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Promoting small-scale maple syrup production on Facebook: A field experiment testing emphasis message frames

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Abstract

Tapping maple trees to produce maple syrup offers many benefits for producers. Since potential producers likely value some of these benefits more than others, communicators seeking to encourage more people to begin maple syrup production should use messaging that emphasizes the benefits that best resonate with potential producers. To test this strategy, known as *emphasis message framing*, we ran Facebook advertisements aimed at people living in Wisconsin, the fourth-leading U.S. state in annual maple syrup production, to test four message frames: building community, achieving food self-sufficiency, engaging in the lifestyle of working

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the land, and spending time in nature. Overall, the frame of working the land was the most effective in terms of link clicks and post reactions. However, among people ages 55+, who were more likely than younger Facebook users to engage with our advertisements, the food self-sufficiency frame received the most clicks while the nature frame received the most post reactions. In all age groups, women were more likely to click on our ads than men. These findings can be applied to future efforts to grow the number of small-scale maple syrup producers in Wisconsin and beyond. Additionally, our results underscore the importance of establishing a clear goal and segmenting audiences when designing social media campaigns. Our methods can serve as a blueprint for anyone seeking to empirically test the effectiveness of different message frames in public outreach related to agriculture or food systems.

Keywords
maple syrup production, emphasis message framing, Facebook, social media, advertising, audience segmentation, nontimber forest products, forestry, extension, environmental communication

Introduction

Maple syrup production is a long-standing tradition in parts of Canada and the United States, originating with the region's Indigenous peoples well before the arrival of Europeans (Cotnoir, 2021; Perkins et al., 2022; Whitney & Upmeyer, 2004). Made in late winter by collecting and boiling the sap of maple trees, primarily the sugar maple (*Acer saccharum*), maple syrup is a product whose value transcends its culinary uses and financial worth. The lifestyle of working the land to make maple syrup is a part of the identity of many producers (Hinrichs, 1998). Maple syrup production creates and strengthens bonds among family members, friends, and local communities, and it also appeals to people as a way to spend time in nature year-round and make a natural food product for self-sufficiency (Hershberger et al., 2024; Hinrichs, 1998; Perkins et al., 2022).

Some producers operate at a large scale, tapping 10,000 trees or more as a significant business enterprise. However, a larger number of producers operate at a much smaller scale, tapping fewer than a hundred or even just a handful of trees (U.S. Department of Agricultue National Agricultural Statistics Service [USDA NASS], 2019). Maple syrup production is a multigenerational tradition for many families, as well as a cultural practice contributing to Indigenous food sovereignty (Dower & Gaddis, 2021; Lange, 2017). Even those who eventually produce maple syrup as a significant source of their income typically start at a small scale and gradually ramp up the size of their operation (Colman, 2021). Across the U.S. Northeast and Midwest, an estimated 86% of ideal maple stands[1] remain untapped, indicating substantial potential for new producers to begin making maple syrup, both as a business and as a personal pursuit (Farrell, 2013; Matthews & Iverson, 2017). Regardless of the reasons that motivate producers to engage in maple sugaring activities, the stewardship of the land that is required for successful maple syrup production can support the health of forest ecosystems (Clark & McLeman, 2012).

Targeted social media advertising is widely recognized as an effective way to reach consumers, but it is understudied as a way to reach current and potential food producers. As of 2021, 69% of U.S.

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In accordance with federal regulations, the Institutional Review Board for the Protection of Human Subjects in Research at the University of Wisconsin–Madison does not consider social media advertising studies to be human subjects research, so this study did not need to be submitted for IRB approval.

Author Contributions
SH: conceptualization, methodology, investigation, data curation, formal analysis, writing—original draft, writing—review and editing, visualization, project administration; BS: conceptualization, supervision, funding acquisition, writing—review and editing; SM: methodology, formal analysis, writing—original draft, writing—review and editing; TJ: conceptualization, writing—review and editing, TG: conceptualization, writing—review and editing, funding acquisition.

[1] A *stand* is a wooded area, typically between a few acres and several hundred acres, in which the trees share characteristics like species, age, and/or size.

residents use Facebook (Auxier & Anderson, 2021), making it a promising platform for reaching people who do not currently produce maple syrup but do have access to maple trees. Facebook allows advertisers to target audiences who have specific interests, as well as run experiments comparing the effectiveness of different ad versions.

This field experiment tests the effectiveness of advertisements encouraging Facebook users to learn more about how to produce maple syrup. We compare four message frames based on the salient motivations of existing maple syrup producers and analyze how the message frame effects vary by age group and gender. Our results can inform future outreach to grow maple syrup production and underscore the value of strategic social media advertising for promoting interest in small-scale food production. Our methods also demonstrate the methodological rigor (in terms of both internal and external validity) that can be achieved with social media message-testing experiments despite the black-box algorithmic aspects of social media advertising (Orazi & Johnston, 2020; Shreedhar, 2021; Witzling et al., 2023).

Message Framing in Communication

In marketing and communication, *message framing* refers to the broad idea that variations in how information is conveyed can influence an audience's attitudes and behavior (Cacciatore et al., 2016). In this experiment, we study *emphasis framing*, in which a message draws attention to one aspect of a topic while deemphasizing other aspects (Shaw et al., 2021). Emphasis frames that resonate with the interests or values of an audience tend to be more engaging and more likely to lead to changes in attitude or behavior than those that are not tailored (Kusmanoff et al., 2020). To be successful, social media marketing campaigns should include strategic decisions about the information included in the message and how that information is framed, both textually and visually (Taylor & Sammons, 2019; Wirz et al., 2022).

Researchers have used Facebook advertisements to test the effects of message frames related to pro-environmental behaviors, such as engaging in residential hydroponic agriculture (Kronrod et al., 2023), collecting electronic waste for recycling (Kronrod et al., 2023), preventing the spread of aquatic invasive species (Shaw et al., 2021), adopting soil conservation practices (Witzling et al., 2023), and donating to wildlife conservation efforts (Shreedhar, 2021). In the public health sphere, similar experiments have sought to encourage people to take protective measures against COVID-19 (Banker & Park, 2020), get vaccinated against COVID-19 (Tjaden et al., 2022), seek out information about HPV vaccination (Reno & Dempsey, 2021), and mitigate the health risks of wildfire smoke (Aminpour et al., 2022). By revealing which message frames are most likely to resonate with different online audiences, such experiments can lead to actionable insights for communication practitioners.

In a previous field experiment among maple syrup producers, Byerly et al. (2019) sought to encourage participation in a songbird habitat conservation program by sending physical mailings with different message frames. The experiment found that neither the offer of public recognition nor the mention of peer participation increased producers' likelihood of requesting more information about the conservation program. However, no studies to date have tested message frames related to promoting maple syrup production on social media. Other message framing studies that do exist tend to focus on marketing to consumers (e.g., Carfora et al., 2022; James & James, 1994; New York State Maple Producers Association, 2022) rather than promoting participation in small-scale food production. Our work begins to fill these gaps and provides insights for Extension educators, maple equipment suppliers, rural development professionals, and others who seek to increase the number of maple syrup producers. Other food systems professionals can apply our methods to conduct evidence-based social media outreach to food producers and potential food producers.

Motivations for Maple Syrup Production

A variety of factors motivate people to begin producing maple syrup. Although economic considerations are quite important to large commercial producers and somewhat important to small commercial producers, finances rarely motivate hobbyists

and other noncommercial producers (Hershberger et al., 2024; Hinrichs, 1998; Lange, 2017; Velardi et al., 2023). For this reason, our experiment excluded economic reasoning and used the message frames of time in nature, food self-sufficiency, building community, and the lifestyle of working the land. These decisions were made based on the literature discussed below.

Time in Nature

In a recent survey of Wisconsin maple syrup producers, spending time in nature was the motivation most often cited by producers. Nearly three-quarters of them said they were "very" or "extremely" motivated by time in nature (Chang et al., 2024). In Vermont, too, many producers value a sense of intimacy with the woods (Lange, 2017).

Nature similarly motivates other people to own forested land. Wildlife habitat, beauty or scenery, hunting, and nature protection are all rated as "important" or "very important" reasons by around three-quarters of Wisconsin private forest landowners who own at least 10 acres (4 hectares) (B. J. Butler et al., 2021). Respect for nature is a common personal value among long-time producers of nontimber forest products (Frey et al., 2023). Thus, a message frame emphasizing the time in nature associated with maple syrup production may resonate with potential producers.

Food Self-Sufficiency

Maple syrup is highly valued along multiple culinary dimensions. First is taste: it can add a unique flavor to a wide range of savory and sweet dishes (Haedrich, 2015). Second is health: maple syrup contains minerals and phenolic compounds that make it a healthier sweetener than refined cane and beet sugar and corn syrup (Saraiva et al., 2022). Third, maple syrup fits into the growing movement to buy and consume local, natural foods (Huddart Kennedy et al., 2018; Kemkes & Akerman, 2019; Murphy et al., 2012). However, people can enjoy these benefits even if they buy maple syrup instead of making it themselves.

A culinary dimension more pertinent to potential producers is the self-sufficiency that comes with producing maple syrup at home. Small-scale farmers are often motivated by the desire for food security and self-sufficiency (Iles et al., 2021), as are participants in community gardens in urban areas (Cattivelli, 2023; Draper & Freedman, 2010; McFarland et al., 2018). Additionally, a growing number of people have taken up do-it-yourself food projects such as home fermentation, canning, and raising livestock as a way to increase their self-sufficiency and reconnect with food systems (W. H. Butler, 2012; North, 2023; Wharton, 2015). Thus, emphasizing the food self-sufficiency aspect of maple syrup (henceforth shortened to "food") could attract the attention of Facebook users.

Building Community

The social aspect of maple syrup production is salient for many producers (Hinrichs, 1998; Whitney & Upmeyer, 2004). The labor-intensive process of gathering and boiling sap has long brought together multigenerational families and neighbors (Lange, 2017). Family is "very" or "extremely" motivating to more than half of Wisconsin maple syrup producers, many of whom descend from multiple generations of producers (Chang et al., 2024; Hershberger et al., 2024). Maple syrup also carries deep cultural importance for many Native communities in Wisconsin, for whom it has long been an integral part of the yearly cycle of food harvesting and production (Techtmann et al., 2014). To this day, producing maple syrup contributes to Tribal food sovereignty. Even for people who have no familial or cultural ties to maple syrup, producing it can strengthen community bonds, making building community a sensible choice for one of the emphasis message frames included in our social media message test.

Lifestyle of Working the Land

Producing maple syrup is a physically demanding endeavor: producers often walk through feet of snow on winter days to check their buckets and tubing, keep their (typically wood-fired) evaporators running for hours on end, and manage the health of their woods during the summer months. About half of Wisconsin maple syrup producers are "very" or "extremely" motivated by the physicality and exercise involved in producing syrup (Chang et al., 2024; Hershberger et al., 2024), and some producers in the Northeast likewise cite

physical exercise as a motivation (Kuehn et al., 2017). Based on these considerations, we chose the lifestyle of working the land (henceforth referred to as "physicality") as our final emphasis message frame for our message test.

Maple Syrup Production in Wisconsin

Wisconsin is the fourth-leading U.S. state in annual maple syrup production, with a yield of 402,000 gallons (1,522,000 liters) in 2023 among producers with more than 100 taps (USDA NASS, 2023a). This number has been trending upward since the early 2000s (USDA NASS, 2023b), and there remains great potential for growth: about 90% of sugar maple trees on ideal stands in Wisconsin remain untapped (Farrell, 2013). The most recent census of U.S. agriculture counted about 1,400 maple syrup farms in Wisconsin (USDA NASS, 2019), a number that does not account for the many producers who make syrup at a very small scale as a hobby or a cultural practice. Most of the maple production in Wisconsin happens in the northern half of the state, where stands of maple trees are more plentiful (Peters et al., 2020). Still, we chose to run a statewide campaign because the southern part of the state is home to some maple syrup producers (Wisconsin Maple Syrup Producers Association, 2019) as well as others who own or have access to forested land but do not reside on the property where the trees are tapped (B. J. Butler et al., 2021; Wisconsin DNR, 2020).

More than half (57%) of Wisconsin's forested land is owned by private families, and another 2.4% is held by Native American tribes (B. J. Butler et al., 2021). Most sugar maples in the state are on private land (Farrell & Chabot, 2012). Among landowners who already harvest nontimber forest products (e.g., ginseng, mushrooms, maple sap), edible products are the most common category and are almost always harvested for personal use (B. J. Butler et al., 2021). Even so, nontimber forest products are an important reason for landownership among only 11% of Wisconsin private forest landowners (B. J. Butler et al., 2021), indicating the importance of testing emphasis message frames related to other benefits of maple syrup production beyond obtaining the food itself.

Our broader project (the Wisconsin Extension Maple Syrup Program) centers on outreach to support Wisconsin maple syrup producers, an initiative that contributes to rural economic development, promotes forest stewardship, and encourages healthy outdoor activities. Through this project, we aim both to grow production volume among existing producers and to increase the number of producers. With the latter goal in mind, we sought to raise interest among potential maple syrup producers through a Facebook advertising campaign, leading to our first research question:

> RQ1: Which emphasis message frames encouraging people to begin producing maple syrup are most effective in getting Facebook users to seek more information (i.e., to click a link) about maple syrup production?

Clicking on a Facebook ad is a private action not visible to other users. On a social media platform like Facebook, more public behaviors such as "liking," commenting on, or sharing a post are also relevant indicators of the success of a marketing campaign. Previous emphasis framing experiments on Facebook have found that the frames that best garner clicks (publicly invisible engagement) are not necessarily the same frames that best garner publicly visible engagement (Shaw et al., 2021; Witzling et al., 2023). Therefore, we also sought to understand the influence of emphasis message frames on public engagement through our second research question:

> RQ2: Which emphasis message frames encouraging people to begin producing maple syrup are most effective in getting Facebook users to publicly engage with the advertisement?

Existing maple syrup producers are an aging demographic. The average age of U.S. maple syrup producers is 53 years old (USDA NASS, 2019), and in the Great Lakes region (Michigan, Minnesota, and Wisconsin), the average is 60 (Snyder et al., 2019). Around half of Wisconsin producers are at least 55 years old (Hershberger et al., 2024). As for potential producers, only 6% of private family forest owners in Wisconsin are younger than 45,

and more than three-quarters are at least 55 years old (B. J. Butler et al., 2021). However, these figures do not account for Wisconsinites who live on forested land owned by older relatives and may currently support management decisions or may inherit the land, nor do they account for Wisconsinites who have access to a handful of maple trees or could potentially use others' land to tap trees. The long-term growth of the maple syrup industry will require encouraging people of all ages, especially younger people, to begin producing syrup.

Regarding gender, 63% of U.S. maple producers, including more than 80% of Wisconsin producers, are male (Chang et al., 2023; USDA NASS, 2019). Men account for around 88% of self-reported primary decision-makers on private forested land in Wisconsin, though many of these ownerships also include women (B. J. Butler et al., 2021). Ownership characteristics and participation in management activities also differ between men and women landowners, with men more likely to have undertaken forest management activities (S. M. Butler et al., 2018). Thus, men may be more receptive than women to information involving forest management recommendations, but women should not be discounted in outreach efforts given our limited knowledge of the gender differences in receptivity to producing maple syrup. Previous Facebook message-testing experiments have found differences in the effectiveness of frames based on gender (Aminpour et al., 2022; Shaw et al., 2021; Witzling et al., 2023) and age (Shreedhar, 2021; Witzling et al., 2023). With these considerations in mind, we pose our final research question:

> RQ3: How do the most cost-effective and engaging emphasis message frames vary by age group and gender?

In summary, we are comparing the effectiveness of four different emphasis message frames chosen based on previous research. We sought to quantify the information-seeking behavior and engagement generated by each advertisement, both for our entire audience and segmented by age group and gender.

Methods

To answer our research questions, we collaborated with a professional artist to create images for each frame, ran a weeklong ad campaign targeted at Facebook users with maple-adjacent interests, and analyzed the data using logistic regressions, as described in the following sections.

Stimuli Development

Once we selected the four emphasis message frames, we operationalized them in both text (<125 characters) and imagery based on multiple rounds of feedback from maple syrup producers and foresters. To isolate the effect of the message frame, each version had the same sentence structure and ended with the same call to action: "Explore our resources for beginning producers."

The content of imagery is often the single most influential factor in people's initial reactions to messages (Radler et al., 2020), making it important to consider in message framing research (Cacciatore et al., 2016). High-quality imagery is especially crucial for capturing users' attention in social media advertisements (Khan, 2022). We commissioned a professional artist with an advanced degree in science illustration to create artwork for each emphasis message frame. We provided initial descriptions of the desired scenes as well as detailed feedback through several rounds of revisions. Throughout this process, we consulted with foresters and maple syrup producers on our broader team to ensure that the images depicted maple syrup production accurately. To isolate the effect of the message frame, the artist used the same general design style in each visual, including the outdoor setting, the color scheme, the maple leaf icon in the corner, and the size and location of text summarizing the frame.

We chose to include people in all visuals since images with people tend to draw more attention than other online content (Djamasbi, 2014). People respond more positively to images featuring people who look like them (Buller et al., 2019), including in the context of advertisements (Brown et al., 2016; Kim & Cheong, 2011), and people are more likely to follow the advice of people they perceive to be similar to themselves (Chung et al., 2020; Stolper & Walter, 2019). Wisconsin is home to

many Native Americans with historical and contemporary connections to maple syrup production, and several reservations are in northern areas of the state with abundant maple stands. With this in mind, the artist depicted people in a racially ambiguous way so that both white and Native American users could see themselves in the artwork. Table 1 shows the final advertisements as they appeared in users' Facebook feeds.

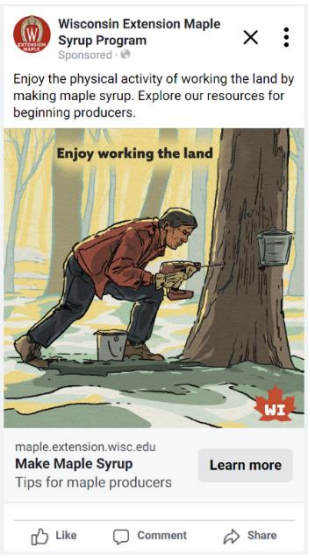
Facebook Ad Campaigns

The advertising infrastructure of Meta (Facebook's parent company, which also owns Instagram) offers six campaign objectives to choose from. The choice of objective influences how the algorithm selects who will see the ad. Since our primary outcome variables of interest related to clicks, we chose "traffic" to match the objective that other advertisers would use in this situation. This decision helped ensure external validity.

We hoped to reach an audience of adults living in Wisconsin who satisfy two criteria: (1) they do not yet produce maple syrup but would potentially be interested in doing so, and (2) they have access to maple trees that they could tap, either on their own land or by leasing trees from someone they know. However, we could not target this audience directly within the constraints of Meta's targeting parameters. To approximate our ideal audience, we targeted Facebook users who Meta's algorithm has identified as having an interest in one or more of the following related topics:

> *Interests:* Organic food, Fishing, USDA Rural Development, Gardening, Hunting, Rural area, Forestry, Sustainable agriculture, Beekeeping, Recreational fishing, Ojibwe language, Urban agriculture, Organic farming, Agricultural show, Crop, Deer hunting, Tree, Ginseng, Farm, Natural foods, Agriculture, or Natural

Table 1. Frame Descriptions and Operationalizations

Frame			
Nature	**Food self-sufficiency (Food)**	**Community**	**Working the land (Physicality)**
Description			
Emphasizes spending time outside in nature.	Emphasizes the process of making maple syrup from scratch.	Emphasizes the role maple syrup can play in forming community among friends, family, and neighbors.	Emphasizes the physicality and lifestyle associated with working the land.
Ads			
			

farming; *Field of study:* Forestry or Natural resource management; *Industry:* Farming, Fishing and Forestry.

We selected these topics from Meta's finite list of choices to reflect interests and activities common among the Wisconsin communities where maples grow, including interests related to all four frames. "Ojibwe language" was included as a topic because maple syrup production is a key cultural tradition for many Native American communities in the state, and "Ojibwe language" is the only Native American language or Tribal Nation of Wisconsin available as an interest to target. "Gardening" and "urban agriculture" were included to target urban residents who are more likely than other urban residents to be interested in producing their own food. "Maple," "syrup," and "maple syrup" were not on Meta's list of options of possible interests.

In addition, we restricted the audience of our ads to be adults living in Wisconsin. To ensure similar sample sizes across age groups and genders, we set up a separate "ad set" for each combination of age group (18–34, 35–54, and 55+), gender (male and female), and frame. Meta estimated that each of our six audience segments consisted of several hundred thousand Facebook users (the minimum lower bound was 275,000 and the maximum upper bound was 550,000). We also enabled Meta's A/B testing feature, which randomly assigned users to four groups, each of which would only see one version of the ad. For example, it was possible for one user to see the nature ad multiple times, but it was not possible for one user to see both the nature ad and the community ad.

To avoid the potential confounding effect of ad placement across Facebook, we opted to display our ads only in the main Facebook feed (both on mobile and desktop), which is the portion of the site with the largest potential audience (Bagadiya, 2023) and where the algorithm places most ads even when given full flexibility. Thus, our ads would appear as users scrolled through posts by their Facebook friends and posts by Facebook pages that they follow.

In line with Facebook's recommendation to run A/B tests for at least seven days to ensure reliable results (Meta, n.d.-b), we ran the ads from 2:00 am CT on Thursday, November 2, 2023, to 1:00 am CT on Thursday, November 9, 2023, spending US$124.49 in each of the 24 frame/age/gender conditions (an average of US$17.78 per condition per day) for a total of US$2,987.76.[2]

Response Variables

Meta provides only aggregate (not individual-level) data, which we used to examine three outcome variables detailed below. In all cases, we chose to examine the number of *unique* users who took a given action, rather than the total number of times *any* user took that action, because our statistical models assumed independent observations.

Unique Link Click-Through Rate (RQ1)

Since the ad's call to action was to click on the link, whether or not a user did indeed click on the link is the most direct measure of the impact of the message frames. The number of unique users who clicked on the link divided by the total number of users reached is known as the unique click-through rate (CTR[3]).

Cost per Unique Link Click (RQ1)

Cost per unique link click (CPC[4]) is the ratio between the money spent on an ad and the number of unique users who clicked on the ad. In the real-world setting of social media advertising, CPC is often more relevant than the raw click-through rate since marketers seek to maximize their impact with a fixed budget. Since advertisers pay for impressions (views of the ad), not clicks directly, CPC is

[2] From 4:38 pm until 8:01 pm on Friday, all the ads were paused by Meta due to an unforeseen payment issue, but the total amount spent in each condition on Friday was very similar to the other days. We chose to end the test at 1:00 am instead of 2:00 am to compensate for the shift from Daylight Savings Time to Standard Time, which occurred during the test.

[3] The abbreviation "CTR" is more commonly used to refer to the *total* number of link clicks divided by the *total number of views of the ad*, including repeated views and repeated clicks by the same user, but in this paper it will only refer to the *unique* click-through rate.

[4] The abbreviation "CPC" is more commonly used to refer to the total cost divided by the *total* number of link clicks, including repeated clicks by the same user, but in this paper it will only refer to cost per *unique* link click.

influenced by the algorithm governing Facebook's ad auctions and thus by how in-demand the target audience is among other advertisers.

Post Reaction Rate (RQ2)

When users see a Facebook ad, just as when they see an unpaid post, they can "react" to it in one of seven ways: "like," "love," "care," "haha," "wow," "sad," and "angry." In our experiment, we view the reaction rate (the number of users who reacted to an ad divided by the number of users reached) as a secondary measure of the impact of the message frames. Social endorsement cues such as reactions can influence people's decisions to click on online content (Messing & Westwood, 2014). Although Facebook comments and shares are also relevant social endorsement cues, we were not able to determine the number of unique users who took these actions, so we omitted them from our analyses.

Statistical Analyses

We analyzed unique link clicks and post reactions (but not CPCs because of their descriptive nature) using statistical methods, and both response variables are binary. For instance, in the case of the unique click-through rate, the user either clicked (1) or did not click (0). Analyzing binary data requires a generalized linear model to avoid unrealistically large or small fitted values for probabilities, such as below 0 or above 1. For ease of interpretation, we used a logistic regression to model the log odds of the event occurring (Matz et al., 2017; Orazi & Johnston, 2020), which is equivalent to using a logit link function.

Our full model was a 4 (Frame) x 3 (Age) x 2 (Gender) experimental design. For each dependent variable, we conducted deviance chi-square tests to see if there was a significant effect of dropping Age compared to the full model, dropping Frame compared to the full model, and dropping Gender compared to the full model. We also conducted deviance chi-square tests to see if there was a significant effect of dropping each two-way interaction compared to the full model. Further details of this method can be found in Faraway (2016).

Using the emmeans package in the R computing language run using RStudio (Lenth, 2023), we calculated the confidence intervals of CTRs and reaction rates in each condition as well as the marginal CTRs and reaction rates, controlling for each independent variable and each pair of independent variables. We also ran pairwise comparisons to calculate the odds ratios of clicks and reactions between conditions. Given the large sample sizes, we used Wald confidence intervals for the odds ratios. To correct for multiple testing, we used Sidak corrections for each set of pairwise comparisons.

Before running the experiment, we conducted a power analysis by analyzing mock datasets. We chose the budget for our study to be able to detect an overall difference in unique click-through rates between frames on the order of two in 1,000.

Results

Our ads were seen a total of 619,818 times by a total of 319,264 Facebook users, garnering a total of 5,349 link clicks among 5,108 unique users. Our overall unique link click-through rate was 1.63%, and our overall cost per unique link click was US$0.58. Our overall *non-unique* link click-through rate of 0.86% was very close to the average across industries, while our overall cost per thousand impressions of US$4.82 and our overall cost per *non-unique* link click of US$0.56 were substantially better than the averages across industries (Emnace, 2023). The number of impressions per condition ranged from 19,994 to 31,125, while the number of unique users reached per condition ranged from 10,588 to 18,060. Table 2 shows selected descriptive results. The full dataset and R code are available in the Supplementary Material.

Unique Link Click-Through Rates

Descriptively, the physicality frame was the most effective and the nature frame was the least effective in terms of CTRs (Figure 1). Table A1 (Appendix) shows the results of our deviance chi-square tests, and Table 3 shows the odds ratios and confidence intervals for statistically significant pairwise comparisons. Controlling for age and gender, the effect of frame on CTR was significant (p<.001). Compared to the nature frame, people were 13% more likely to click on the community frame, 13% more likely to click on the food frame, and 22%

more likely to click on the physicality frame.

We also found significant effects of gender when controlling for age and frame (p=.0054) and age when controlling for gender and frame (p<.001). Women were 10% more likely to click on the ads than men. Compared to people ages 18–34, those ages 35–54 were 21% more likely to click on an ad, and those ages 55+ were 67% more likely to click on an ad.

The interaction of age and frame was significant (p<.001), indicating that the pattern of CTRs for each frame varied with age group (Figure 2a). Descriptively, though the physicality frame had the highest CTR for both the 18–34 age group and the 35–54 age group, the food frame had the highest CTR for the 55+ age group. Several pairwise comparisons were statistically significant. For people ages 18–34, the physicality frame garnered clicks at a rate 31% higher than the nature frame. For people ages 35–54, the physicality frame garnered clicks at a rate 35% higher than the nature frame

Figure 1. Model Predictions for Click-Through Rates (CTRs) Based on Frame

The bars are marginal predictions equivalent to a simple average of the CTRs for the six age/gender combinations within each frame. Error bars denote 95% confidence intervals; *p<.05, **p<.01, ***p<.001.

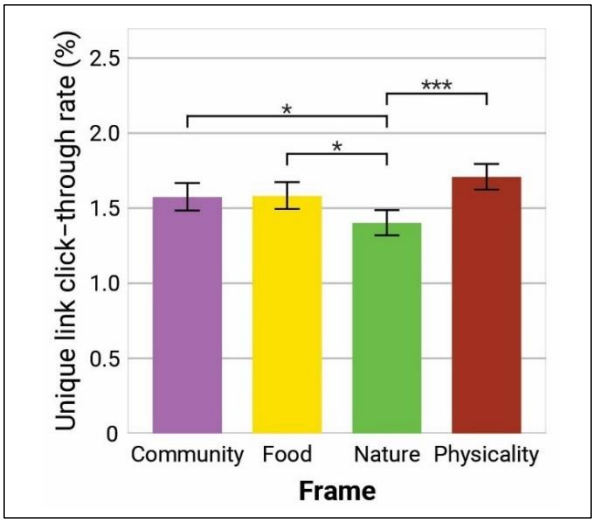


Table 2. Descriptive Results of the Main Campaign for Each Combination of Gender, Age, and Frame

Gender	Age	Frame	Reach	Unique link clicks	CTR (%)	CPC ($)	Reactions	Reaction rate (%)
Female	18–34	Community	10,588	131	1.24	0.95	18	0.17
		Food	11,543	155	1.34	0.80	18	0.16
		Nature	11,580	130	1.12	0.96	21	0.18
		Physicality	12,864	176	1.37	0.71	26	0.20
	35–54	Community	11,859	211	1.78	0.59	49	0.41
		Food	12,653	183	1.45	0.68	50	0.40
		Nature	12,863	187	1.45	0.67	57	0.44
		Physicality	14,478	270	1.86	0.46	60	0.41
	55+	Community	10,731	223	2.08	0.56	47	0.44
		Food	11,626	269	2.31	0.46	45	0.39
		Nature	11,716	238	2.03	0.52	108	0.92
		Physicality	13,663	284	2.08	0.44	72	0.53
Male	18–34	Community	13,078	175	1.34	0.71	32	0.24
		Food	13,990	147	1.05	0.85	15	0.11
		Nature	12,987	137	1.05	0.91	20	0.15
		Physicality	15,513	228	1.47	0.55	35	0.23
	35–54	Community	14,944	185	1.24	0.67	50	0.33
		Food	15,538	213	1.37	0.58	41	0.26
		Nature	15,387	190	1.23	0.66	49	0.32
		Physicality	18,060	313	1.73	0.40	69	0.38
	55+	Community	11,924	238	2.00	0.52	47	0.39
		Food	12,549	302	2.41	0.41	49	0.39
		Nature	12,579	220	1.75	0.57	75	0.60
		Physicality	16,551	303	1.83	0.41	95	0.57

and 28% higher than the food frame. For people ages 55+, the food frame garnered clicks at a rate 26% higher than the nature frame and 22% higher than the physicality frame.

The interaction of gender and frame was not significant, indicating that the pattern of CTRs for each frame among men did not differ meaningfully from the pattern of CTRs for each frame among women (Figure 2b). Descriptively, the physicality frame performed best among both men and women, while the nature frame performed worst among both men and women. This difference was statistically significant for men but not for women.

Lastly, the interaction of age and gender was significant (p<.001, Figure A1). Controlling for frame, women ages 35–54 were 18% more likely to click than men of the same age group. In the other two age groups, the differences between genders controlling for frame were not significant. The trend of increasing CTR with increasing age held true for both men and women: women ages 55+ were 31% more likely to click than women ages 35–54, who in turn were 29% more likely to click than women ages 18–34; men ages 55+ were 44% more likely to click than men ages 35–54 and 64% more likely to click than men ages 18–34.

Figure A2 (Appendix) shows the model predictions for CTRs in all 24 conditions.

Cost per Unique Link Click

Because the aggregate form of our data does not allow us to calculate a standard error or confidence intervals for CPCs, we report these results only descriptively. Consistent with the results for CTRs, the physicality frame was the most cost-effective with a CPC of US$0.47, followed by the food

Table 3. Results of Pairwise Comparisons for Model Predictions of Probability of Unique Clicks

Control variables	Significant pairwise comparisons	Odds ratio	95% confidence interval
Age and gender	community/nature	1.13*	[1.004, 1.26]
	food/nature	1.13*	[1.01, 1.27]
	physicality/nature	1.22***	[1.10, 1.36]
Age and frame	female/male	1.10**	[1.04, 1.16]
Gender and frame	(35–54)/(18–34)	1.21***	[1.11, 1.33]
	(55+)/(18–34)	1.67***	[1.53, 1.82]
	(55+)/(35–54)	1.38***	[1.27, 1.49]
Gender[a]	18–34: physicality/nature	1.31*	[1.03, 1.66]
	35–54: physicality/nature	1.35***	[1.11, 1.65]
	35–54: physicality/food	1.28**	[1.05, 1.56]
	55+: food/nature	1.26**	[1.06, 1.49]
	55+: food/physicality	1.22**	[1.04, 1.42]
Age[b]	male: physicality/nature	1.27***	[1.09, 1.50]
Frame[c]	female: (35–54)/(18–34)	1.29***	[1.11, 1.50]
	female: (55+)/(18–34)	1.69***	[1.47, 1.96]
	female: (55+)/(35–54)	1.31***	[1.15, 1.50]
	male: (55+)/(18–34)	1.64***	[1.43, 1.89]
	male: (55+)/(35–54)	1.44***	[1.27, 1.64]
	35–54: female/male	1.18**	[1.03, 1.35]

*p<.05, **p<.01, ***p<.001

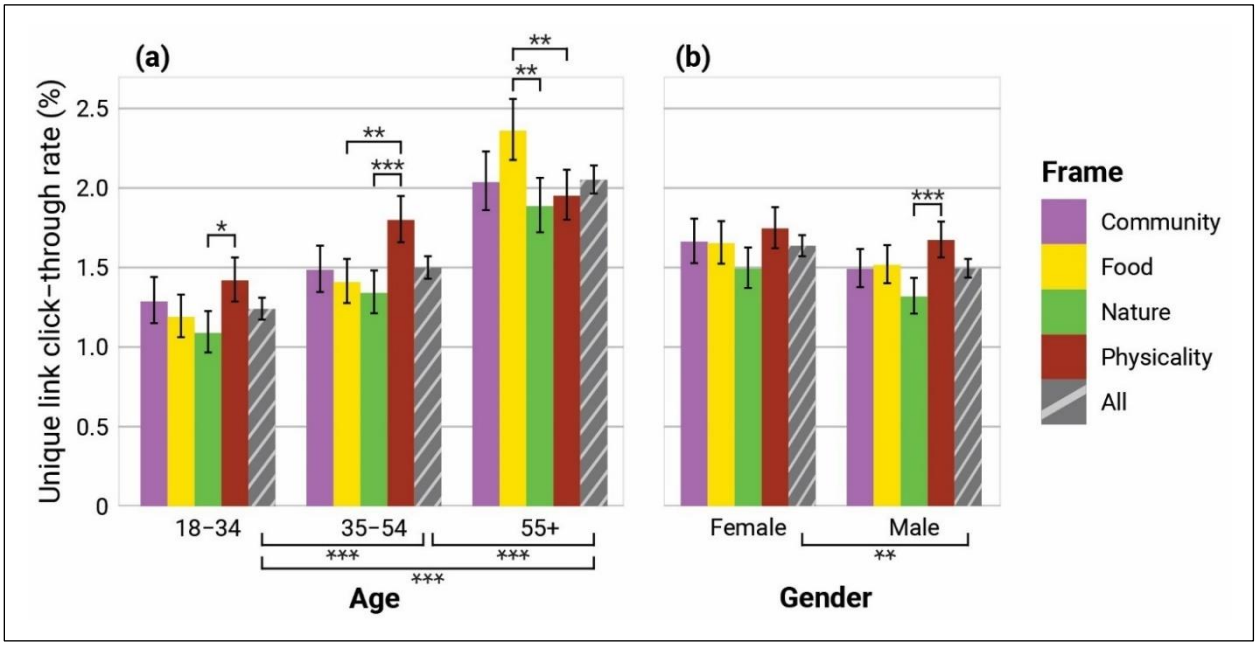
[a] Of the 66 possible pairwise comparisons, only the 18 within-age-group comparisons were run, and a Sidak correction was applied to the family of 18 tests.

[b] Of the 28 possible pairwise comparisons, only the 12 within-gender comparisons were run, and a Sidak correction was applied to the family of 12 tests.

[c] Of the 15 possible pairwise comparisons, only the 6 within-gender comparisons and the 3 within-age-group comparisons were run, and a Sidak correction was applied to the family of 9 tests.

Figure 2. Model Predictions for CTRs Based on (a) Age and Frame and (b) Gender and Frame

In (a), the solid bars are marginal predictions equivalent to a simple average of the CTRs for the two gender groups within each age/frame combination; the striped bars are equivalent to the simple average of the solid bars for the same age group. In (b), the solid bars are marginal predictions equivalent to a simple average of the CTRs for the three age groups within each gender/frame combination; the striped bars are equivalent to the simple average of the solid bars for the same gender. Error bars denote 95% confidence intervals; *p<.05, **p<.01, ***p<.001.



frame at US$0.59, the community frame at US$0.64, and the nature frame at US$0.68.

Table 2 shows the CPCs in all 24 conditions. Within most age/gender combinations, the trends in CPCs between frames mirrored the trends in CTRs. The one major discrepancy was that for both men and women in the 55+ age group, the physicality frame had a CPC just as low as the food frame. This was because the physicality frame had a lower cost per 1,000 impressions in that age group, meaning that the users whom the algorithm selected to see the physicality ad in the A/B test were cheaper to reach than those who saw the food ad.

Even though women had a higher CTR than men, the CPC for women (US$0.61) was higher than that for men (US$0.56). This was because women were more expensive to reach than men on average. When looking at CPCs by age group, the 55+ group was US$0.48, 35–54 was US$0.57, and 18–34 was US$0.78. These differences are due mostly to the differences in CTRs, since the 18–34 and 55+ age groups had very similar costs per 1,000 impressions, and the 35–54 age group was only slightly less expensive to reach.

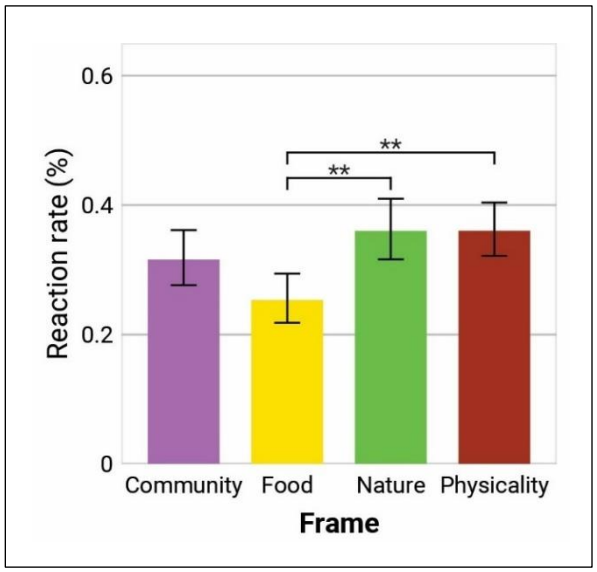
Reaction Rates

Of the 1,148 total reactions, nearly all were "likes" (1,071) or "loves" (68). Descriptively, the nature and physicality frames had the highest reaction rates, while the food frame had the lowest reaction rate (Figure 3). Table A2 shows the results of our chi-square deviance tests, and Table 4 shows the odds ratios and confidence intervals for significant pairwise comparisons. Controlling for age and gender, the effect of frame on reaction rate was significant (p<.001). Compared to the food frame, people were 42% more likely to react to the nature frame and 42% more likely to react to the physicality frame.

We found a significant effect of age controlling for gender and frame (p<.001). Compared to those ages 18–34, those ages 35–54 were more than twice as likely to react. Furthermore, those ages 55+

Figure 3. Model Predictions for Reaction Rates Based on Frame

The bars are marginal predictions equivalent to a simple average of the reaction rates for the six age/gender combinations within each frame. Error bars denote 95% confidence intervals; *p<.05, **p<.01, ***p<.001.



were 39% more likely to react than those ages 35–54. Controlling for age and frame, women appeared about 14% more likely to react than men, but this difference in reaction rates by gender was not statistically significant.

The interaction of age and frame was significant (p=.027, Figure 4a). For those ages 55+, the nature frame garnered the most reactions, with a reaction rate 79% higher than the community frame and 91% higher than the food frame. For those ages 18–34 and 35–54, reaction rates did not differ significantly by frame.

The interaction of gender and frame was not significant (p=.25, Figure 4b), nor was the interaction of age and gender (p=.62, Figure A3). Among women, the nature frame garnered the most reactions, while among men, the physicality frame garnered the most reactions. However, these trends were not statistically significant aside from the fact that men reacted to the physicality frame at a rate 65% higher than the food frame. Both men and women exhibited significant trends of increasing reaction rates with increasing age. Women ages

Table 4. Results of Pairwise Comparisons for Model Predictions of Probability of Reaction

Control variables	Significant pairwise comparisons	Odds ratio	95% confidence interval
Age and gender	physicality/food	1.42**	[1.11, 1.83]
	nature/food	1.42**	[1.09, 1.86]
Age and frame	—	—	—
Gender and frame	(35–54)/(18–34)	2.09***	[1.69, 2.60]
	(55+)/(18–34)	2.90***	[2.35, 3.59]
	(55+)/(35–54)	1.39***	[1.18, 1.63]
Gender[a]	55+: nature/food	1.91***	[1.31, 2.80]
	55+: nature/community	1.79***	[1.22, 2.62]
Age[b]	male: physicality/food	1.65**	[1.12, 2.43]
Frame[c]	female: (35–54)/(18–34)	2.36***	[1.65, 3.39]
	female: (55+)/(18–34)	3.05***	[2.14, 4.35]
	male: (35–54)/(18–34)	1.86***	[1.31, 2.63]
	male: (55+)/(18–34)	2.77***	[1.97, 3.89]
	male: (55+)/(35–54)	1.49***	[1.15, 1.94]

*p<.05, **p<.01, ***p<.001

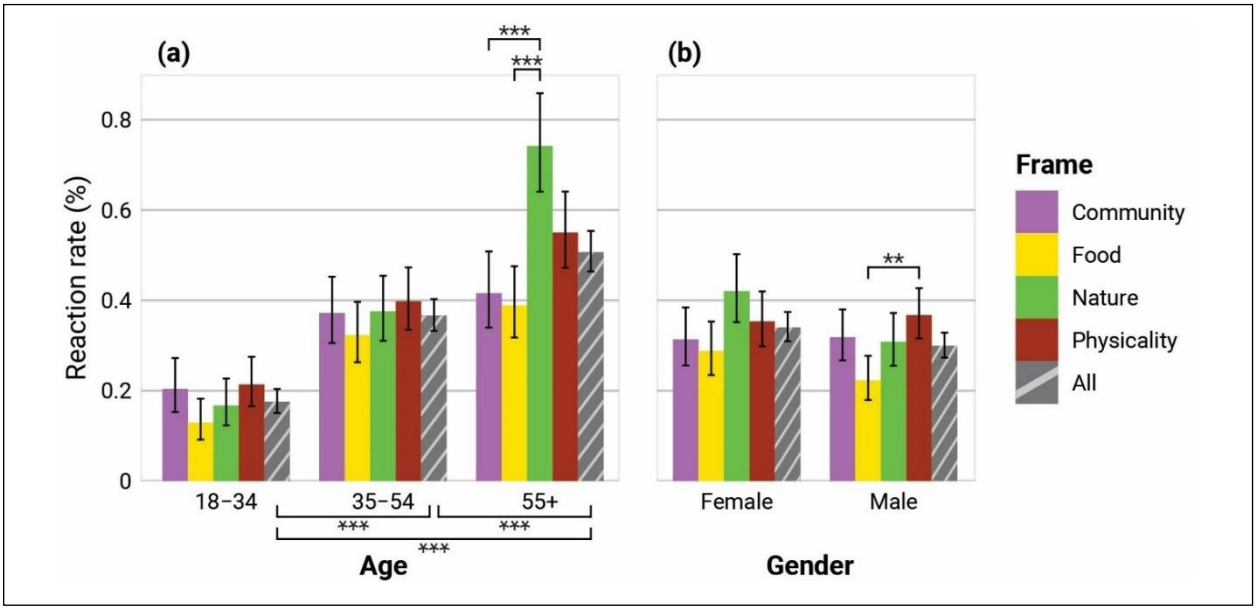
[a] Of the 66 possible pairwise comparisons, only the 18 within-age-group comparisons were run, and a Sidak correction was applied to the family of 18 tests.

[b] Of the 28 possible pairwise comparisons, only the 12 within-gender comparisons were run, and a Sidak correction was applied to the family of 12 tests.

[c] Of the 15 possible pairwise comparisons, only the 6 within-gender comparisons and the 3 within-age-group comparisons were run, and a Sidak correction was applied to the family of 9 tests.

Figure 4. Model Predictions for Reaction Rates Based on (a) Age and Frame and (b) Gender and Frame

In (a), the solid bars are marginal predictions equivalent to a simple average of the reaction rates for the two gender groups within each age/frame combination. The striped bars are equivalent to the simple average of the solid bars for the same age group. In (b), the solid bars are marginal predictions equivalent to a simple average of the reaction rates for the three age groups within each gender/frame combination. The striped bars are equivalent to the simple average of the solid bars for the same gender. Error bars denote 95% confidence intervals; *p<.05, **p<.01, ***p<.001.



55+ were 3.05 times more likely to react than women ages 18–34; men ages 55+ were 2.77 times more likely to react than men ages 18–34.

Looking at all 24 conditions (Table 2 and Figure A4), the reaction rate for women ages 55+ for the nature frame was much higher than the reaction rate for any other condition, while men ages 55+ were just as likely to react to the physicality frame as they were to react to the nature frame.

Comparisons to an Unstratified Campaign

The model predictions shown in Figures 1 and 3 give the expected CTRs and reaction rates for each frame if a campaign reached equal numbers of Facebook users from all six age/gender combinations. However, it seems unlikely that the audience of Wisconsinites who match our targeted interests is evenly distributed across these demographic groups, and unstratified pilot campaigns indeed yielded skewed demographics. Therefore, we ran a follow-up campaign to estimate the population proportions of each demographic group, with the reference population being the Facebook users to whom the algorithm would show our ads without stratification. Using the same targeted interests as the main campaign, we ran an A/B test between the four frames from Sunday, November 12, 2023, through Saturday, November 18, 2023, spending a total of US$399.68 (US$99.92 per frame).

In line with our pilot campaigns, the audience skewed older and male, with men ages 55+ accounting for more than 43% of the users reached (Table 5). We used the population proportions in Table 5 (renormalized to omit Unknown gender users) and the results of our main campaign to compute weighted averages of the CTRs, CPCs, and reaction rates for each frame. Table 6 shows these weighted averages, which estimate the results we would have obtained if we had not stratified our main US$3,000 campaign by age and gender. All the CTR and reaction rate population estimates are higher than in our main campaign. The food frame has the highest estimated CTR (2.04%), and the nature frame has the highest estimated reaction rate (0.58%). These results occurred because people 55+ were the most likely

to click (especially on the food frame) and react (especially to the nature frame), and this age group forms the largest percentage of the population. Even so, the physicality frame still has the lowest estimated CPC (US$0.43) due to the previously mentioned differences in the cost per 1,000 impressions between conditions.

Discussion

With the goal of encouraging nonproducers to seek information about beginning maple syrup production, we ran a field experiment using Facebook advertisements to compare visual and textual emphasis message frames emphasizing the community, food, nature, and physicality aspects of maple syrup production. Our results have practical implications for Extension educators, maple equipment suppliers, rural development professionals, and others who seek to increase their community's maple syrup production. Our methods can also serve as a model for Extension educators, natural resource professionals, and other communicators working to support local food systems who want to determine which emphasis frames would be most successful for achieving different outcomes on social media among their target audiences.

Implications for Maple Syrup Production

The frame of physicality (the lifestyle of working the land) was overall the most effective at garnering link clicks and post reactions. However, important differences emerged between age groups. People ages 55+ were the most likely to click on or react to our advertisements, while people ages 18–34 were the least likely to click or react. The relative lack of interest among those ages 18–54 reflects the maple industry's ongoing challenge to recruit more young people to take up maple production, even young people whose families have a history of maple syrup production (Cannella et al., 2022; Snyder et al., 2019). In line with our results, other studies have noted that older adults tend to click on and engage with social media advertisements at higher rates than younger adults (Marketing Charts, 2019; Shreedhar et al., 2021; Witzling et al., 2023).

Among the 55+ age group, which also forms the largest proportion of our target audience, the food self-sufficiency frame garnered the most clicks. Men ages 55+ were the most cost-effective demographic in terms of CPC. Thus, for future campaigns aimed at older demographics, framing maple syrup production as a way to create a healthy sweetener from scratch is likely to garner the most

Table 5. Cross-tabulation of Estimated Population Percentages of Each Demographic Group Within the Targeted Audience Based on the Follow-Up Unstratified Ad Campaign

	Female	*Male*	*Unknown*[a]	**Total**
18–34	1.5%	3.2%	0.2%	4.8%
35–54	9.0%	19.0%	0.6%	28.6%
55+	22.4%	43.2%	0.9%	66.5%
Total	32.9%	65.4%	1.8%	100%

[a] "Unknown" refers to both nonbinary Facebook users as well as those whose gender is not available to the algorithm.

Table 6. Estimates of the Population's Unique Link Click-Through Rates, Cost per Unique Link Click, and Reaction Rate for Each Frame Based on the Population Proportions in Table 5

Frame	*Community*	*Food*	*Nature*	*Physicality*	*Average*
CTR (%)	1.82	2.04	1.65	1.85	1.84
CPC (US$)	0.58	0.50	0.60	0.43	0.53
Reaction rate (%)	0.39	0.35	0.58	0.49	0.45

interest. Future campaigns aimed at younger demographics should instead emphasize the physical activity of working the land as a reason to engage in maple syrup production, and they should consider using social media platforms such as Instagram that are more popular among younger adults than Facebook (Barnhart, 2023; Target Internet, 2023).

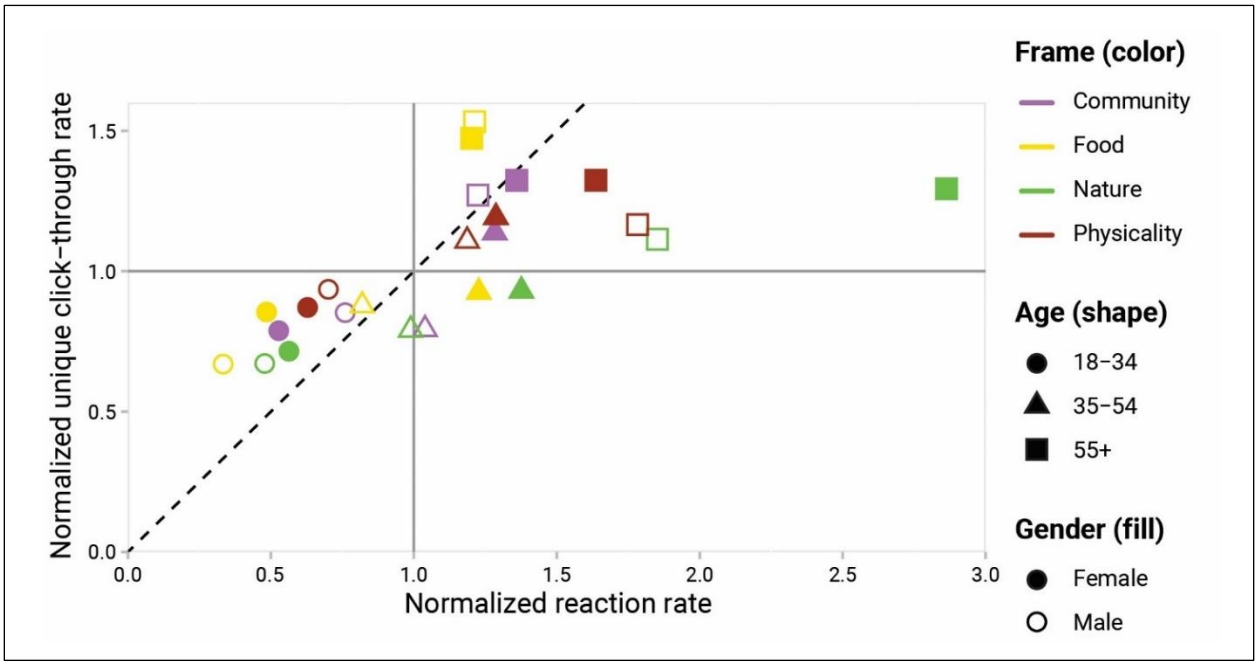
Despite most existing maple syrup producers being male (Chang et al., 2023; USDA NASS, 2019), women were consistently more likely to click on our ads than men of the same age group, indicating that Wisconsin women with maple-adjacent interests are a receptive audience and should not be overlooked in efforts to encourage Wisconsinites to begin maple syrup production. However, women still had a higher CPC than men because women were more expensive to show the ads to in the first place, a common observation among marketers (Lebesgue, 2023) that has also held true in Facebook message-testing research on other topics (Shaw et al., 2021; Witzling et al., 2023).

In contrast to the results for link clicks, people ages 55+ (especially women) were most likely to react ("like," "love," etc.) to the frame emphasizing time in nature, while people in the 18–34 and 35–54 age groups did not react to any frame significantly more frequently than the others. This result suggests that future efforts to spur public engagement around beginning maple syrup production should leverage the idea of spending time in nature rather than focusing solely on the lifestyle of working the land or food self-sufficiency.

Taking all these findings together, the most effective frame can be physicality, food, or nature, depending on the age group, gender, and whether the goal is post clicks or post reactions. A way of visualizing this conclusion is shown in Figure 5, which compares the CTRs and reaction rates broken down by age, gender, and frame. The general upward trend shows that conditions with higher

Figure 5. Scatter Plot of Normalized CTRs versus Normalized Reaction Rates in All Conditions

CTR values are normalized by dividing by the simple average of the CTRs across all 24 conditions; reaction rate values are normalized by dividing by the simple average of the reaction rates across all 24 conditions. Points above the horizontal line represent conditions with higher-than-average CTRs; points right of the vertical line represent conditions with higher-than-average reaction rates. Points below and to the right of the dashed line represent conditions that were relatively more effective for reactions than for clicks; points above and to the left of the dashed line represent conditions that were relatively more effective for clicks than for reactions.



CTRs also tended to have higher reaction rates. However, some conditions performed relatively better for reactions than clicks or vice versa. For example, the 55+ nature conditions were much better for reactions than for clicks, while the 55+ food conditions were somewhat better for clicks than for reactions. Among people ages 18–34, clicks outperformed reactions, though both metrics still fell below the overall averages. Among people ages 35–54, reactions generally outperformed clicks.

Although community does motivate many existing maple syrup producers, the community frame did not emerge as the most effective frame by any of the metrics we used for any audience segment. That said, community did not consistently emerge as the least effective frame, suggesting that community could be a good choice of frame for some audience segments based on factors other than age and gender.

Our research focused on generating interest among potential future producers, but future research could use similar methods to engage with current producers on timely issues such as the changing climate (Ahmed et al., 2023). For example, warmer winters are causing the typical maple syrup season to shift earlier in the year, and unusually hot summer temperatures may cause the following season's sap to have a lower sugar content than normal (Rapp et al., 2019). Social media advertisements could provide information to empower producers to adapt their operations to be resilient to these changes (Hershberger, 2023). Whether aimed at future producers or current producers, efforts to encourage maple syrup production should consider the overall health of local forest ecosystems as well as possible tradeoffs with timber value.

Implications for Communicating about Food Systems

Facebook advertisements can be a cost-effective way of reaching large audiences and testing messages for communication campaigns related to food systems through rigorous real-world experiments. With a US$3,000 campaign, we were able to find statistically and practically significant differences in a 4 (frame) x 3 (age group) x 2 (gender) experimental design. For communicators with fewer audience segments or fewer frames to test, a proportionally smaller budget would likely suffice to draw actionable conclusions. By running only one large campaign rather than a series of smaller replicate campaigns, our method guaranteed that each Facebook user saw no more than one of our message frames (Banker & Park, 2020; Orazi & Johnston, 2020; Shreedhar, 2021; Tjaden et al., 2022), overcoming a methodological limitation of some previous Facebook message-testing experiments (Shaw et al., 2021; Witzling et al., 2023).

In our case, the most effective frame varied by age group, underscoring the importance of audience segmentation for effective communication (Klöckner, 2015; Wirz et al., 2022). When segmentation is not possible, communicators should at least understand the demographic breakdown of their target audience by running a small unstratified test, keeping in mind that the population of Facebook users with a given set of interests is not the same as the population of people who could be reached through other media or in-person outreach.

As shown in Figure 5, our experiment also found that the most effective message frames for clicks (a private action) may not be the most effective message frames for reactions (a public action), echoing prior Facebook message-testing research (Shaw et al., 2021; Witzling et al., 2023). Therefore, establishing a clear goal for a social media campaign is a necessary step in determining which message frame to use (Witzling et al., 2023).

Limitations

Although our field experiment has high ecological validity, we did make two small sacrifices of external validity in order to eliminate confounding variables. First, we opted not to use the Advantage detailed targeting feature, even though many advertisers use this and other AI-driven features (such as tailoring ads' text to individual users) to potentially improve their results. Second, we restricted ad placements, appearance, and audience more than other advertisers might, so our observed click-through rates may be lower (and cost per click values may be higher) than those that a similar campaign would achieve with more algorithmic flexibil-

ity (Meta, n.d.-a). Even with the steps we took to minimize algorithmic influences, the algorithm is still a black box whose parameters Meta is constantly adjusting, as evidenced by the variations in cost per 1,000 impressions between frames within each age group and gender. Another important limitation related to the algorithm is that our campaign was optimized for clicks (the dependent variable of our first research question), but Meta does offer the option to instead optimize for post engagement (of which the dependent variable of our second research question forms one part), which would have likely yielded different results.

Our ad campaigns represent a snapshot in time. The competition for Facebook ad slots ebbs and flows, and maple syrup production is a highly seasonal activity. Thus, the same campaign at a different time of year might yield different results. Future research could replicate our study at a larger scale, in other geographic regions, and during multiple times of year.

As for our audience, we have no way of knowing what proportion of the users who saw our ads actually have access to maple trees to tap but do not yet tap them. Based on the post comments, we know that some current maple syrup producers saw our ads. Additionally, three of our research team members (who frequently visit websites related to maple syrup production) saw our ads. These anecdotes suggest that our ads reached people already producing maple syrup as well as those with maple-adjacent interests. However, even if the people who clicked on our ads were in our target audience, that is far from a guarantee of further action (Shreedhar, 2021), especially time-consuming activities like tapping trees to harvest sap followed by boiling the sap into syrup. Our work sets the foundation for future research that could use Meta Pixel (Meta, n.d.-c) with the same emphasis message frames to track how ad clicks translate into further outcomes such as spending time on an educational website, subscribing to an e-newsletter, or signing up for an Extension course on maple syrup production.

Since non-Facebook users could differ systematically from Facebook users in some characteristic relevant to maple syrup production, our results are not necessarily representative of the population of *all* Wisconsinites who have maple-adjacent interests. Future message tests could apply our methods to other social media platforms or e-mail marketing programs, with the choice of platform based on where the target audience is most likely to be active. In a similar vein, the most effective frames for in-person engagement may not correspond with the most effective frames for online campaigns. With face-to-face trainings or longer-form educational materials like videos, it may be appropriate to include all four motivational emphasis message frames studied here.

Finally, as with any message-testing experiment, operationalizing our conceptual frames was a subjective task, especially with the visuals. It is possible that some users responded to our ads based on features of the imagery unrelated to the intended frame (e.g., whether the appearance of the people in the ads matched the user's gender or ethnicity). Other artistic interpretations of the emphasis frames could have yielded different results.

Conclusion

Social media advertising is a relatively untapped channel for reaching potential food producers. Our message-framing experiment shows that Facebook advertisements are an effective way to increase interest in maple syrup production as well as to assess the relative appeal of different emphasis frames to a target audience. Framing maple syrup production in terms of the lifestyle of working the land was the most cost-effective message overall. Among people ages 18–54, this frame also attracted the most clicks. However, among people ages 55+, framing maple syrup production as a means of food self-sufficiency generated more clicks than the other frames, while emphasizing the time in nature involved in producing maple syrup led to the most public engagement. Our results can inform strategic messaging for future outreach aimed at bringing more people into the world of maple syrup production, and our methods offer a rigorous way to compare message frames and optimize social media outreach in other food systems contexts.

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Appendix

Table A1. Results of Tests for Significance in the Model for Unique Link Clicks

Variable(s) tested	Control variables	χ^2	*p*
Frame (main effects and interactions)	Age and Gender (main effects and interactions)	$\chi^2(18)=69.7$***	<.001
Gender (main effects and interactions)	Age and Frame (main effects and interactions)	$\chi^2(12)=28.1$**	.0054
Age (main effects and interactions)	Gender and Frame (main effects and interactions)	$\chi^2(16)=255$***	<.001
Age/Frame interaction and Age/Gender/ Frame three-way interaction	Main effects of Gender, Age, Frame; all two-way interactions except Age & Frame	$\chi^2(12)=44.8$***	<.001
Gender/Frame interaction and Age/Gender/ Frame three-way interaction	Main effects of Gender, Age, Frame; all two-way interactions except Frame & Gender	$\chi^2(9)=14.9$	.092
Age/Gender interaction and Age/Gender/ Frame three-way interaction	Main effects of Gender, Age, Frame; all two-way interactions except Age & Gender	$\chi^2(8)=16.6$***	<.001

*p<.05, **p<.01, ***p<.001

Figure A1. Model Predictions for Click-Through Rates (CTRs) Based on Age and Gender

The bars are marginal predictions equivalent to the simple average of the CTRs for the four frames within each age/ gender combination. Error bars denote 95% confidence intervals; *p<.05, **p<.01, ***p<.001.

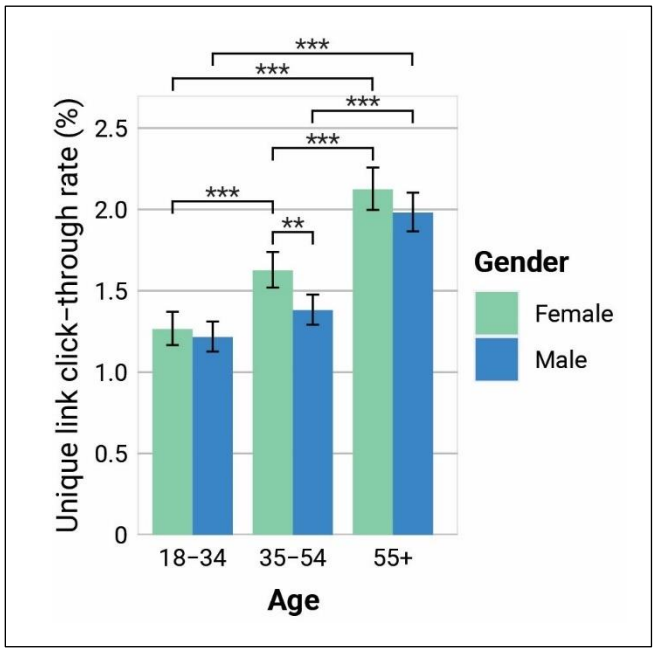
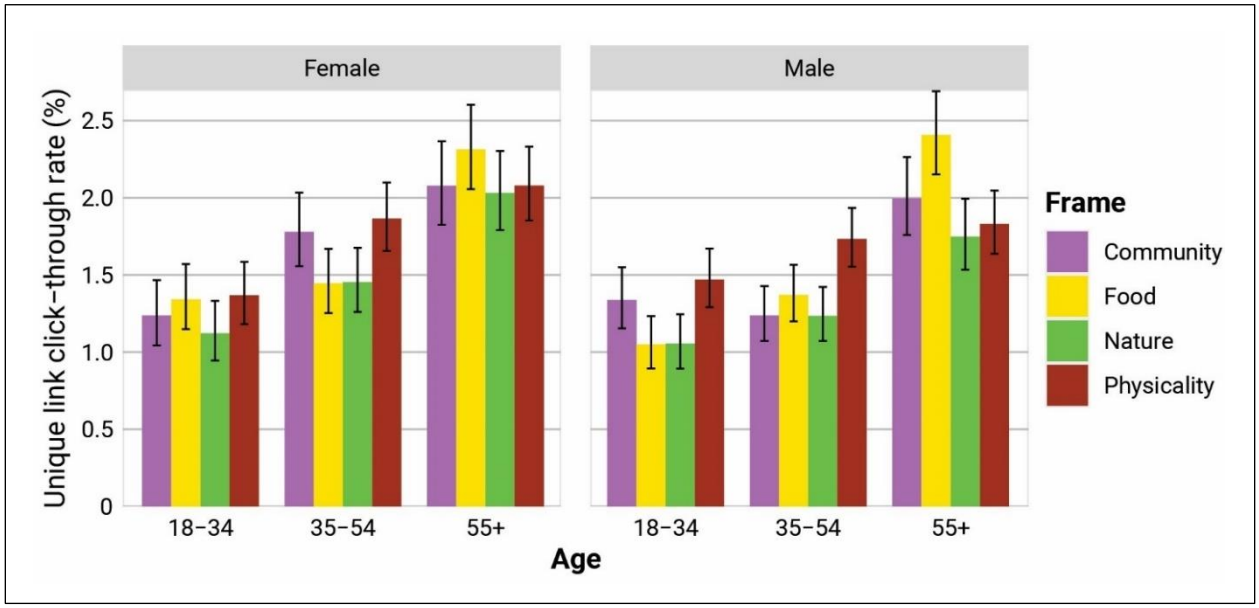


Figure A2. Model Predictions for CTRs in All 24 Conditions



Error bars denote 95% confidence intervals.

Table A2. Results of Tests for Significance in the Model for Reactions

Variable(s) tested	Control variables	χ^2	*p*
Frame (main effects and interactions)	Age and Gender (main effects and interactions)	$\chi^2(18)=58.0$***	<.001
Gender (main effects and interactions)	Age and Frame (main effects and interactions)	$\chi^2(12)=20.3$	.062
Age (main effects and interactions)	Gender and Frame (main effects and interactions)	$\chi^2(16)=207$***	<.001
Age/Frame interactions and Age/Gender/ Frame three-way interaction	Main effects of Gender, Age, Frame; all two-way interactions except Age & Frame	$\chi^2(12)=23.1$*	.027
Gender/Frame interaction and Age/Gender/ Frame three-way interaction	Main effects of Gender, Age, Frame; all two-way interactions except Gender & Frame	$\chi^2(9)=11.4$	.25
Age/Gender interaction and Age/Gender/ Frame three-way interaction	Main effects of Gender, Age, Frame; all two-way interactions except Age & Gender	$\chi^2(8)=6.26$	.62

*p<.05, **p<.01, ***p<.001

Figure A3. Model Predictions for Reaction Rates Based on Age and Gender

The bars are marginal predictions equivalent to the simple average of the reaction rates for the four frames within each age/gender combination. Error bars denote 95% confidence intervals; *p<.05, **p<.01, ***p<.001.

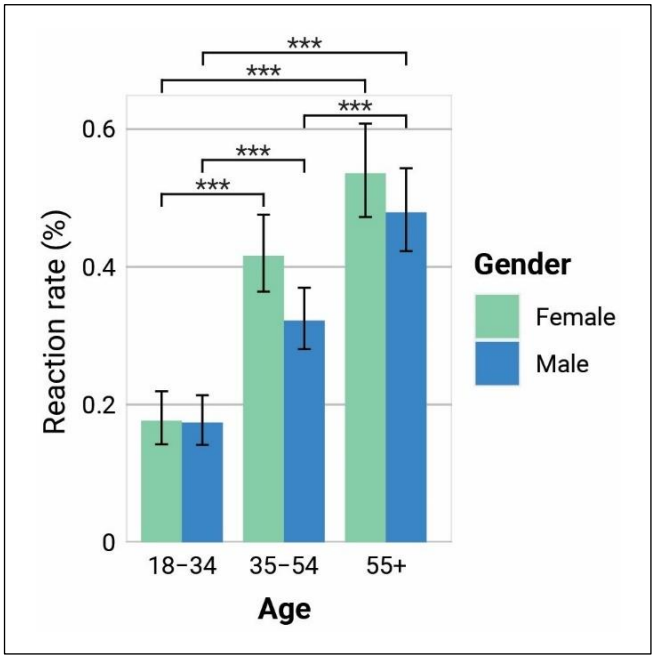
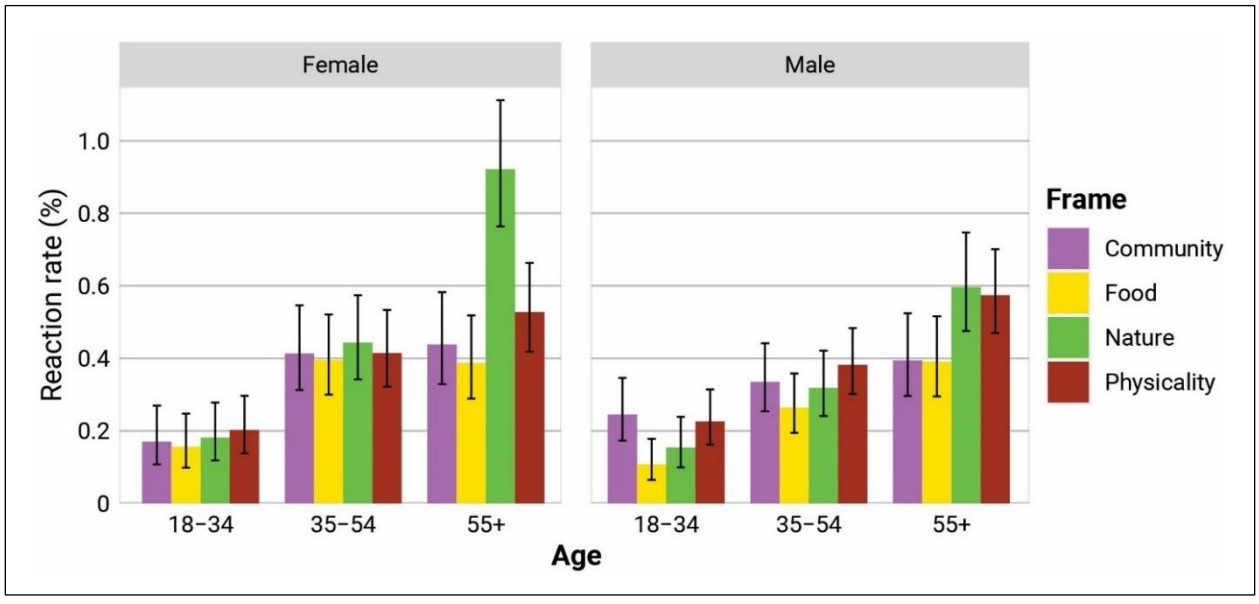


Figure A4. Model Predictions for Reaction Rates in All 24 Conditions



Error bars denote 95% confidence intervals.