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Abstract: Everyone has inner contradictions, and particularly in the area of the environment, many people act in ways that contradict their intentions. Measures that make people aware of these discrepancies trigger inner processes that can lead to changes in behaviour. In an action campaign promoting voluntary slower driving speeds in a Swiss municipality, our use of measures that confronted people with contradictions resulted in a remarkable reduction of average driving speeds. The processes triggered in persons during the campaign were simulated by means of an agent-based simulation. To this end, we developed a model based on the social psychological theory of cognitive dissonance. This theory states ways in which people deal with inner inconsistency. The simulation model was fed with data that was collected in a representative survey both prior to the action campaign (pre-survey) and after the campaign (post-survey). The data from the pre-survey served as the initial data for the simulation; the post-survey data allowed us to determine people's perceptions of the measures as well as attitude and behaviour changes. Assumptions were formulated as to how the measures work. Using these assumptions and the collected data, it was possible to model successfully the dissonance processes occurring in people through the course of the action campaign: For more than 60% of the simulated persons, their attitudes and behaviour changes were (post) predicted correctly with a deviation of 20 points. For future action campaigns, therefore, it should be possible to determine in advance the measures that will be most effective by conducting simulations on the basis of preliminary surveys.

Keywords: agent based social simulation, contradictions, campaign, validation, campaign consulting

1. INTRODUCTION

Each of us goes through daily life with some inner contradictions. This is particularly evident when it comes to environmental concerns: While we *believe* it is important to protect the environment, our *actions* seldom reflect that concern. We know that there is air pollution over our cities, but we continue to drive our cars. How we deal with these inconsistencies psychologically, whether we suppress them or process them, what effects they have on our thinking or behaviour – these are the issues addressed by dissonance theory in social psychology [Festinger, 1957]. The results of the research on dissonance theory provide a knowledge base that make it possible to develop measures for changing people's attitudes and behaviour by targeting their inner contradictions [Frey & Gaska, 1993]. This is pertinent to the area of environmental attitudes and behaviour as well.

Dissonance theory, however, is a static theory. It explains how people react to certain information inputs, but it does not explain the dynamic process of how people change their attitudes and behaviour on the basis of new incoming information over time. For this reason, we designed a simulation model that represents the processes of repeated processing of inner contradictions on the basis of dissonance theory. In the following, a brief discussion of the simulation model is followed by information about a real world environmental action campaign that we initiated and studied. The campaign implemented measures designed to target people's inner inconsistencies. The way in which people process inner inconsistencies can be represented best through a simulation of dissonance theory. For the campaign, we describe data collection, operationalisation of the measures, and how these were implemented in a simulation. The results of the simulation behaviour are then

examined to see how well the model replicates the changes in attitude and of the people involved in the real world campaign. The advantages and difficulties of this study, as well as implications for future research, are discussed in the final section.

2. THE SIMULATION MODEL

In order to model agents' processing of contradictions between attitudes and behaviour towards the environment, we applied the theory of cognitive dissonance, a theory in social psychology [Festinger 1957; Frey & Gaska, 1993]. This theory states ways in which people deal with inner inconsistency. The processes in reducing inconsistencies according to this theory are shown in Figure 1. Looking at Figure 1, we can describe the processes occurring in the agent as follows: If agents experience a discrepancy, or dissonance, between attitude and behaviour, they will attempt to reduce dissonance; there will be changes of cognition (cognised attitude or cognised behaviour). That cognition will change that shows the least resistance to change. A comparison of people's attitudes and behaviour with the values that they hold yields resistance to change. Personal values make up a person's general, basic orientation. The greater the resistance to change is, the smaller the difference between values and attitude or behaviour. This means that the more that an attitude or behaviour "fits," or is consistent with, the importance, or value, the person places on things, the greater the resistance to change. The extent of attitude or behavioural change is determined by the difference between these two variables, or in other words, by the magnitude of the actual dissonance.
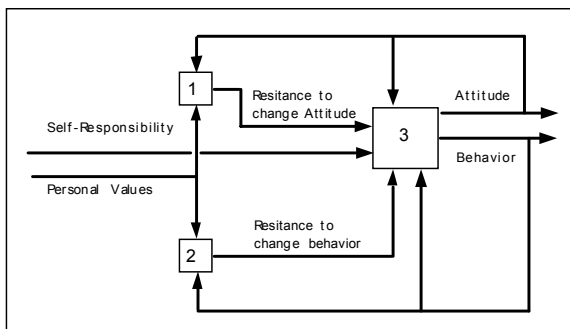

Figure 1. Graphic representation of the processes implemented in the model. The arrows show the variables; transition functions are in the boxes.

This change in attitude or behaviour is then weighted in terms of self-responsibility, in such a way that if a person has no feeling of self-responsibility, there will be no change, as no dissonance exists.

The following lists the pseudo-code of transition functions in the boxes (numbers are indicating the boxes):

Box 1:
Resistance to change Attitude = |Personal Values – Attitude|;

Box 2:
Resistance to change Behaviour = |Personal Values – Behaviour|;

Box 3:
If Resistance to change Attitude > Resistance to change Behaviour then Behaviour Change;

If Resistance to change Behaviour > Resistance to change Attitude then Attitude Change;

If Attitude Change then Attitude = Attitude(t-1) + (Behaviour – Attitude)*Self-Responsibility;

If Behavioural Change then Behaviour = Behaviour(t-1) + (Behaviour – Attitude)*Self-Responsibility;

For more detailed information about the concept of the agent, see Mosler [2001].

3. THE REAL WORLD CAMPAIGN AND THE MEASURES IMPLEMENTED

The data for the present study was collected in a collective action campaign called "Slow Down!" in the municipality of Münsingen near Bern (Switzerland). During the action phase of the campaign, drivers in Münsingen voluntarily reduced their driving speeds through the town. Reduced driving speed is desirable from the standpoints of environmental protection and traffic safety, and it was what the majority of municipal residents wanted for the streets in their community. The entire process was initiated by us, and we served as campaign consultants and evaluators. The plan was to first find a sufficient number of participants and then to have them begin the "slow down" in a co-ordinated way (simultaneously). To carry out the plan, we made use of a self-commitment instrument: drivers were asked to commit themselves in writing to drive more slowly (30km/h) when the action began. There are 4,000 car owners among the 10,000 residents in Münsingen, and over 1,000 persons committed themselves in writing to participate. What is more, speed measurements at several locations in the municipality revealed a marked and significant reduction in driving speeds during and after the campaign [for details, see Mosler, Gutscher & Artho, 2001].

The campaign applied a number of different intervention measures designed to encourage drivers in Münsingen to slow down. Three types of

these measures are pertinent to cognitive dissonance theory:

Personal commitment in writing to drive slowly was designed to engender dissonance, in that an inner inconsistency would arise between the behaviour people pledged to perform and their previous behaviours and attitudes.

Prompts were designed to make existing inner inconsistency salient, thereby setting off the dissonance process within the person. As prompts, 120 coloured flags showing the campaign logo and the "Voluntary Slow-Down in Münsingen: 30 km/h" slogan were hung throughout the town, and key chains and bumper stickers showing the campaign logo were distributed to serve as daily reminders.

Feedback measures to make inner inconsistency salient were also used. During the entire action phase, three mobile units measuring driving speeds were moved from place to place within the municipality. Clocked speeds posted on the electronic boards gave drivers feedback on their actual speeds and served to remind them about the campaign.

To evaluate the campaign, a questionnaire survey was conducted before and after the action. The questionnaire was used to determine the values of the relevant variables for each respondent and to discover people's reactions to the measures implemented. For the before and after surveys, we built a panel of 1,400 persons. The sample was derived randomly from the total population of 7,318 18- to 65-year-olds in Münsingen. The response rate was 49% for the pre-survey and 31% for the post-survey, whereby the returned questionnaires were sufficiently representative with regard to the demographic structure of the municipality.

4. OPERATIONALISATION OF THE VARIABLES AND MEASURES AND THEIR IMPLEMENTATION IN THE SIMULATION

The following questionnaire items determined the values for the variables in the simulation (for space reasons, we list example items only):

Behaviour: "Please estimate how fast you usually drive within the town of Münsingen" (7 response choices, from 1 = under 25km/h to 7 = over 50km/h).

Attitude: "I think that always driving 30km/h or slower in Münsingen is …" (6 response choices, from 1 = sensible to 6 = ridiculous).

Personal Values: "I find it important that people drive more slowly in the town of Münsingen" (6 response choices, from 1 = agree completely to 6 = strongly disagree).

Self-responsibility: "When I turn into a street in the town of Münsingen, it is completely up to me whether I reduce my driving speed or not" (6 response choices, from 1 = strongly disagree to 6 = agree completely).

For the simulation, we assumed that inner contradictions persist until they become salient. Salient means that people notice the inconsistencies and think about them [compare Mosler, 2001]. The degree of saliency of dissonance was operationalised with a dissonance factor that, depending on magnitude, increases or decreases a person' dissonance in a multiplicative fashion (if the dissonance factor is zero, the person experiences no dissonance). The effect of the measures feed into this dissonance factor as follows:

1. For persons who reported that they signed a *self-commitment* form, the dissonance factor was increased by a specified amount.

2. The effects of the *prompts* depended on people's responses to the item "What parts of the action campaign did you notice?" If they checked all three prompts (flags, key chains, bumper stickers), the prompts had a triple effect (three times the specified amount); if they checked only one prompt, the prompts had a single effect (specified amount).

3. For *feedback* from mobile units measuring driving speeds, the dissonance factor was increased by a specified amount if respondents reported that they had noticed "mobile units measuring driving speeds" and lived in a neighbourhood where a mobile unit was stationed in a particular week.

It was also assumed that dissonance triggered by the measures disappears over time. The dissonance factor was therefore decreased in every run of the simulation by an amount that increased with people's higher values on the item "I actually want to drive more slowly within the town, but I just forget about it most of the time" (6 response choices, from 1 = not true at all to 6 = absolutely true).

The values from the questionnaire were transposed into the 0-100 scale of the simulation by means of linear scale transformation.

The self-commitment and the prompts had an effect only on people who actually participated in the "slow down." Feedback, however, was assumed to affect non-participants as well, for they knew what type of behaviour the campaign was promoting.

The "Slow Down!" campaign ran for 25 weeks from 1 February to 18 July 1999, and the simulation was conducted over 25 time steps. This means that the dissonance process was calculated

25 times for each simulated person. In the simulation, the self-commitment was entered into Week 4, prompts were in effect starting from Week 7, and the feedback instrument was in effect from the start to finish of the action campaign.

All the variables in the simulation were transformed to a scale from 0 to 100. For attitude, 100 means "completely in favour of the slow down" and 0 means "completely against the slow down." For behaviour, 100 means that a person drove slower than 25 km/h, and 0 means that a person drove faster than 50km/h.

5. SIMULATION RESULTS

A look at Figure 2 will aid understanding of the simulated processes of the action campaign. The figure shows the events and their effects on 4 persons (Persons A – D).
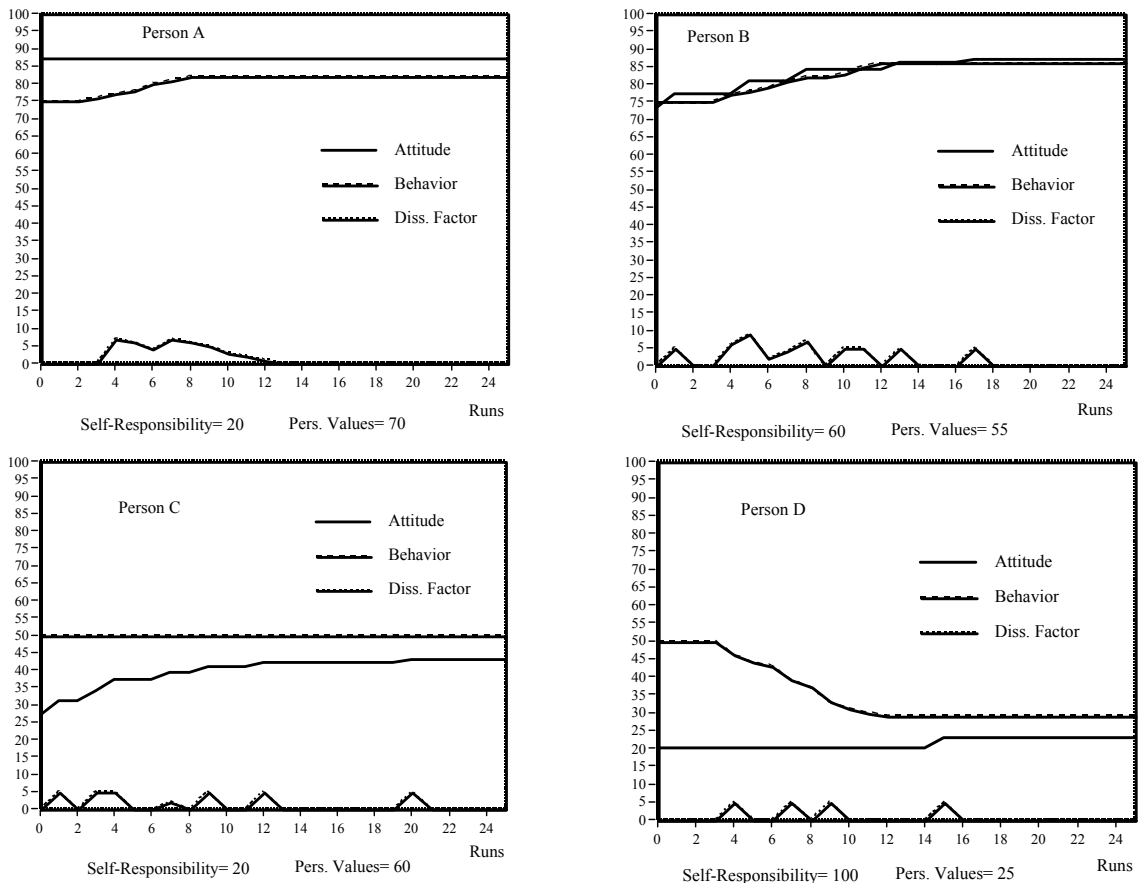

Figure 2. Change in attitude and behaviour and the dissonance factor in 4 persons during the 25 campaign weeks. For attitude and behaviour, 100 on the ordinate axis means slow driving, and 0 means fast driving.

Person A participates in the slow down, which triggers a contradiction between the behaviour she pledged to perform and her initial behaviour and attitude. Person A's fundamental value is that slower driving is important (high <u>personal values</u>); she does not think that it is completely up to her whether she drives slowly or not (low <u>self-responsibility</u>); she has a positive attitude towards slower driving in the town; and she already drives quite slowly. In Week 4 of the campaign, self-commitment has an effect on Person A, which can be seen in the rise of the dissonance factor curve. However, the curve drops again quite soon due to

forgetting. In Week 7, several prompts have an effect. The dissonance process triggered in Person A leads to the desired result: the value for the behaviour variable increases, or in other words, *Person A now reduces speed* when driving through the town.

Person B participates in the slow down, which triggers a discrepancy between the behaviour she pledged to perform and her initial behaviour and attitude. This person is only somewhat convinced of the importance of slow driving (medium personal values); she thinks that it is partly up to her whether she drives slowly or not (medium self-

responsibility); she has a positive attitude towards slower driving in the town; and she already drives quite slowly. Here again, self-commitment has an effect on Person B in Week 4, and prompts and feedback have an effect in Weeks 1, 5, 7, 8, 10, 11, 13, and 17. For Person B, the strong and frequent dissonance that is elicited results in a change in both attitude and behaviour. *Attitude and behaviour come closer and closer to the behaviour promoted by the campaign: Person B drives more slowly.*

Person C does not participate in the slow down and is only somewhat convinced of the importance of slow driving (medium personal values); she thinks that it is in part completely up to her whether she drives slowly or not (medium self-responsibility); she tends to take a negative attitude towards slower driving in the town; and she drives medium slowly. Feedback has an effect on Person C in Weeks 1, 3, 4, 7, 9, 12, and 20. Person C's personal values are closer to her behaviour than her attitude (resistance to changing behaviour is greater than resistance to changing attitude), and so her attitude adapts to her behaviour. Thus the effect of the Slow Down! Campaign on Person C is that *she does not change her behaviour*, *but her attitude towards slower driving becomes more positive.*

Person D also does not take part in the action campaign and her basic attitude is that slow driving is not important (low personal values); she thinks that it is completely up to her whether she drives slowly or not (high self-responsibility); she tends to be against slower driving in the town (low initial attitude); and she drives medium slowly. Feedback has an effect on Person D in Weeks 4, 7, 9, and 15. Person D's personal values are closer to her attitude than her behaviour (resistance to changing attitude is greater than resistance to changing behaviour), so that Person D now adapts her behaviour to her attitude. Thus the effect of the Slow Down! on Person D is contrary to the aims of the campaign, as *she drives faster.*

In order to test how adequately the model reflects the actual processes in the real persons, we compared the measured end values (real world questionnaire) and the simulated end values for attitude and behaviour to find out if they agreed. Because for the effects of the measures some assumptions had to be made about the parameters, we optimised the parameters for one-half of the sample according to random selection. These parameter values were then used to test the simulation of the other half of the sample. From the total sample, only the 134 persons who had provided responses to all questionnaire items relevant to the simulation could be used for the simulation. Tables 1 and 2 show the results.

Table 1. Frequencies in percent (absolute frequencies in parentheses) of differences between measured and simulated end values of attitude and behaviour in the first half of the sample (percent values calculated without missing values).

Difference	0 - 10	11 - 20	21 -	Missing
Attitude	50% (30)	37% (22)	13% (8)	7
Behaviour	45% (30)	20% (13)	35% (23)	1

Table 2. Frequencies in percent (absolute frequencies in parentheses) of differences between measured and simulated end values of attitude and behaviour in the second half of the sample (percent values calculated without missing values).

Difference	0 - 10	11 - 20	21 -	Missing
Attitude	69% (34)	15% (7)	16% (8)	18
Behaviour	29% (19)	32% (21)	39% (26)	1

Table 1 reveals that for approximately 50% of the first half of the sample, the optimised simulation calculated attitude and behaviour correctly with a deviation of up to 10 points on the scale (scale from 0 to 100). Almost 90% of the values for attitude and 65% of the values for behaviour were determined correctly with a deviation of up to 20 points. For the second half of the sample, for which the simulation was not optimised further, we find attitude determined correctly with a deviation of up to 10 points for almost 70% of the persons (which may be due to the high number of missing values). For behaviour, this is the case for not quite 30% of the persons. For deviations of up to 20 points, the results for the second half of the

sample are only somewhat worse than for the first half.

All in all, then, the simulation models the processes quite well for attitude, but the results for behaviour are not very satisfactory. Possible reasons for this are examined below.

6. DISCUSSION

Why did the simulation yield variable values that do not correspond very exactly to the values for attitude and behaviour as measured by the real world questionnaire? I think that the following considerations are relevant:

- The measurement of the variables may be inaccurate, meaning that the values obtained through the questionnaire are not very precise and thus have a certain level of uncertainty. The poor result of the comparison with regard to behaviour may be due to the fact that different items were used for the pre-survey and the post-survey.
- Perhaps the measurement of the effects of the campaign measures is inaccurate.
- Parameter optimisation may require improvement.
- The dissonance model may have an inadequate structure, in particular with respect to the assumptions on how the measures work.
- It may be that processes other than dissonance determine attitude and behaviour.

This last point always has to be considered if we demand that simulation results show the best possible correspondence to real data. Simulation models must not be too complex, however, or they will not contribute to our understanding of the phenomenon. This means, of course, that certain parts of the phenomenon are not taken into account, so that there is always something that remains unexplained. Nevertheless, we can safely say that the simulation model does indeed provide a first approximation of dissonance-determined processes in campaigns.

With the simulation it was possible to replicate the development of dissonance processes, which were triggered by measures, in many, different people over a period of time.

To our knowledge, this is after all the first-ever attempt to model and to simulate the social psychological theory of dissonance, and, moreover, to apply that model to real processes in a real world environmental action campaign. In any case, the simulation improves our understanding of the processes that take place in a campaign that is designed to produce attitude and behaviour change through addressing inner contradictions. We may now justifiably begin to

experiment with the simulation and investigate, for example, whether increased use of the feedback tools would have yielded greater effects on people, or examine what measures could have prevented the negative effects of the campaign (like those on Person D in Figure 2). These steps will bring us closer to the ultimate goal that underlies all our simulation efforts: To use simulation, into which pre-campaign data have been fed, as a support tool for determining in advance what intervention measures that will lead to optimal changes in a population.

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