Randomized (Controlled) Trials on Nicotine Messaging

Andrea Villanti, PhD, MPH
Tobacco Online Policy Seminar
• Funding from NIH, FDA, and HRSA
  • Presenting on findings from R03CA212694, R01DA051001

• No other financial relationships to disclose.

• No industry funding; no off-label medications use discussed

• The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health or the Food and Drug Administration.
Observational data on nicotine misperceptions

Education to correct nicotine misperceptions

Messages with more nuance can reduce misperceptions

Conditions under which messages are effective

How do we optimize messages? Measures?

Scientific method

Observation / question

Report conclusions

Research topic area

Hypothesis

Analyze data

Test with experiment

Brief and extended exposure trials
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<tbody>
<tr>
<td>4</td>
<td>Wave 5</td>
<td>Wave 6</td>
<td>Wave 7</td>
<td>Wave 8</td>
<td>Wave 9</td>
<td>Wave 10</td>
</tr>
</tbody>
</table>

Nicotine perceptions

**WARNING:** This product contains nicotine. Nicotine is an addictive chemical.
U.S. adults' addiction and harm beliefs about nicotine and low nicotine cigarettes


Center for Tobacco Products, Food and Drug Administration, United States

Brief report

Public misperception that very low nicotine cigarettes are less carcinogenic

M Justin Byron,1,2 Michelle Jeong,2,3 David B Abrams,4 Noel T Brewer2,3
Perceived susceptibility to:
- Nicotine-related harm
- Tobacco-related harm

Perceived severity of:
- Nicotine-related harm
- Tobacco-related harm

Demographic factors
- Tobacco use status
- Peer/parent tobacco use

Perceived threat of:
- Nicotine-related harm
- Tobacco-related harm

Cues to Action (FDA)
- Tobacco warning labels
- Public education

Likelihood of tobacco use (susceptibility, progression)

(Perceived benefits of action) – (Perceived barriers to action)

Figure 1. Adapted conceptual framework of Health Belief Model
Nicotine beliefs

4,091 participants aged 18-40 completed Wave 10 of the Truth Initiative Young Adult Cohort Study.

Nicotine is a cause of cancer.

- True: 54.8%
- False: 21.0%
- Don’t know: 24.2%

The claim that a cigarette brand is low in nicotine means that it is less addictive.

Nicotine beliefs

Nicotine perceptions re: health risks

According to you, how large a part of the cancer caused by cigarette smoking comes from the nicotine itself?

- A very large part or all of the health risks: 60.4%
- A relatively large part: 35.4%
- A relatively small part: 30.9%
- None or a very small part: 8.7%

According to you, how large a part of the health risks of cigarette smoking come from the nicotine itself?

- A very large part or all of the health risks: 65.8%
- A relatively large part: 41.2%
- A relatively small part: 27.8%
- None or a very small part: 6.5%

Poll 1

• In 2019, approximately what proportion of US adults incorrectly believed that nicotine caused cancer – or were unsure (i.e., don’t know)?

  • 50%
  • 60%
  • 70%
  • 80%

HINTS 2019:
The nicotine in cigarettes is the substance that causes most of the cancer.

  • Strongly agree 33%
  • Agree 25%
  • Don’t know 20%
  • Disagree 15%
  • Strongly disagree 7%
Poll 2

• How has the proportion of US adults with correct beliefs about nicotine and cancer changed since the first reported estimates from 2015?

• Increased

• Stayed the same

• Decreased
Nicotine does NOT cause most of the cancer caused by smoking

Figure. Trends in Nicotine Beliefs in U.S. Adults, 2015-2019 (HINTS)
Widespread misperceptions of nicotine’s role in health harms

• “Nicotine is responsible for most of the health harms and cancer caused by smoking”

• “Nicotine replacement therapy (NRT) is as harmful to health as smoking”

• “E-cigarettes are as or more harmful to health than cigarettes”

• “Reduced nicotine content (RNC) cigarettes are less harmful than average cigarettes”
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Report conclusions
Pilot study: Brief exposure

• **Study team:**
  • Andrea Villanti
  • Andrew Strasser
  • Joseph Cappella
  • Eric Donny
  • Darren Mays
  • Julia West

**GOAL:** To test the effect of a single, brief exposure to nicotine education messages on beliefs about nicotine, nicotine replacement therapy (NRT), e-cigarettes, and reduced nicotine content (RNC) cigarettes.
Methods

• 521 U.S. adults (aged 18+) on Amazon Mechanical Turk completed a 15-minute survey on “Communicating about cancer risk behaviors.”
  • Paid $2.50 for survey completion

• 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)
  • No message control (n=130)
Experimental Messages

• Messages were adapted from several evidence-based sources for a lay audience:
  • FDA’s 2017 comprehensive plan for tobacco and nicotine regulation
  • FDA’s 2013 modifications to labeling of NRT products for over-the-counter human use
  • 2014 U.S. Surgeon General’s Report on the Health Consequences of Smoking
  • Reports on carcinogens from the International Agency for Research on Cancer.

**All slides presented in order; exposed to each slide for at least 5 seconds.

Sun Safety Education Intervention

Indoor tanning and Ultraviolet (UV) radiation from the sun cause skin cancer and premature aging.

UV radiation from the sun is just as strong on cloudy and partly cloudy days.

Indoor tanning beds, booths, and lamps emit UV radiation at much higher levels than typical sunlight.

Conditions such as snow, water, or even reflections off of buildings intensify the sun’s ultraviolet radiation.

Wearing sunscreen alone does NOT prevent skin cancer.

Limit sun exposure, wear protective clothing, and avoid indoor tanning to reduce your risk of skin cancer.

**All slides presented in order; exposed to each slide for at least 5 seconds.**
<table>
<thead>
<tr>
<th>Nicotine beliefs</th>
<th>Study condition</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nicotine messaging (n = 263)</td>
<td>Combined controls (n = 258)</td>
</tr>
<tr>
<td>Nicotine is a cause of cancer. (^b)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>False</td>
<td>78.3</td>
<td>36.8</td>
</tr>
<tr>
<td>Don't know</td>
<td>5.3</td>
<td>26.0</td>
</tr>
<tr>
<td>True</td>
<td>16.4</td>
<td>37.2</td>
</tr>
<tr>
<td>In your opinion, how large a part of the health risks of cigarette smoking comes from the nicotine itself? (^b)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None/small part</td>
<td>76.4</td>
<td>55.8</td>
</tr>
<tr>
<td>Large/very large part</td>
<td>23.6</td>
<td>44.2</td>
</tr>
<tr>
<td>In your opinion, how large a part of the cancer caused by cigarette smoking comes from the nicotine itself? (^b)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None/small part</td>
<td>84.0</td>
<td>62.8</td>
</tr>
<tr>
<td>Large/very large part</td>
<td>16.0</td>
<td>37.2</td>
</tr>
<tr>
<td>Nicotine false beliefs scale (alpha = 0.86) (^a, c)</td>
<td>4.90 (2.06)</td>
<td>6.71 (2.48)</td>
</tr>
</tbody>
</table>

## Results – Nicotine, NRT, E-cigarette, RNC beliefs

<table>
<thead>
<tr>
<th>Study condition</th>
<th>Nicotine messaging (n = 263)</th>
<th>Control (n = 258)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicotine false beliefs scale (alpha = 0.86)</td>
<td>4.90 (2.06)</td>
<td>6.71 (2.48)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>NRT false beliefs scale (alpha = 0.74)</td>
<td>9.89 (2.63)</td>
<td>11.07 (2.84)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>E-cigarette false beliefs scale (alpha = 0.79)</td>
<td>6.58 (2.21)</td>
<td>6.97 (2.24)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>RNC cigarette false beliefs scale (alpha = 0.91)</td>
<td>20.99 (6.80)</td>
<td>22.16 (6.53)</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

* Mean (SD); ** Column percent

- Nicotine false beliefs scale comprised of 3 items (listed above in this table; range 3 - 11)
- NRT false beliefs scale comprised of 6 items (range 6 - 18)
- E-cigarette false beliefs scale comprised of 4 items (range 3 - 12)
- RNC cigarette false beliefs scale comprised of 9 items (range 9 - 39)

American Journal of Preventive Medicine

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

Andrea C. Villanti, PhD, MPH, Julia C. West, BA, Darren Mays, PhD, MPH, Eric C. Donny, PhD, Joseph N. Cappella, PhD, Andrew A. Strasser, PhD

**Aim 1**: Population-based trial in U.S. adults (Villanti)

**Aim 2**: Lab-based trial in adults who smoke cigarettes AND receive normal vs. low nicotine content cigarettes (Strasser)
• Test the impact of nicotine corrective messaging (NCM) on nicotine beliefs and the subsequent impact on intention and use of tobacco and nicotine products in adult smokers and non-smokers followed for 12 weeks.
Study design, sample and recruitment

• 794 U.S. English-speaking adults aged 18+ recruited in spring 2021 from NORC’s AmeriSpeak® national consumer market research panel.

• Amerispeak® panelists 18+ sent email invitation describing the study; interested panel members directed to the initial baseline survey.
Methods

• At end of baseline survey, participants randomized in 1:1 ratio:
  • Nicotine Corrective Messaging (NCM) intervention (n=393)
  • Delayed Message (DM) control condition (n=401).

• Four waves of data collection over 13 weeks between 2/12/21 and 5/14/21.

<table>
<thead>
<tr>
<th>Aim 1: Population trial</th>
<th>Baseline</th>
<th>Randomized + Exposure 1</th>
<th>Key measures + Exposure 2</th>
<th>Exposure 3</th>
<th>Key measures</th>
<th>Exposure 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention (NCM)</td>
<td>n = 393</td>
<td>N = 313 (80%)</td>
<td>N = 295 (75%)</td>
<td>N = 290 (74%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control (DM)</td>
<td>N = 401</td>
<td>N = 318 (79%)</td>
<td>-</td>
<td>N = 319 (80%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Wave 3 provided only to Intervention condition, by design
Nicotine is the **addictive** substance in tobacco products.

Nicotine makes it easier for people to start smoking regularly.

Nicotine makes it harder for people to quit smoking.

Nicotine does **not** cause cancer.

Chemicals in cigarette smoke, **not nicotine**, largely cause cancer, heart disease, and other health problems in people who smoke.

Nicotine can be used **safely** in quit smoking products like nicotine patches, gum, or lozenges, even long-term.

E-cigarettes may expose users to **significantly lower** amounts of toxic substances than regular cigarettes.

But they can contain as much or more nicotine.

Low nicotine cigarettes are **as harmful** as regular cigarettes.

But they may help people quit and prevent new users from becoming addicted to cigarettes.
**Measures**

**Primary outcomes:**
- Nicotine false beliefs (3 items)
- NRT false beliefs (6 items)
- E-cigarette false beliefs (4 items)
- Reduced nicotine content (RNC) cigarette false beliefs (9 items)

**Secondary outcomes:**
- Intention to use nicotine/tobacco products
- Nicotine/tobacco use and behavior

<table>
<thead>
<tr>
<th>Intervention/Exposure</th>
<th>Aim 1: Population study</th>
<th>Aim 2: Lab study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicotine messaging vs. control</td>
<td>Wave 1</td>
<td>Week 1</td>
</tr>
<tr>
<td>Normal nicotine vs. RNC cigarette</td>
<td>Wave 1</td>
<td>Week 1</td>
</tr>
<tr>
<td>Heatmapping</td>
<td>Waves 1-4</td>
<td>Week 1</td>
</tr>
<tr>
<td>Perceived message effectiveness</td>
<td>Wave 4</td>
<td>Week 5</td>
</tr>
<tr>
<td>Message credibility</td>
<td>Wave 4</td>
<td>Week 5</td>
</tr>
<tr>
<td>Eye-tracking</td>
<td></td>
<td>Weeks 1-4</td>
</tr>
<tr>
<td>Biomarkers</td>
<td></td>
<td>Weeks 0, 5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Aim 1: Population study</th>
<th>Aim 2: Lab study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicotine beliefs</td>
<td>Waves 1, 2, 4</td>
<td>Weeks 0, 2, 5</td>
</tr>
<tr>
<td>Intention to use nicotine/tobacco products</td>
<td>Waves 1, 2, 4</td>
<td>Weeks 0, 2, 5</td>
</tr>
<tr>
<td>Nicotine/tobacco use and behavior</td>
<td>Waves 1, 2, 4</td>
<td>Weeks 0, 2, 5</td>
</tr>
<tr>
<td>Subjective rating of study cigarette</td>
<td>Waves 1, 2, 4</td>
<td>Weeks 0, 2, 5</td>
</tr>
<tr>
<td>Manipulation check</td>
<td>Waves 1, 2, 4</td>
<td>Weeks 0, 2, 5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Moderators</th>
<th>Aim 1: Population study</th>
<th>Aim 2: Lab study</th>
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</thead>
<tbody>
<tr>
<td>Sociodemographics</td>
<td>Wave 1</td>
<td>Week 0</td>
</tr>
<tr>
<td>Literacy</td>
<td>Wave 1</td>
<td>Week 0</td>
</tr>
<tr>
<td>Cancer risk beliefs</td>
<td>Wave 1</td>
<td>Week 0</td>
</tr>
<tr>
<td>Cancer risk behaviors</td>
<td>Wave 1</td>
<td>Week 0</td>
</tr>
<tr>
<td>Fagerstrom test for nicotine dependence</td>
<td>Wave 1</td>
<td>Week 0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other key constructs</th>
<th>Aim 1: Population study</th>
<th>Aim 2: Lab study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitudes about nicotine</td>
<td>Waves 1, 2, 4</td>
<td>Weeks 0, 2, 5</td>
</tr>
<tr>
<td>Nicotine-related norms</td>
<td>Waves 1, 2, 4</td>
<td>Weeks 0, 2, 5</td>
</tr>
<tr>
<td>Behavioral control</td>
<td>Waves 1, 2, 4</td>
<td>Weeks 0, 2, 5</td>
</tr>
<tr>
<td>Stages of change</td>
<td>Wave 1, 4</td>
<td>Week 0, 5</td>
</tr>
<tr>
<td>Policy support</td>
<td>Wave 4</td>
<td>Week 5</td>
</tr>
</tbody>
</table>
• **Bivariate analyses** examined differences in:
  • Distribution of demographic characteristics by study condition
  • Primary outcomes by study condition at Wave 4

• **Linear regression models** examined differences in false belief scale scores (nicotine, NRT, e-cigarette, RNC cigarette) by study condition at Waves 2 and 4
  • Exploratory analyses examined effect of message dose on Wave 4 false belief scales
Results

• No differences in distribution of demographic characteristics by study condition

Table 1a. Demographics (Unweighted)

<table>
<thead>
<tr>
<th></th>
<th>All (n = 794)</th>
<th>Intervention (n = 393)</th>
<th>Control (n = 401)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>400 (50%)</td>
<td>186 (47%)</td>
<td>214 (53%)</td>
<td>0.089</td>
</tr>
<tr>
<td>Male</td>
<td>394 (50%)</td>
<td>207 (53%)</td>
<td>187 (47%)</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td>0.747</td>
</tr>
<tr>
<td>18-24</td>
<td>55 (7%)</td>
<td>25 (6%)</td>
<td>30 (7%)</td>
<td></td>
</tr>
<tr>
<td>25-34</td>
<td>162 (20%)</td>
<td>78 (20%)</td>
<td>84 (21%)</td>
<td></td>
</tr>
<tr>
<td>35-44</td>
<td>124 (16%)</td>
<td>57 (14%)</td>
<td>67 (17%)</td>
<td></td>
</tr>
<tr>
<td>45-54</td>
<td>123 (15%)</td>
<td>61 (15%)</td>
<td>62 (15%)</td>
<td></td>
</tr>
<tr>
<td>55-64</td>
<td>145 (18%)</td>
<td>74 (19%)</td>
<td>71 (18%)</td>
<td></td>
</tr>
<tr>
<td>65-74</td>
<td>135 (17%)</td>
<td>68 (17%)</td>
<td>67 (17%)</td>
<td></td>
</tr>
<tr>
<td>75+</td>
<td>50 (6%)</td>
<td>30 (8%)</td>
<td>20 (5%)</td>
<td></td>
</tr>
<tr>
<td>Smoker¹</td>
<td>119 (15%)</td>
<td>61 (15%)</td>
<td>58 (14%)</td>
<td>0.676</td>
</tr>
<tr>
<td>Daily smoker²</td>
<td>76 (10%)</td>
<td>37 (9%)</td>
<td>39 (10%)</td>
<td>0.882</td>
</tr>
</tbody>
</table>

Preliminary findings. Please do not distribute.
Results: Primary outcomes at Wave 4 follow-up (n = 609)

<table>
<thead>
<tr>
<th>False Beliefs</th>
<th>Intervention (NCM) (n = 290) Mean (SD)</th>
<th>Control (DM) (n = 319) Mean (SD)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicotine false beliefs</td>
<td>7.5 (2.3)</td>
<td>7.8 (2.1)</td>
<td>0.084</td>
</tr>
<tr>
<td>NRT false beliefs</td>
<td>10.9 (2.8)</td>
<td>11.3 (2.8)</td>
<td>0.048</td>
</tr>
<tr>
<td>E-cigarette false beliefs</td>
<td>8.9 (2.2)</td>
<td>9.2 (2.1)</td>
<td>0.032</td>
</tr>
<tr>
<td>RNC cigarette false beliefs</td>
<td>29.8 (4.7)</td>
<td>30.3 (4.1)</td>
<td>0.174</td>
</tr>
</tbody>
</table>

Preliminary findings. Please do not distribute.
Results at both follow-ups

- Greater change in beliefs at Wave 4 follow-up than Wave 2 follow-up, controlling for baseline false beliefs in participants completing both follow-ups

Complete case analysis (n = 551)

- Nicotine false beliefs
- NRT false beliefs
- E-cigarette false beliefs
- RNC cigarette false beliefs

Adjusted b coefficient

Preliminary findings. Please do not distribute.
Intervention participants receiving all three message exposures had the greatest reductions in false beliefs vs. control.
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Rutgers Center for Tobacco Studies
Key findings and questions

• Brief nicotine corrective messaging can reduce nicotine misperceptions after a single exposure

• Multiple exposures to nicotine corrective messaging reduces nicotine misperceptions at sufficient dose (3 exposures)

• Why the difference???
Comparison of two trials

**Brief exposure trial***

- **EXPOSURE 1 & OUTCOMES**
  - Nicotine messaging
  - Nicotine beliefs
  - Intention/use of nicotine and tobacco products

***Exposure and outcome assessment separated by seconds

**Multiple exposures trial**

- **BASELINE & EXPOSURE 1**
  - Nicotine messaging
  - Nicotine beliefs
  - Intention/use of nicotine and tobacco products

- **OUTCOMES & EXPOSURE 2**
  - Nicotine messaging
  - Nicotine beliefs
  - Intention/use of nicotine and tobacco products

- **EXPOSURE 3**
  - Nicotine messaging
  - Nicotine beliefs
  - Intention/use of nicotine and tobacco products

- **OUTCOMES**
  - Nicotine messaging
  - Nicotine beliefs
  - Intention/use of nicotine and tobacco products

**Beliefs assessed at baseline prior to exposure.**

**Did this prime respondents in any way?**

---

*Exposure and outcome assessment separated by ~1-4 weeks at each wave
Implications

• The public health impact of FDA’s proposed nicotine reduction policy hinges on the extent to which tobacco users and non-users understand the harms of nicotine in relation to specific products, including nicotine replacement therapy (NRT).

• Results from two messaging trials support that corrective messaging about nicotine can reduce nicotine misperceptions, including those related to e-cigarettes, NRT and reduced nicotine content cigarettes.
  • Population-level efforts will require multiple campaign exposures to achieve reductions in false beliefs

• Limitation:
  • Even if we change beliefs, we know little about how nicotine corrective messaging will impact uptake/use of reduced nicotine content cigarettes, e-cigarettes, OR NRT.
Ongoing: Aim 2 lab-based study testing interaction of NCM intervention and reduced nicotine content cigarettes

**Table 1. Factorial design of Aim 2 lab-based study**

<table>
<thead>
<tr>
<th>Nicotine Corrective Messaging (NCM) Intervention</th>
<th>Delayed Message Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal nicotine content cigarettes</td>
<td>n = 40</td>
</tr>
<tr>
<td>Reduced nicotine content cigarettes</td>
<td>n = 40</td>
</tr>
</tbody>
</table>
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Observation / question
Repeated exposures vs. single exposure did not impact message response

<table>
<thead>
<tr>
<th></th>
<th>Intervention (Mean, SD)</th>
<th>Control (Mean, SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived message effectiveness (range 1-5)</td>
<td>3.78 (0.90)</td>
<td>3.80 (0.98)</td>
</tr>
<tr>
<td>Accurate (range 1-7)</td>
<td>5.07 (1.57)</td>
<td>4.97 (1.50)</td>
</tr>
<tr>
<td>Authentic (range 1-7)</td>
<td>4.93 (1.52)</td>
<td>4.89 (1.50)</td>
</tr>
<tr>
<td>Believable (range 1-7)</td>
<td>5.07 (1.62)</td>
<td>5.13 (1.56)</td>
</tr>
</tbody>
</table>
Two new experiments

Message experiment

• May 2022
• N = 2,962
  • 18-45 year olds in the U.S. (mTurk)

• **Goal:** To test message response and impact on nicotine/RNC beliefs
Message experiment - Methods

- Participants were randomized to one of 26 text-based messages compiled from:
  - Our ongoing research (n=8; R01DA051001)
  - VLN messages authorized by FDA (n=6), and
  - Messages from FDA’s “From Plant to Product to Puff” education campaign (n=12).

- Participants then completed:
  - three-item scale of perceived message effectiveness (PME)
  - single item on nicotine beliefs (cause of cancer) and
  - six items assessing RNC cigarette beliefs
• Range, n=100-124 participants per message

• Analyses examined:

1. Relationships between mean PME, nicotine and RNC cigarette beliefs; and

2. Effect of exposure to specific messages on nicotine and RNC cigarette beliefs in the full sample.
Results - PME and nicotine/RNC beliefs

• Across all messages, a one-unit increase in mean PME was correlated with higher odds of endorsing a false belief about nicotine (nicotine causes cancer; odds ratio (OR) 1.33, 95% CI 1.24, 1.42).

• Mean PME was not correlated with false beliefs about RNC cigarettes in crude analyses, but it was correlated with greater false beliefs about RNC cigarettes in current cigarette smokers (b 0.43, 95% CI 0.22, 0.65).

**Figure.** Nicotine Education Message Experiment (n=2,962)
Results – Individual message effects

Examination of individual messages suggested that:

- Exposure to 5 of the candidate messages increased the odds of a correct belief about nicotine;
- 1 message substantively increased correct beliefs about RNC cigarettes.

<table>
<thead>
<tr>
<th>Source</th>
<th>Message</th>
<th>Correct belief about nicotine/cancer</th>
<th>Correct beliefs about RNC cigarettes</th>
</tr>
</thead>
<tbody>
<tr>
<td>R01_5</td>
<td>Chemicals in cigarette smoke, not nicotine, largely cause cancer, heart disease, and other health problems in people who smoke.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>VLN_1</td>
<td>Very low nicotine cigarettes have 95% less nicotine than regular brands.</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>VLN_3</td>
<td>Very low nicotine cigarettes greatly reduce your nicotine consumption.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>VLN_4</td>
<td>Very low nicotine cigarettes help you smoke less.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>FDAN_3</td>
<td>Nicotine can change the way your brain works, causing you to crave more nicotine.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>R01_8</td>
<td>Low nicotine cigarettes are as harmful as regular cigarettes.</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

But they may help people quit and prevent new users from becoming addicted to cigarettes.
Two new experiments

Message experiment

• May 2022
• N = 2,962
  • 18-45 year olds in the U.S. (mTurk)

• Goal: To test message response and impact on nicotine/RNC beliefs

Measures experiment

• August 2022
• N = 2,526
  • 18-45 year olds in the U.S. (mTurk)

• Goal: To determine how the survey item itself affects prevalence of nicotine misperceptions
Persistent Misperceptions about Nicotine among US Physicians: Results from a Randomized Survey Experiment

Michelle T. Bover Manderski 1,2,* ID, Michael B. Steinberg 3,4 ID, Olivia A. Wackowski 2,5, Binu Singh 2, William J. Young 2 and Cristine D. Delnevo 2,5 ID
• Participants were randomized to one of 10 survey items about the role of nicotine in causing cancer from:
  • HINTS
  • PATH
  • Prior research
  • Newly-developed items

• Participants then completed:
  • An open-ended cognitive interview question about their response
Measures experiment - Methods

• Range, n=240-267 participants per survey item

• Three embedded experiments:
  • **Difference in response options**
    • HINTS item (with and without “don’t know)
    • Nicotine is a cause of cancer (T/F/DK vs. Likert agreement)
  
  • **Difference in stem:**
    • Nicotine directly contributes to the development of cancer.
    • Nicotine, on its own, directly contributes to the development of cancer.

• Analyses examined prevalence of correct beliefs by study condition
<table>
<thead>
<tr>
<th>Wording</th>
<th>Response options</th>
<th>Source</th>
<th>Alternate</th>
</tr>
</thead>
</table>
| The nicotine in cigarettes is the substance that causes most of the cancer caused by smoking. | 1. Strongly agree  
2. Agree  
3. Disagree  
4. Strongly disagree  
5. Don’t know | HINTS                                                                 | 1. Strongly agree  
2. Agree  
3. Disagree  
4. Strongly disagree  
5. Don’t know Adapted from HINTS |
| Do you believe nicotine is the chemical that causes most of the cancer caused by smoking cigarettes? | 1. Definitely yes  
2. Probably yes  
3. Probably not  
4. Definitely not | PATH                                                                   | 1. Strongly agree  
2. Agree  
3. Disagree  
4. Strongly disagree |
| Nicotine directly contributes to the development of cancer.             | 1. Strongly agree  
2. Agree  
3. Disagree  
4. Strongly disagree | Adapted from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8306881/ | Nicotine, on its own, directly contributes to the development of cancer. Adapted from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8306881/ |
| Nicotine is a cause of cancer                                           | 1. True  
2. False  
3. Don’t know | Villanti et al, 2019                                                  | 1. Strongly agree  
2. Agree  
3. Disagree  
4. Strongly disagree  
5. Don’t know *New* |
| According to you, how large a part of the cancer caused by cigarette smoking comes from the nicotine itself? | 1. None or a very small part  
2. A relatively small part  
3. A relatively large part  
4. A very large part or all | Perceived severity - nicotine; Wikmans & Ramstrom 2010                  | 1. Strongly agree  
2. Agree  
3. Disagree  
4. Strongly disagree  
5. Don’t know |
| Just the nicotine in cigarettes causes cancer.                         | 1. Strongly agree  
2. Agree  
3. Disagree  
4. Strongly disagree | *New*                                                                 | 1. Strongly agree  
2. Agree  
3. Disagree  
4. Strongly disagree |
| Nicotine only causes cancer because it keeps people addicted to cigarette smoking. | 1. Strongly agree  
2. Agree  
3. Disagree  
4. Strongly disagree | *New*                                                                 | 1. Strongly agree  
2. Agree  
3. Disagree  
4. Strongly disagree |
According to you, how large a part of the cancer caused by cigarette smoking comes from the nicotine itself? (None/very small)

- Nicotine directly contributes to the development of cancer.
- Nicotine is a cause of cancer.
- Nicotine only causes cancer because it keeps people addicted to cigarette smoking.
- Nicotine, on its own, directly contributes to the development of cancer.
- The nicotine in cigarettes is the substance that causes most of the cancer caused by smoking (HINTS).
- Do you believe nicotine is the chemical that causes most of the cancer caused by smoking cigarettes? (PATH)
- The nicotine in cigarettes is the substance that causes most of the cancer caused by smoking (HINTS; without DK).
- According to you, how large a part of the cancer caused by cigarette smoking comes from the nicotine itself? (None/very small/relatively small)

Just the nicotine in cigarettes causes cancer.
According to you, how large a part of the cancer caused by cigarette smoking comes from the nicotine itself? (None/very small)

Nicotine directly contributes to the development of cancer.

Nicotine is a cause of cancer.

Nicotine is a cause of cancer. (Likert)

Nicotine only causes cancer because it keeps people addicted to cigarette smoking.

Nicotine, on its own, directly contributes to the development of cancer.

The nicotine in cigarettes is the substance that causes most of the cancer caused by smoking (HINTS)

Do you believe nicotine is the chemical that causes most of the cancer caused by smoking cigarettes? (PATH)

The nicotine in cigarettes is the substance that causes most of the cancer caused by smoking (HINTS; without DK)

According to you, how large a part of the cancer caused by cigarette smoking comes from the nicotine itself? (None/very small/relatively small)

Just the nicotine in cigarettes causes cancer.

FINDING:
HINTS & PATH items produce higher prevalence of correct beliefs in this sample; other items align with US prevalence estimates.
According to you, how large a part of the cancer caused by cigarette smoking comes from the nicotine itself? (None/very small)

Nicotine directly contributes to the development of cancer.

Nicotine is a cause of cancer.

Nicotine only causes cancer because it keeps people addicted to cigarette smoking.

Nicotine, on its own, directly contributes to the development of cancer.

The nicotine in cigarettes is the substance that causes most of the cancer caused by smoking (HINTS).

Do you believe nicotine is the chemical that causes most of the cancer caused by smoking cigarettes? (PATH)

The nicotine in cigarettes is the substance that causes most of the cancer caused by smoking (HINTS; without DK)

According to you, how large a part of the cancer caused by cigarette smoking comes from the nicotine itself? (None/very small/relatively small)

Just the nicotine in cigarettes causes cancer.

“I believe nicotine is a carcinogen which can damage the body and cause cancer. I was in a DARE program growing up.”

“I think everyone knows that nicotine causes cancer.”

9.6 21.6 23.2 24.3 31.6 33.3 43.8 44.2 49.6 50.0 80.7
"There are many other ingredients in cigarettes that are harmful to those who smoke them."

"The smoke also contributes to cancer. It obviously is not good for your lungs. I actually don't know how nicotine contributes to cancer."
According to you, how large a part of the cancer caused by cigarette smoking comes from the nicotine itself? (None/very small)

Nicotine directly contributes to the development of cancer.

Nicotine is a cause of cancer.

Nicotine is a cause of cancer (Likert)

Nicotine only causes cancer because it keeps people addicted to cigarette smoking.

Nicotine, on its own, directly contributes to the development of cancer.

The nicotine in cigarettes is the substance that causes most of the cancer caused by smoking (HINTS)

Do you believe nicotine is the chemical that causes most of the cancer caused by smoking cigarettes? (PATH)

The nicotine in cigarettes is the substance that causes most of the cancer caused by smoking (HINTS; without DK)

According to you, how large a part of the cancer caused by cigarette smoking comes from the nicotine itself? (None/very small/relatively small)

Just the nicotine in cigarettes causes cancer.

**FINDING:** Greater proportion correct when you force the choice (remove “Don’t Know”)
Embedded experiment 2: T/F/DK vs. Likert

FINDING:
No difference between T/F/DK and Likert that included “Don’t Know”
Embedded experiment 3: “Directly” vs. “on its own”

According to you, how large a part of the cancer caused by cigarette smoking comes from the nicotine itself? (None/very small)

Nicotine directly contributes to the development of cancer.
Nicotine is a cause of cancer.
Nicotine is a cause of cancer (Likert)
Nicotine only causes cancer because it keeps people addicted to cigarette smoking.
Nicotine, on its own, directly contributes to the development of cancer.

The nicotine in cigarettes is the substance that causes most of the cancer caused by smoking (HINTS)
Do you believe nicotine is the chemical that causes most of the cancer caused by smoking cigarettes? (PATH)
The nicotine in cigarettes is the substance that causes most of the cancer caused by smoking (HINTS; without DK)
According to you, how large a part of the cancer caused by cigarette smoking comes from the nicotine itself? (None/very small/relatively small)

Just the nicotine in cigarettes causes cancer.

FINDING: Consistent with earlier findings in physicians. “On its own” may reduce misperceptions.
More questions than answers!

- Observational data on nicotine misperceptions
- Education to correct nicotine misperceptions
- Messages with more nuance can reduce misperceptions
- How do we optimize messages? Measures?
- Conditions under which messages are effective
- Brief and extended exposure trials