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Impact of Brief Nicotine Messaging on Nicotine-Related Beliefs in a U.S. Sample

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Abstract

Introduction: The current study pilot tested the effect of a single, brief exposure to nicotine education messages on beliefs about nicotine, nicotine-replacement therapy (NRT), e-cigarettes, and cigarettes with reduced nicotine content (RNC).

Methods: Five hundred twenty-one U.S. adults (aged ≥18 years) on Amazon Mechanical Turk completed a 15-minute survey in 2018. After completing items on sociodemographics, literacy, and cancer risk behaviors, participants were randomized in a 2:1:1 ratio to one of three conditions: nicotine education (n=263), sun safety education (attention control, n=128), or no message control (n=130). All participants completed items regarding nicotine, NRT, e-cigarette, and RNC cigarette beliefs, as well as norms about nicotine use, behavioral control regarding cigarette/tobacco use, and intention to use cigarettes, NRT, e-cigarettes, and RNC cigarettes in the next 12 months. Analyses were conducted in 2019.

Results: Following exposure, nicotine education participants reported fewer false beliefs about nicotine (p<0.001), NRT (p<0.001), e-cigarettes (p<0.05), and RNC cigarettes (p<0.05) compared with the control conditions. Nicotine messaging doubled the probability of a correct response

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(false, 78.3% vs 36.8%) to *nicotine is a cause of cancer* and dramatically reduced the probability of responding *don't know* to this item (5.3% vs 26.0%). There was no impact of the intervention on beliefs about other substances within cigarette, norms, or behavioral intentions.

Conclusions: Findings from the current study support that a brief nicotine messaging intervention—similar to the messages likely to be seen on warning labels or in media campaigns—is likely to correct misperceptions of nicotine, NRT, e-cigarettes, and RNC cigarettes.

INTRODUCTION

Authoritative reviews of carcinogens in tobacco and tobacco smoke have not listed nicotine among the carcinogens[1–4] and evidence syntheses conclude that combustion compounds in tobacco smoke are the primary contributors to the cardiovascular risk of tobacco use.[5,6] However, population studies have quantified widespread misperceptions of nicotine,[7–9] with some smokers equating the harms of using U.S. Food and Drug Administration-approved nicotine-replacement therapy (NRT) for smoking cessation with the harms of cigarette smoking.[10–16]

Findings from RCTs support that cigarettes with reduced nicotine content (RNC) can reduce cigarettes per day, and exposure to and dependence on nicotine, with minimal smoking compensation among users.[17,18] The Food and Drug Administration is considering a nicotine reduction standard in cigarettes, but has not described how consumer education on nicotine would be used to support the intended effect of this policy on current tobacco users, non-users, or the population overall.[19]

The goal of the current study was to pilot test the effect of a single, brief exposure to nicotine educational messages on beliefs about nicotine, NRT, e-cigarettes, and RNC cigarettes in a convenience sample of adults.

METHODS

Study Sample

The authors conducted an online trial in 521 U.S. adults (aged ≥18 years) on Amazon Mechanical Turk who completed a 15-minute survey on "Communicating About Cancer Risk Behaviors" in 2018. After completing items on sociodemographics, literacy,[20] and cancer risk behaviors (e.g., physical activity), participants were randomized in a 2:1:1 ratio to one of three conditions: nicotine messaging (n=263), sun safety messaging (attention control, n=128), or no message control (n=130). Participants in the "no message control" condition immediately completed outcome measures. Participants in the two messaging intervention conditions completed these items after exposure to the educational messages. This study was deemed exempt by the IRB at the University of Vermont.

Intervention

Six images were presented to participants in the nicotine messaging condition using a black slide template with smoke and content adapted from several evidence-based sources [1–3,5,21,22] for a lay audience. The six tested messages were: (1) *nicotine is the addictive*

substance in tobacco products, (2) *nicotine makes it easier for people to start smoking regularly*, (3) *nicotine makes it harder for people to quit smoking,* (4) *nicotine does not cause cancer,* (5) *chemicals in cigarette smoke, not nicotine, largely cause cancer, heart disease, and other health problems related to smoking,* and (6) *nicotine can be used safely long-term in quit smoking products like nicotine patches, gum, or lozenges.* Participants in the sun safety condition also received six messages of similar length to the nicotine messages using an orange slide template with a sun, including *indoor tanning and ultraviolet radiation from the sun cause skin cancer and premature aging* and *wearing sunscreen alone does not prevent skin cancer.*

Measures

Primary outcomes were nicotine, NRT, e-cigarette, and RNC cigarette beliefs. Secondary outcomes were norms about nicotine use, behavioral control regarding cigarette/tobacco use, and intention to use cigarettes, NRT, e-cigarettes, and RNC cigarettes in the next 12 months. These measures are detailed with their response options in Tables 2 and 3. Items on the relative harm of e-cigarettes or nicotine products compared with cigarettes were initially asked on a 5-point scale (*much less harmful* to *much more harmful*), but collapsed to a 3-point scale. Nine items on RNC cigarette beliefs were adapted from previous studies[23,24] and assessed on a 5-point scale from *definitely not true* to *definitely true*. Items were summed to create subscales, with higher scale values indicating a greater number of false beliefs. Norms items on the social acceptability of specific tobacco products and other substances were assessed on a 5-point scale (*not at all* to *extremely*) and items on people's opinions of using nicotine on a 5-point scale (*very positive* to *very negative*). Acceptability of uses of nicotine was assessed by ranking three options from *most acceptable* (1) to *least acceptable* (3). Intention to use specific products in the next 12 months was assessed in past 30–day tobacco users and non-users, with those reporting *definitely yes, probably yes,* and *probably not* coded as susceptible to future use and those reporting *definitely not* coded as not susceptible, in line with other studies.[25,26]

Statistical Analysis

Bivariate analyses examined differences in sociodemographic characteristics (age, gender, race/ethnicity, education, subjective financial situation), past 30–day tobacco use, and response to nicotine, NRT, e-cigarette, and RNC cigarette beliefs, norms, behavioral control, and intention to use by study condition using chi-square tests and *t*-tests in 2019. As there were no significant differences in the primary outcomes between the two control conditions, comparisons focused on the nicotine messaging versus combined control conditions. Multiple linear regression analyses examined the relationship between study condition and the four false beliefs scales, controlling for past 30–day tobacco use status.

RESULTS

Approximately half of participants were male (52%), 46% were aged 25–34 years, 80% were white, 11% were of Hispanic ethnicity, 87% had at least some college education, and 40% reported past 30–day tobacco or e-cigarette use (Table 1). The study groups did not

differ on pre-exposure measures of sociodemographic characteristics, literacy, or past 30–day tobacco use.

Table 2 shows a strong effect of nicotine messaging on reducing false beliefs about nicotine, NRT, e-cigarettes, and RNC cigarettes compared with the combined control conditions. Importantly, the nicotine messaging condition doubled the probability of a correct response (false, 78.3% vs 36.8%) to *nicotine is a cause of cancer* and dramatically reduced the probability of responding *don't know* to this item (5.3% vs 26.0%). It also increased correct responses regarding the contribution of nicotine to health risks and cancer caused by cigarette smoking ($p<0.001$). Of particular interest, the impact of the educational intervention was specific to nicotine; there was no impact on beliefs about other substances within a cigarette ($p>0.040$ for all). In multivariable models, exposure to nicotine messaging remained associated with a lower level of nicotine (b= −1.82, $p<0.001$), NRT (b= −1.16, $p<0.001$), and e-cigarette (b= −0.39, $p=0.043$) false beliefs, after controlling for past 30–day tobacco use; the relationship between study condition and RNC cigarette false beliefs in this model was marginally significant (b= −1.13, $p=0.054$).

There were no differences in nicotine-related norms, behavioral control, or intentions to use tobacco or nicotine products by study condition (Table 3). The only marginally significant difference between groups was for social acceptability of marijuana ($p=0.049$).

DISCUSSION

Findings from the current study support that a brief nicotine messaging intervention—similar to the messages likely to be seen on warning labels or in media campaigns—can correct misperceptions of nicotine, NRT, e-cigarettes, and RNC cigarettes in a general population sample of adults. Brief exposure to nicotine messages in this pilot study, however, did not impact norms about nicotine, behavioral control, or intention to use tobacco or nicotine products.

Limitations

This study used an online convenience sample and a single, brief exposure to sample nicotine education messages. While it provides encouraging preliminary evidence of the potential for messaging to correct misperceptions of nicotine, studies with repeated exposures in a population sample are needed to determine whether public education on nicotine would produce similar results in U.S. adults.

CONCLUSIONS

Public education is an essential complement to the Food and Drug Administration's efforts to move smokers away from combusted tobacco products and prevent non-users from trying nicotine and tobacco products. Communication via mass media, warnings, and effective labeling are central components of such educational efforts, and must convey correct information in a way that the public understands. Studies with more intensive exposure to such messages are needed to determine the durability of these effects and extension to

behavioral outcomes, as well as studies to examine their effects in subgroups of interest (e.g., tobacco users).

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Table 1.

Participant Characteristics and Baseline Smoking Beliefs, by Study Condition

Characteristics	Study condition		Total (n=521) %	*p*-value
	Nicotine messaging (*n*=263) %	Combined controls (*n*=258) %		
Sex				0.516
Female	46.8	49.6	48.2	
Male	53.2	50.4	51.8	
Age, years				0.605
18–24	9.5	11.6	10.6	
25–34	44.9	46.9	45.9	
35–44	27.4	20.9	24.2	
45–54	8.4	10.5	9.4	
55–64	6.8	7.4	7.1	
≥65	3.0	2.7	2.9	
Hispanic ethnicity				0.524
No	88.6	90.3	89.4	
Yes	11.4	9.7	10.6	
Race				0.342
White	82.1	79.1	80.6	
Black or African American	8.4	6.6	7.5	
American Indian or Alaska Native	1.1	0.8	1.0	
Asian	5.3	8.5	6.9	
More than 1 race	2.7	3.1	2.9	
Other	0.4	1.9	1.2	
Highest level of education completed				0.282
Less than high school	0.4	1.6	1.0	
High school/GED	14.1	10.9	12.5	
Some college/Associate’s degree	35.7	32.9	34.4	
Bachelor’s/Advanced degree	49.8	54.7	52.2	
Subjective financial status				0.949
Live comfortably	22.1	23.3	22.6	
Meet needs with a little left	43.7	44.2	44.0	
Just meet basic expenses	30.4	28.3	29.4	
Don’t meet basic expenses	3.8	4.3	4.0	
Single-item literacy screener				0.468
Adequate reading ability	87.5	85.3	86.4	
Limited reading ability	12.5	14.7	13.6	
Use of tobacco products, past 30 days				0.434
None	63.1	57.8	60.5	
Other tobacco products only	5.7	6.2	6.0	
E-cigarettes	6.1	10.1	8.1	
Cigarettes	18.6	17.8	18.2	

Characteristics	Study condition		Total (n=521) %	*p*-value
	Nicotine messaging (*n*=263) %	Combined controls (*n*=258) %		
Cigarettes and e-cigarettes	6.5	8.1	7.3	
Baseline smoking beliefs[a]				
Nicotine is the main substance in tobacco that makes people want to smoke	1.95 (1.03)	2.08 (1.13)	2.01 (1.08)	0.179
Smoking behavior is something basic about a person that they can't change very much	4.89 (1.26)	4.91 (1.32)	4.90 (1.29)	0.851

Notes: Missing data: None. Column percentages unless otherwise noted. Boldface indicates statistical significance ($p<0.05$).

[a]Mean (SD).

Table 2.

Differences in Nicotine and Cigarette Beliefs, by Study Condition

Beliefs	Study condition		*p*-value
	Nicotine messaging (*n*=263)	Combined controls (*n*=258)	
Thinking about the harm that individual substances within a cigarette may cause, how much harm comes from[a]			
Substances produced when raw tobacco burns? (missing=25)	3.30 (1.31)	3.21 (1.26)	0.44
The nicotine in a cigarette? (missing=23)	2.34 (1.36)	3.13 (1.29)	**<0.001**
Naturally occurring substances in tobacco? (missing=23)	2.66 (1.23)	2.70 (1.21)	0.69
Things that are added to cigarettes during the manufacturing process? (missing=23)	3.94 (1.11)	3.91 (1.13)	0.79
Nicotine false beliefs			
Nicotine is a cause of cancer[b]			**<0.001**
False	78.3	36.8	
Don't know	5.3	26.0	
True	16.4	37.2	
In your opinion, how large a part of the health risks of cigarette smoking comes from the nicotine itself?[b]			**<0.001**
None/small part	76.4	55.8	
Large/very large part	23.6	44.2	
In your opinion, how large a part of the cancer caused by cigarette smoking comes from the nicotine itself?[b]			**<0.001**
None/small part	84.0	62.8	
Large/very large part	16.0	37.2	
Nicotine false beliefs scale (α=0.86)[a,c]	4.90 (2.06)	6.71 (2.48)	**<0.001**
NRT false beliefs			
It is easy to get addicted to nicotine gum[b]			0.321
False	13.3	11.6	
Don't know	26.2	32.2	
True	60.5	56.2	
Long term use of nicotine from patches or gums is almost as harmful to health as cigarette smoking[b]			**<0.001**
False	59.3	33.7	
Don't know	21.3	24.4	
True	19.4	41.9	
Are nicotine products (like gum, patches, lozenges) more likely, about the same, or less likely to cause someone to become addicted as regular cigarettes?[b]			**0.016**
Less likely	40.7	29.1	
About the same	47.9	55.0	
More likely	11.4	15.9	
Are nicotine products (like gum, patches, lozenges) more likely, about the same, or less likely to cause someone to have a heart attack as regular cigarettes?[b](missing=1)			**<0.001**

Beliefs	Study condition		*p*-value
	Nicotine messaging (*n*=263)	Combined controls (*n*=258)	
Less likely	62.7	44.7	
About the same	27.8	44.4	
More likely	9.5	10.9	
Are nicotine products (like gum, patches, lozenges) more likely, about the same, or less likely to cause cancer as regular cigarettes?[b]			**0.001**
Less likely	72.2	56.2	
About the same	22.1	32.9	
More likely	5.7	10.9	
Relative harm of nicotine products (like gum, patches, lozenges) compared to cigarettes[b]			**0.010**
Less harmful	76.4	64.3	
About the same	16.0	24.0	
More harmful	7.6	11.6	
NRT false beliefs scale (α=0.74)[a,d]	9.89 (2.63)	11.07 (2.84)	**<0.001**
E-cigarette false beliefs			
Long term use of electronic cigarettes (e-cigarettes) is almost as harmful to health as cigarette smoking[b]			**0.022**
False	35.0	30.6	
Don't know	27.8	20.5	
True	37.3	48.8	
Are electronic cigarettes (e-cigarettes) more likely, about the same, or less likely to cause someone to have a heart attack as regular cigarettes?[b] (missing=1)			0.059
Less likely	52.9	42.8	
About the same	38.4	48.2	
More likely	8.7	8.9	
Are electronic cigarettes (e-cigarettes) more likely, about the same, or less likely to cause cancer as regular cigarettes?[b] (missing=1)			**0.038**
Less likely	57.0	47.1	
About the same	34.2	45.1	
More likely	8.7	7.8	
Relative harm of e-cigarettes (like JUUL, Vuse, MarkTen, blu, or Joyetech) compared to cigarettes[b] (missing=2)			0.463
Less harmful	61.3	56.6	
About the same	28.4	33.3	
More harmful	10.3	10.1	
E-cigarette false beliefs scale (α=0.79)[a,e]	6.58 (2.21)	6.97 (2.24)	**0.043**
Reduced nicotine content cigarette false beliefs			
Cigarettes that are lower in nicotine are less likely to cause cancer than regular cigarettes[a]	2.05 (1.07)	2.29 (1.01)	**0.010**
Cigarettes that are lower in nicotine are safer than regular cigarettes[a]	2.16 (1.11)	2.32 (1.09)	0.110

Beliefs	Study condition		*p*-value
	Nicotine messaging (*n*=263)	Combined controls (*n*=258)	
Cigarettes that are lower in nicotine are healthier than regular cigarettes[a]	2.10 (1.09)	2.24 (1.14)	0.137
Cigarettes that are lower in nicotine have fewer chemicals than regular cigarettes[a]	2.14 (1.11)	2.24 (1.12)	0.289
Smoking cigarettes that are lower in nicotine make it easier to quit smoking completely compared to regular cigarettes[a,f]	2.81 (1.13)	3.03 (1.10)	**0.024**
Cigarettes that are lower in nicotine also have less tar than regular cigarettes[a]	2.40 (1.03)	2.38 (1.03)	0.810
High nicotine content cigarettes are worse for your health than low nicotine cigarettes, even if you smoke the same number of each[a]	2.63 (1.16)	2.82 (1.13)	0.053
A low nicotine cigarette is safer to smoke than a high nicotine cigarette, even if you don't quit[a]	2.35 (1.14)	2.41 (1.08)	0.545
Low nicotine cigarettes are healthier for you than high nicotine cigarettes even before you quit[a]	2.53 (1.16)	2.44 (1.09)	0.372
RNC cigarette false beliefs scale (α=0.91)[a,g]	20.99 (6.80)	22.16 (6.53)	**0.047**

Notes: If missing number not provided, there is not missing data on that item. Boldface indicates statistical significance ($p<0.05$).

[a]Mean (SD).

[b]Column percent.

[c]Nicotine false beliefs scale comprised of 3 items (listed above in this table; range 3–11).

[d]NRT false beliefs scale comprised of 6 items (listed above in this table; range 6–18).

[e]E-cigarette false beliefs scale comprised of 4 items (listed above in this table; range 3–12).

[f]This item was reverse-coded.

[g]RNC cigarette false beliefs scale comprised of 9 items (listed above in this table; range 9–39).

NRT, nicotine replacement therapy; RNC, reduced nicotine content.

Table 3.

Norms, Behavioral Control, and Intention to Use Nicotine and Tobacco, by Study Condition

Variable	Nicotine messaging	Combined controls	*p*-value
Norms, full sample	(*n*=263)	(*n*=258)	
How socially acceptable among your peers do you think each of the following products are?[a]			
Nicotine	2.45 (1.10)	2.60 (1.14)	0.132
Caffeine	4.53 (0.79)	4.51 (0.86)	0.776
Alcohol	3.94 (0.97)	4.02 (1.04)	0.410
Marijuana	3.04 (1.23)	3.25 (1.19)	**0.049**
Cigarettes	2.48 (1.16)	2.47 (1.22)	0.924
E-cigarettes	2.80 (1.17)	3.00 (1.26)	0.059
Nicotine products (i.e., gum, patches, lozenges)	2.89 (1.23)	2.83 (1.30)	0.635
Hookah	2.63 (1.23)	2.77 (1.26)	0.187
Low nicotine cigarettes	2.33 (1.14)	2.42 (1.14)	0.400
Rank the following three uses of nicotine in terms of their acceptability to you and people like you[a] (range: 1–3)			
Nicotine delivered via the patch for cessation of tobacco use (missing=78)	1.76 (0.86)	1.90 (0.86)	0.086
Nicotine delivered via the e-cigarettes for either cessation or harm reduction (missing=78)	1.89 (0.67)	1.85 (0.69)	0.533
Nicotine delivered via e-cigarettes for purposes other than cessation or harm reduction (i.e., recreational use of e-cigarettes) (missing=78)	2.35 (0.80)	2.25 (0.84)	0.196
Opinion of using nicotine[a]			
Most people	3.78 (0.90)	3.79 (0.86)	0.845
People who are important to you	3.74 (1.01)	3.80 (0.96)	0.483
Behavioral control among past 30-day tobacco users	(*n*=97)	(*n*=109)	
How confident are you that you could resist smoking a cigarette in situations where others are smoking?[b]			0.722
Not at all confident	23.7	23.9	
Somewhat confident	33.0	36.7	
Moderately confident	21.7	15.6	
Very confident	21.6	23.9	
How confident are you that you can quit smoking cigarettes/using tobacco products totally and for good if and when you wanted to?[b]			0.789
Not at all confident	19.6	19.3	
Somewhat confident	42.3	41.3	
Moderately confident	17.5	13.8	
Very confident	20.6	25.7	
If a tobacco product made a claim that it was less harmful to health than other tobacco products, how likely would you be to use that product?[b]			0.439
Very likely	16.5	10.1	
Somewhat likely	32.0	34.9	
Somewhat unlikely	24.7	25.7	

Variable	Nicotine messaging	Combined controls	*p*-value
Very unlikely	16.5	22.9	
Don't know	10.3	6.4	
Intention to use among past 30-day tobacco users	(*n*=97)	(*n*=109)	
Cigarettes[b]			0.768
No	12.4	13.8	
Yes	87.6	86.2	
E-cigarettes[b]			0.539
No	9.3	11.9	
Yes	90.7	88.1	
Low nicotine cigarettes[b]			0.597
No	21.7	24.8	
Yes	78.3	75.2	
NRT[b]			0.441
No	23.7	28.4	
Yes	76.3	71.6	
Intention to use among non-past 30-day tobacco users	(*n*=166)	(*n*=149)	
Cigarettes[b]			0.378
No	85.5	81.9	
Yes	14.5	18.1	
E-cigarettes[b]			0.143
No	80.1	73.2	
Yes	19.9	26.8	
Low nicotine cigarettes[b]			0.382
No	88.6	85.2	
Yes	11.4	14.8	
NRT[b]			0.912
No	91.0	90.6	
Yes	9.0	9.4	

Notes: If missing number not provided, there is not missing data on that item. Boldface indicates statistical significance ($p<0.05$).

[a]Mean (SD).

[b]Column percent.

NRT, nicotine replacement therapy.