It's not what you say, but how you say it

The effectiveness of message frame-tailoring in online computer-tailored health communication

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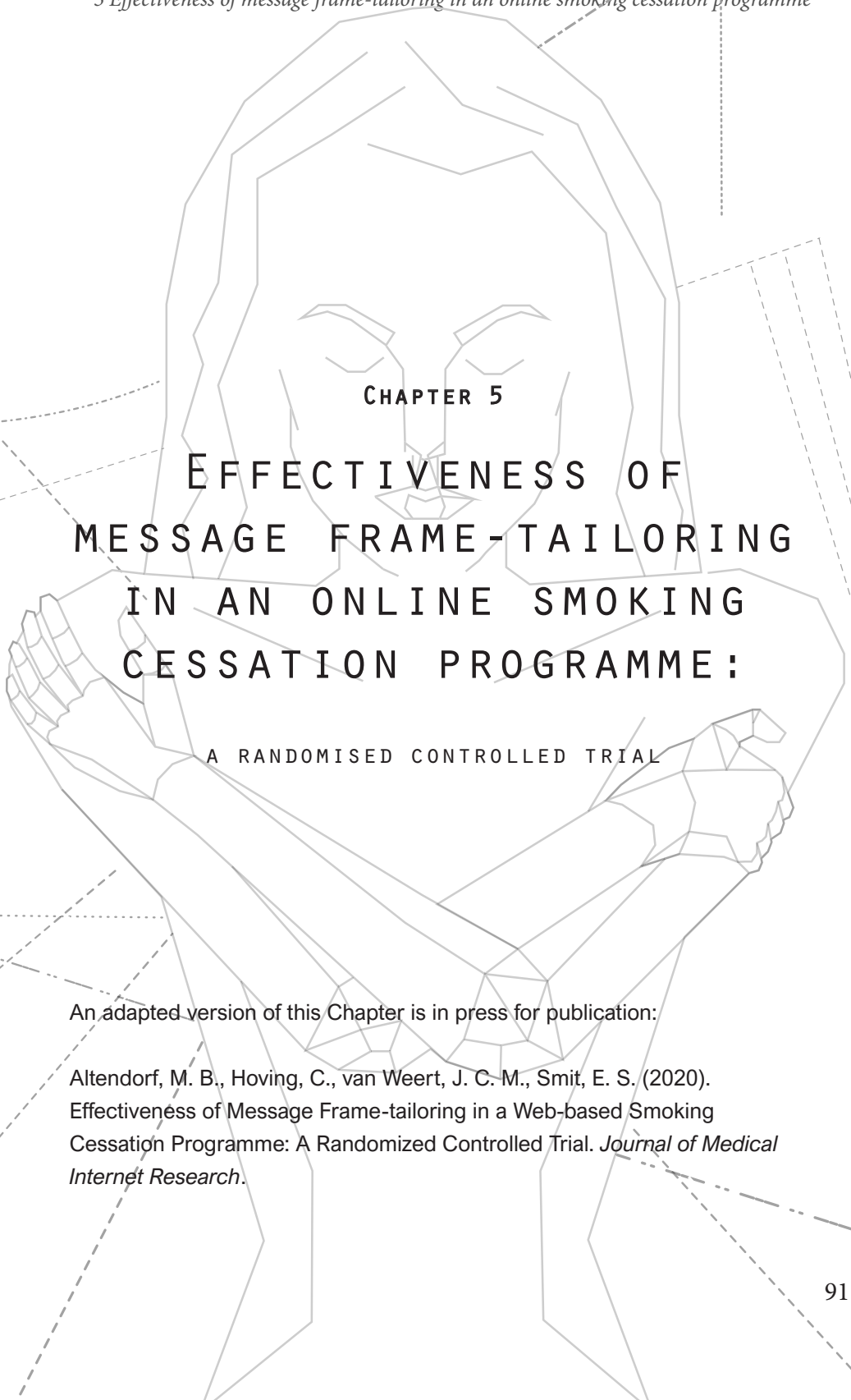
Publication date
2020

Document Version
Other version

License
Other



Chapter 5

Effectiveness of message frame-tailoring in an online smoking cessation programme:

A randomised controlled trial

An adapted version of this Chapter is in press for publication:

Altendorf, M. B., Hoving, C., van Weert, J. C. M., Smit, E. S. (2020). Effectiveness of Message Frame-tailoring in a Web-based Smoking Cessation Programme: A Randomized Controlled Trial. *Journal of Medical Internet Research*.

Abstract

Often online computer-tailored interventions are matched in content to an individual's characteristics, beliefs, and behavioural factors. This is called *content-tailoring*. Consequently, such interventions lead to better message processing and a higher likelihood of behaviour change, such as smoking cessation. However, a meta-analysis of online computer-tailored interventions showed that effect sizes, albeit positive, remain small – this suggests room for improvement. A promising strategy to enhance the effectiveness of online computer-tailored interventions is to tailor the message frame – *how* a message is communicated – based on the preferred communication style, in addition to content-tailoring. A factor that determines an individual's communication style preference is the need for autonomy; while some individuals prefer an autonomy-supportive communication style (offering choice and use of suggestive language), others might prefer a directive communication style, which is replete with imperatives and does not provide choice. Tailoring how messages are presented, e.g., based on the need for autonomy, is called message frame-tailoring. The present study aimed to test the effectiveness of message frame-tailoring based on the need for autonomy, in isolation and in combination with content-tailoring within the context of an online computer-tailored smoking cessation intervention. Primary outcome measure was seven-day point-prevalence of smoking abstinence. Secondary outcomes were perceived message relevance, self-determined motivation to quit smoking, and socio-cognitive beliefs. A randomised controlled trial with a 2 (message frame-tailoring vs. no message frame-tailoring) x 2 (content-tailoring vs. no content-tailoring) design was conducted among adult smokers intending to quit (N = 273). Structural equation modelling in R revealed that the content-tailored condition increased smoking abstinence rates one month after the start of the intervention (b = .57, p = .021). However, neither message frame-tailoring nor its interaction with content-tailoring did significantly predict smoking abstinence. In our model, message frame-tailoring, content-tailoring, as well as their interaction significantly predicted perceived relevance of the smoking cessation messages, which consequently predicted self-determined motivation. In turn, self-determined motivation positively affected attitudes and self-efficacy for smoking cessation, but only self-efficacy consequently

predicted smoking abstinence. Participants in the control condition perceived the highest level of message relevance (M = 4.78, SD = 1.27). However, messages that were frame-tailored for high need for autonomy in combination with content-tailored messages led to significantly higher levels of perceived message relevance (M = 4.83, SD = 1.03) than content-tailored messages only (M = 4.24, SD = 1.05, p = .003). Message frame-tailoring based on the need for autonomy does not seem an effective addition to conventional content-tailoring techniques in online smoking cessation interventions in increasing smoking cessation rates. However, smokers with a high need for autonomy seem to benefit more from frame-tailored messages than their peers with a low need for autonomy.

Introduction

Smoking tobacco is the single most preventable cause of non-communicable diseases, such as cancer (World Health Organization, 2014a). Behavioural support through online *computer content-tailored* (CCT) smoking cessation interventions can be effective in improving quit rates among smokers over and above more static interventions, such as generic online smoking cessation information (Lustria et al., 2013). Online CCT smoking cessation interventions aim to provide smokers with individualised cessation information, which is assessment-based (e.g., based on assessment of participants' current behavioural beliefs) and automatically created by computer software (De Vries & Brug, 1999; Hawkins, Kreuter, Resnicow, Fishbein, & Dijkstra, 2008; Kreuter & Wray, 2003; Noar, Harrington, & Aldrich, 2009). Previous studies showed that content-tailored messages increase perceived message relevance and enhance desired behaviour (Hawkins, Kreuter, Resnicow, Fishbein, & Dijkstra, 2008; Lustria et al., 2016; Noar, Benac, & Harris, 2007; Petty & Cacioppo, 1986; Zhao & Peterson, 2017). Although online CCT smoking cessation interventions are found to lead to better message processing and a higher likelihood of performance of advocated behaviours (Kreuter & Wray, 2003; Noar et al., 2007; Rimer & Kreuter, 2006b), effect sizes tend to remain small (Lustria et al., 2013). In order to enhance online CCT health intervention effectiveness, it is suggested to also use message *frame-tailoring* (i.e., tailor *how* a message is presented, to a person's preferred communication style) in addition to message content-tailoring (Resnicow et al., 2008, 2014; Rimer & Kreuter, 2006; Smit, Linn, & van Weert, 2015). However, to date no smoking cessation interventions have been rigorously tested that incorporate both content-tailoring and frame-tailoring.

A promising factor for message frame-tailoring is people's *need for autonomy*, (NFA) which determines one's preference for an autonomy-supportive or more directive communication style, as shown in several studies conducted in face-to-face and other offline health settings in the fields of cancer prevention and healthy nutrition (Resnicow et al., 2008, 2014; Smit & Bol, 2019). In self-determination theory (Ryan & Deci, 2000) it is theorised that the satisfaction of a person's NFA is essential for the development of self-determined motivation, well-being, and behavioural engagement (i.e., Ng,

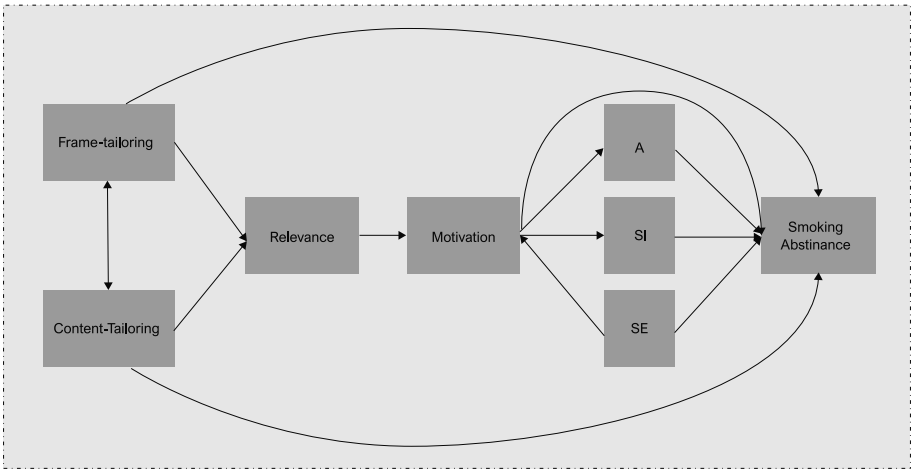
Ntoumanis, Thøgersen-Ntoumani, et al., 2012; Williams et al., 2006, 2002). In turn, motivations to change are more likely to be translated into actions via socio-cognitive beliefs (i.e., attitudes, subjective norms and self-efficacy perceptions) when this motivation is self-determined (Hagger & Chatzisarantis, 2009). While people with a higher NFA prefer to choose their own way of how to obtain a goal, such as to quit smoking, those with a lower NFA rather prefer to be told through clear-cut expert advice how best to reach their goal (Gagné & Deci, 2005; Hagger & Chatzisarantis, 2009; Resnicow et al., 2008, 2014; Smit & Bol, 2019). To illustrate, two studies on the effects of printed health communication showed that people's preference for a certain communication style moderated intervention impact (Resnicow et al., 2008, 2014). That is, people who received messages that were frame-tailored according to their communication style preference (e.g., when high in their NFA) and were presented with messages in an autonomy-supportive message style using suggestive language through words as "may" or "could", more often performed the desired behaviour than those who received no frame-tailored messages or messages in a controlling message style, i.e., with messages in directive wording like "must" or "should".

To the best of our knowledge however, there has no study been conducted yet that has investigated whether message frame-tailoring based on the NFA enhances content-tailored smoking cessation intervention's effectiveness in an online context. Therefore, the present study aims to test the effectiveness of message frame-tailoring based on the NFA, in isolation and in combination with content-tailoring, within the context of an online CCT smoking cessation intervention. The online / internet environment is specifically promising to enhance intervention effectiveness, as it has a great reach and is thus an "easy to access" medium, compared to tailored print health information (Taylor et al., 2017).

Specifically, we hypothesise that frame-tailoring based on people's NFA will lead to higher smoking abstinence rates (*H1a*) than no frame-tailoring, that content-tailoring will lead to higher abstinence rates (*H1b*) than no content-tailoring and that the combination of message frame-tailoring and content-tailoring will lead to the overall highest abstinence rates (*H1c*). Also, we expect that the above described effects of message frame-tailoring, content-tailoring and their combination are mediated by perceived relevance of the message

(*H2a*), self-determined motivation (*H2b*), and socio-cognitive beliefs (*H2c*). Figure 1 depicts the full conceptual model.

Figure 1. Conceptual model.



Note. A = Attitudes. SI = Social Influence. SE = Self-efficacy. Smoking abstinence = 7-day point prevalence abstinence of smoking.

Methods

Study design and procedure

To test the hypotheses we relied on data collected within a six month randomised controlled trial (RCT) using a 2 (frame-tailoring vs. no frame-tailoring) x 2 (content-tailoring vs. no content-tailoring) between-subjects design. This paper presents the data of T0 (baseline measurement), TI (immediate post-intervention follow-up), and T2 (one-month post-intervention follow-up) measurement in the context of the online CCT smoking cessation programme PAS (Personal Advice in Stopping smoking). Prior to study enrolment, smokers in the Dutch general public were targeted through social media (e.g., Facebook, Twitter, LinkedIn), Google advertisements, Dutch (online) newspapers and radio. Once smokers were willing to participate, they were provided with study information and could give their online informed consent, after which they could create their own username and password. Subsequently (T0), participants were automatically assigned to one of the

four conditions through computer randomisation and asked to complete the baseline questionnaire (T0), invited to use the intervention, and asked to complete the immediate post-intervention evaluation (T1). One month later, they were prompted via email to fill out a brief follow-up questionnaire (T2). Participants received a 10-euro voucher for their total 45-minute participation when completing the last and third follow-up questionnaire after six months.

The study was approved by the Institutional Review Board (reference number 2017-PC-7599) and is registered with the Dutch Trial Register (NL6512 / NRT-6700).

Participants

At baseline, 534 participants were recruited from mid-December 2018 to March 2019, of which 273 participants (51%) could be followed-up after one month. The participant flow throughout the study can be found in Figure 2. Inclusion criteria for participants were: being 18 years or older, intending to quit smoking within the upcoming six months, providing online informed consent, and having smoked during the last seven days. An a-priori power analysis estimated that a sample size of a minimum of 198 participants should be sufficient to detect small effects and interaction effects (power = .80, OR = 1.68, R^2 content-tailoring =.03) (Faul, Erdfelder, Lang, & Buchner, 2007; Smit, De Vries, & Hoving, 2012).

Experimental conditions

Content-tailoring. In the *content-tailored* condition, participants received smoking cessation advice adapted according to their answers in the questionnaire, which was grounded in the I-Change Model. Questions concerned participants' smoking behaviour, attitude, self-efficacy, social influence, action and coping planning, as well as their intention to quit smoking and/or to maintain quit (Smit, Candel, Hoving, & De Vries, 2016; Smit, De Vries, & Hoving, 2010).

Frame-tailoring. Message frame-tailoring was based on an assessment of the participant's individual NFA. Participants with a NFA received *autonomy-supportive message frames.* Autonomy-supportive message frames encouraged people to accept responsibility for their own behaviour, by taking

the message recipient's perspective into account through reflective feedback, by using language which minimised pressure on the reader, and by providing choice (e.g., by choosing whether or not to receive additional information on smoking cessation or by choosing whether or not to decide on a quit smoking date) (Deci et al., 1994; Markland et al., 2005; Resnicow et al., 2008, 2014). Participants with a low NFA received *controlling message frames* that consisted of directive and forceful sentences with imperatives and commands. Also, authorative statements, such as "experts say" were made and positive filling terms (e.g., luckily, good) were avoided. In addition, participants were not provided with choice, but just received all smoking cessation information and a quit date within the next two weeks. A detailed description of the development of message frames is provided in Chapter 4 of this dissertation.

Control condition. In the control condition, participants received a generic smoking cessation advice, which was not tailored to their pre-assessed answers and neither to their NFA.

Pilot testing

Previous to this study, an extensive usability test of PAS was conducted among smoking cessation experts (N = 5) and smokers from different socio-demographic backgrounds (N = 7), which is described in detail elsewhere (Van Strien-Knippenberg, Altendorf, Hoving, Van Weert & Smit, 2019). Also, the questionnaire and stimulus materials were pilot tested and used in previous online experiments and (Altendorf, Smit, Azrout, Hoving & van Weert, 2019; Van Strien-Knippenberg et al., 2019; Smit et al., 2012).

Measures

At baseline (T0), we measured demographic variables, the frame-tailoring and content-tailoring variables, i.e., NFA, I-Change Model variables. Immediately post intervention (T1), the manipulation assessment and participants' perceived relevance were measured. At one-month follow-up (T2), self-determined motivation, socio-cognitive beliefs, and smoking abstinence were assessed. All items were measured on a seven-point scale ranging from 1 = *strongly disagree* to 7 = *strongly agree*, unless indicated otherwise. Full descriptions of scales including item-wording is listed in appendix B1.

Demographics. Age, gender, living arrangement, educational level, presence of respiratory or cardiovascular diseases and – in case of female gender – pregnancy, smoking related behaviours (e.g., cigarettes smoked per day) were assessed.

Dependent variable. We measured seven-day point prevalence abstinence from smoking (smoking abstinence) by asking participants whether they had smoked in the last seven days (*yes* = 0, *no* = 1).

Mediators. *Perceived relevance* of the smoking cessation message was assessed using three items from Zhao and Peterson (2017). The scale was reliable and higher scores signified higher perceived relevance (Cronbach's alpha = .87, *M* = 4.44, *SD* = .08).

Self-determined motivation to quit smoking was measured using the Treatment Self-Regulation Questionnaire (six items) (TSRQ; Levesque et al., 2007), which had good reliability (Cronbach's alpha = .92, *M* = 5.34, *SD* = .21). Higher scores on the response scale denoted higher levels of self-determined motivation to quit.

Attitudes towards smoking cessation, social influence beliefs, self-efficacy, and intention to quit smoking were assessed based on the I-Change Model (De Vries, 2017). Twelve items measured *attitude* towards smoking cessation, which were answered on a five-point Likert scale (1 = *completely disagree*, 5 = *completely agree*). Higher scores indicated higher perceptions pros or cons of smoking cessation, respectively. Two sub-scales were formed with each six items assessing perceived pros and cons of smoking cessation, respectively. Both sub-scales appeared to have good reliability (Cronbach's alpha $_{pros}$ = .79, *M* = 3.55, *SD* = .62; Cronbach's alpha $_{cons}$ = .76, *M* = 2.36, *SD* = .51).

Social influence was measured using the concepts of social support (three items) and social norms (three items). Answers were given within six response categories. The sub-scales for social support and social norms had poor reliability (Cronbach's alpha $_{social\ support}$ = .58; Cronbach's alpha $_{social\ norms}$ = .48) and therefore we could use neither of those scales.

Self-efficacy was measured by nine items, which were answered on a five-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*). The scale was reliable (Cronbach's alpha $_{cons}$ = .91, *M* = 3.51, *SD* = .29) and higher scores indicated higher perceived self-efficacy for smoking cessation.

Tailoring variable*. NFA* was assessed with the Health Causality Orientations Scale (HCOS; Deci & Ryan, 1985b). Responses were given on a five-point Likert scale (1 = *very unlikely*, 5 = *very likely*). Four items from the HCOS reflect people's autonomous orientation, which were used to determine participant's NFA. Higher mean scores indicated a higher NFA. For tailoring, the cut-off point to determine a high or low NFA was 3.8 on the HCOS, which was based on results from an earlier online experiment (Altendorf, Smit, Azrout, Hoving & van Weert, 2019).

Manipulation check

To assess the validity of our frame-tailoring, we used four items assessing to which degree participants perceived the tone of the advice as controlling or autonomy-supportive, e.g., 'The advice was formulated in a pressuring tone'. The validity of our content-tailored manipulation was measured with three items asking whether participants felt that the smoking cessation advice was specifically written for them, e.g., *In this programme, I received advice based on the responses that I gave to the questions.* Responses were given on a five-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*).

Statistical analysis

Descriptive analyses with SPSS version 25 were conducted to determine sample characteristics and to check for differences in background variables and smoking-related behaviours (e.g., number of cigarettes smoked on an average day) between conditions. We used two-sided t-tests and chi-square tests and analysis of variance (ANOVA) where appropriate. In addition, a non-response analysis with two-sided t-tests and chi-square tests was conducted to determine whether selective dropout had occurred. We compared complete cases with lost-to follow-up cases at T2 with regard to the same set of variables. Then, structural equation modelling (SEM) in R with the lavaan package version 0.6-3 (Rosseel, 2012) was conducted. Manifest variables were used for data analysis, due to the rather small sample size (N = 273) for SEM analysis. Covariances were added among the two subscales measuring attitude towards smoking cessation, as those subscales measured different parts of the same concept. Next, we built the path model with smoking abstinence (measured at

T2) as the main outcome. Based on our hypotheses, we added direct paths from the exogenous variables (i.e., frame-tailoring, content-tailoring, and their combination) to smoking abstinence. Next, we added directs paths from the exogenous variables to perceived relevance and to self-determined motivation. We also added a direct path from perceived relevance to self-determined motivation. From self-determined motivation, direct paths to attitudes and self-efficacy perceptions and to smoking abstinence were added. Also, direct paths from attitudes and self-efficacy perceptions to smoking abstinence were added. The correlation matrix and a table with all direct and indirect standardised effects is available in appendix B1 and B2. The significance level was set at 5% and in the text below, direct unstandardised effects are reported.

Results

Randomisation and manipulation check

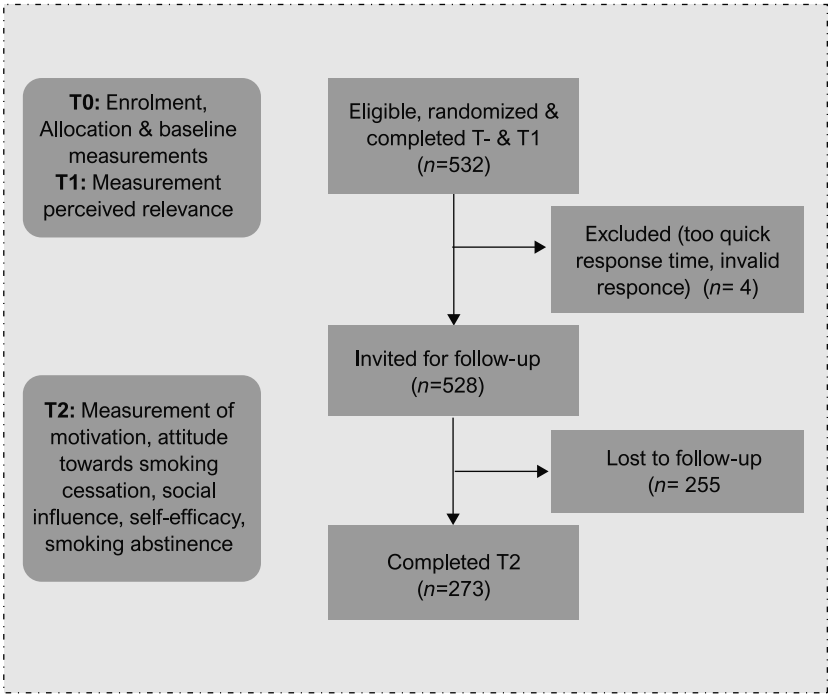
Comparison of participants in the different experimental conditions and the control condition in regard to their demographics, such as age and educational level, chronic diseases, as well as their smoking behaviours did not show significant differences between conditions. In terms of the manipulation, as expected, the frame-tailored and the content-tailored conditions were significantly more often perceived as such by participants, compared to the non-frame-tailored and non-content-tailored conditions, respectively. Thus, the manipulation succeeded. An overview of all items assessing our manipulations, together with their mean values in each of the experimental conditions is provided in appendix B3.

Sample characteristics and attrition

Comparisons of the 273 participants who completed the study and the 255 participants who were lost-to-follow-up after one month showed no significant differences in gender, educational level, smoking behaviours, and chronic diseases, but the chi-square test for condition and intervention drop-out was significant ((3)= 11.154, N = 528, p = .014): Less participants in the message frame- and content-tailoring condition were lost to follow-up (9.5%), compared to participants who received message frame-tailoring without content-tailoring (12.3%), a generic advice (i.e., the control condition; 13.4%), or no message

frame-tailoring but content-tailoring only (13.1%). Also, participants who dropped out were significantly younger than those who completed the follow-up measurement ($M_{\text{participants dropped out}}$= 40.11, $SD_{\text{participants dropped out}}$= 14.28; $M_{\text{participants completed}}$= 43.05, $SD_{\text{participants completed}}$= 13.52, $F(1) = 5{,}893$, $p = .016$).

Figure 2. Flow chart of participants.



Participant age was added as a covariate to our structural model, because it was significantly correlated with smoking abstinence and with intervention drop-out. As our model with the covariate was very complex, for clarity purposes, we will only report the results of variables that were of substantial interest based on the theory. Table 1 provides an overview of the sample characteristics of the participants who completed the study and participants lost to follow-up.

Table 1. Comparison of participants who completed the study with those who dropped out.

	Participants completed T0		Participants completed T2		Dropout at T2	
	n	%	*n*	%	*n*	%
	528		273		255	
Demographics						
Sex (female)	341	64.6	106	38.8	81	31.8
Age (years), M (SD)	41.63 (13.95)[a]		43.05 (13.526)		40.11 (14.28)*	
Educational level						
High	233	44.1	133	48.7	100	39.2
Middle	228	43.2	111	40.7	117	45.9
Low	67	12.7	29	10.6	38	14.9
Other/missing	0	0	0	0	0	0
Living arrangement						
With partner	110	20.8	61	22.3	49	19.2
With partner and child(ren)	119	22.5	61	22.3	58	22.7
With child(ren)	55	10.4	25	9.2	30	11.8
Alone	208	39.4	110	40.3	98	38.4
Other/missing	36	6.8	16	5.9	20	7.8
Number of daily smoked:						
Cigarettes, M (SD)	11.13 (8.34)		10.6 (7.92)		11.63 (8.75)	
Shags, M (SD)	3.69 (8.26)		3.8 (8.40)		3.75 (8.12)	
Cigars, M (SD)	0.40 (2.68)		0.24 (1.85)		0.57 (3.34)	
Cigarillos, M (SD)	0.18 (1.38)		0.19 (1.34)		0.18 (1.42)	
Pipes, M (SD)	0.13 (1.17)		0.07 (0.78)		0.18 (1.49)	
Earlier quit attempts, M (SD)	5.74 (0.58)		5.29 (11.41)		6.23 (15.27)	
Existence of (chronic) disease						
Heart disease	39	7.4	21	7.7	18	7.1
COPD	106	20.1	58	21.2	48	18.8
Diabetes	25	4.7	13	4.8	12	4.7
Cancer	29	5.5	12	4.4	17	6.7

Note. M=Mean; Standard deviations are presented in parentheses. [a] = significant mean difference $F(1, 526) = 5.893$, $p = .016$.

The assumptions of multivariate normality and linearity had been met and no multicollinearity existed. We conducted our SEM analysis with the diagonal weighted least squares (DWLS) estimator, which provides robust values from the full weight matrix to compute standard errors. No missing data among endogenous variables were observed. We identified outliers among endogenous variables (i.e., perceived relevance, self-determined motivation, perceived pros of smoking cessation, self-efficacy), which were checked, considered random and therefore not removed.

Model Testing

Our hypothesised path model appeared to have a poor model fit according to conventional goodness-of-fit indices (Byrne, 2016). Based on the modification indices and the residual covariance matrix, we assumed it to be necessary to trim our path model by discarding a variable from the model (i.e., the cons of smoking cessation), which subsequently led to good model fit. Table 2 provides an overview of model fit indices for the hypothesised and fitted model.

Table 2. Fit indices of the path model with smoking abstinence as outcome.

Models Fit indices	Hypothesised model	Final (trimmed) model
CMIN *(df)*	75.431 *(18)****	20.249 *(13), p=.089*
CFI	.814	.967
RMSEA [CI]	.10 [.08, .13]	.04 [.00, .08]

Note. CMIN = Chi-square. Df = degrees of freedom. CFI = comparative fit index. RMSEA = root mean square error of approximation. CI = 90% Confidence interval.
*** $p < .001$.

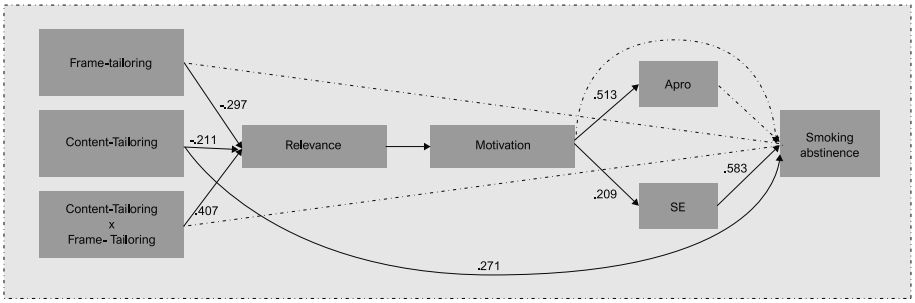
The results from SEM analysis are depicted in the structural model in Figure 3. For clarity reasons we present the results only for the significant regression coefficients.

Hypothesis testing

Effects of message frame-tailoring and content-tailoring on smoking abstinence. Contrary to our expectations, neither message frame-tailoring based on smoker's NFA nor the combination of message frame-tailoring and

content-tailoring significantly affected smoking abstinence. As expected, however, we identified a significant positive effect from content-tailoring on smoking abstinence (b = .574, p = .021). In the frame-tailored and content-tailored condition, N = 23 (30.3%) smokers refrained from smoking, while N = 12 (15.8%) smokers in the frame-tailored only, N = 11 (14.5%) smokers in the control condition, and N = 30 (39.5%) smokers in the content-tailored only condition refrained from smoking. Thus, we could only partly confirm the first hypothesis (i.e., *H1b*).

Figure 3. Final model with significant paths only.



Note. Results are presented as standardised direct effects. Apro = pros of smoking cessation. SE = self-efficacy. Dotted lines represent non-significant paths. Straight lines represent significant paths (p < .05).

Mediation of perceived relevance, self-determined motivation, and socio-cognitive beliefs about smoking cessation. As shown in the model (Figure 3), we identified a significant main effect of content-tailoring, message frame-tailoring based on people's NFA as well as their combination on smokers' perceived relevance of the smoking cessation message – the first mediator in our model. An ANOVA showed significant differences between the conditions (F(3, 269) = 4.818, p = .003) and, subsequently, Tukey's post-hoc test was used to identify the conditions with significant differences. The control condition (i.e., no content- or message frame-tailoring) was perceived as significantly more relevant than message frame-tailoring or content-tailoring alone ($M_{\text{difference control condition minus frame-tailoring only}}$ = .65, SE = .20; $M_{\text{difference control condition minus content-tailoring only}}$ = .54, SE = .19) and similarly relevant as the condition with both content- and message-frame tailoring. Surprisingly, a generic smoking cessation advice

thus led to similarly high levels of perceived message relevance as a message that was tailored both in terms of content and message frame, and to higher perceived relevance than messages tailored in terms of only one of these aspects. As these findings were against the expected direction, we decided to inspect the data even more closely by comparing participants with a high and low NFA within the message frame-tailored conditions. In doing so, we identified that smokers with a high NFA generally perceived their message as more relevant compared to participants who had a low NFA, when they received a frame-tailored smoking cessation message – both with and without content-tailoring. Moreover, the combination of message frame-tailoring and content-tailoring led to significantly higher perceived relevance than content-tailoring messages only, but only for smokers with a high NFA ($M_{\text{difference high NFA frame- \& content-tailoring minus content-tailoring only}} = .59; SE = .19; p = .041$). In addition, those with a high NFA in the frame-tailored and content-tailored condition perceived the messages as significantly more relevant compared to those with a low NFA who received frame-tailored, but not content-tailored messages. To illustrate these findings, means per condition for all continuous variables in the SEM are provided in Table 3.

Subsequently, perceived relevance had a positive effect on self-determined motivation to quit smoking ($b = .32$, $p < .001$). Furthermore, although self-determined motivation did not have a direct effect on smoking abstinence, there was a positive effect of self-determined motivation on the perceived pros of smoking cessation (i.e., positive attitudes) ($b = .37$, $p < .001$) and a positive effect on self-efficacy perceptions ($b = .15$, $p < .001$). Next, we could confirm a positive effect from self-efficacy perceptions on smoking abstinence ($b = .72$, $p < .001$).

In sum, the effect of message frame-tailoring, content-tailoring, as well as their combined effect on smoking abstinence was mediated by perceived relevance, self-determined motivation to quit and self-efficacy on smoking abstinence. As such, we could confirm the second hypothesis. An overview of the hypothesised direct and indirect effects from our final model is provided in Table 4.

Table 3. Mean values per condition for all endogenous variables.

Condition	**Frame-tailoring & content-tailoring**	High NFA	Low NFA	**Frame-tailoring & no content-tailoring**	High NFA	Low NFA	**No frame-tailoring & no content-tailoring**	**No frame-tailoring & content-tailoring**	Overall mean	*F (df)**
Dependent variable	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	
Relevance	**4.59 (1.05)**	4.83 (1.03)[a,b]	4.26 (1.01)[a,c]	**4.13 (.96)**	4.29 (1.07)	3.97 (.83)	**4.78 (1.27)**[c]	**4.24 (1.05)**[b]	4.43 (1.10)	4.364 (5)
Motivation	**5.33 (1.32)**	5.57 (1.42)	5.00 (1.10)	**5.16 (1.11)**	5.36 (1.00)	4.98 (1.19)	**5.42 (1.14)**	**5.42 (1.26)**	5.34 (1.22)	ns
SE	**3.52 (.84)**	3.70 (.82)	3.27 (.82)	**3.47 (.69)**	3.50 (.56)	3.44 (.81)	**3.48 (.83)**	**3.54 (.96)**	3.51 (.84)	ns
Apro	**3.64 (76)**	3.87 (.74)	3.33 (.69)	**3.43 (.96)**	3.55 (.84)	3.32 (1.06)	**3.55 (.91)**	**3.52 (.86)**	3.55 (.86)	ns
Acon	**2.36 (.83)**	2.21 (.84)	2.56 (.80)	**2.22 (.77)**	2.13 (.79)	2.31 (.76)	**2.43 (.90)**	**2.39 (.94)**	2.35 (.86)	ns

Note. N = Number of participants. M= Mean. SD = Standard Deviation. NFA = Need for autonomy. SE = Self-efficacy. Apro = Attitudes about pros of smoking cessation. Acon = Attitudes about cons of smoking cessation. SS = Social support for smoking cessation. SN = Social norms of smoking cessation.
* = ANOVA based on the six subgroups of tailoring. The four experimental conditions are in bold lettering. Means with differing subscripts within rows differ significantly at $p < 0.05$, whereas a = differs from frame-tailoring for low NFA & content-tailoring; b = differs from no frame-tailoring & content-tailoring; c = differs from frame-tailoring for low NFA & content-tailoring.

Table 4. Standardised indirect & direct effects trimmed model.

Dependent variable	*3*	*4*	*5*	*6*	*7*
Independent variable					
1 Content-tailoring					
Indirect effect	-	-0.062*	ns	ns	ns
Direct effect	-0.474*	-	-	-	0.271*
2 Frame-tailoring					
Indirect effect	-	-0.088*	ns	-0.026*	-
Direct effect	-0.297*	-	-	-	ns
3 Perceived relevance					
Indirect effect	-	-	0.151**	0.062*	ns
Direct effect	-	0.295**	-	-	-
4 Self-determined motivation					
Indirect effect	-	-	-	-	ns
Direct effect	-	-	0.513**	0.209**	ns
5 Attitudes					
Indirect effect	-	-	-	-	-
Direct effect	-	-	-	-	-0.173+
6 Self-efficacy					
Indirect effect	-	-	-	-	-
Direct effect	-	-	-	-	0.583**
7 Smoking abstinence					

Note. In the model we control for age and only the paths to self-determined motivation, social norms, smoking abstinence were significant ($p < .05$). ns = not significant. ** = significant at $p < .001$. * = significant at $p < .05$. + = marginal significant, $p = 0.05$.

Discussion

The aim of this study was to test the effectiveness of message frame-tailoring based on smokers' NFA in isolation and in combination with content-tailoring in the context of an online CCT smoking cessation intervention.

Effect of tailoring on smoking abstinence and perceived relevance

Our results confirm findings from earlier research on content-tailoring (Lustria et al., 2013; Smit et al., 2012), as we could identify a positive effect of content-tailoring on seven-day point prevalence abstinence rates one month after the start of the intervention. However, contrary to our expectations, we did not find

that message frame-tailoring based on the NFA in isolation and in combination with content-tailoring led to higher smoking abstinence rates, as compared to no frame-tailoring.

The mediating role of perceived relevance, self-determined motivation, and socio-cognitive beliefs

Overall, our findings were in line with our hypothesis that perceived relevance, self-determined motivation to quit, and socio-cognitive beliefs mediated the effects of content-tailoring, message frame-tailoring and their combination on smoking abstinence. That is, we could demonstrate a positive effect of perceived message relevance on self-determined motivation to quit smoking. Therefore, we could confirm earlier findings concerning Elaboration Likelihood Model research (Petty, Heesacker, & Hughes, 1997), that demonstrated that people who perceive their messages as relevant are also more motivated to devote more cognitive effort on processing messages. Moreover, self-determined motivation positively predicted positive attitudes and self-efficacy beliefs of smoking cessation. Last, we found a positive effect of self-efficacy on smoking abstinence, an effect also observed in an earlier meta-analysis on the integration of self-determination theory and the theory of planned behaviour by Hagger and Chatzisarantis (2009).

However, contrary to our expectations, attitudes towards smoking cessation did not significantly predict smoking abstinence, which is a finding that is not supported by earlier research (Hagger & Chatzisarantis, 2009). According to the theory of planned behaviour (Ajzen, 1991), positive attitudes lead to an enhanced intention for behaviour change, which in turn predicts behaviour change. We only assessed intention to quit smoking at the same moment as we assessed smoking cessation behaviour itself – and, theoretically, intention should be assessed at the moment in time that proceeds the assessment of current behaviour. Therefore, we cannot determine whether attitudes might have indirectly – instead of directly – predicted smoking abstinence, something which could have been assumed based on theory and empirical evidence (Smit et al., 2014; Vangeli, Stapleton, Smit, Borland, & West, 2011). A potential explanation for not identifying a significant effect of attitude on smoking abstinence could be that we could only use one subscale of

attitudes, i.e., the pros of smoking cessation. The subscale about the cons of smoking cessation had to be discarded during SEM analysis, due to the noise it caused in the data and also to reach model fit. This may have led to the attitude variable as included in our model not being fully representative of the theoretical construct in its entirety. However, other smoking cessation research also showed that not attitudes, but self-efficacy perceptions were the main predictors of smoking cessation among smokers intending to quit (Smit, Hoving, Schelleman-Offermans, West, & De Vries, 2014; Vangeli et al., 2011).

Moreover, we had to discard the social influence scale (De Vries, Mudde, Dijkstra, & Willemsen, 1998; De Vries et al., 2003b) as it had a poor reliability (see appendix B1). Thus, we could not test for a possible mediation effect of social influence, which might be an important factor in explaining variance in smoking abstinence rates (Van Den Putte, Yzer, & Brunsting, 2005). We recommend that efforts are made in future research to improve the comprehensibility and subsequently the reliability of the social influence scale by adapting the response categories of the sub-scales (e.g., specification of terms, such as "majority of your children" that seemed to be difficult to answer when having two children) – and to include the resulting reliable scale in further analyses similar to those presented here.

Exploring message frame-tailoring on the NFA

Also, in our model, we found that content-tailoring, message frame-tailoring and their combination had a significant effect on participants' perceived message relevance. However, effects were against expectation as both message frame-tailoring and content-tailoring led to significantly lower perceived message relevance compared to the control condition (i.e., generic smoking cessation messages). This finding is contradictory with earlier tailoring-research (Cacioppo & Petty, 1986; Hawkins, Kreuter, Resnicow, Fishbein, & Dijkstra, 2008; Resnicow et al., 2008), which has demonstrated that content-tailored messages lead to better message processing, better message recall and more positive behavioural outcomes via more perceived message relevance. In order to get a better understanding of this finding we checked the time participants took to finish the intervention. Although the control condition messages were similar in length and contained generic smoking cessation

information, we wanted to explore whether smokers in the control condition had processed the messages longer and perhaps more thoroughly, resulting in their perceptions of relevance being higher than in the other conditions. However, as participants between conditions did not differ significantly in the time they used to finish the intervention (data not reported) this idea no longer holds as a possible explanation.

A potential alternative explanation comes from exploratory data analyses conducted with the participants with a high and a low NFA separated within the message frame-tailored conditions. That is, results from these analyses showed that participants high in NFA who received message frame-tailoring – thus, messages in an autonomy-supportive frame – as an addition to content-tailoring did perceive their messages as significantly more relevant, compared to participants low in NFA who received message frame-tailoring and to participants that received messages that were content-tailored only. This finding supports research by Resnicow and colleagues (2008) which demonstrated that participants with a preference for an autonomous form of communication perceived autonomy-supportive messages as more relevant compared to those with a preference for controlling forms of communication. Also, although not significant, when comparing the means of all other mediators, participants with a high NFA generally had a higher level of self-determined motivation, more positive attitudes about smoking cessation, and higher self-efficacy perceptions, compared to those with a lower NFA – regardless of whether they received content-tailored messages or not. Moreover, the messages received in the control condition were perceived as more relevant than the messages received in the frame-tailored, but not content-tailored condition (i.e., controlling condition) by smokers with a low NFA. Participants with a high NFA perceived the control condition messages as equally relevant as the messages in all other conditions.

This pattern of findings points towards the question whether smokers with a lower NFA might prefer different message frames than those provided to them in our study (i.e., message frames using controlling language use and without the provision of choice). It could be that the controlling language that was used might have been too controlling, resulting in message resistance and an insufficiently ability to motivate participants with a low NFA to refrain from

smoking (Rains, 2013). Negative message evaluations like resistance have shown to lead to less deep message processing (Cacioppo & Petty, 1986), resulting in lower message effectiveness. Thus, low NFA participants might need differently tailored message-frames, e.g., a clear-cut expert advice about smoking cessation in a less controlling language, such as without the use of imperatives or terms like "must" and "should". In addition, as we found that messages provided in the control condition as well as in the content-tailored only condition were perceived as more relevant than the frame-tailored messages among low NFA participants. This might indicate that participants prefer a different kind of message framing. That is, in both conditions, the control condition and in the content-tailored condition only, the message frame was rather neutral and potentially, this way of communication matched better with participants communication preference than the controlling message frames in the frame-tailored conditions. This raises the question whether there is third group of people with a "moderate" NFA that was not taken into account in the present study. We have used the HCOS scale to assess the NFA in this study and dichotomised people into high versus low NFA groups based on the four autonomous orientation items. However, we did not use the subscales assessing people's controlled and/or impersonal orientations to classify respondents. Therefore, future research might want to investigate whether the categorisation into high and low NFA based on those four HCOS items is valid or whether a more extensive set of items (i.e., controlled orientation) should be taken into account. Such research efforts would help to optimise message frame-tailoring based on the NFA and enable further research into its effectiveness.

Also, it could be that participants with a lower NFA might be less susceptible to messages in a controlling message style than those with a high NFA to the autonomy-supportive messages, due to for instance, different message processing needs that potentially correlate with the NFA, such as the need for cognition. For instance, it could have been that the message frames for low NFA participants did not sufficiently meet their relatively lower autonomy-needs, but neither their preferences for (low levels of) information processing. In a similar vein, it could be expected that those with a higher NFA might have better health outcomes than their low NFA counterparts, as high NFA

individuals might also report higher needs for cognition and thus be more motivated to process health messages and eventually change their health behaviour than low NFA individuals (Cacioppo & Petty, 1986). In support of this reasoning, in an exploratory data analysis, which was not reported, we found that – although differences were not significantly – participants with a high NFA also had higher rates of smoking abstinence and perceived the messages as more relevant than those with a low NFA. Following, it seems to be necessary to study whether the NFA indeed correlates with the need for cognition and how their potential interaction might influence message effectiveness. Moreover, we recommend future research to (qualitatively) investigate among those with a low NFA (and potentially a low need for cognition) how messages should be formulated to meet their communication preferences and message processing needs in order for these messages to lead to optimal health outcomes.

Study strengths and limitations

Findings from this study contribute to a growing understanding of the effects of message frame-tailoring, however, in the present study, approximately 50% of the participants could not be followed up one month after the baseline measurement. While this is common for RCTs and in particular, for internet-based longitudinal studies (De Leeuw, 2005; Van Horn, Green, & Martinussen, 2009), the high rates of attrition – while also differing between conditions – may have reduced the internal validity of the results presented – and, as a consequence, may have biased the estimates of effectiveness. To prevent high attrition rates in the first place, we used strategies such as sending several email reminders to participants, only including participants who were sufficiently motivated to participate, as well as offering shopping vouchers after completion of the intervention and follow-up questionnaires. Moreover, we used a forced data entry option, so we only had missing values on outcome variables when the entire case was missing and there were no missing values, for instance, for any of the mediating variables while data on smoking abstinence was present – or vice versa. We acknowledge that the complete cases analysis we conducted might have led to a bias in the results presented. However, imputing the missing values for the nearly 50% of cases that dropped-out of the study would have introduced such a degree of uncertainty that the results

presented may have been even less reliable. Specifically, as participants who completed the one-month follow-up differed significantly in age from those who dropped out. Nevertheless, a major strength of this study was that we were able to recruit such a large sample of eligible smokers, that the sample size was still sufficient for analysis according to our a priori power analysis.

Conclusion

This study extends the tailoring literature by providing first evidence for the effects of message frame-tailoring based on the NFA in isolation and in combination with content-tailoring. Based on our findings, we cannot conclude that message frame-tailoring based on the NFA is an effective addition to conventional content-tailoring techniques in online health interventions in increasing smoking cessation rates, overall. However, smokers with a high NFA seemed to benefit from frame-tailored messages, compared to their peers with a low NFA. To enhance the effectiveness of online smoking cessation interventions, future research efforts should therefore be directed towards investigating whether the dichotomisation of smokers into two categories – a low NFA and a high NFA group - proofs to be valid, or whether a third moderate NFA-group might exist. Moreover, it seems necessary to study (qualitatively) which type of message frame might be most beneficial for smokers with a low NFA.