Tailored information helps people progress towards reducing their beef consumption

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1 Introduction

Household consumption has been identified as a major contributor to climate change (Hertwich & Peters, 2009). However, even though the majority of people in western countries perceives climate change as a critical threat and accepts human activities as its cause (Lorenzoni & Pidgeon, 2006), the level of individual action is limited and information campaigns have yielded only minimal effects (Abrahamse, Steg, Vlek, & Rothengatter, 2005). It has been argued that increasing the effectiveness of information aimed at inducing behavior change requires information being tailored to the individuals' need (Abrahamse, Steg, Vlek, & Rothengatter, 2007). In this paper, we argue for tailoring information based on the different psychological steps of behavioral change which have been described in behavior change models. In one of these models, Bamberg (2013b) predicts that in order to change their climate-relevant behavior people need to go through different stages with a particular need for information to match each stage's specific challenges. Information not matching the stage will in the best case be ignored, but might also confuse or irritate people. Based on four studies we analyzed if people select the information they received from a web page designed to reduce their beef consumption based on the stage of change they are in (self-tailoring). Furthermore, we study if providing information tailored to the stage is more successful in getting people to progress through the stages of change comparative to access to information targeting all stages simultaneously, mismatched information, and a no-information control.

1.1 Beef consumption as a high impact behavior

If psychologically motivated environmental campaigns are to be effective, they need to focus on behaviors that have a large environmental impact and at the same time have a high enough psychological plasticity (Dietz, Gardner, Gilligan, Stern, & Vandenbergh, 2009). Individual household consumption directly or indirectly plays a significant role in contributing to climate change and other dimensions of the environmental footprint. Within a household's impact, shelter, transportation, and food are typically the main categories where household decisions can make an important difference (Tukker & Jansen, 2008). Within the food category, the consumption of meat and dairy products is of increased importance (Carlsson-Kanyama, 1998a, 1998b), and especially beef has a high ecological footprint. For this study, we thus focused on beef consumption as an example of behavior that can be targeted with a tailored approach.

Jungbluth, Tietje, and Scholz (2000) argue that a change in food consumption and here especially the reduction of beef and dairy products is one of the priority consumer actions to achieve a large environmental benefit with because there are only a few structural barriers to change food choices. Not surprisingly, consumers have been targeted by extensive information campaigns to trigger a change towards more sustainable behavioral patterns, so far without more substantial effects. In Norway, where the studies described in this paper were conducted, reducing beef consumption was highlighted as a key action by politicians and climate researchers in the public debate about consumers' contributions to climate change mitigation. The "three B's" beef (in Norwegian "*biff*"), dwelling (in Norwegian "*bolig*"), and car (in Norwegian "*bil*"), have almost become a symbol of consumer engagement in CO_2 emission reductions. They are used by politicians, researchers and in media (Hirsti, Molde, & Thet Mon, 2014; Holden, 2001). In spite of this broad public discussion, beef consumption is high in Norway, and consumers are largely unaffected by the negative climate impact their

consumption has. The Norwegian consumption of meat has increased by the factor 2.16 since the 1950 and reached a peak of 72.0 kg per person per year in 2013; since then it is stable on this level (Helsedirektoratet, 2015). In the last 15 years alone, meat consumption has increased by 21.0%. More than a fourth of Norwegian meat consumption is beef, a significant fraction of that minced beef or meatballs (Matprat, not dated). Even if the societal discussion in Norway has emphasized the role of meat, especially beef, for reducing climate emissions repeatedly, is can be assumed that this does not play a role in everyday dietary decisions. A comparative study in the Netherlands and the US found that only a small fraction of consumers was aware of the outstanding impact that meat and dairy consumption has on the climate (de Boer, de Witt, & Aiking, 2016). Furthermore, this lack of knowledge was stronger for heavy meat-eaters. A recent poll in Nordic countries shows that even if 50% of Norwegians claim that they want to eat climate friendly, willingness to reduce beef consumption is low in Norway as compared to its Scandinavian neighbors and also the belief in reduction of beef consumption as an effective climate measure is lowest in Norway (Keldsen, 2015). Thus, the background for our study is to increase the perceived small impact of beef consumption on climate change and motivate more Norwegians to reduce their beef consumption.

It has been argued previously by several authors, that purely information-based campaigns have small to no effect on people's climate-relevant behavior (Abrahamse et al., 2005; Klöckner, 2015), but more successful intervention strategies are usually resource demanding and difficult to implement on the large scale, which would be mandatory to achieve the necessary reductions to reach the climate and other environmental goals. However, communication through the internet and smartphone applications offers new possibilities in overcoming the main shortcoming of large-scale information campaigns, namely their inability to tailor the information to the needs of the recipient. With this study, we explore the

potential that lies in providing people with tailored information, based on a detection of their stage of behavior change. Tailoring can be understood in several ways. On the one hand, tailoring can mean that people are provided with information that they need to manage the task that they are conducting at the moment. In terms of the stage model introduced in the next section, this would mean that people receive the information that they need to successfully answer the questions arising in their particular stage and manage the progression to the next stage. If they for example wonder, which alternatives they have to reduce their beef consumption, a list of alternatives with their advantages and disadvantages would be the information they need. On the other hand, tailored information can also mean that people are provided with persuasive communications adapted to the cues they are receptive to in the stage of change they are in (Latimer et al., 2008; Ludden, van Rompay, Kelders, & van Gemert-Pijnen, 2015). Latimer et al. (2008) for example found that tailoring of information to the regulatory focus (promotion oriented versus prevention-oriented) increased both the exercising intensity and the positive emotional reaction to the training. In line with this, some people in an early stage could, for example, be particularly receptive to information framed towards a health goal, others for information framed towards global justice. This study employs both perspectives on tailoring.

Even though web- or app-based tools have large potential, it should be noted, that studies have shown that such web tools often are used by highly selected groups of people (mostly highly educated women) and that the users often drop out quickly (Ludden et al., 2015). Ludden et al. (2015) studied design features that increase the effectiveness of web-based health or dietary applications and found that the personalization (hence an option of tailoring), ambient information, which means removing the "need to go online" by displaying the relevant information at the point of decision-making, and the use of metaphors to transfer information into storylines that engage were related to more usage and stronger effects. When

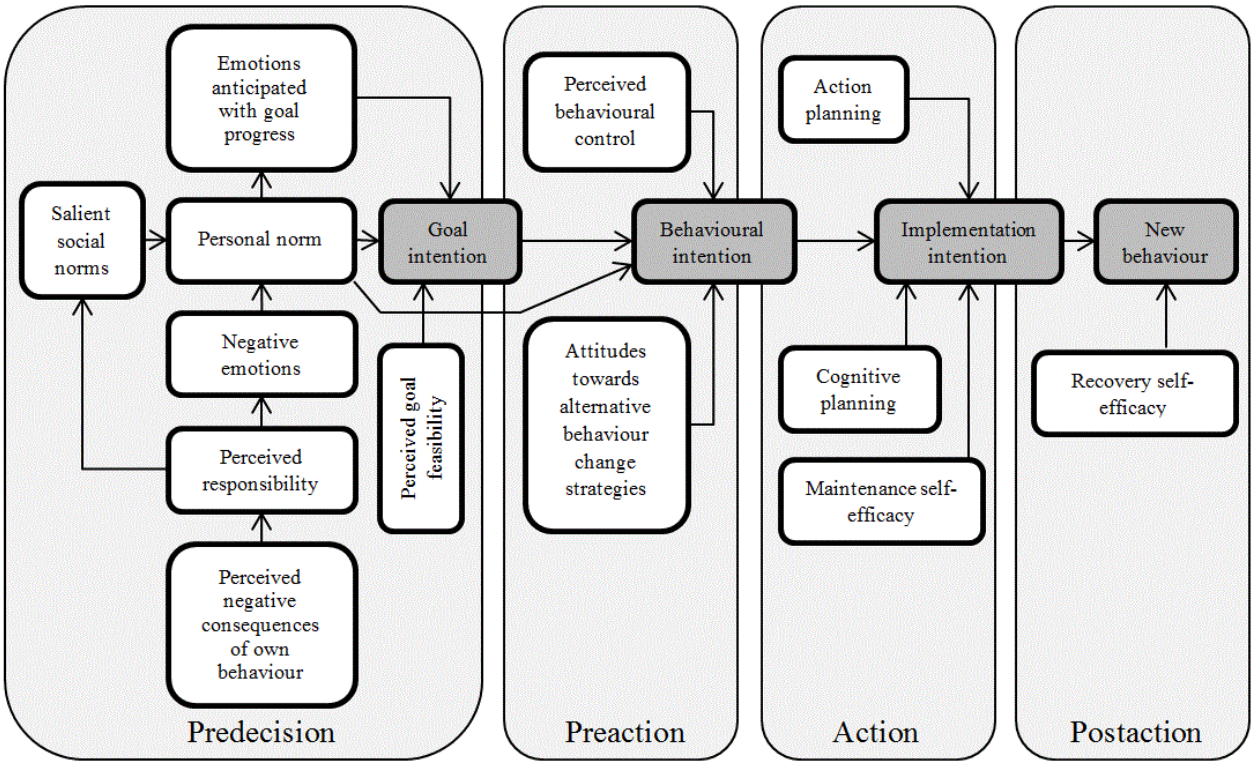
designing our website, we addressed at least some of their recommendations (see below for a more detailed description). A crucial aspect of web-based communication is certainly to treat people at the right point in time and by the right medium. This point is discussed more when the website and recruitment are presented below and in the general discussion section.

1.2 Behavior change as a process of stages

Already in the early 1990s, health psychologist argued that behavior change – especially of everyday behavior – is not a one-step process, but a series of different steps that need to be taken (Prochaska & DiClemente, 1994; Prochaska, DiClemente, & Norcross, 1992). This way of thinking has more recently been applied to environmental behavior by Bamberg (2007, 2013a, 2013b). Bamberg's stage model of self-regulated behavior change (see *Figure 1*) postulates that behavior change follows a series of four stages: (1) the predecision stage, (2) the decision stage, (3) the action stage, and (4) the post-action stage. Each stage has its main challenge that the individual has to address in order to progress to the next stage. A specific intention is formed that marks the transition. These specific intentions are determined by stage-specific predicting variables. In the *predecision stage,* the main question is, "why do I need to act?" The intention marking the transition to the next stage is the goal intention (e.g. "within the next two months I intend to do something about my beef consumption"). Variables facilitating the formation of such an intention are salient social norms, feelings of moral obligation to act, the anticipation of positive emotions when acting or negative emotions when something valuable is lost. In the *decision stage,* the main question is, "what can I do?" Here, a behavioral intention is formed (e.g., "within the next two months I intend to reduce my beef consumption by substituting beef with fish"). Variables influencing this particular intention are attitudes towards the behavioral alternatives in question and the perceived efficacy of implementing them. In the following *action stage,* the main question is, "how do I implement my decision?" In this phase, an implementation intention (e.g., "when I

buy groceries tomorrow afternoon I intend to buy fish for dinner") is formed. It is determined by planning abilities and procedural knowledge. The final *post-action stage* is characterized by overcoming relapse and temptations to fall back into old behavioral patterns. Here the main question is, "how do I overcome a potential relapse?" The model does not assume that people proceed linearly through the stages, but rather oscillate back and forth between stages of change. The model has been successfully applied to environmental behaviors, among others car use (Bamberg, 2013a) and electric car purchase (Klöckner, 2014).

Fig. 1: The stage model of self-regulated behavior change (Bamberg, 2013a, p.153)



1.3 Interventions from a stage perspective

The model is not only relevant to describe people's change processes, but also interesting from an intervention perspective, especially if resources for the intervention are limited, and a large number of people is targeted. The model predicts that – depending on the stage of

change people are in – different tailored messages would be most effective for progress to the next stage. People in the predecision stage would be mostly affected by information about the "why" of action, people in the decision stage would be receptive to the "what to do" of the behavior, whereas people in the action stage mostly need information on the "how to do that" particular behavior. Finally, people in the post-action stage would be receptive to information supporting them when they relapse.

Previous research regarding the Transtheoretical Model (Prochaska & DiClemente, 1994) indicates that tailoring information based on the stage of change can enhance the effectiveness of information packages. Rakowski et al. (1998) found that a tailored approach motivated significantly more women to take a mammography as compared to a standard information package. Dijkstra, De Vries, and Roijackers (1999) found that stage-tailored intervention packages increased the likelihood of smokers to initiate a smoke abstinence. Several literature reviews report some positive, but also contradictive or disappointing results for stage based intervention approaches in promoting physical activity (Adams & White, 2003; Hutchison, Breckon, & Johnston, 2008) or health behavior (Bridle et al., 2005). Hutchison et al. (2008) conclude, however, that most of the intervention studies did not use intervention material that was carefully targeting the respective needs and constructs in each stage. Furthermore, for our context the effectiveness of theoretically derived tailored interventions in the environmental domain has to our knowledge not been systematically studied in a randomized control trial which not only compares the tailored messages to a no-information and a standard information condition but also a mismatched information condition, providing reduced information but addressing the wrong stage. This allows us to test the effects of tailoring the information and reducing the amount of information separately. Nakajima, Yamabe, and Sakamoto (2011) for example argue, that tailoring information to the needs of consumers at a given point in time (e.g., by stage of change) is basically a measure to reduce information

overload which would benefit the decision-maker. It might be, however, that any reduction in the amount of information (not just to the theoretically relevant bits) may increase the effectiveness of a message. Based on the research results presented above, we aim to test the following four hypotheses:

H1: When presented with an information web page with information addressing all stages of change, users of the website try to self-tailor the information, mostly focusing their attention (measured in the number of clicks per respective section of the website) on stage-relevant information.

H2: A tailored intervention approach only giving access to the stage-relevant information on the web page will result in more stage progression than (a) no information, (b) access to all information, and (c) reduced but mismatched information.

H3: The effects described in H2 are stronger with repeated deliveries of tailored information interventions.

The rationale for the third hypothesis is that repeating a targeted information provision with for example several weeks between the interventions allows for the participants to progress to the next stage and then receive information tailored to the needs in the new stage. Such a strategy allows for a guided progression through several stages consecutively.

H4: Stage progression corresponds with a detectable reduction in beef consumption.

2 Design of the studies

The web page described below was used in three consecutive studies following a pilot study. The pilot and the first study analyzed web usage of the *reducebeef.org* web page separately among participants in the different stages of change. Based on the results of the first study, we conducted two additional studies where we explored the effects of tailoring information in

randomized field experiments. Study 2 was based on a random sample of Norwegian citizens; Study 3 was using the members of a representative online panel provided by a large data collection company (TNS Gallup). Both studies had the same design: The stage of change of the participants was measured in several waves with a screening instrument (two waves in Study 2, three waves in Study 3). In addition, beef consumption per week was estimated in grams with a detailed retrospective dairy. Participants were randomly assigned to one of four groups: (1) a control group without access to the website, (2) a group that received access to the complete website as used in Study 1, (3) a group that received only access to the part of the website tailored to their stage of change, and (4) a group that got only access to a random part of the website not matching their stage of change. For participants in the tailored and the mismatched group, it was neither communicated nor detectable that they only had access to a restricted version of the web page. Links to the web page were sent between the waves.

2.1 The "Reduce beef" web page – a theory-guided intervention tool

Based on the stage model of self-regulated behavior change, we designed a web page with the aim to promote the reduction of beef consumption, which was selected as a typical high-impact everyday household climate change related behavior. The website was designed following the stage model's theoretical framework and messages targeting the different variables in the various stages were developed. To further engage and increase identification with the messages, we designed three "typically Norwegian" characters representing different population segments. They were portrayed by professional actors in short video clips. The videos addressed the background story of the character, why he or she decided to reduce their beef consumption, what alternative he or she chose to reduce it, how this change was implemented, and how obstacles were overcome. We offered three main reasons to reduce beef consumption (address climate change, fight world hunger, and improve personal health) and three main alternative actions (reduce portion size for beef, substitute beef with other

meats or fish, and increase the number of vegetarian meals). By doing this, we aimed to address that information matching the current goal orientation (e.g., health vs. environment vs. global justice) gains stronger effects (Latimer et al., 2008). An English version of the website can be found at http://reducebeef.org/stage-0/?language=en (for the original Norwegian version click the Norwegian flag in the right corner). Different sections of the website presented information targeting the various stages of the model.

The entry point of the web page was different, depending on the intervention group the participants were in. In Study 1 and in the all information condition in Study 2 and 3, participants were directed to the front page, which displayed three big speech bubbles in the center if the page: The one on the left included the question "WHY SHOULD YOU DO SOMETHING about your beef consumption?" with the first half of the sentence capitalized. The bubble in the center included "WHAT CAN I DO to reduce my beef consumption?" and the one to the right included "HOW DO I MASTER the challenges of reducing my beef consumption?" (in Study 1 this section of the page was divided into two sections, one addressing the action and one the postaction stage). Underneath the three characters of the web page, Kari, Ola and Randi (three common Norwegian names) were introduced with a short paragraph of text and a short video of them introducing themselves. The name of the project (reduce beef) was included as a large "home button" in the center on top of the page, and small buttons to the background of the study, a button for switching the language, etc. were included in the header and footer of the page. Colors were light, and a brightened picture of a salad (barely recognizable) was used as a background. The three bubbles were clearly the dominating visual element of the front page. Their order was not randomized. By clicking on one of the bubbles, the users were directed to the respective subpages. In the targeted and mismatched condition, the users were directed to the respective subpage directly, and this

page was set as their front page so that they could not enter the front page with all information by accident.

On the respective subpages the user was met with the same three characters again, now telling their story about why they decided to reduce their beef consumption (targeted at the predecision stage), how they reduced their beef consumption (targeted at the decision stage), and which obstacles they met and how they overcame them (targeted at the action and post-action stages). Each character had his or her own subsection of the subpage displaying the video, some speech bubbles next to it with statements addressing key constructs in the respective stage (e.g., “What are the most important goals in life?” triggering personal norms), and a text under the video, presenting more background for the arguments that the respective character presents. A link to the scientific sources was shown at the bottom of the page. In later stages, links to external pages with recipes were included.

By using a stage-based structure of the web page and three characters with different background stories, different motivations to reduce beef consumption and various measures to achieve this we took both a perspective of tailoring to the stage a person is in and the respective regulatory focus a person has. The web page was pretested with a small sample of users and adapted based on their feedback. No deeper analyses for example by means of eye-tracking during usage was conducted.

3 Study 1

In Study 1 we analyzed the user behavior on the web page when users had free access to all parts and related that to the stage of change people are in.

3.1 Method

In Study 1, the stage of change of the participants with respect to reduction of beef consumption was first diagnosed, using a short stage-screening tool developed by Bamberg (Bamberg, 2007; Klöckner, 2015). This instrument asks the participants to indicate which of the following statements describes how they at the current point in time perceive their status of change:

(1) I am satisfied with the level of my beef consumption at the moment and see no need to change it.
(2) I should reduce my level of beef consumption but at the moment I feel that this is impossible for me.
(3) I would like to reduce my beef consumption, but I am at the moment unsure about how to replace it.
(4) I know how I can reduce my beef consumption, but I have not put it into practice.
(5) I have reduced my beef consumption in the last months.

The participants selected just *one* of the statements. Thus, no scoring of the answers was necessary. Statements (1) and (2) were coded as an indication of the predecision stage, statement (3) as an indication of the decision stage, statement (4) as an indication of the action stage, and (5) as an indication of the post-action stage. It might be debated of statement 1 and 2 describe a similar status, but Bamberg (2013a, 2013b) argues that they in practice lead to the same locked-in situation. To be consistent with his use of the screening instrument, we decided to follow his coding. Participants could not be placed in more than one stage. The measure – though being based on just one item and thus prone to more measurement error that multi-item measures – has been validated in a number of studies (Bamberg 2007, 2013a, 2013b, Klöckner, 2017).

Thereafter, participants were granted access to the beef reduction web page, and their web-usage was tracked at the group level (hence per stage group not individually). No restrictions were made on the website; they could freely choose which parts of the web page to enter. We sent the link to the website to the participants via e-mail and tracked their use behavior. The tracking was restricted to the group level to protect the participants' privacy. Google analytics was utilized for the tracking and the information about the stage was encrypted in the link to the web page. For the analyses, the number of clicks in the different sections of the website were tracked for two weeks and differences between the groups in the distribution of clicks were analyzed by means of Chi^2-tests.

3.2 Pilot study

A small pilot was conducted in early spring 2013. 80 participants were recruited among students of the Norwegian University of Science and Technology (NTNU) of which 50 visited the web page (50.1% male, 49,9% female; mean age 28.94 years, SD=6.22). Of the 50 participants in the pilot, 38 were diagnosed in the predecision stage, one in the decision stage, six in the action stage, and five in the postaction stage. These 50 participants clicked 2,690 times on the web page. 74.1% of these clicks were within the four main areas of the web page, the remaining 25.9% on the front-page, the characters' background pages, the information page about the study, and the references page of the website. The clicks distributed differently across the four areas of the web page in the four stage groups. Participants in the predecision and decision stage mostly focused their interest on the information targeting these two stages, whereas the participants in the action and post-action stage focused more on information targeting the later stages. The differences between the groups' attention of information are significant (Chi^2=501.55, df=9, p<.001). However, due to the small numbers of participants, especially in the stages after the predecision stage, the results are not conclusive. We, therefore, conducted a larger study with the same design.

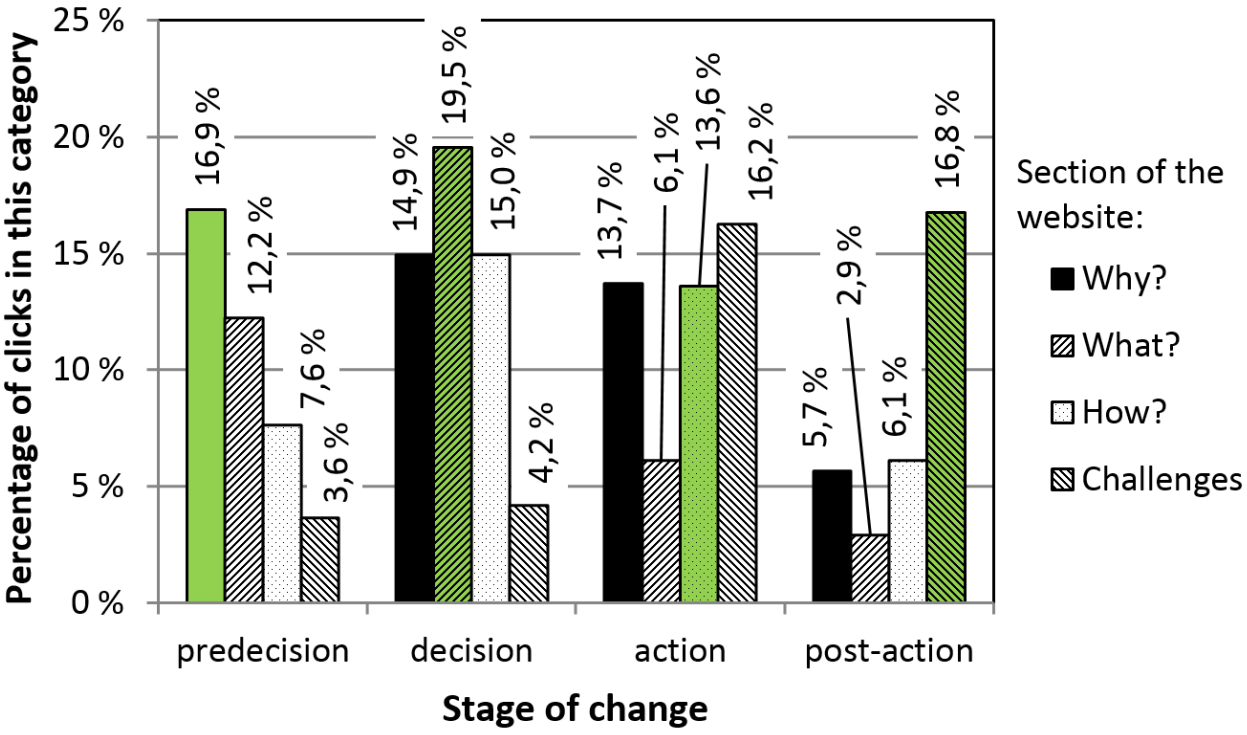
3.3 Sample

Study 1 was conducted in late spring 2013. 400 participants were initially recruited among students of NTNU, of which 389 participants used the web page (49.8% male, 50.2% female; mean age 30.93 years, SD=5.94). The recruitment of the sample was conducted in a way that participants in stage 2-4 were oversampled to gain more power to compare the groups. After a screening with the stage measure, participants were recruited until at least 90 persons per stage were in the sample. Eventually, 120 participants were diagnosed in the predecision stage, 90 in the decision stage, 89 in the action stage, and 90 in the postaction stage. Otherwise, the methodology was identical to the pilot. The participants answered the questionnaire with the stage diagnostic first and then used the website right away in a computer lab at the university campus.

3.4 Results

The 389 participants of Study 1 clicked 18,680 times on the web page, and 44.3% of the clicks were within the four target areas. *Figure 2* presents how the clicks distributed. Participants in the predecision stage focus mainly on information about "why to reduce beef consumption". Participants in the decision stage focus mainly on the "what to do" information. Participants in the action stage lack a clear focus and attend "overcoming challenges", "how to do", and "why to reduce beef consumption" information almost equally often, whereas participants in the post-action stage focus mostly on the "overcoming challenges" information. The differences in the patterns are significant (Chi^2=1774.95, df=9, p<.001).

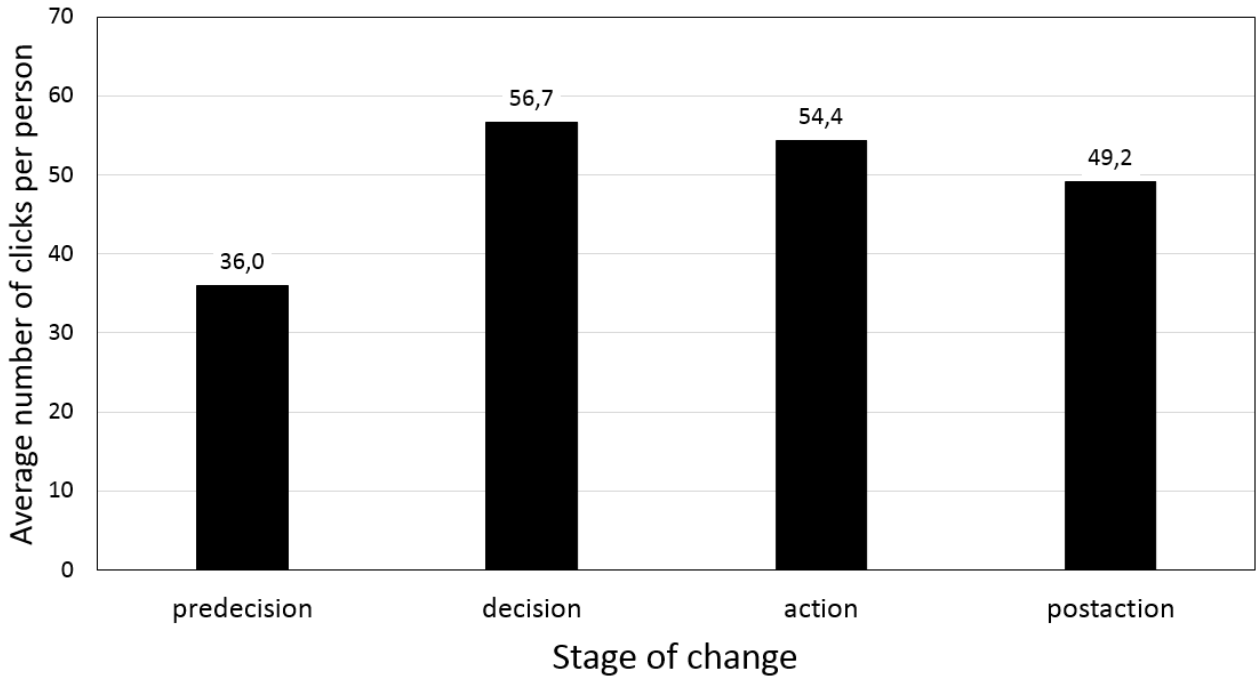
Figure 2: Percentage of the number of clicks on the respective parts of the reduce-beef homepage per group in Study 1 (N=369, total 18,680 clicks).



Note: The matching category to each stage is marked in green in the online version of the paper. Clicks on other sections of the website such as "project and contact information" and "presentations of the three characters" received the clicks missing to 100% in each group.

Figure 3 shows the average number of clicks that the participants in each stage had on the web page in the tracking period. It is visible, that participants in the predecision stage clicked the least (which means they explored the web page to a lesser degree), whereas participants in the decision stage had the highest click per person rate.

Figure 3: Average number of clicks per person on the reduce-beef homepage per group in Study 1 (N=369, total 18,680 clicks).



3.5 Discussion

The results indicate that the participants attempt to self-tailor the information to their needs. However, there is always a significant fraction of clicks in sections that are not matching the stage of change, especially in the categories presented to the left on the home screen (thus the first things to attend when following Norwegian reading habits). Furthermore, it appears that people in the decision and action stage clicked the most on the web page, indicating that they either had more need for the information on the website or the information was better tailored to their needs. One can assume, that motivation to collect information is much higher in the two intermediate stages of the model than in the first or last, when behavior change is not a goal.

4 Study 2

4.1 Methods

In Study 2, a longitudinal randomized field experiment with a control group was conducted. 30,000 Norwegians 18 years old or older were randomly selected from the population registry. In winter 2013, we sent a letter to invite them to participate in a study about beef consumption with the link to the online survey. 1,690 people started with the study of which 1047 reported the first stage measurement (51.4% male, 48.6% female; mean age 40.4 years, SD=17.4). It was not possible to conduct a response bias analysis comparing responders and non-responders since we did not have more information than the address of non-responders. We measured the stage of change for the participants and then divided them randomly into four groups: (1) no information, (2) all information available, (3) randomly provided mismatched information, and (4) tailored information matching the stage of change. Individualized links to the web page were sent to all groups but the control group. After eight weeks the stage measure was recorded again. 869 people answered this second wave (55.3% male, 44.7% female; mean age 45.2 years, SD=16.5), their data is reported here. In wave 1, the distribution of participants to the four experimental groups was 235 in the control group, 273 in the all information group, 264 in the random mismatched information group, and 275 in the tailored information group. In wave 2, the respective numbers were 192 in the control group (18.3% dropout), 219 in the all information group (19.8% dropout), 225 in the random mismatched information group (14.8% dropout), and 232 in the tailored information group (15.6%). There is no pattern in the dropout rates in the different groups that suggest a selective dropout. To test behavioral effects of the interventions, a detailed retrospective self-report beef consumption diary was administered to the participants after the stage measure in wave 1 and 2. The participants were asked to report how often during the last week they ate pieces of beef, beef meat cakes, beef burgers, puddings, patties, etc., meat cakes with more

than 50% beef, meat cakes with less than 50% beef, beef stews, and processed beef meals. For each variety, a photograph was shown illustrating how it looked like and how much a portion with 100g beef in it would look like. Then participants were asked how many of such 100g portions they approximately ate per meal. The amount of beef was then estimated as the sum of all 100g portions eaten per week. A similar measure is used by the Norwegian Institute for Consumer Research when food consumption patterns are studied. The reported average beef consumption in the week before wave 1 was 327.8 grams (SD=365.5) and in the week before wave 2 was 365.2 grams (SD=405.8).

4.2 Results

The results displayed in the right half of *Table 1* show that the percentages of people in the four stages differed depending on the wave (T1 or T2) and intervention group (control, all info, random, tailored). A Generalized Estimating Equation (GEE) analysis was chosen as the analysis method as it is a generalized regression-based approach that allows for a repeatedly measured ordered categorical dependent variable (stage of change) with a categorical predictor (intervention group) and the time point as an additional predictor. GEE assumes that the thresholds for progressing from one stage to the next (thresholds are equivalent to constants in linear regression) are constant across time points and then estimates the impact of the predictors on the probability to be in a higher category of the dependent variable. For the estimation of the impact of a categorical predictor, one category and time point needs to be selected as the reference category. We chose the control group at T1 as the reference point.

The results are displayed in the left half of *Table 1* indicates that only the tailored information group had a substantial stage progression between wave 1 and wave 2 in Study 2. Being in the tailored group after the intervention (Tailored T2) had a highly significant positive impact on stage progression as compared to the control group at T1. The effect of being in the random

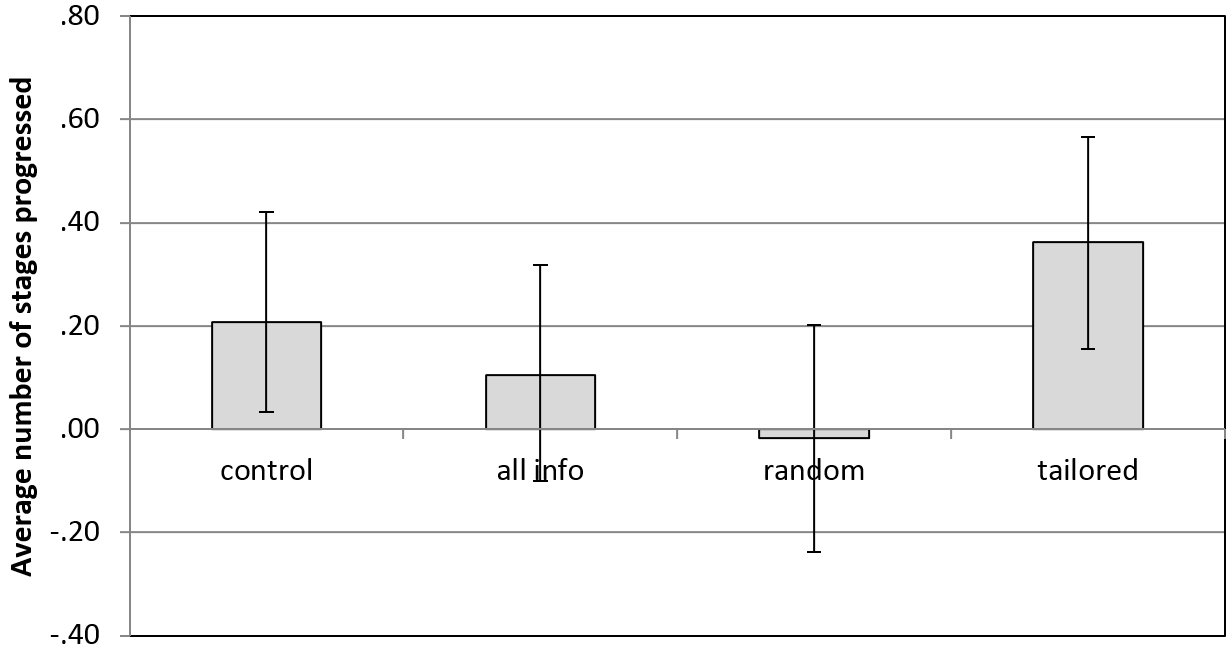
group at T2 as compared to control at T1 was also positive and significant but of much smaller magnitude. *Figure 4* displays the average stage progression per group in Study 2. It needs to be acknowledged that this figure is based on a different type of analysis. Whereas the GEE compares the effect of time and intervention group as compared to the control at T1 as a reference, the numbers in *Figure 4* are the average stage progressions for each individual (which means each individual can have a value between -3 = going three stages back from postaction to predecision and +3 = going three stages up from predecision to postaction). In other words, here the individual pro- and regressions are averaged, and each group is its own reference. The figure shows that the most positive average stage progression can be found in the tailored group, whereas the random group has on average even a slightly negative progression. However, 95% confidence intervals for the four estimates overlap, so no conclusion can be drawn if the differences are likely to be found in the population. Only the control and the tailored group have confidence intervals that to not include 0.

Table 1: Results from the Generalized Estimating Equation analysis of the data of Study 2 (N=869) and Study 3 (N=3,559)

										predecision		decision		action		postaction	
		b	SE	CI low	CI high	Wald	df	p		%	n	%	n	%	n	%	n
Study 2	Threshold 1	1,362	0,179	1,012	1,713	58,104	1	<.001	***								
	Threshold 2	1,815	0,184	1,454	2,176	97,229	1	<.001	***								
	Threshold 3	2,270	0,188	1,902	2,639	145,919	1	<.001	***								
	Control T1[a]	0								79,79 %	154	4,66 %	9	5,18 %	10	10,36 %	20
	Control T2	0,450	0,240	-0,020	0,920	3,527	1	0,060		72,40 %	139	5,21 %	10	6,77 %	13	15,63 %	30
	All info T1	0,024	0,245	-0,456	0,505	0,010	1	0,921		79,45 %	174	3,65 %	8	6,85 %	15	10,05 %	22
	All info T2	0,271	0,238	-0,195	0,737	1,302	1	0,254		76,26 %	167	3,65 %	8	5,94 %	13	14,16 %	31
	Random T1	0,433	0,233	-0,024	0,890	3,451	1	0,063		72,89 %	164	3,11 %	7	8,00 %	18	16,00 %	36
	Random T2	0,489	0,231	0,037	0,941	4,502	1	0,034	*	71,56 %	161	7,11 %	16	5,78 %	13	15,56 %	35
	Tailored T1	0,426	0,230	-0,025	0,878	3,422	1	0,064		73,71 %	171	4,31 %	10	7,33 %	17	14,66 %	34
	Tailored T2	1,274	0,211	0,860	1,689	36,306	1	<.001	***	43,97 %	102	31,90 %	74	5,17 %	12	18,97 %	44
Study 3	Threshold 1	1,644	0,104	1,441	1,846	252,240	1	<.001	***								
	Threshold 2	2,318	0,107	2,108	2,527	469,040	1	<.001	***								
	Threshold 3	3,111	0,109	2,896	3,325	810,955	1	<.001	***								
	Control T1[a]	0								82,77 %	663	4,99 %	40	5,99 %	48	6,24 %	50
	Control T2	0,639	0,133	0,378	0,899	23,166	1	<.001	***	76,90 %	616	4,99 %	40	5,49 %	44	12,61 %	101
	Control T3	1,150	0,118	0,918	1,382	94,510	1	<.001	***	60,67 %	486	18,23 %	146	9,49 %	76	11,61 %	93
	All info T1	0,037	0,144	-0,245	0,318	0,065	1	0,799		82,20 %	739	3,56 %	32	6,67 %	60	7,56 %	68
	All info T2	0,564	0,132	0,306	0,822	18,381	1	<.001	***	77,20 %	694	4,45 %	40	7,23 %	65	11,12 %	100
	All info T3	1,686	0,121	1,449	1,924	193,573	1	<.001	***	47,94 %	431	17,35 %	156	16,02 %	144	18,69 %	168
	Random T1	0,673	0,128	0,421	0,925	27,490	1	<.001	***	73,68 %	672	3,07 %	28	8,33 %	76	14,91 %	136
	Random T2	1,334	0,124	1,091	1,577	115,664	1	<.001	***	62,50 %	570	8,77 %	80	6,91 %	63	21,82 %	199
	Random T3	2,432	0,121	2,194	2,670	402,064	1	<.001	***	30,92 %	282	21,38 %	195	13,05 %	119	34,65 %	316
	Tailored T1	0,252	0,125	0,007	0,497	4,065	1	0,044	*	82,68 %	783	8,45 %	80	5,49 %	52	3,38 %	32
	Tailored T2	1,770	0,117	1,542	1,999	230,499	1	<.001	***	40,02 %	379	31,68 %	300	13,09 %	124	15,21 %	144
	Tailored T3	3,476	0,118	3,245	3,706	872,618	1	<.001	***	1,69 %	16	12,67 %	120	34,00 %	322	51,64 %	489

[a] reference category; *** p<.001, ** p<.01, * p<.05

Figure 4: Average stage progression per group in Study 2 (N=826) with bootstrapped 95% confidence intervals.



To test potential behavioral effects of the intervention conditions on the change in the amount of beef consumed, an analysis of variance with experimental condition and stage of change in wave 1 as well as their interaction as independent variables and the difference in beef consumption between wave 1 and 2 as dependent variable was calculated. The amount of beef consumption in wave 1 was included as a covariate to control for differences in beef consumption on the onset of the study. *Figure 5* displays the estimated marginal means for the effects in the four intervention conditions. The ANOVA results are reported in *Table 2*. The analysis shows that there are no detectable behavioral effects in Study 2, the beef consumption change does not differ significantly between the groups, initial stage membership and their interaction. The covariate "level of beef consumption in wave 1" has a highly significant impact on the achieved reduction, indicating larger reductions for higher starting values, which is to be expected due to regression to the mean effects.

Figure 5: Estimated marginal means of the change of beef consumption in the intervention groups in Study 2 (N=868) with 95% confidence intervals.

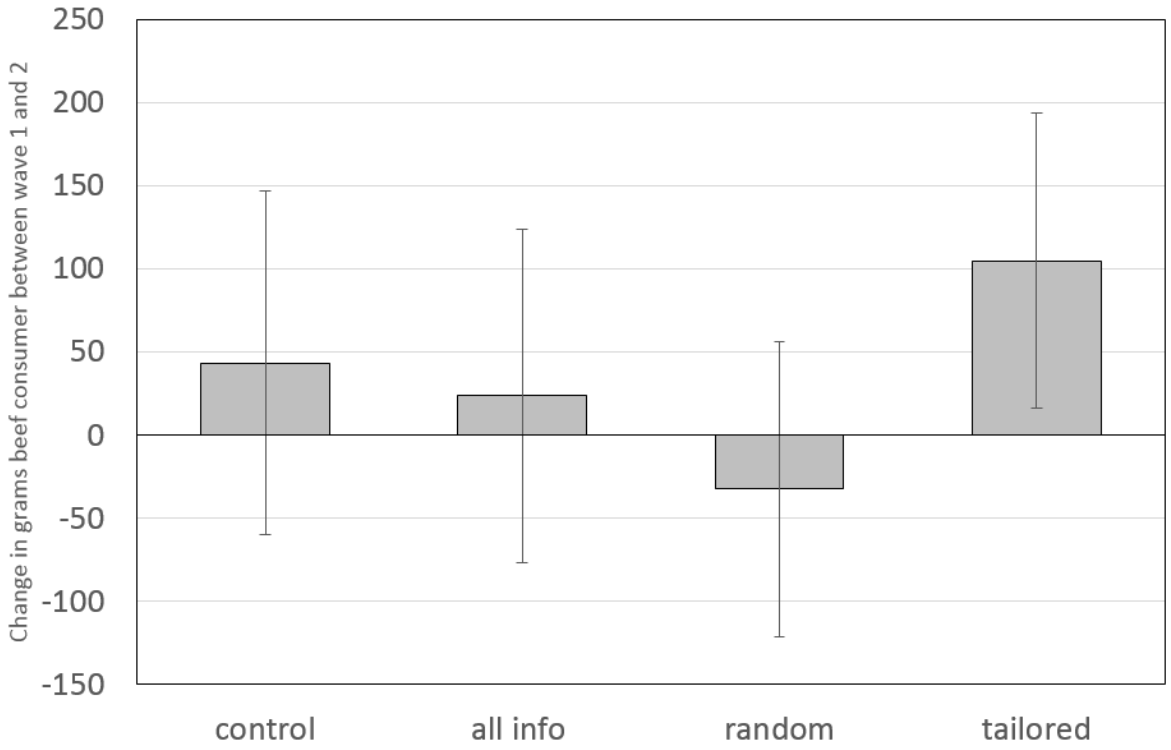


Table 2: Results from the ANCOVA of beef consumption reduction with experimental condition, initial stage membership, and condition x stage interaction as independent variables and initial amount of beef consumption as covariate.

	Sum of squares	*df*	*F*	*p*
Experimental condition	706745.12	3	1.426	.234
Initial stage of change	337092.04	3	.680	.564
Condition x initial stage	1247735.17	9	.839	.580
Initial beef consumption (covariate)	88893083.85	1	538.166	<.001***
Error	133628862.4	809		

*** p<.001

4.3 Discussion

Study 2 provides first indications that tailoring seems to have a positive effect on stage progression. The GEE results show that compared to the control group at T1 only the tailored group at T2 has a substantially higher likelihood of stage progression. The analysis of average stage progression per group indicates that tailored information might have the best effect, but the results are inconclusive, based on wide and overlapping confidence intervals. No behavioral effects could be shown. Furthermore, Study 2 suffered from an extremely low response rate (about 3%) so that it is highly questionable that the sample represents the population. Therefore, we replicated the study with a representative and larger sample recruited via an online panel. In addition, we added a third wave to the study to explore the benefits of repeating a stage-tailored intervention approach.

5 Study 3

5.1 Methods

Due to the extremely low response rate in Study 2 and the resulting self-selection bias, we conducted Study 3 with members of the online panel provided by TNS Gallup. The operator of the panel did not provide information about how many panel members were contacted to recruit the obtained number of participants, but in general terms, the panel description reports response rates around 60%. The study was identical to Study 2 but included three waves and only four weeks intervals between the waves. It was conducted in spring 2014. 3,895 respondents started answering the survey, 3,508 people completed the three waves in Study 3 (52.8% male, 47.2% female; mean age 43.4 years, SD=14.9). In wave 1, the distribution of participants to the four experimental groups was 970 in the control group, 974 in the all

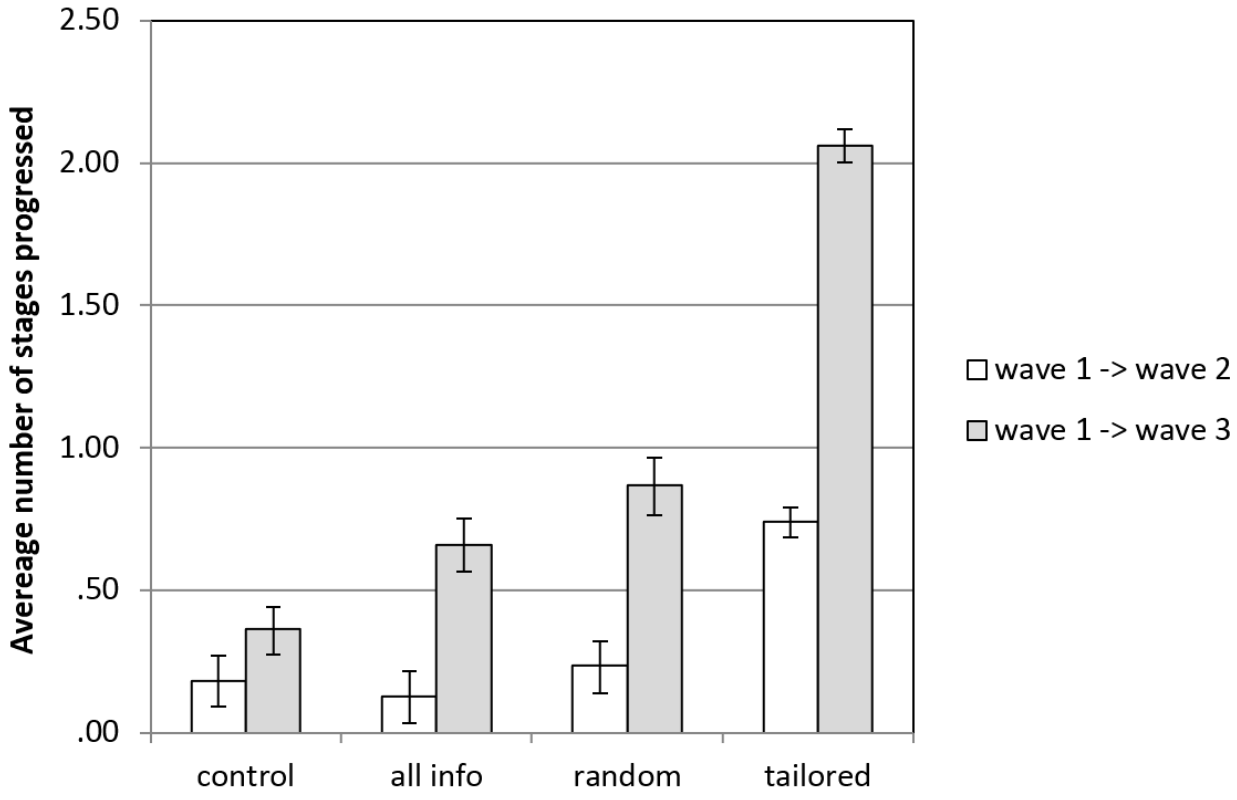
information group, 975 in the random mismatched information group, and 976 in the tailored information group. In wave 3, the respective numbers were 801 in the control group (17.4% dropout), 899 in the all information group (7.7% dropout), 912 in the random mismatched information group (6.5% dropout), and 947 in the tailored information group (3.0%). Whereas the three experimental conditions have approximately the same low dropout rates, the dropout in the control group was about 4-5 times higher, which might be explained by that they just responded to the questionnaire and did not receive any intervention in between. Behavior effects were measured in the same way as in study 2, comparing the initial beef consumption with the final level of beef consumption in the week before wave 3. The reported average beef consumption in the week before wave 1 was 326.1 grams (SD=364.8) and in the week before wave 2 was 328.7 grams (SD=369.5).The same analysis strategy as in Study 2 was applied.

5.2 Results

Table 1 reports the results of the GEE analysis for the sample in Study 3. Before the first round of interventions, the all info group is not different from the control group, the tailored group has a significantly but only slightly higher probability of stage membership in later stages, but the mismatched group has a significantly more advanced stage membership already before the intervention starts. Since the groups were in no way treated differently in wave one and only randomized into the different conditions after the wave 1 survey was completed, this difference is attributed to be random. The comparisons of T2 and T3 values against control T1 show that all groups progress. Due to the larger sample, all groups at later time points are significantly different from the reference group control at T1. However, this increase is strongest for the tailored group, followed by the mismatched group (but keep in mind the higher starting level), the all information group and finally the control. This pattern emerges already at T2 but is more distinct for T3.

The display of the average stage progression in wave 2 and wave 3 as compared to wave 1 in all intervention groups in *Figure 6* shows the same picture, the effects are strongest in the tailored group, especially in wave 3, followed by the mismatched group and the all information group.

Figure 6: Average stage progression per group in Study 3 (N=868) with bootstrapped 95% confidence intervals.



The analysis of behavioral effects was conducted with the same analysis as in Study 2, this time, however, comparing wave 1 and 3. The amount of beef consumption in wave 1 was again included as a covariate. *Figure 7* displays the estimated marginal means for the effects in the four intervention conditions. The ANOVA results are reported in *Table 3*. The analysis shows that three of the experimental groups have overlapping confidence intervals, but the *all information* group shows a significant increase in beef consumption, as opposed to

(insignificant) decreases in the other groups. The ANCOVA shows significant main effects of experimental condition and initial stage membership and a significant interaction. The covariate is also highly significant.

Figure 7: Estimated marginal means of the change of beef consumption in the intervention groups in Study 3 (N=3343) with 95% confidence intervals.

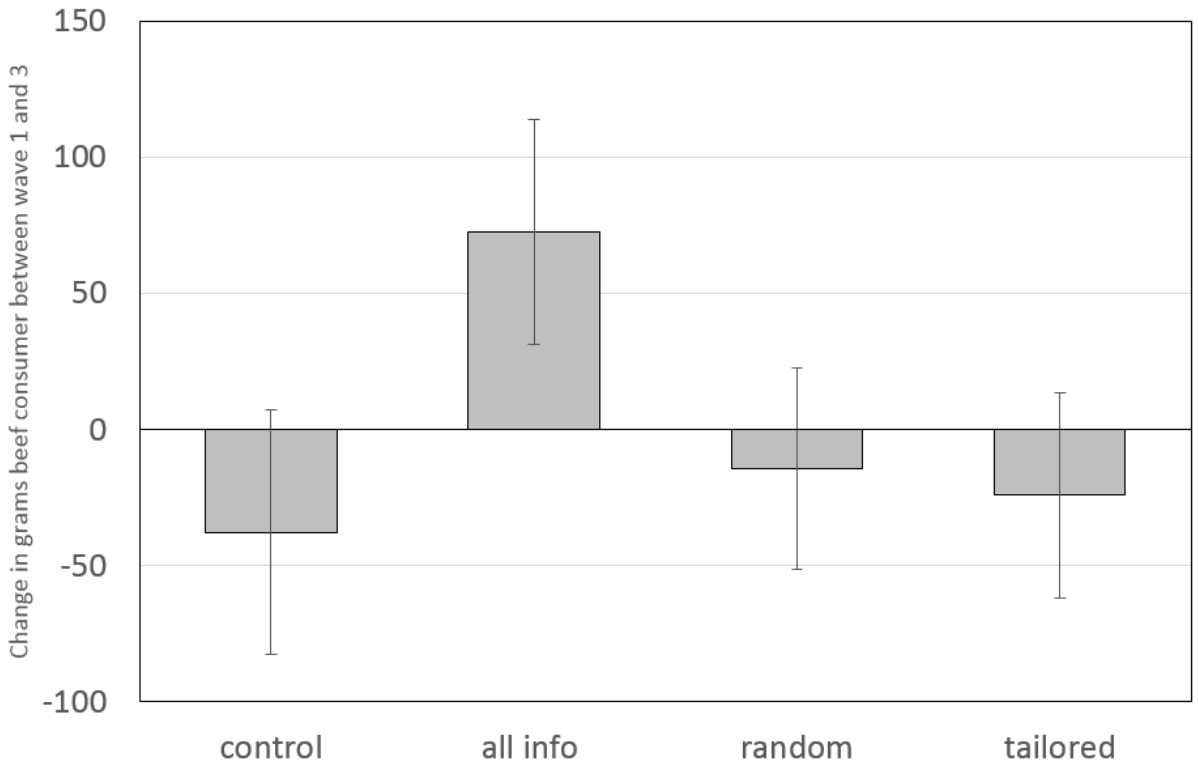


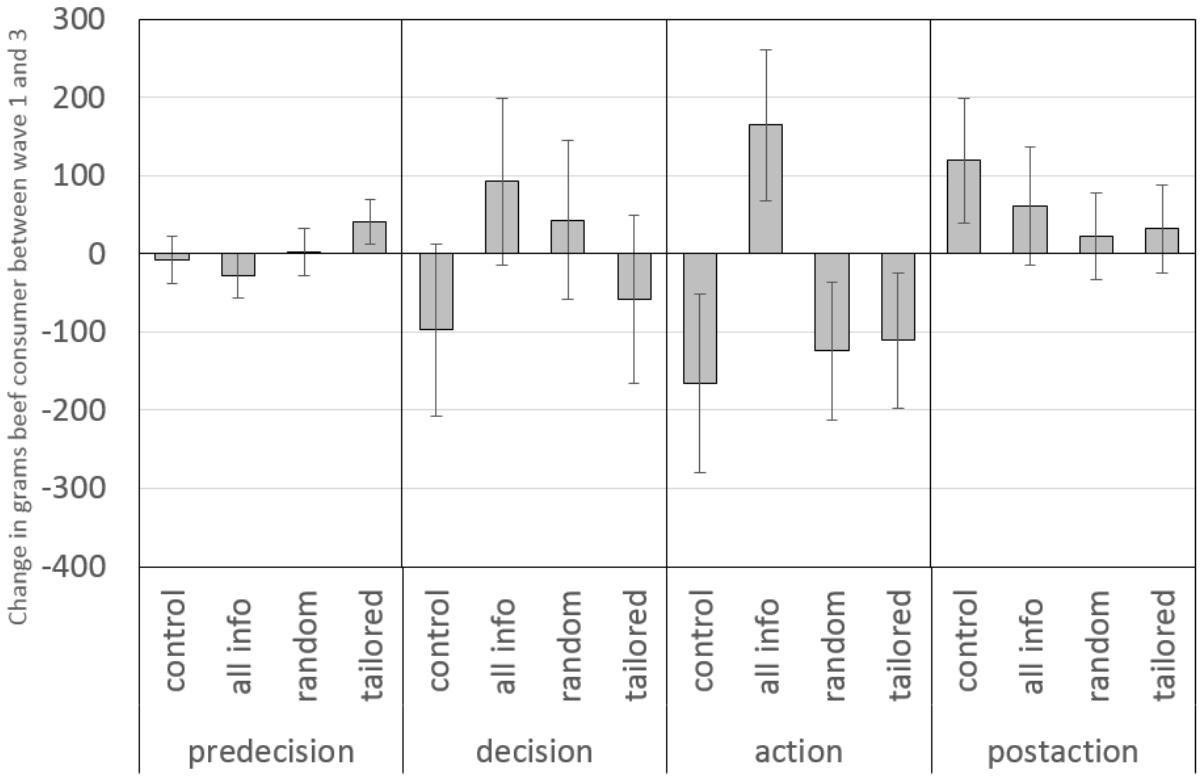
Table 3: Results from the ANCOVA of beef consumption reduction with experimental condition, initial stage membership, and condition x stage interaction as independent variables and initial amount of beef consumption as covariate.

	Sum of squares	*df*	*F*	*p*
Experimental condition	2242002.53	3	5.552	.001**
Initial stage of change	2170702.73	3	5.375	.001**
Condition x initial stage	6500971.73	9	5.366	<.001***
Initial beef consumption (covariate)	287831156.1	1	2138.147	<.001***
Error	447736470.5	3326		

** p<.01; *** p<.001

Figure 8 visualizes the interaction between initial stage and experimental condition in the reduction of beef consumption. Participants who started in the predecision stage showed only very small changes, the only significant is the slight increase for participants in the tailored condition, which is contrasted by a slight decrease in the all information condition. Participants who started in the decision stage showed decreases in control and tailored condition and increases in the two other conditions, but the confidence intervals overlap. In the action stage, all conditions reduce beef consumption significantly, with the exception of the all information group, which shows a significant increase. In the postaction stage, all groups increase their beef consumption again, but only in the control group this increase is significant.

Figure 8: Estimated marginal means of the change of beef consumption in the intervention groups per initial stage of change in Study 3 (N=3343) with 95% confidence intervals.



5.3 Discussion

Study 3 confirms the results found in Study 2 for most findings: Also in Study 3 the tailored information yields the strongest effects on stage progression as compared to the other interventions. Due to the larger sample size, the error margins of the estimates in Study 3 are much smaller, and the results are therefore more conclusive. Furthermore, Study 3 is based on a representative sample with much lower self-selection bias, which also makes the findings in Study 3 more robust. One obvious difference between Study 2 and 3 needs to be noted. Whereas in Study 2 the mismatched information group displayed a small negative average progression, the picture changed in Study 3: Here the mismatched group received the second best progression score. We tend to accept the results of Study 3 as closer to the real population effects because Study 2 was based on a smaller and in addition much more biased

sample. This makes the sample of Study 2 more vulnerable for outliers. However, it might also be the case that the pre-intervention difference between the groups (more advanced stage membership in the mismatched group) had an effect here, since it might be possible that stage transitions closer to behavior are easier to achieve than between the earlier stages. The behavioral effects in Study 3 are again inconclusive. Even though the analyses shows significant effects of the experimental conditions on reduction of beef consumption, this effect seems to be caused by an increase in the all information condition, rather than a decrease in the other intervention conditions. The interaction analysis shows, that this effect seems to be caused by increased beef consumption of participants in the all information group that started in the decision or action stage. We have no clear explanation for this effect, other than assuming that the stronger stimulation with beef related visual and text based stimuli might have triggered an unconscious craving for eating beef.

6 General Discussion

The results of Study 1 show that people – when faced with a website that contains a lot of information targeting the different stages of the change process to reduce beef consumption – try to self-tailor to their needs: People in later stages of change focus more on information relevant for these later stages, whereas people in earlier stages of change focus more on information relevant for these earlier stages. However, the results also show that people not only attend information that is targeting the specific stage of change they are in. They also go into other sections of the website. This showed especially for participants in the action stage that even slightly prioritized two "wrong" sections of the web page over the section that was targeted at their stage. This could, in theory, be interpreted in three different ways: (1) the screening instrument that detects the stage of change is not able to place people in their respective stage of change with 100% accuracy, (2) even if people are placed correctly in one stage of change they might still feel the need for information targeting other stages, or (3)

people try to self-tailor, but do not succeed perfectly because their reading habits make them attend the information presented further to the left first (which especially for people in later stages leads them to also look at information targeting the first stage). We believe that most likely all three components play a role here, but that the last one is the theoretically most interesting, which also would confirm hypothesis H1. A more conclusive support to the last interpretation would have been to develop different versions of the website with different orders of the subsections. However, the results of Study 2 and 3 also support the assumption that the imperfect self-tailoring is more than just an indication of a poor screening instrument or poor targeting of the information pieces to the stages.

In Study 2 and 3, we systematically studied if providing tailored information guides people more successfully through stages of change than just providing all relevant information to everybody. We compared stage progression in the tailored condition against no information, all information and reduced but mismatching information. The interesting result is that tailored information outperforms the other conditions in both studies. In Study 2, we found that only the tailored information condition was connected to a substantial stage progression between the two time-points. In Study 3, we found again that the tailored condition had the strongest effect on stage progression, especially when repeated a second time which implies that people that changed stage between the first two measurements were provided with a different section of the website in the second intervention period. It is furthermore interesting that the full information condition, which of course also included the sections of the website that match the predicted need of the person, performs only marginally better than a no-information condition in Study 3 and even slightly worse in Study 2. The results for the random, mismatched information condition were different between Study 2 and 3. In Study 3, it does not reach the high level of the tailored information condition, but still outperforms the all information condition, in Study 2 the result for this condition was poorest of all four

conditions. If we place more weight on the results of Study 3 based on the larger and less biased sample, it appears that reducing the amount of information made it more convincing, even if it was not matching the stage of change. Study 2 and 3 thus confirm hypothesis H2, Study 3 also shows that the effects of tailored information get stronger if the tailored process follows people through their change process with repeated, adjusted information. A limitation of the presented studies is that it was not possible to control the actual information use on the website due to privacy limitations. This means that we cannot be sure which pieces of available information were attended by the participants in the different conditions, especially in the "all information" condition, which effectively is a "self-tailoring" condition, and the mismatched condition, where the degree of mismatch could not be controlled.

Our studies confirm some theoretical assumptions that can be derived from stage based change models like the transtheoretical model (Prochaska & DiClemente, 1994; Prochaska et al., 1992) or more recently and more tailored to the environmental domain the stage model of self-regulated behavior change (Bamberg, 2007, 2013a, 2013b). Even if previous results are inconclusive about if tailoring interventions to stages of change is a promising strategy or not (Adams & White, 2003; Bridle et al., 2005; Hutchison et al., 2008) this study demonstrates that there might be a significant potential in combining targeting techniques and web-based environmental communication. The results further suggest that a part, but not all of the positive effect of tailored information is caused by the reduction of the amount of information that needs to be processed, which counteracts information overload (Eppler & Mengis, 2004). Thus, if we only analyzed the effect of tailored versus full information, we might have overestimated the effect caused by tailoring by including also the effect of reducing the information overload.

However, it needs to be acknowledged that the results discussed so far build on self-reported stage membership. The analysis of reduction of beef consumption give no clear conclusion of

the behavioral effect of the interventions. In Study 2, no effect could be found, in Study 3 no reduction could be detected in the control and two of the interventions groups, but a significant increase could be detected in the all information group. Being cynical, one could thus conclude, that maybe people did not proceed through the stages after all, but were just curious what happens if they clicked another stage description in the detection instrument. However, we find that not a very convincing explanation of the results because it would affect all conditions similarly and could not explain the distinct differences between the conditions. The interesting question is therefore, why the behavioral effects did not show. One explanation is the high level of noise included in the behavioral measure. Even if the measure was adapted from consumer research in Norway, it showed high variability over the different measurement points. Another explanation could be that presenting people with information and especially visual stimuli of beef might not only influence their intentions to reduce beef consumption, but also – subconsciously – trigger their craving to eat beef. The link between visual stimulation and eating behavior has been shown for example by Spence, Okajima, Cheok, Petit, and Michel (2015). This effect should then be strongest for people in the all information condition.

Before considering upscaling the strategy, the key element in any web-based intervention technique needs to be discussed, though, namely motivation to use a web page. In all three studies, participants were not behaving naturally as they were participants in a research project and thus more motivated to do what was asked of them, checking the website. Especially the participants of Study 1 who were recruited at the university campus and checked the website in a computer lab on the campus were very motivated to actually use the website. Also, participants in Study 3 who were rewarded with points in the point system of the panel operator for answering the questionnaires can be assumed to have a far above the average motivation to use the website, which also shows in the lower dropout rates as

compared to Study 2. Both effects contribute to higher than normal access of the website. Results of Study 1 show that people in the predecision stage click less on the website indicating that they are less motivated to explore even if they use the website. However, since the most serious problem for intervention websites seems to be to make people visit regularly and not to visit a site once (Ludden et al., 2015), our web page might have an advantage since it does not require repeated usage as long as the stage of change has not changed. This does not mean, however, that the problem of motivating people in real life to visit an intervention website like the one we tested is trivial. Possibly, the best approach would be to implement such web-based interventions in an organizational context (for example an internal campaign in a university or a large company), where people can motivate each other to participate.

Another aspect that this study does not address is the mechanisms behind stage progression. What characterizes people who progress based on an intervention campaign? It could, for example, be reasonable to assume that participants that spend more time on a website and click on more links are more affected, but because we were not allowed to track website behavior on the individual level this question could not be addressed in this study. Another question is, what are the variables driving such progression? Studies in other domains show that an increase in intention strength seems to be a trigger of stage transition (Klöckner, 2014), but little is known about the dynamics of the variables described in Bamberg's model (2013a, 2013b).

7 Conclusion

With respect to climate-relevant behavior change, we conclude from the four studies, that tailoring information to the stage of change people are in increases the chances to get closer to implementing the changes. Presenting the same information, but hidden among other information not relevant for the individual's next stage progression appears to be much less

effective, probably even less effective than presenting a smaller amount of information that is *mismatched* to the individual's stage of change. The concept of information overload (Eppler & Mengis, 2004) might explain why this is the case: Presenting a user of a website with too much information makes it difficult for him or her to identify what is most relevant. Adaptive technologies on websites and smartphones offer greater possibilities to tailor the information by implementing a screening with relatively simple instruments similar to the stage measure used here. The research presented here indicated that this approach might increase the effectiveness of information campaigns substantially.

Furthermore, the research indicates that designing websites with different narratives that people with different motivations can relate to might be of advantage. We used three different actors to impersonate three "typical Norwegians". Also their motivations for limiting their beef consumption and their approach differed which opens up for users of such a web service to identify with one character and to find the narrative fitting one's personal motivation. However, the crucial issue that this study does not explicitly address is how to motivate people in real life to use such a website (even if the site does not require frequent interaction this is a big hurdle). Following the findings of Ludden et al. (2015), taking opportunities for ambient information rather than information that needs to be approached actively seems promising, so the opportunities that lie in new communication technologies in this direction should be explored more (e.g. through the use of mobile devices or ambient displays).

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