Working mechanisms of computer-tailored health education: evidence from smoking cessation

Arie Dijkstra1,2

Abstract

To further develop tailored interventions, their working mechanisms must be identified. In the present study, three tailored messages that each contained one potential working mechanism—personalization, adaptation or feedback—were compared with a standard information condition. Two hundred and two students who smoked tobacco daily were randomly divided over four conditions. After the computer pre-test questionnaire, they read the information in their condition and filled in the immediate post-test. After 4 months, they were sent a follow-up questionnaire assessing their quitting activity. The data show that personalization (44.5%) and feedback (48.7%), but not adaptation (28.6%), led to significantly more quitting activity after 4 months than did the standard information (22.9%). Moreover, the effect of condition on quitting activity was completely mediated by individuals’ evaluations of the tailoring.

Introduction

The tailoring of information to individual characteristics to enhance effectiveness may be a large step forward in the field of health education (Skinner et al., 1993; De Vries and Brug, 1999; Kreuter et al., 1999; Brug et al., 2003). During the last 10 years, many studies have been conducted to show the superiority of tailored materials over standard materials. Several studies show that tailored information is more effective than existing standard materials. However, in most of these studies, tailored and non-tailored materials were used that not only differed in the extent to which they took individual characteristics into account, but also differed in the type of information given, the amount of information and the layout (Skinner et al., 1999; Strecher et al., 1994). Few studies have been undertaken in which tailored materials were compared with similar, but non-tailored, materials. Only such studies can show whether the tailoring of information is a fundamental step forward in persuasion. The results of these well-controlled studies are mixed. Some found that tailoring was more effective (Brug et al., 1996, 1998) and others found no difference (Dijkstra et al., 1998; Owen et al., 1989), while other researchers found interaction effects (Skinner et al., 1994), meaning that tailored information was effective only in subgroups of the examined samples. Therefore, the state of the art is that tailored information can be more effective than non-tailored information.

To further develop tailored materials, their working mechanisms must be identified. That is, the working mechanisms are responsible for the sometimes superior efficacy of tailored materials, and further shaping and testing of the working mechanisms may lead to more effective tailored materials. Working mechanisms can be understood from at least two angles. (1) Working mechanisms are characteristics of the information that is communicated. (2) These characteristics are considered to

1Social and Organizational Psychology, University of Groningen, Grote Kruisstraat 2/1, 9712 TS Groningen, The Netherlands
2Correspondence to: A. Dijkstra; E-mail: a.dijkstra@ppsw.rug.nl
lead to cognitive changes because they target specific psychological factors. The main characteristic of tailored interventions that has been used to explain the effects is the provision of feedback. The term tailoring of information is often used interchangeably with the term feedback. However, some studies indicate that tailored interventions have additional different characteristics. For example, Skinner et al. (Skinner et al., 1994) showed that a message that was tailored to socioeconomic status, but seemed to be written for a general audience, was more effective than its non-tailored equivalent. With regard to the psychological mechanisms that are involved in the effects of tailored information, heightened attention to the information provided is seen as the main mediator (De Vries and Brug, 1999; Dijkstra and De Vries, 1999). Indeed, a recent study using EEG measurements showed that people who were confronted with tailored information showed stronger attention processes (Kessels et al., 2005). However, although these data support the notion of heightened attention to tailored information, the question remains why people give more attention to tailored information. In sum, although several researchers of tailored health information have hypothesized on the working mechanisms and the psychological mechanisms involved, to the best of our knowledge no studies have been designed and published in which working mechanisms were explicitly theorized on.

The present study was designed to enhance our understanding of the sometimes superior effects of tailored communications from two perspectives: the characteristics of the tailored information and the psychological processes involved. Different working mechanisms and psychological processes have been proposed in the literature (by Brug, Abrams, Kreuter, Dijkstra, etc.). In the present study, the structure of characteristics of tailored communications as proposed by Dijkstra and De Vries (Dijkstra and De Vries, 1999) is refined. In tailored communications, three potential working mechanisms are distinguished: personalization, adaptation and feedback. Personalization refers to incorporating recognizable aspects of a person in a general text. The recognizable feature or set of features refers undeniably to the person, e.g. the person’s first name or the combination of objective behavioral features such as the number of cigarettes smoked, the number of years the person smoked and the brand smoked. Whereas, in personalization, specific features are mentioned in a text with general content, adaptation of information refers to adaptation of the content of the text itself. By adapting a text to a person’s relevant characteristics, such as sociodemographic characteristics or the person’s intention to change, the content information may become more relevant and less redundant.

For example, a persuasive text for a smoker with small children may differ from that for a smoker without children. Similarly, the information offered to a smoker with low motivation to quit may differ from the information offered to a smoker with high intention to quit. The remaining working mechanism, feedback, refers to the provision of information about a person’s state about which the person him/herself may not have been (fully) aware (Kluger and DeNisi, 1996). For example, people may not be aware of the psychological denial they use to lower their anxiety for physical consequences. If the denial can be assessed, this information may be provided as feedback. In attempts to lower fat consumption, feedback on actual fat consumption has been proven to be of major importance (Oenema and Brug, 2003).

One psychological theoretical perspective that has been taken to explain the effects of tailoring is that of the Elaboration Likelihood Model (ELM) (Petty and Cacioppo, 1986). According to this model, personal relevant information is processed with more thoughtful consideration. Kreuter et al. (Kreuter et al., 2000), indeed, show that the better the information was matched to individuals’ needs and preferences, the more positive thoughts they had. However, in the present study, operationalizations of two of the three tailoring working mechanisms consist of over 95% of general information: in a personalization condition and in a feedback condition, only some small personal information units are incorporated into a general text. Therefore, the text itself does not become more personally relevant; only some personal cues are added. ELM...
makes no predictions on the effects of putting one’s name in a text while 99% of the text is a standard not personalized text. ELM is about the relevance of a text, not about how personally relevant cues lead a general text to become more personally relevant. That is, in ELM, personal relevance mostly refers to an objective relevance, such as measures that are taken ‘at one’s own university’ (high relevance) versus ‘another university’ (low relevance). Furthermore, the present study is among smokers. According to ELM, smokers are by definition ‘highly involved’ in the topic of smoking cessation and information on smoking would be ‘personally relevant’ for smokers. Thus, although the ELM might be used to study tailoring when it comes to effects of offering less redundant or more relevant information, for the present study a psychological theory is needed that explains how reading a general text with only some personal cues in it can lead to more psychological changes than a general text without these cues. In the present study, the ‘self-referent encoding’ of information is used as the primary explanation, i.e. the working mechanisms are thought to induce a process of ‘self-referent encoding’. We assume that a latent scan of all environmental stimuli—including offered information—operates, which is focused on identifying self-relevant stimuli. If a stimulus is identified as being relevant for or referring to the self, the process of self-referent encoding of the information is started. Self-referent encoding refers to the interpretation and coding of external information against the background of the self. Self-referent encoding comprises a deeper and richer processing of information in which the information is more actively compared with the person’s own previous experiences, which comprise the self (Rogers et al., 1999). Self-referent encoding has been shown to enhance recall of offered information in several studies (Symons and Johnson, 1997). Personalization and feedback are thought to contain cues that trigger a process of self-relevant encoding. The extent to which adapted information is interpreted as being relevant for the self is thought to depend on the person’s involvement in the issue, i.e. in the case of low involvement with the topic of the tailored information, the adapted information can be discarded because it does not explicitly or undeniably refer to the self.

In the present study, we used a self-report measure of self-referent encoding. We argue that, during the reading of a tailored message, the extent of the self-referent encoding is experienced as the extent to which the information matches or takes into account the self. Kreuter et al. (Kreuter et al., 1999) used a thought-listing procedure to assess, after a person had read a tailored text, the number of thoughts that connected information in the text with the reader. Tailored information led to significantly more of these positive thoughts than did non-tailored information. We think that the extent to which the information is experienced as matching or taking into account the self is partly based on the number of positive thoughts that refer to connections between the text and the reader. In several studies, tailored communications were rated as significantly more personal or as better taking into account the individual’s situation (Brug et al., 1996, 1998; Dijkstra, 1999; Oenema and Brug, 2003). Moreover, Dijkstra (Dijkstra, 1999) showed that the extent to which the information was experienced as personal was significantly related to behavioral change. In the present study, we expected that the extent of self-referent encoding would mediate the effects of the working mechanisms on cognitive and behavioral changes.

Method

Participant recruitment and characteristics
Students who were daily smokers were recruited in the Faculty of Social Sciences by two means. First, students could register their phone numbers on forms distributed in the lounge of the faculty. Later, they were phoned to make an appointment to come to the laboratory. About half of the participants in this study were recruited using this procedure. Second, students in the faculty lounge were asked to participate in the study immediately; no students refused to join the study.
Students were told that the study concerned the evaluation of a text that was to be used in a new brochure on smoking and smoking cessation. Participants would earn €5 and when they completed the 4 months follow-up assessment they had the chance of winning one of four bonus prizes amounting to €25.

Two hundred and two students participated in the study of whom 59% were female and the mean age was 22.2 years (SD = 6.5). On average, the students had smoked for 5.8 years (SD = 6) and they smoked 13 cigarettes a day (SD = 7.4). The mean score on a measure of intention to quit smoking in the following 6 months with a seven-point scale was 3.2 (SD = 1.92).

Procedure
On arrival in the laboratory, participants were registered, and they were asked to take a place in a cubical room and to follow the instructions on the personal computer. After three screens of short instructions, the pre-test assessment was conducted. Following this, the participants were exposed to the information in the condition they were randomly assigned to. After reading the text, the participants were directed to the post-test assessment. After the post-test, the program indicated that the study was over. The participants filled in a form to receive their financial compensation and they were asked whether they agreed to receive a follow-up questionnaire after 4 months. They were informed that completion of the follow-up assessment would earn them a chance to win one of four bonus prizes of €25. All participants agreed to this, and registered their names and addresses. Of the 202 laboratory participants, 141 (70%) returned the follow-up questionnaire 4 months later.

Experimental conditions
Participants were randomly assigned to one of four conditions (Table I). In all conditions the information that was offered comprised four screens of information of about 200 words each.

STAN condition
The STAN condition \((n = 51)\) offered the standard non-tailored information. In the three tailored conditions, this information was tailored in three different ways. The information in the STAN condition consisted of four texts. The first text dealt with the long-term serious negative health consequences of smoking, such as the risk of lung cancer.

<table>
<thead>
<tr>
<th>Conditions/working mechanisms</th>
<th>Example text</th>
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<tbody>
<tr>
<td>Standard</td>
<td>The serious consequences Smoking tobacco is responsible for 82% of deaths due to lung cancer in the Netherlands; of the people who die from lung cancer, eight have been smoking.</td>
</tr>
<tr>
<td>Personalisation(^a)</td>
<td>Dear Peter, Smoking tobacco is responsible for 82% of deaths due to lung cancer in the Netherlands; of the people who die from lung cancer, eight have been smoking.</td>
</tr>
<tr>
<td>Adaptation(^b)</td>
<td>The serious consequences Smoking tobacco is responsible for 69% of deaths due to lung cancer in the Netherlands among women; of the women who die from lung cancer, seven have been smoking.</td>
</tr>
<tr>
<td>Feedback(^c)</td>
<td>The serious consequences It appears from your responses to the questionnaire that you underestimate the dangers of smoking. Smoking tobacco is responsible for 82% of deaths due to lung cancer in the Netherlands; of the people who die from lung cancer, eight have been smoking.</td>
</tr>
</tbody>
</table>

\(^{a}\)The participant’s first name is Peter.
\(^{b}\)The participant’s sex is female.
\(^{c}\)The participant’s score on a measure of perceived negative outcomes of smoking is low.
and heart disease: risk figures and serious symptoms were described. Furthermore, it was argued that quitting smoking was effective in avoiding these risks and symptoms. The second text offered information on the short-term negative physical consequences of smoking, such as reduced blood oxygen, a smaller lung volume and a pale appearance. The contents of tobacco smoke and their effects were described briefly. Again, it was argued that quitting smoking was effective in reversing these negative effects. The third text was on the negative social consequences of smoking. It described how smokers are increasingly treated as addicts and mentioned that most non-smokers are bothered by cigarette smoke. Furthermore, it was said that (high) proportions of non-smokers, but also smokers, agree with the statement that smoking should be forbidden in workplaces. The fourth text dealt with the negative self-evaluative consequences of smoking. The text contrasted smoking and its effects to important values such as being healthy and not doing stupid things. Furthermore, it was argued that the negative self-evaluative emotions would disappear in the case of quitting smoking.

**PERS condition**
The PERS condition \((n = 50)\) offered the same text as did the STAN condition, but it incorporated four recognizable personal features in the text. In the text on the first screen, the individual number of cigarettes and the type of cigarettes a participant smoked (cigarettes with or without filter or hand-rolled cigarettes) were mentioned. In the second text, a person’s first name and the number of years he or she had smoked were mentioned once. In the third text, only a person’s first name was mentioned once; in the fourth text, a person’s first name was mentioned twice.

**ADAP condition**
In the ADAP condition \((n = 51)\), the information was adapted to certain individual features, but the texts were written as if they were meant for a general audience. For females, the text on the first screen offered information on the long-term consequences of smoking specifically in women \((n = 32)\). Males were offered information specifically about the consequences in men \((n = 19)\). If the participant indicated at the pre-test that he or she took part in sport weekly, the second text dealt with the short-term negative consequences of smoking in general for sports accomplishments \((n = 19)\). Otherwise, the text was not about physical activity, but tried to focus attention on bodily symptoms of smoking such as coughing and dizziness \((n = 32)\). If the participant indicated at the pre-test that non-smokers ‘regularly’ or ‘often’ inhaled their secondary smoke, the third text offered general information on the effects of passive smoking and the inconvenience to non-smokers \((n = 29)\). Otherwise, the text did go into passive smoking, but argued that the perception of smoking was changing in society \((n = 22)\). If the participant indicated at the pre-test that he or she would not evaluate him/herself more positively if he or she stopped smoking, the fourth text argued that smokers are often defensive when persuasive attempts are made to encourage them to stop smoking and that they therefore often use excuses to smoke \((n = 38)\). If the participant indicated that he or she would evaluate him/herself more positively if he or she stopped smoking, the text was about how painful feelings of shame and dissatisfaction with oneself can be, and how strong the relief is in the case of quitting \((n = 13)\).

**FEED condition**
The FEED condition \((n = 50)\) added one or two sentences of personal feedback on the basis of pre-test scores before the non-tailored information was provided (while removing the first one or two introductory non-tailored sentences). In the text on the first screen, individual feedback (two possible feedback messages) was added on the participants’ awareness of the serious dangers of smoking on the basis of a pre-test item that assessed the expected long-term consequences (e.g. ‘It appears from your responses to the questionnaire that you underestimate the dangers of smoking’). In the second text, individual feedback (three possible feedback messages) was added on experienced symptoms attributed to smoking on the basis of (1) a pre-test item that assessed the frequency with
which participants experienced smoking-related symptoms and (2) the number of cigarettes smoked a day (e.g. ‘You hardly notice from the reactions of your body that you are smoking. This might be because you are not a heavy smoker. However,...’). In the third text, individual feedback (two possible feedback messages) was added on the participants’ high or low awareness of the increasingly negative views of smoking on the basis of shame for smoking assessed at the pre-test (frequent shame indicated high awareness; e.g. ‘From your answers, it seems that you barely perceive that smoking is viewed increasingly negatively’). In the fourth text, individual feedback (four possible feedback messages) was added on having or not having a biased view of the consequences of smoking in order to regulate negative emotions. This was done on the basis of an excuses score and the reported positive self-evaluation in the case of quitting (e.g. ‘From the questionnaire, it seems that you are so dissatisfied with yourself because you smoke that you try not to think about it’).

Measures

In the pre-test, the following variables were assessed for psychometric use. Smoking behavior was assessed in terms of the number of years smoked and the number of cigarettes smoked per day. The demographic information assessed concerned gender and age. Intention to quit was assessed in the following way. Smokers were asked to indicate the plan that best described their own plans with regard to their smoking behavior. The categories were ‘I am planning to quit within 30 days’ (1), ‘I am planning to quit within 6 months’ (2), ‘I am planning to quit within 12 months’ (3), ‘I am planning to quit within 5 years’ (4), ‘I am planning to quit sometime in the future but not within 10 years’ (5), ‘I am planning to keep on smoking but to cut down’ (7) and ‘I am planning to keep on smoking and not to cut down’ (8). Self-efficacy was assessed using three items on seven-point scales on the difficulty of quitting smoking, on being able to quit smoking and on the perception that a person can quit smoking ($\alpha = 0.76$). Because the participant’s state of arousal could affect the reactions towards the information offered in the conditions, the present state of arousal was assessed using four items on seven-point scales: ‘How nervous do you feel at this moment?’, ‘How relaxed do you feel at this moment?’, ‘How unsure do you feel at this moment?’ and ‘How calm do you feel at this moment?’. The mean item score was used as the scale score ($\alpha = 0.81$). The following post-test variables were assessed immediately after the participants had read the information. The main outcome measure was the attitude towards smoking. Attitude was assessed using eight items on seven-point scales. Principal component analyses showed two clearly separate factors which we called affective attitude towards smoking ($\alpha = 0.78$) and cognitive attitude towards smoking ($\alpha = 0.80$). The affective attitude scale was composed of two items: ‘I find smoking: very unpleasurable (1)/very pleasurable (7); very untasteful (1)/very tasteful (7)’. The cognitive attitude scale was composed of four items: ‘I find smoking: bad (1)/good (7); stupid (1)/smart(7); very unwise (1)/very wise (7); totally safe (1)/very dangerous (7). Two sets of information evaluation measures were used. The first set concerned four items on the general message evaluation on seven-point scales: ‘Did you find the information reliable?’, ‘Did you find the information difficult to understand?’, ‘Did you find the information interesting?’ and ‘Did you find that the information was honest?’. The second set of evaluation items concerned the tailoring evaluation items. These items were expected to be related to the extent of the self-referent encoding of the information: ‘Was the information directed to you personally?’, ‘Did the information take into account your personal situation as a smoker?’, ‘Did you recognize your own opinion in the information?’ and ‘Did the information take into account who you are?’.

To assess quitting activity at the 4-month follow-up, a single measure of quitting activity was composed indicating ‘any quitting activity’ (1) or ‘no quitting activity at all’ (0). Four items were used to assess quitting activity: a ‘no’ in response to the questions (1) ‘Did you smoke at all since you were in the laboratory?’, (2) ‘Did you smoke during the last 7 days?’ or (3) ‘Did you smoke during the last 10 days?’.
30 days?’ was coded as quitting activity. Furthermore, a ‘yes’ in response to the question (4) ‘Did you make an attempt to quit since you were in the laboratory?’ was coded as quitting activity. No biochemical verification of the self-reported quitting behavior was conducted, for three reasons. First, the announcement of biochemical verification could be expected to increase non-response and dropout. Second, with regard to the questions (1) and (4), no biochemical validation is possible. Third, the present study can be classified as placing ‘low demands’ on the participants; hence, their self-reported smoking behavior was considered to be sufficiently valid [see (Velicer et al., 1992)].

Randomization and attrition

A randomization check was conducted by comparing individuals in each condition with respect to gender, age, number of cigarettes smoked a day, number of years the individuals smoked, intention to quit, self-efficacy and arousal assessed at the pre-test. The results showed that the conditions differed significantly with respect to the number of years the individuals smoked and age. However, neither variable had a significant relationship with any of the outcome measures ($P > 0.25$). The characteristics of the participants who did not return the 4-month follow-up questionnaire were compared with those of the participants who did with respect to the pretest variables. The results showed that the group that failed to return the follow-up questionnaire comprised a significantly larger number of males and that members of this group had smoked for significantly fewer years. Again, neither variable was related to the follow-up outcome measure, quitting activity.

Statistical analyses

To test the effects of condition on quantitative outcome measures, analyses of variance were used. To test the effects of condition on the dichotomous outcome measure ‘Quitting activity’, logistic regression analysis was used. Pre-test variables were included as covariates when the $P$ value of the relation with the dependent variable was smaller than 0.20. All tests were two-sided and the significance level used was $P < 0.05$.

Results

Process evaluation

To test whether the manipulations had differentially influenced the participants’ perceptions of non-specific features of the tailored texts, ANCOVAs were computed using each of the four process evaluation measures as dependent variables, condition as factor, and age, number of cigarettes smoked a day and self-reported arousal at the pre-test as covariates. The covariates were added ($P < 0.20$) to increase the statistical power by accounting for unexplained variance.

As shown in Table II, the conditions did not differ with regard to perceived reliability, difficulty and honesty of the information provided. With regard to interestingness, however, the conditions differed significantly, $F(3,194) = 5.58$, $P = 0.001$. Contrast analyses showed that the FEED condition was rated as significantly more interesting ($P < 0.05$) than the three other conditions, which did not differ significantly from each other.

<table>
<thead>
<tr>
<th>Table II. Means of process evaluation items in each condition</th>
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<tbody>
<tr>
<td>Condition</td>
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<tr>
<td>Reliability</td>
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<tr>
<td>Difficulty</td>
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<tr>
<td>Interestingness</td>
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<td>Honesty</td>
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Means with the same superscript differ significantly ($P < 0.05$).
Tailoring evaluation

To test whether the manipulations had differentially influenced the participants’ perceptions of the extent to which the information was tailored, ANCOVAs were computed using each of the four process evaluation measures as dependent variables, condition as factor, and age, number of cigarettes smoked a day and self-reported arousal at the pre-test as covariates. First, it was tested whether the effects of condition on tailoring evaluation depended on pre-test intention to quit. For none of the four measures was this the case. Second, the main effects of condition were tested. As shown in Table III, the extent to which participants perceived the information as being directed to them personally approached significance, $F(3,194) = 2.16, P = 0.094$. Contrast analyses showed that participants in the FEED condition scored significantly higher ($P < 0.05$) than those in the STAN and ADAP conditions. The PERS condition did not differ significantly from any of the other conditions. The extent to which participants perceived the information as having taken into account their situation as smokers differed significantly, $F(3,194) = 11.42, P < 0.001$. Contrast analyses showed that participants in the PERS condition and in the FEED condition scored significantly higher ($P < 0.05$) than those in the STAN condition. In addition, scores in the ADAP condition were significantly lower ($P < 0.05$) than the scores in the FEED condition. With regard to the extent to which participants recognized their own opinions in the information, the conditions did not differ significantly. The extent to which participants perceived the information as having taken into account who they were differed significantly, $F(3,194) = 3.48, P = 0.017$. Contrast analyses showed that participants in the PERS condition and in the FEED condition scored significantly higher ($P < 0.05$) than those in the STAN condition. In addition, scores in the ADAP condition were significantly lower ($P < 0.05$) than the scores in the FEED condition.

Condition effects on attitude

To test the effects of condition on attitudes, two ANCOVAs were conducted—one using affective attitude and one using cognitive attitude as dependent variables (Table IV). In addition to self-reported arousal at the pre-test and the number of cigarettes smoked, the process evaluation items were entered as covariates. To start with, several interactions of condition with pre-test measures were tested. However, no significant interaction effects ($P > 0.20$) of condition, on the one hand, and gender, age, number of cigarettes smoked a day, the number of years the person smoked, self-efficacy, intention and arousal experienced at the pre-test, on the other, were found. A significant main effect of condition on affective attitude was found, $F(3,194) = 2.68, P = 0.048$. Contrast analyses showed that participants in the PERS condition scored significantly lower ($P < 0.05$) than participants in the STAN and FEED conditions. Thus, participants in the PERS condition rated smoking as less pleasant and tasteful than did participants in the two other conditions.

<table>
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<tr>
<th>Table III. Means of tailoring evaluation items in each condition</th>
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<tbody>
<tr>
<td>Condition</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>Directed at you personally</td>
</tr>
<tr>
<td>Takes into account your personal situation as a smoker</td>
</tr>
<tr>
<td>Recognizes your own opinion in the information</td>
</tr>
<tr>
<td>Takes into account who you are</td>
</tr>
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</table>

Means with the same superscript differ significantly ($P < 0.05$).
conditions. The ADAP condition did not differ significantly from the other conditions. Furthermore, a significant main effect of condition on cognitive attitude was found, $F(3,194) = 3.09, P = 0.028$. Contrast analyses showed that participants in the FEED condition scored significantly higher ($P < 0.05$) than did those in the PERS and ADAP conditions. Thus, participants in the FEED condition rated smoking more positively than did participants in the other conditions.

### Condition effects on quitting activity after 4 months

Of the 141 participants who returned the 4-month follow-up questionnaire, 25.6% reported having been engaged in an attempt to quit following the laboratory assessment or being engaged in an attempt to quit at that time. To test the effects of condition on quitting activity, a logistic regression analysis was performed using condition as the independent variable, quitting activity (yes/no) as the dependent variable, and gender, age, number of cigarettes smoked a day and intention to quit at pre-test as covariates. To start with, several interactions of condition with pre-test measures were tested. However, no significant interactions ($P > 0.20$) of condition, on the one hand, and gender, age, number of cigarettes smoked a day, number of years the person smoked, self-efficacy, intention and arousal experienced at pre-test, on the other, were found. The change test indicated that the addition of the variable ‘condition’ to the covariates significantly improved the model, $\chi^2(3, N = 141) = 8.20, P = 0.042$. Contrast analyses showed that the proportions of participants (Figure 1) in the PERS condition (44.7%) and in the FEED condition (48.5%) who made an attempt to quit were significantly larger than the proportion in the STAN condition (22.9%). The percentage in the ADAP condition who attempted to quit (28.6%) did not differ significantly from that in the STAN condition.

### Mediation analyses in the prediction of attitude

In order to test to what extent the tailoring evaluations mediated the effects of condition on post-test attitudes, tailoring evaluations should be significantly related to condition and to attitudes. As shown in Table III, two tailoring evaluation items were related significantly to condition (‘Did the information take into account your personal situation as a smoker?’ and ‘Did the information take into account who you are?’). However, neither item had a significant correlation with affective attitude. Thus, tailoring evaluations did not mediate the effects of condition on affective attitude. Of the two tailoring evaluation items that were significantly related to condition, one item correlated significantly with

![Fig. 1. Percentages of quitting attempts in the information conditions as assessed after four months. Stan = standard condition; Pers = personalization condition; Adap = adaptation condition; Feedb = feedback condition. Bars with the same superscripts differ significantly ($P < 0.05$).](image-url)
cognitive attitude. This item was entered as a covariate in the ANCOVA with condition as factor and cognitive attitude as dependent variable. However, the $F$ and $P$ values of the main effect of condition did not change in the presence of the tailoring evaluation item [$F(3,194) = 3.09, P = 0.028$]. Thus, no mediation effect of tailoring evaluation was detected.

**Mediation in the prediction of quitting activity**

In order to test to what extent the tailoring evaluations and post-test attitudes mediated the effects of condition on quitting activity, tailoring evaluations and post-test attitudes should be significantly related to condition and to quitting activity. As shown in Table IV, both measures of attitude were significantly related to condition. Furthermore, affective attitude, but not cognitive attitude, was significantly related to quitting activity as indicated by the significant improvement of the model, $\chi^2 (3, N = 141) = 10.62, P = 0.001$. When condition was entered in this model including affective attitude, the improvement test approached significance, $\chi^2 (3, N = 141) = 6.34, P = 0.096$. Thus, only slight changes in $\chi^2$ and $P$ values occurred, indicating a minimal mediation effect of affective attitude. Furthermore, the two tailoring evaluation items that were significantly related to condition were entered in the logistic regression analyses to predict quitting activity. Entering the items improved the model significantly [$\chi^2 (3, N = 141) = 10.92, P = 0.004$] due to the significant contributions of both items as indicated by the Wald tests. When condition was entered in this model, the improvement test was no longer significant, $\chi^2 (3, N = 141) = 4.38, P = 0.22$. Thus, the effect of condition on quitting activity was mediated by the scores on the tailoring evaluation items.

**Discussion**

The present study was a first attempt to develop a theory of tailoring information to individuals' characteristics, by testing potential working mechanisms separately and assessing the proposed mediating process of self-referent encoding. The main result was that personalization and feedback led to significantly more quitting activity than did the standard information only. Thus, incorporating small pieces of information on a person in a standard text—comprising no more than 800 words—increased the persuasive power of the text: it doubled the number of participants who reported quitting activity during or after 4 months. Furthermore, the data showed that the self-report of self-referent encoding mediated the effect of both working mechanisms on behavior. This may mean that the process of self-referent encoding is activated by the information on the person, which was incorporated in the standard text. In sum, the results of the present study provide experimental evidence that personalization and feedback can be responsible for the (sometimes) higher effectiveness of tailored intervention, at least in smoking cessation.

Several questions remain, however. To begin with, how did self-referent encoding lead to changes in behavior? We expected that a more intensive self-referent encoding would lead to more cognitive changes. One primary indicator of these cognitive changes would be the attitude towards smoking, as assessed at the immediate post-test. However, neither measures of attitude seemed to mediate the effects of the conditions on behavior. First, we might assume that the more intensive self-referent encoding led to other cognitive changes. In addition to changes in attitude, changes in intention to quit might be expected. Unfortunately, we did not assess intention to quit at the post-test. Second, we might assume that relevant cognitive changes took place at another point in time. For example, the self-referent encoding may have led to a higher sensitivity to and accessibility of information on smoking or smoking cessation after the laboratory session. This may have led to a higher frequency of thinking or worrying about the consequences of smoking, which can motivate people to quit smoking (Dijkstra and Brosschot; 2003; McCaul and Mullens, 2003). To further track the cognitive changes that are caused by self-referent encoding, future studies may include more frequent post-tests.
Another question raised by the present data is why the adaptation of the information was not more effective than the standard information. The concept of adaptation of information is similar to the concept of ‘target group segmentation’, in which general populations are segmented into relevant target groups and in which persuasive information is adapted to specified target group characteristics, such as demographic and behavioral or psychological states (Ahmad, 2003). In target group segmentation—as in the presently used adaptation of information—persuasive information is not personalized, but still written for a large audience. Two explanations can be offered for the presently found lack of effects of the adaptation condition. Firstly, the information in the adaptation condition did not contain explicit cues that indicated that the information was targeted at the individual. Therefore, the information may not have activated the process of self-referent encoding. This explanation is supported by the self-report data on self-referent encoding: the information in the adaptation condition was not perceived to better take into account ‘their situation as smokers’ and ‘who they are’ than the standard information. Moreover, no interactions between condition and intention to quit at the pretest were found with regard to self-referent encoding and quitting activity. Thus, the idea that the effects of the information in the adaptation condition would depend on the level of involvement did not hold. A second explanation for the lack of effects found of the information in the adaptation condition may have to do with the operationalization of the working mechanism. The adaptation of the information was based not on empirical data, but rather on a common sense approach. There are many possible ways in which information can be adapted to the individual and the results of the present study show that not all are effective. Ideally, adaptation of information is based on match–mismatch studies (Dijkstra et al., 1998; Williams-Piehota et al., 2005) or outcome studies, which show an interaction between an individual characteristic and certain adaptations of information.

Another finding of interest is that the participants in the feedback condition rated the information as more interesting than did the participants in the other conditions, whereas the personalized information was not rated as more interesting than the information in the standard and in the adaptation conditions. Feedback may have been more interesting because participants learned something new about themselves or they felt acknowledged by the feedback. In any case, the data show that the conditions which did lead to more self-referent encoding were not by definition rated as more interesting. In addition, the correlations between the two items of self-referent encoding and the interestingness of the information were both positive, but only 0.31 and 0.20, respectively. Thus, the self-report of self-referent encoding seems not to be just an effect of interestingness of the information.

The immediate effects of the conditions on both measures of attitudes were not easy to interpret. With regard to the affective attitude, only personalization of the information led to a more negative attitude. Thus, after a person’s name and some smoking attributes were mentioned in a general text on the negative outcomes of smoking, the participants rated smoking as less pleasurable and less tasteful. With regard to the cognitive attitude, the feedback condition led to a more positive attitude towards smoking. A process of psychological reactance may have caused this. In any case, the immediate effects of the information conditions on attitudes did not seem to be relevant in the generation of behavior in the longer term by the information conditions. This finding may undermine the behavioral relevance of studies of attitudes with only immediate post-tests.

The results of the present study must be interpreted against the background of its following features. First, the participants in the study were all university students. This means that the sample was selective with regard to level of education and age. On the other hand, the sample included students with high and low intentions of quitting smoking. Moreover, the students were all daily smokers. In addition, the study showed that even in students who were well acquainted with computer technology and who may have had insight into the composition of the computer-generated texts, the manipulations
were effective. Finally, the investigated psychological mechanism of self-referent encoding is considered to be a fundamental process which does not depend on demographics. Importantly, the self-report of self-referent encoding has been found to predict quitting activity in naturalistic samples of smokers (Dijkstra, 1999). Second, the process of self-referent encoding was assessed using self-report. This might not be the optimal way to assess a more or less automatic information-processing process. However, the data showed the expected results: in the information conditions which contained cues about the self, more self-referent encoding was reported and exactly those conditions led to more quitting activity. Nevertheless, in future studies, different and more objective measures of self-referent encoding should be used, such as a recall measure (Symons and Johnson, 1997). Third, the information in the conditions was designed to motivate smokers to engage in an attempt to quit by increasing their perceptions of the negative outcomes of smoking and the positive outcomes of quitting. The conditions did not contain information meant to sustain an attempt to quit. Moreover, the main behavioral outcome measure was engaging in an attempt to quit, rather than sustained quitting.

Although we have distinguished the three working mechanisms conceptually, an almost infinite number of operationalizations are possible and can be tested. In personalization, the pieces of information incorporated in a general text must be central parts of the self that refer with high probability to the individual. Whether the incorporated information is a person’s first name, last name or nickname, or a set of recognizable individual features that are or are not related to the behavior to be influenced, might not be important. However, studies should address the conditions under which different types of personalization have desired effects. The same applies to all the possible different ways of adaptation of information and the different types of feedback. Furthermore, possible interactions between the working mechanisms should be investigated. For example, adaptation might only be effective when it is personalized. With regard to the proposed process of self-referent encoding, several conceptual and research issues remain. For example, it could be tested under which conditions the process of self-referent encoding is activated, whether there is a threshold for the activation and whether the process needs maintenance by offering self-referent cues by time intervals or by number of information units.

Although the psychology of persuasive communication has made massive progress through the years, the possibilities that are offered by computer technology have barely been addressed yet. Although many of the angles to study these new possibilities will be primarily inspired by existing knowledge of (persuasive) communication, the field of tailored communications might be directed at developing explicit theories of tailored communications.

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