A Randomized Controlled Trial Testing the Efficacy of Brief Messages to Correct Misperceptions About Nicotine

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Abstract: Despite the known dangers of smoking and the common desire to quit[1] millions of Americans continue to smoke cigarettes,[2] demonstrating the need for additional interventions. Noncombustible nicotine products expose users to fewer and/or lower levels of harmful constituents,[3–5] and may have lower disease risk compared to combustible cigarettes.[6–8] Alternatively, very low nicotine products, such as very low nicotine cigarettes (VLNC), might reduce dependence and aid cessation.[9,10] In 2019, FDA started authorizing such products to use modified risk or modified exposure marketing claims if manufacturers demonstrated a benefit to population health.[11] The misperception that nicotine is a major cause of cancer is common[12] and may relate to inaccurate relative harm perceptions about tobacco products. This study used strategies identified in the literature to mitigate the continued influence of misinformation[13–15] in messages about the role of nicotine in tobacco products as well as product relative risk compared to smoking cigarettes to assess changes in beliefs about nicotine and relative harm as well as intention to switch to noncombustible products among adults who smoke cigarettes.

Objectives: The study tested the combined use of two strategies for correcting misinformation: an explicit reason for why the misinformation came to be believed and a causal alternative to replace the retracted misinformation, in messages correcting the misperception that nicotine causes cancer. Outcomes of interest included beliefs that nicotine is a cause of cancer, relative harm beliefs comparing other tobacco products to cigarettes, and intention to switch to a noncombustible product.

Background: The persistence of misperception has been noted in other disciplines, including cognitive psychology and political science. Many experiments in these fields have demonstrated that exposure to corrective information can elicit correct recall of the corrective information, however, misinformation is often still used to make inferences about related topics, which has come to be known as the Continued Influence Effect (CIE).[13-15] It has been theorized that, when presented with corrective messaging, individuals may engage in 'surface updating' (the individual updates only the specific misperception addressed in the message), but fail to engage in 'global updating' (fully integrating information into beliefs so it can be applied via inferential reasoning and behavioral decisions).[13,14,16] Thus, it is possible that after exposure to corrective information about nicotine, an individual could accurately state that nicotine is not the main cancer-causing constituent in tobacco (surface updating), yet fail to accurately characterize the relative harm of a non-combustible nicotine-containing product when compared to a combustible cigarette if that product was not discussed in the message (global updating).[16]

Maintaining 'coherence' in a corrective message may help mitigate the CIE. Coherence refers to the explanatory power inherent in communicating the causal relationship between two things. Coherence can be achieved in correctives by providing a causal alternative - [it's the toxicants generated during combustion, not nicotine, that are responsible for most disease risk from tobacco] – to fill the gap left by retracted information [nicotine does not cause cancer].[15,17–20] Causal alternatives may be important because identifying and understanding causal relationships is necessary for constructing meaning and representing information in memory.[21] A second strategy involves providing a reason the misinformation first came to be believed, which can prompt individuals to evaluate the original misperception more critically, thus mitigating its effect.[20]

Study Procedures

Participants were recruited online using Amazon Mechanical Turk. After clicking on the tasks, participants first consented to answering questions on a screening questionnaire to determine eligibility. Eligible participants then read an informed consent for the experiment. After agreeing to participate, participants were asked questions about their sociodemographic characteristics, beliefs, behaviors, and behavioral intentions about different tobacco products. Participants were then randomized to view one of four messages using a 1:1:1:1 ratio using the "evenly present elements" option in Qualtrics. One message had only a causal alternative, one had only a reason the misinformation about nicotine causing cancer came to be believed, one have both strategies, and one had neither strategy. As randomization

was conducted in Qualtrics, both experimenters and participants were blinded to randomization. After message exposure, participants answered questions about the message and their beliefs and intentions to use different tobacco products. The survey took between 10-15 mins to complete. The study protocol was approved by the Institutional Review Board at the Johns Hopkins Bloomberg School of Public Health on August 4, 2021 (IRB00015120). No participants were removed while the study was ongoing, but responses that showed signs of being repeat responders or bots (according to metrics from survey platform Qualtrics) were later dropped from analysis.

Inclusion Criteria
1. Were established smokers (smoked at least 100 cigarettes in their lifetime and currently smoked cigarettes some or all days).
2. Were 21 years of age or older (the legal age of tobacco purchase in the US).
3. Had not completed the cognitive interview during message development.
4. Rated their agreement with the following statement as at least 50 out of 100: "The substance nicotine causes cancer."

Exclusion Criteria
1. Were not established smokers (had not smoked at least 100 cigarettes in their lifetime or did not currently smoke some or all days)
2. Were under the age of 21.
3. Had completed a cognitive interview during message development.
4. Rated their agreement with the following statement as less than 50 out of 100: "The substance nicotine causes cancer."

Study Statistics
    a. Primary outcome variable
        1. Change in Accuracy of Belief That Nicotine Causes Cancer
        2. Change in Relative Harm Beliefs Regarding E-cigarettes
        3. Change in Relative Harm Beliefs Regarding NRT
        4. Change in Relative Harm Beliefs Regarding Very Low Nicotine Cigarettes
        5. Change in Inferential Beliefs Regarding Smokeless Tobacco
        6. Change in Inferential Beliefs Regarding Cigarillos
        7. Change in Beliefs About Intention to Switch Products

    b. Statistical plan: Stata version 15 was used for all statistical analyses. Fisher's exact tests were used to assess balancing across conditions by categorical variables to account for small cell size (e.g. cell sizes with n<10). ANOVAs were used to assess differences in continuous variables to assess balancing. Analysis of Covariance (ANCOVA) was used to identify differences by condition in agreement that nicotine causes cancer, controlling for pre-exposure belief (RQ1a) and intention to switch to a noncombustible controlling for pre-exposure intention (H2). Post hoc testing was used to assess pairwise differences between conditions when the covariate for condition was significant at p<.05, comparing each condition to the condition with both components of coherence. Sidak's adjustment was used to control the type I error. Research questions and hypotheses with relative harm outcomes (RQ1b-d, H1a-b) were dichotomized due to failure to meet the assumptions of ANCOVA and were analyzed using logistic regression. Responses "much more harmful," "somewhat more harmful," and "not less or more harmful" were considered high relative harm perceptions. Responses "somewhat less harmful" and "much less harmful" where considered low relative harm perceptions. Unadjusted regressions as well as regression adjusted for pre-message exposure beliefs and product use were run. Inclusion of pre-exposure beliefs as a covariate in the models for NRT and cigarillos resulted in unstable odds ratios due to near perfect

prediction. Pre-exposure beliefs were thus dropped in these models. Marginal estimates for each condition were calculated and plotted for all adjusted models.

Risks
a. Risks were minimal and included boredom of discomfort from answering survey questions.
b. To mitigate this risk, participants read in the informed consent that they were free to skip any questions they didn't want to answer or quit their participation at any time.
c. There were no unanticipated problems or deviations during data collection.

Benefits
a. Participants did not participate directly from being in the study. Findings can help to inform what kind of messaging might be helpful to adults who smoke in order to increase belief accuracy about different tobacco products and increase intention to quit to a less harmful noncombustible product.

Payment and Remuneration
a. Participants were paid $5.00 for completing the survey. Participants who were eligible but did not fully complete the survey were still paid.

Costs
a. No costs were associated with participation.

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