

Title: Assessing The Influence of Warnings with Testimonies from Former Smokers on Smoking and Quitting Behaviour

Short title: EFFECTS OF TESTIMONIAL WARNINGS

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The data that support the findings of this study are openly available in Open Science Framework <https://osf.io/nzgvd> (pilot Experiment) and <https://osf.io/a3ps7> (main experiment).

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Abstract

Objectives: Cigarette pack warnings are widely used internationally for reducing smoking behavior. Current warnings typically consist of a textual or graphic warning that smoking can lead to negative (health) outcomes. Though these warnings have proven benefits, they also have important limitations. Most notably, they do not produce beneficial changes in important cognitive determinants of smoking cessation such as self-efficacy to refrain from smoking and they do not reduce smoking for specific subsets of the target population. Recent studies provide evidence for the effectiveness of health warnings that include health-related testimonies from former smokers.

Methods: We designed cigarette pack warnings that consist of more general testimonial statements from former smokers, selected in a pilot study for their potential impact on two important cognitive determinants of smoking (i.e., self-efficacy beliefs and outcome expectancies). In the main study, online participants were either exposed to the new testimonial warnings, to graphic health warnings, or to text-only health warnings on four separate occasions during a 24 hour window.

Results: In a sample of 416 daily smokers, we observed beneficial changes in self-reported cigarette smoking, craving, quit intentions, evaluations of smoking, self-efficacy and outcome expectancies, immediately after viewing the warnings a first time and after multiple exposures. These effects were comparable for participants in the three warning type groups, with some (small) differences for changes in outcome expectancies and craving.

Conclusions: Warnings with general testimonies from former smokers might provide a useful evidence-based addition to currently used cigarette pack health warnings.

Keywords: cigarette smoking, smoking cessation, cigarette pack warnings, testimonial warnings, self-efficacy

Smoking is one of the leading causes of preventable death and disease worldwide (Naghavi et al., 2013). It is therefore of great importance to understand how one can efficiently prevent initiation and encourage cessation of smoking. The most widely adopted strategy of tobacco control is the placing of warnings on tobacco products (e.g., cigarette packs) (World Health Organization, 2017). These warnings typically consist of text messages designed to inform people about the negative health consequences of smoking such as ‘Smoking causes lung cancer’. An increasing number of countries now require adding graphic images depicting the described health problems to cigarette pack warnings (e.g., a picture of blackened lungs). Evidence suggests that exposure to graphic compared to text-only warnings leads to several more beneficial outcomes such as better knowledge about smoking harms, stronger intentions to quit smoking, and more reduction in actual smoking behavior (Brewer et al., 2016; Hammond, 2011; Noar et al., 2016a; Noar et al., 2016b) .

Although exposure to (graphic and text-only) health warnings has proven effective in changing several important smoking-related outcomes, these warnings have also been subject to criticism. First, some studies found only small or non-significant changes in smoking behavior following exposure to health warnings or found changes that were restricted to specific subsamples of smokers (e.g., infrequent but not frequent smokers) (Lavoie et al., 2015; Monarrez-Espino et al., 2014; Munafò et al., 2011). Other studies found that exposure to health warnings can sometimes backfire and lead to unwanted effects (Evans et al., 2017; Van Dessel et al., 2018). To explain these results, theorists have argued that health warnings sometimes initiate a freedom threat in smokers, resulting in feelings of fear or cognitive dissonance. Some (frequent) smokers might react to the warnings when they believe that reduction of these negative feelings is more easily achieved by raising counterarguments against the warning messages than by accepting them and changing smoking behavior (e.g., because they believe they are unable to quit smoking)

(de Hoog et al., 2007; Peters et al., 2013). In-line with these ideas, smokers often report more reactant feelings and more negative thoughts about cigarette warnings that are more fear-evoking (e.g., graphic compared to text-only warnings: Noar et al., 2016b; LaVoie et al., 2015) and the effectiveness of fear-evoking warnings is reduced in smokers who consider themselves unable to quit smoking (Kok et al., 2018).

A second criticism is that the currently used health warnings have not always been extensively tested for their effectiveness or their working mechanism in scientific studies and it is therefore unclear how these warnings achieve their effects and whether they produce better results than alternative warnings (Ruiter & Kok, 2005; Chun et al., 2018). Importantly, with regard to their working mechanism, health warnings might only target one very specific pathway for reducing smoking. Specifically, effects might be strongly mediated by fear induction and changes in people's knowledge about the dangers of smoking. Though this mechanism can be important, some smokers are well aware of the dangers of smoking, as, for instance, reflected in the fact that daily smokers sometimes exhibit negative evaluations of smoking (Van Dessel et al., 2018). This might explain why health warnings are not always effective in important smoking populations (Peters et al., 2013).

Research suggests that the most effective interventions to change smoking habits incorporate a variety of compatible strategies and target several working mechanisms (Thurgood et al., 2015). For instance, current anti-smoking therapies (e.g., cognitive behavior therapy) typically involve educating smokers about negative aspects of smoking but also target several other (cognitive) factors that might mediate smoking behavior, such as maladaptive smoking-related beliefs and expectancies (Killen et al., 2008). From this perspective, it might be beneficial to develop cigarette pack warnings that also target different pathways.

Some countries (e.g., Australia, Indonesia) have recently implemented a novel type of cigarette pack warnings with photographs and the personal details of (former) smokers whose health has been affected by smoking. Recent studies support the effectiveness of these testimonial warnings (Sutton et al., 2018; Hammond et al., 2019). For instance, one study found that testimonial health warnings produced more beneficial effects than the text-only health warnings currently used in the US and similar effects compared to pictorial warnings (Brennan et al., 2017). As has been robustly established in persuasion research, not only message content but also the perceived source of a persuasive message is an important determinant of message effectiveness (Briñol & Petty, 2009). Typical health warnings provide no source information (e.g., graphic warnings used in the UK do not indicate the message source) or only generic information (e.g., text-only warnings used in the US indicate that they come from the surgeon general). Counterarguments to these warnings often reveal low credibility and trustworthiness of the source of these warnings (Kowitt et al., 2019). In testimonial health warnings, the message source (the former smoker) is typically directly referred to on the cigarette pack. Because current smokers might consider this source more reliable and easier to relate to, these warnings might induce less psychological reactance, promoting adoption of the message (Skubisz et al., 2016).

Although testimonial health warnings may already be an effective addition to currently used warnings, one could also design testimonial warnings that not only have a different source (i.e., former smokers) compared to current health warnings but also different content. Former smokers can communicate much information that might be valuable to current smokers such as how or why they achieved quitting smoking. Testimonial warnings that incorporate such information might have added value compared to current health warnings. For instance, former smokers are often intrinsically motivated to help other smokers and, because they have succeeded in quitting, they

might communicate useful tools that could also help other smokers (Russell et al., 2018). Moreover, because there are many former smokers across the globe, a big pool of statements can be recruited to allow updating testimonial warnings at regular time points (an important feature of effective warnings: Brewer et al., 2016). These statements can be very diverse in content, potentially targeting several different pathways for change. Importantly, the effectiveness of general testimonial warnings might be boosted by selecting testimonial statements that target important cognitive determinants of smoking behavior as established in scientific research.

The current study provides an initial test of the effectiveness of general testimonial warnings. We first contacted 50 former smokers and asked them to provide a one- or two-sentence statement they thought might help current smokers to quit smoking. Thirteen statements were selected that (1) had a recurring theme across the statements (utilizing the “wisdom of the crowds”), (2) were considered least likely to induce psychological reactance, and (3) were considered to target important cognitive determinants of smoking. In-line with leading theories in psychology, we focused on two key determinants of (addictive) behavior: outcome expectancies (Eder et al., 2015) and self-efficacy beliefs (Bandura, 1997). Predictive processing (Friston, 2010) and goal-directed theories of human behavior (Moors et al., 2017) assume behavioral change requires change in predictions about the expected outcomes of the target behavior (smoking) and its alternative (quitting smoking). We therefore selected testimonial statements that might (a) facilitate positive outcome expectancies of quitting smoking, (b) reduce positive outcome expectancies of smoking (in the short-term), and (c) increase smokers’ confidence in their ability to stop smoking. Smoking research suggests that changes in these cognitive determinants can persuade smokers to engage in attempts to quit smoking and improve the success of these attempts (Gwaltney et al., 2015; Isharat et al., 2016).

Thirteen general testimonial warnings were created that depicted one of the testimonies together with an image and description of the former smoker on a cigarette pack. We selected four warnings based on a pilot study in which daily smokers rated the properties of these warnings in terms of their potential influence on reactance, self-efficacy and outcome expectancies. In the main study, we probed effects of exposure to cigarette packs that depicted either the four novel testimonial warnings or four (text-only or graphic) health warnings. The aim of this study was to provide an initial test of the influence of exposure to testimonial compared to graphic and text-only health warnings on smoking-related outcomes. We hypothesized that both after initial and multiple exposures to testimonial compared to text-only or graphic health warnings, participants would exhibit stronger beneficial changes in (1) ratings of warning characteristics, (2) (cognitive) determinants of smoking, (3) smoking frequency, (4) craving, (5) quit intentions, and (6) liking and wanting scores. We also expected that changes in determinants of smoking would moderate changes in the other outcomes. We did not have specific hypotheses about potential effects of other moderators.

Methods

Pilot study

Procedure. Testimonial warnings were selected on the basis of a pre-registered pilot study with 63 Prolific Academic participants (19 women; mean age=41, $SD=10$, range=24-64). In this study, participants rated 21 cigarette pack warnings presented in random order: 13 testimonial warnings (see Introduction), four text-only health warnings currently used in the US, and four graphic health warnings previously proposed by the US FDA. Each warning was presented for 6 seconds after which a prompt would indicate that participants could now push the space bar to proceed to the rating questions (Burkhalter et al., 2019). Participants first rated reactance by indicating to what

extent they (1) felt annoyed about the warnings, (2) felt the warning tried to manipulate them, and (3) thought of points that went against what was being said while they were reading the message. A reactance rating score was computed by averaging the three ratings (Cronbach's Alpha=.82). Next, participants rated the warnings' impact on self-efficacy by indicating to what extent the message made them feel more confident they might be able to stop smoking. Finally, participants rated outcome expectancy properties by indicating to what extent (1) the message made them believe more that positive things would happen if they would quit smoking and (2) the message made them believe less that smoking helps them get positive things. All questions were rated on 7-point Likert scales ranging from "not at all" to "very strongly".

Main study

Participants. The main study consisted of three study phases implemented online in a sample of daily smokers (Figure 1). We recruited 854 current smokers (510 women, mean age=40, $SD=12$) for Phase 1 via the Prolific Academic research website (<https://prolific.io>). Participants were invited for the study only if they had indicated on the Prolific Academic pre-screener that (1) they are smokers, (2) they smoke "more than one cigarette per day", (3) they are older than 18 and younger than 75 years of age, and (4) they are current residents of the US or of the UK. We recruited participants from both the United States (US) and the United Kingdom (UK) to allow testing for differences between these populations due to prior exposure to text-only health warnings in the US and to graphic health warnings in the UK.

Data from participants were excluded if they (1) had not completed the required warning reading task in-between study phases (6.1%), (2) did not complete Study Phase 3 (37.6%), or (3) did not correctly identify the warnings they had seen (2.1%), leaving data from 416 participants (219 women, mean age=40, $SD=12$). There were slightly more exclusions than expected, such that

the sample size allows 90% power to find a small between-subjects effect ($\eta^2_p=0.025$) in the crucial ANOVA, which was slightly less than the 95% power we aimed for. There was no evidence for condition-dependent attrition. Participant characteristics were not significantly different for excluded participants. Target sample size, study design, data-analytic plans and experimental hypotheses were pre-registered on the Open Science Framework and are available together with raw data, experimental and analytic scripts at https://osf.io/8gvm7/?view_only=c79f25135fc340b8a5f5342942e6d451. The study protocol was approved by the Ethics Committee of University X.

Design. The study involves a factorial design with the within-subjects factor Exposure (outcome measurement before exposure, after initial exposure, after multiple exposures) and two between-subject factors: Country of Residence (UK or US) and Warning Type (testimonial, graphic health, or text-only health warning). Participants were either presented with (a) the four testimonial warnings selected in the pilot study, (b) the four text-only health warnings currently used in the US, or (c) the four graphic health warnings previously proposed by the US FDA. Two types of health warnings were used because their effects can sometimes be dissimilar (Noar et al., 2016b). We recruited double the number of participants in the testimonial warning condition (50%) compared to the text-only (25%) and graphic health warning condition (25%) to maximize statistical power for testing the hypothesis that exposure to testimonial compared health warnings leads to differential changes in smoking behavior and (cognitive) determinants of smoking.

Procedure. In Phase 1, participants first completed demographics questions, informed consent and the Fagerström Test for Nicotine Dependence (FTND: Heatherton et al., 1991), and indicated the total number of previous quit attempts and the number of hours since they smoked their last cigarette (Table 1). They then completed measures of nine outcome variables (outcome

measurement before exposure): (1) self-reported smoking frequency (i.e., the number of cigarettes smoked during the previous 24 hours), (2) self-reported craving (West & Ussher, 2010), (3) self-reported quit intention (Burkhalter et al., 2009), (4) self-efficacy (Bandura, 1997), (5) positive outcome expectancies of smoking, (6) positive outcome expectancies of quitting smoking (Gwaltney et al., 2015), (7) self-reported liking of smoking (Van Dessel et al., 2018), (8) implicit liking of smoking (Payne et al., 2005), and (9) implicit wanting of smoking (Krieglmeier et al., 2019).

Participants were then shown four warnings in a slide-show set-up (Macy et al., 2016). Half of the participants saw the four testimonial warnings, whereas the other participants saw four health warnings (either text-only or graphic warnings). Each of the four warnings was presented for six seconds after which participants could push the space bar to proceed to the next warning. Each warning was presented twice, leading to a total of eight warning presentations.

After viewing the warnings, participants completed all measures a second time (outcome measurement after initial exposure): except for the measures of self-reported smoking frequency and craving. Participants were then informed they needed to visit a study link at three separate occasions before they could complete the final part of the study which would take place 24 hours after Phase 1. At this link, participants completed the warning viewing task with the same warnings (Phase 2).

One day after completing the first experiment phase, participants were reminded to perform the final part (Phase 3). Participants completed all outcome measures once more (outcome measurement after multiple exposures) except for the implicit wanting and liking measures. Participants then rated reactance, self-efficacy and outcome expectancy inducing properties of the warnings they had seen.

Data analyses. In-line with the pre-registered data analysis plan, data-analyses were performed in R (version 3.3.2). For outcome variables measured at different time points, we computed difference scores by subtracting scores after initial exposure and scores after multiple exposures from baseline scores. We performed linear regressions that included the factors Warning Type, Country of Residence, Exposure, and Gender, and the covariates Age, FTND Score, and Number of Quit Attempts, and follow-up *t*-tests. Given the study focus, we only elaborate on effects that included the factor Exposure or Warning Type. A more elaborate overview of the results of all pre-registered analyses is provided in the Supplementary Material.

Results

Pilot study

Results. In-line with the preregistered hypotheses, planned analyses revealed that participants rated (1) less reactance, (2) increased self-efficacy, (3) increased positive outcome expectancies of quitting smoking, and (4) reduced positive outcome expectancies of smoking for testimonial warnings than for text-only or graphic health warnings. For all outcomes, observed differences between the warning types were bigger for participants who smoked more cigarettes.

For selection purposes, ratings for the 13 distinct testimonial warnings were also compared, revealing significant differences for all outcomes. The four warnings with the highest average compound ratings (with reactance ratings reverse scored) were selected for use in the main study. Full details of this pilot study results are available in the Supplementary Material and pre-registered materials, data, and analyses scripts can be found at the Open Science Framework (anonymized link: https://osf.io/nzgvd/?view_only=4fcec372096245698e898dd77db0bb6d).

Main study

Warning characteristics. For ratings of reactance to the warnings, we observed only main effects of Country, $F(1,395)=4.33$, $p=.04$, $\eta^2_p=0.01$, and Gender, $F(1,395)=11.46$, $p<.001$, $\eta^2_p=0.03$, and an interaction effect of Age and Warning Type, $F(2,395)=4.92$, $p=.02$, $\eta^2_p=0.01$. This indicated lower reactance ratings for older participants if they saw testimonial or text-only health warnings but higher ratings if they saw graphic health warnings. Planned contrasts did not reveal lower reactance ratings for testimonial warnings ($M=2.55$, $SD=1.52$) than for graphic ($M=2.83$, $SD=1.75$) or text-only health warnings ($M=2.70$, $SD=1.60$), $ps>.077$ (Table 2).

For ratings of increase in self-efficacy due to warning exposure, the expected effect of Warning Type was revealed, $F(2,395)=4.60$, $p=.01$, $\eta^2_p=0.02$, indicating higher ratings of self-efficacy inducing properties of testimonial warnings ($M=4.35$, $SD=1.68$) than of text-only ($M=3.78$, $SD=1.71$) and graphic health warnings ($M=3.79$, $SD=1.83$), $ps<.004$. We also observed main effects of Quit Attempts, $F(1,395)=10.21$, $p<.001$, $\eta^2_p=0.03$, and FTND score, $F(1,395)=5.03$, $p=.03$, $\eta^2_p=0.01$.

For ratings of increase in positive outcome expectancies of quitting smoking due to warning exposure, analyses revealed only main effects of Country of Residence, $F(1,395)=4.56$, $p=.03$, $\eta^2_p=0.01$, and Quit Attempts, $F(1,395)=11.61$, $p<.001$, $\eta^2_p=0.03$. Planned contrasts did not reveal higher outcome expectancy ratings for testimonial warnings ($M=4.76$, $SD=1.70$) than for text-only ($M=4.45$, $SD=1.76$) or graphic health warnings ($M=4.61$, $SD=1.84$), $ts>.066$.

For ratings of decrease in positive outcome expectancies of smoking due to the warnings, only a main effect of Age was observed, $F(1,395)=11.85$, $p<.001$. Contrasting pilot study results, planned contrasts revealed *lower* ratings for testimonial warnings ($M=2.98$, $SD=1.86$) than for graphic health warnings ($M=3.44$, $SD=1.79$), $t(309)=-2.12$, $p=.035$. There was no significant difference with text-only health warnings ($M=3.28$, $SD=1.82$), $ts>.16$.

Self-efficacy and outcome expectancies. For self-efficacy difference scores, there was a significant Intercept, $F(1,403)=115.00$, $p<.001$, indicating increase in self-efficacy ratings after initial exposure ($M=0.61$, $SD=1.13$), $t(412)=10.92$, $p<.001$, and after multiple exposures ($M=0.58$, $SD=1.23$), $t(412)=9.59$, $p<.001$ (Table 3). There were also main effects of FTND Score, $F(1,403)=6.87$, $p=.009$, $\eta^2_p=0.02$, and Quit Attempts, $F(1,403)=10.33$, $p<.001$, $\eta^2_p=0.03$, and an interaction of FTND score with Exposure, $F(1,403)=5.42$, $p=.02$, $\eta^2_p=0.01$.

For difference scores of positive outcome expectancies of smoking cessation, we also observed a significant Intercept, $F(1,403)=15.46$, $p<.001$, indicating increase in positive outcome expectancies of smoking cessation after initial exposure ($M=0.30$, $SD=1.07$), $t(412)=5.75$, $p<.001$, and after multiple exposures ($M=0.18$, $SD=1.19$), $t(412)=3.10$, $p=.002$. A main effect of Warning Type was observed, $F(1,403)=3.25$, $p=.040$, $\eta^2_p=0.01$, indicating more increase for testimonial warnings than for text-only health warnings, $t(304)=2.35$, $p=.031$, and no significant differences with graphic health warnings, $ps>.45$. The effect of Exposure was also significant, $F(1,403)=4.08$, $p=.04$, $\eta^2_p=0.01$, indicating more increase after initial than after multiple exposures.

For difference scores of positive outcome expectancies of smoking, we did not observe a significant Intercept, $F(1,403)=0.05$, $p=.83$, $\eta^2_p<0.01$. There was a significant effect of Warning Type, $F(1,403)=6.25$, $p=.002$, $\eta^2_p=0.03$. This effect was qualified by an interaction with Exposure, $F(1,403)=13.18$, $p<.001$, $\eta^2_p=0.06$, indicating a stronger increase after initial exposure for participants who viewed testimonial warnings than for participants who viewed text-only or graphic health warnings, $ps<.001$, but no differences between participant groups after multiple exposures, $ps>.72$. There was also a main effect of FTND Score, $F(1,403)=4.25$, $p=.025$, $\eta^2_p=0.01$ and an interaction effect of Country x Exposure, $F(1,403)=5.77$, $p=.016$, $\eta^2_p=0.01$.

Smoking frequency, craving, and quit intentions. Analyses on difference scores in smoking frequency after multiple exposures (there was no measurement after initial exposure) revealed a significant Intercept, $F(1,403)=27.73$, $p<.001$, indicating reduction in smoking frequency ($M=-1.12$, $SD=4.23$), $t(412)=-5.39$, $p<.001$ (Table 4). The main effect of Gender was also significant, $F(1,403)=4.51$, $p=.034$, $\eta^2_p=0.01$.

For difference scores in craving ratings, a significant Intercept was also observed, $F(1,403)=5.60$, $p=.018$, indicating reduction in craving ($M=-0.11$, $SD=0.96$), $t(412)=-2.31$, $p=.022$. There was also a significant interaction effect of Country x Warning Type, $F(2,403)=4.07$, $p=.018$, $\eta^2_p=0.02$. This indicated a significant reduction in craving only for US participants who viewed testimonial warnings and UK participants who viewed graphic health warnings, $ps<.028$, and not for other participant groups, $ps>.20$.

The analyses on quit intention difference scores revealed a significant Intercept, $F(1,403)=60.68$, $p<.001$, indicating increase in quit intentions after initial exposure ($M=0.50$, $SD=1.37$), $t(412)=7.45$, $p<.001$, and after multiple exposures ($M=0.58$, $SD=1.58$), $t(412)=7.49$, $p<.001$. There were no other significant effects, $ps>.096$.

Liking and wanting scores. For difference scores in self-reported liking, there was a significant Intercept, $F(1,394)=29.36$, $p<.001$, indicating decrease in liking of smoking after initial exposure ($M=-0.34$, $SD=1.30$), $t(412)<-5.16$, $p<.001$, and after multiple exposures, ($M=-0.41$, $SD=1.58$), $t(412)<-5.15$, $p<.001$. There were no other significant effects, $ps>.052$.

Implicit liking scores in the AMP were calculated by subtracting the proportion of “pleasant” responses on trials with smoking-related prime from the proportion of “pleasant” responses on trials with non-smoking related primes. Split-half reliability was high ($r[508]=.85/$

.87). Analyses on difference scores revealed a significant effect of Age, $F(1,394)=4.55$, $p=.034$, but no significant Intercept, $F(1,394)=0.86$, $p=.36$.

Implicit wanting scores in the AAT were calculated by (1) subtracting median RTs on approach smoking trials from median RTs on approach control trials, (2) subtracting median RTs on avoid smoking trials from median RTs on avoid control trials, and (3) subtracting the latter difference score from the former difference score (Wiers et al., 2009). Split-half reliability of the AAT score was very low ($r[512]=.06/.17$). Analyses on difference scores revealed no significant Intercept or any other effects, $ps>.29$.

Moderation by changes in cognitive determinants. For exploratory purposes, we also examined moderation of changes in smoking frequency, craving, and quit intentions after multiple exposures by changes in self-efficacy and outcome expectancies. For smoking frequency difference scores, we observed main effects of Difference In Self-efficacy, $F(1,386)=4.57$, $p=.033$, $\eta^2_p=0.01$, and Difference In Positive Outcome Expectancies Of Smoking, $F(1,386)=7.77$, $p=.006$, $\eta^2_p=0.02$, indicating more reduction in cigarettes smoked for participants who reported (1) more increase in self-efficacy and (2) more reduction in positive outcome expectancies of smoking.

For craving difference scores, we observed a main effect of Difference In Self-efficacy, $F(1,384)=13.73$, $p<.001$, $\eta^2_p=0.03$, indicating more reduction in craving for participants who reported more increase in self-efficacy.

For quit intention difference scores, we observed main effects of Difference In Self-efficacy, $F(1,386)=18.05$, $p<.001$, $\eta^2_p=0.04$, and Difference In Positive Outcome Expectancies Of Smoking Cessation, $F(1,386)=4.07$, $p=.044$, $\eta^2_p=0.01$, indicating more increase in quit intentions for participants who reported (1) more increase in self-efficacy and (2) more increase in positive outcome expectancies of smoking cessation.

Discussion

Results suggest that exposure to testimonial warnings positively influenced (1) smoking behavior, (2) moderators of smoking behavior (i.e., quit intentions, craving, and self-reported - but not implicit - liking of smoking), and (3) cognitive determinants of smoking (i.e., self-efficacy and positive outcome expectancies of smoking - but not positive outcome expectancies of smoking). These effects were similar to effects of text-only and graphic health warnings and were evident immediately after initial exposure to the warnings and one-day later with 3 exposures in-between.

The observation that beneficial changes after exposure on all probed outcomes were similar for participants who viewed testimonial warnings and participants who viewed graphic and text-only health warnings contrasts with our prediction that testimonial warnings would impact cognitive determinants more strongly and therefore produce stronger changes on other outcomes. One potential reason for this unexpected result is the inadequate selection of testimonial warnings for the main study. Though the results of the pilot study straight-forwardly showed testimonial warnings had the desired characteristics (i.e., they were rated as inducing more beneficial change in cognitive determinants of smoking), the main study only partly corroborated these results. Specifically, ratings reflected more self-efficacy inducing qualities of testimonial warnings than health warnings but did not show less reactance, less positive outcome expectancies of smoking or more positive outcome expectancies of quitting smoking due to the testimonial warnings. In fact, results indicated that testimonial warnings communicated more positive outcome expectancies of smoking. Note that these dissociative results of the main and pilot study could also (partially) reflect reduced statistical power in the main study which used a between-subjects design and showed only 4 compared to 13 testimonial warnings.

Importantly, our results provide some indications that testimonial warnings could provide a useful addition to health warnings. First, we observed beneficial changes after exposure on all probed outcomes. Because the current study did not include a control condition without intervention it is difficult to make strong claims about the extent to which these effects reflect changes due to warning exposure or due to unrelated processes (e.g., fatigue, demand compliance). Importantly, however, results of exposure to testimonial warnings were similar to effects of exposure to health warnings, which has shown beneficial effects in previous studies (e.g., Brewer et al., 2016; Noar et al., 2016a,b).

Second, exploratory analyses revealed that changes in the targeted constructs of self-efficacy, outcome expectancies, and reactance, predicted beneficial changes in smoking behavior, smoking intentions, and craving. This suggests that separation of these cognitive constructs is meaningful in practice and that selecting (testimonial) statements that target these determinants could prove beneficial.

Third, there were some notable, albeit small, differences in effects of the three types of warnings. This is important because it suggests that testimonial warnings might influence smoking behavior through different pathways (e.g., by changing self-efficacy) than health warnings (e.g., by inducing fear of unwanted health effects). This could also imply that different subgroups might be differentially impacted by the different warning types. A first difference we observed is the stronger increase in positive outcome expectancies of smoking cessation for participants who viewed testimonial compared to text-only health warnings. Combined with the fact that we also observed that stronger increase in these outcome expectancies relates to more increase in quit intentions, this suggests that testimonial warnings may have important added value to health warnings. Another difference is that reduction in craving after warning exposure was observed only

for participants who were exposed to testimonial warnings or graphic (but not text-only) health warnings. This accords with evidence that text-only health warnings are not always effective in changing craving (Noar et al., 2016b). Notably, this effect was dependent on country of residence such that craving was reduced only for US participants who viewed testimonial warnings and for UK participants who viewed graphic warnings. This moderation effect could relate to the observation that UK participants were less resistant to graphic health warnings. UK participants are more used to seeing graphic warnings which might facilitate their adoption. A third difference between warning effects was the unexpected increase in positive outcome expectancies of smoking after initial exposure to testimonial (but not health) warnings. This accords with warning characteristic ratings and could reflect inadequate selection of the four testimonial warnings on this characteristic. A fourth interesting difference is that more frequent smokers gave more beneficial ratings of testimonial warnings in the pilot (but not in the main) study.

Notably, there were several limitations to the current study which could have influenced effects of exposure to (testimonial) warnings. First, the current study included a sample of Prolific Academic participants. Though this a diverse sample (in terms of age, gender, or study background) and this sample had the required characteristics (in terms of smoking history), this sample also has limitations. For instance, these participants complete the study at home and therefore often report distractions which might interfere with effects (Clifford & Jeret, 2014). Second, we tested the effects of exposure to different types of cigarette pack warnings as viewed (on four separate occasions) in a slide-show set-up during an experimental study. Though previous studies have shown that such procedures can provide relevant information and reveal important effects (Kowitz et al., 2019; Van Dessel et al., 2018), more naturalistic experience with the warnings and exposure on many more occasions might produce stronger effects (Brewer et al., 2016). Alternatively, it is

also possible that effects are due to non-naturalistic characteristics of the experimental set-up and may not translate to meaningful effects in real-life. Third, as noted above, there might have been issues with the selection of the four testimonial warnings that were used. These might be resolved when a larger pool of testimonial (or other) warnings to select from is available, such that statements might be selected that better target cognitive determinants. This could, for instance, be achieved by launching a call to recruit testimonies from former smokers. Another limitation is that the photographs of testimonial statements showed former smokers of White race (Belgian nationality) and rather old age. This could limit the extent to which some participants can relate to the warnings which might influence warning effectiveness (Hammond, 2011).

Yet, the current study is only the first study testing the effectiveness of (testimonial) warnings that are designed to facilitate important determinants of smoking. Similar studies that compare the effectiveness of cigarette pack warnings in large samples are needed to help direct current efforts to find new, evidence-based, warnings. Performing these studies with pre-registered methods, analyses, and open data, might add to the importance of the obtained results.

Conclusion

Cigarette pack warnings have important effects on smoking behavior. The current study provides the first test of the effectiveness of a new type of cigarette pack warnings that include general testimonial statements from former smokers and target cognitive moderators of smoking in line with state-of-the-art cognitive theories. Exposure to testimonial warnings selected for their potential effect on self-efficacy and outcome expectancies produced similar effects on self-reported smoking and important determinants of smoking compared to text-only and graphic health warnings. There were some notable differences in effects for specific outcomes in specific sub-

samples suggesting that these different types of warnings might target different pathways and that testimonial warnings might provide a useful addition to currently used cigarette pack warnings.

Supplementary Material

The Supplementary Material includes a detailed overview of the pilot study, the main study design and results, and the warnings used in the main study.

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TablesTable 1. *Participant characteristics and baseline ratings.*

	Gender	Country of residence	Age	Smoking frequency (cigarettes/day)	Craving
			Mean (SD)	Mean (SD)	Mean (SD)
Testimonial Warnings	104 women 100 men	111 UK 93 US	40 (13)	14.99 (8.11)	4.15 (1.18)
Text-only health warnings	51 women 51 men	58 UK 44 US	40 (12)	14.60 (9.37)	4.07 (1.18)
Graphic health warnings	63 women 44 men	62 UK 45 US	41 (12)	15.34 (7.74)	4.20 (1.19)
	Quit attempts	Quit intentions	Liking of smoking	FTND	Time since smoking
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Testimonial Warnings	3.08 (2.44)	9.42 (3.62)	4.19 (1.93)	4.52 (2.35)	1.96 (3.11)
Text-only health warnings	2.90 (2.46)	9.50 (3.43)	3.94 (1.87)	4.70 (2.25)	1.86 (3.20)
Graphic health warnings	3.00 (2.34)	9.50 (3.43)	4.11 (1.82)	4.79 (2.28)	1.94 (3.62)

Table 2. *Rated Warning Characteristics.*

	Testimonial warnings		Text-only health warnings		Graphic health warnings	
	Mean (SD)	95% CI	Mean (SD)	95% CI	Mean (SD)	95% CI
Reactance	2.56 (1.52)	[2.35, 2.77]	2.70 (1.60)	[2.38, 3.01]	2.83 (1.75)	[2.50, 3.17]
Increase in self-efficacy	4.35 (1.68)	[4.12, 4.58]	3.78 (1.60)	[3.47, 4.10]	3.79 (1.83)	[3.43, 4.14]
Increase in positive outcome expectancies quitting smoking	4.76 (1.70)	[4.53, 4.99]	4.45 (1.67)	[4.12, 4.78]	4.61 (1.84)	[4.26, 4.96]
Decrease in positive outcome expectancies smoking	2.98 (1.86)	[2.72, 3.23]	3.28 (1.82)	[2.94, 3.64]	3.44 (1.79)	[3.10, 3.78]

Table 3. *Self-efficacy and Outcome expectancy scores before and after exposure.*

	Testimonial warnings		Text-only health warnings		Graphic health warnings	
	Mean (SD)	95% CI	Mean (SD)	95% CI	Mean (SD)	95% CI
Self-efficacy:						
- <i>Baseline</i>	4.22 (1.66)	[3.99, 4.22]	3.96 (1.58)	[3.65, 4.27]	3.81 (1.52)	[3.52, 4.11]
- <i>After initial exposure</i>	4.82 (1.64)	[4.59, 5.05]	4.57 (1.55)	[4.26, 4.87]	4.42 (1.60)	[4.11, 4.73]
- <i>After multiple exposures</i>	4.80 (1.63)	[4.58, 5.03]	4.43 (1.63)	[4.11, 5.75]	4.49 (1.68)	[4.16, 4.81]
Positive outcome expectancies quitting smoking:						
- <i>Baseline</i>	5.25 (1.59)	[5.03, 5.49]	5.25 (1.55)	[4.94, 5.55]	5.39 (1.52)	[5.10, 5.68]
- <i>After initial exposure</i>	5.64 (1.51)	[5.43, 5.85]	5.58 (1.43)	[5.30, 5.86]	5.49 (1.60)	[5.18, 5.79]
- <i>After multiple exposures</i>	5.54 (1.51)	[5.34, 5.75]	5.36 (1.51)	[5.07, 5.66]	5.41 (1.55)	[5.11, 5.71]
Positive outcome expectancies smoking:						
- <i>Baseline</i>	2.46 (1.62)	[2.24, 2.68]	2.62 (1.51)	[2.29, 2.94]	2.33 (1.55)	[2.03, 2.62]
- <i>After initial exposure</i>	3.05 (2.14)	[2.76, 3.35]	2.37 (1.60)	[2.06, 2.69]	2.07 (1.44)	[1.79, 2.34]
- <i>After multiple exposures</i>	2.46 (1.62)	[2.24, 2.68]	2.51 (1.63)	[2.19, 2.83]	2.36 (1.57)	[2.05, 2.66]

Table 4. *Smoking frequency, craving, and quit intention scores before and after exposure.*

	Testimonial warnings		Text-only health warnings		Graphic health warnings	
	Mean (SD)	95% CI	Mean (SD)	95% CI	Mean (SD)	95% CI
Smoking frequency						
(number of cigarettes/day):						
- <i>Baseline</i>	14.99 (8.11)	[13.87, 16.10]	14.60 (9.37)	[12.76, 16.44]	15.34 (7.74)	[13.85, 16.82]
- <i>After multiple exposures</i>	14.18 (7.83)	[13.10, 15.26]	13.21 (8.61)	[11.51, 14.90]	13.88 (7.03)	[12.53, 15.23]
Craving:						
- <i>Baseline</i>	4.15 (1.18)	[3.99, 4.31]	4.07 (1.18)	[3.84, 4.30]	4.20 (1.19)	[3.99, 4.41]
- <i>After multiple exposures</i>	4.10 (1.22)	[3.93, 4.27]	3.98 (1.17)	[3.75, 4.21]	3.96 (1.23)	[3.73, 4.20]
Quit intentions:						
- <i>Baseline</i>	9.42 (3.62)	[8.92, 9.92]	9.50 (3.43)	[8.83, 10.17]	9.50 (3.43)	[8.85, 10.16]
- <i>After initial exposure</i>	9.96 (3.59)	[9.46, 10.45]	9.97 (3.46)	[9.29, 10.65]	9.97 (3.67)	[9.27, 10.68]
- <i>After multiple exposures</i>	10.03 (3.56)	[9.54, 10.52]	10.10 (3.30)	[9.45, 10.75]	10.01 (3.68)	[9.30, 10.72]

