Mosler, H.-J.: Promotion and adoption of SODIS in 2 areas of Bolivia with psychological behavior change strategies (Poster at the *International Conference on Research for Development*, Berne, Switzerland)

2008	Tamas, A. & Mosler, H.-J.: Comparing different communication strategies to promote Solar Water Disinfection (SODIS) (Poster at the *Annual Conference of the North South Centre: Research for Development*, Zurich, Switzerland)
2008	Tamas, A., Mosler, H.-J. & Tobias, R.: Promotion of a sustainable water disinfection method in Bolivia (Poster at the *9th Swiss Global Change Day*, Berne, Switzerland)
2007	Tamas, A.: Adoption and behavior continuation of a healthy innovation: The example SODIS (Solar Water Disinfection) (Paper at the *7th biennial Conference on Environmental Psychology*, Bayreuth, Germany)
2006	Tamas, A. & Mosler, H.-J.: Changing unhealthy habits – the effects of prompts and public self-commitment on drinking safe water (Paper at the *19th IAPS International Conference*, Alexandria, Egypt)
2006	Tamas, A., Mosler, H.-J. & Tobias, R.: Diffusion of Solar Water Disinfection (SODIS) in Bolivia – Changing behaviour on a household level (Poster at the *26th International Congress of Applied Psychology*, Athens, Greece)
2005	Tamas, A. & Mosler, H.-J.: Qualitative and quantitative analysis of factors that promote or hinder recycling, composting, and reusing waste in households of Santiago de Cuba (Paper at the *6th biennial Conference on Environmental Psychology*, Bochum, Germany)
2005	Tamas, A., Mosler, H.-J., Tobias, R., Caballero Rodriguez, T. & Guzman Miranda, O.: Factors determining the intension to reuse, separate and compost household waste in the city of Santiago de Cuba (Paper at the *Waste - The Social Context*, Edmonton, Alberta, Canada)