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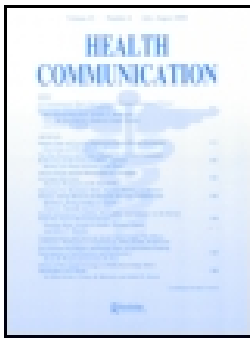
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Communicative Processes Underlying DIY eJuice Mixing Among Young Adult International ENDS Users

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ABSTRACT

The use of electronic nicotine delivery systems (ENDS) is increasing around the world, with contemporary trends outpacing scientific understanding of the health implications. Such trends include do-it-yourself eJuice mixing (DIY eJuice), which involves the unregulated homemade mixing of fogging agents, nicotine salts, and flavorants to create personalized liquid for ENDS products. The purpose of this study was to employ a grounded theory approach to gather formative data on the communicative processes surrounding the behavior of DIY eJuice mixing among international, young adult ENDS users. Participants were recruited locally for mini focus group discussions via SONA ($n = 4$) and internationally for an open-ended survey via Prolific ($n = 138$). Questions explored experiences with the online DIY eJuice community, motivations for mixing, information seeking strategies, flavor preferences, and perceived benefits of mixing. Thematic analysis and flow sketching revealed the underlying processes of social cognitive theory to explain the communicative processes of DIY eJuice mixing behaviors. Specifically, environmental determinants emerged in the form of online and social influences; personal determinants in the form of curiosity and control; and behavioral determinants following a benefits/barriers analysis, particularly regarding cost. These findings provide theoretical implications for the role of health communication constructs in understanding contemporary trends in ENDS use and practical implications for tobacco prevention messaging and tobacco control regulations.

Electronic nicotine delivery systems (ENDS) are noncombustible tobacco products (e.g., vapes, hookah pens, e-cigarettes) that heat liquid to deliver chemical ingredients (US Food & Drug Administration [FDA], 2020). Typical liquids (known as e-liquids or, more colloquially, eJuice) include nicotine, cannabidiol (CBD), tetrahydrocannabinol (THC), or a combination of the three with a flavor and fogging ingredient (e.g., propylene glycol, vegetable glycerin; Walley et al., 2019). Over the last decade, ENDS use has been steadily growing with an estimated 35 million global users (World Health Organization [WHO], 2019); young adults are the fastest growing demographic (Wang et al., 2020). Although many nations regulate the manufacturing, promotion, and sale of ENDS products (Kennedy et al., 2017), none are known to provide regulatory oversight for individuals who mix their own do-it-yourself (DIY) eJuice.

DIY eJuice refers to the process in which users mix their own ENDS eJuice for personal use. The curiosity over this trend is curating online communities of amateur chemists dabbling in eJuice experimentation. Following research on ENDS-use, the underlying communicative processes that surround the behavior of DIY eJuice mixing are expected to be closely tied to motivations for use and influences of online information exchange. However, formative research is needed to confirm such relationships as well as explore additional possible explanations. This information would support tobacco prevention messaging efforts and public health

policies that seek to resonate with members of this unique community.

The purpose of this study is to employ a grounded theory approach to investigate the underlying communicative processes surrounding DIY eJuice mixing. This study begins by identifying the role of motivation in tobacco prevention messaging and reviewing the communication challenges associated with user motivations to use ENDS products. This is followed by anticipated challenges for navigating DIY eJuice mixing communities, which have developed into unique online spaces of information exchange. These foundational areas of research build toward a need for a grounded theory approach in gathering formative information on the unique communicative processes surrounding DIY eJuice mixing.

Motivations for ENDS use & associated communication challenges

Understanding motivations for tobacco use have been essential to the development of persuasive messaging strategies that effectively reduces tobacco use (e.g., Clayton et al., 2017; Lang & Yegiyani, 2011; Leshner et al., 2018). For the last decade, research has extensively explored general motivations behind young adult use of ENDS, with most studies identifying the increase in youth consumption stemming from (mis)perceptions of health benefits (Ambrose et al., 2014; Berg et al., 2015; Paek et al., 2014), cost (Dawkins et al., 2013; Wong et al.,

2016; Zhu et al., 2013), and flavor options (Lewis & Wackowski, 2006). These motivations present communication challenges for efforts that seek to prevent and reduce ENDS use, particularly among international, young adult users.

When ENDS products first hit the market, the dearth of scientific research and understanding left room for advertisers and corporations to fill the space with unsubstantiated claims, such as ENDS products as cessation AIDS, healthy alternatives to smoking, and cost-effective (Grana & Ling, 2014). Thus, it is no surprise that most people hold the misperceptions that ENDS products are safe (Ambrose et al., 2014; Berg et al., 2015; Paek et al., 2014). In addition, a recent content analysis of almost 1,000 e-cigarette related tweets found the public continues to appear unaware of the health-related risks of ENDS use (Martinez et al., 2018). Communication and intervention research programs are now fighting the uphill battle of countering years of (and millions of dollars in) undisputed, misleading ENDS advertising (see Allem et al., 2017 for exemplar in anti-ENDS communication battles).

The most prevalent motivator for ENDS use appears to be the attraction of flavored eJuices. The role of flavors in the promotion of tobacco use, especially to youth, is well documented (Lewis & Wackowski, 2006) and the primary reason that flavored combustible cigarettes were banned by the FDA in 2009 under the Tobacco Control Act (FDA, 2009), a decision that has been supported as effectively reducing use among youth (Courtemanche et al., 2017). From a communication perspective, flavored tobacco products produce a persuasive effect that entices users to ignore the potential harms of use and risk the negative health effects. So much so that adolescent ENDS use is positively associated with the availability of ENDS flavors (Berg, 2016; Bold et al., 2016; Kong et al., 2015; Morean et al., 2018), with sweet and fruity flavors being the most preferred (Russell et al., 2018). Until eJuice flavors are banned, communication is the only viable strategy to counter enticing flavor messaging from big tobacco. Just as communication research has found media coverage of ENDS flavors to be associated with positive ENDS perceptions (e.g., Kikut et al., 2020), communication strategies can be used to promote negative perceptions of ENDS products and shed light on the reality that flavors are marketed as a means to mask the known harms of use.

All of these motivators for ENDS use stem from discrepancies in user perceptions and trends with known scientific understanding of ENDS products and marketing tactics. Despite public health experts working to stay ahead of the health implications of ENDS use, scholars have noted that trends remain one step ahead of formative understanding (e.g., Cox et al., 2019). For instance, in fall 2019, the US was inundated with hospitalizations and deaths associated with ENDS use. According to the Centers for Disease Control and Prevention (CDC) (2020), six-months after the initial outbreak, “e-cigarette, or vaping, product use-associated lung injury” (EVALI) accounted for 2,668 hospitalizations and 68 deaths. During this time, public health and tobacco control researchers worked tirelessly to identify the specific ENDS-related factor causing EVALI, eventually identifying vitamin E acetate as an additive in ENDS (most notably used in THC-based liquids) as the most likely factor (Blount et al., 2020).

This avoidable crisis highlights two critical communication break downs surrounding ENDS use. First, formative research and scientific understanding frequently falls behind current social trends. For example, incorporation of vitamin E acetate as an additive to extend quantity was an untested solution that operated on the assumptions that because vitamin E is digestible and easy to access, it would also be safe to inhale (which was clearly shown to be a false assumption). Formative research exploring mixing behaviors is important for having information readily available to respond to risk associated with trending behaviors. Second, there is no regulatory oversight regarding appropriate additives for eJuice. As nations strengthen their ENDS-related policies, it will be important for tobacco control advocates to recognize the implications on DIY eJuice mixing. For instance, after the European Union revised their Tobacco Products Directive strengthening regulations on the limits of nicotine concentration, studies found the counter effect was an increase in DIY eJuice mixing as a way to bypass regulation (Ward et al., 2020). Should such stockpiling behaviors happen again, formative research will be essential for guiding public health messaging to mitigate such intentions. Thus, formative research on the communicative processes surrounding the behavior of DIY eJuice mixing among young adult ENDS users is essential for public health preparedness.

DIY eJuice & online information exchange

The trend of DIY eJuice mixing is growing fast with kits containing mixing bottles and measuring syringes readily available for purchase online or in-person at ENDS retail shops. Mixing processes typically begin with a fogging agent (e.g., propylene glycol, vegetable glycerin; Walley et al., 2019) and nicotine concentrate and then proceed to add flavor (Davis et al., 2016) to achieve the desired taste, nicotine concentration, and throat hit. The extent to which ENDS users are choosing to mix their own eJuice over purchasing is currently unknown, although expected to be growing as government agencies increase ENDS-related regulations (Ward et al., 2020). In addition, the wide availability of online forums, such as the *DIY_eJuice* mixing communities on Reddit (2012) and Discord (n.d.), with international user engagement that seek to assist mixers with questions and ideas reinforces the notion that trends in DIY eJuice mixing are on the rise around the world.

While limited research is available on the trends and culture surrounding DIY eJuice mixing, evidence suggests that mixing has created a hobbyist mentality for ENDS users (Cox et al., 2019; Trucco et al., 2020), resulting in the formation of extensive and dedicated online information exchange communities. Moreover, in a content analysis of vaping-related apps, researchers found the most highly rated content to be information on creating DIY liquids and coils (Meacham et al., 2020), suggesting the primary use of the app was as a means of accessing mixing-related content from other ENDS users. Trucco et al. (2020) suggest that the hobbyist mentality could be part of the appeal for young adult users. Although not problematic on the surface, this is concerning in light of the finding that a large proportion of vaping apps with content on

DIY did not have age controls for use, allowing any aged user to learn about DIY mixing ideas and approaches (Meacham et al., 2020). Online forums might have the best of intentions for providing helpful answers and tips to assist DIY eJuice mixers with their recipes. However, concerns over the chemicals used in DIY mixing is on the rise as research continues to find discrepancies in lab tests of labeled concentrations (e.g., Cameron et al., 2014; Davis et al., 2015, 2016; Trehy et al., 2011).

To date, only one study has sought to explore the motivations and perceptions surrounding ENDS users' decision to mix DIY eJuice. In the study, Cox et al. (2019) recruited 41 daily ENDS users who mix their own liquid to participate in an interview that would later be content analyzed for motivation-based keywords. Their findings revealed four distinct motivators for mixing: fun/novelty, making higher nicotine concentrations, cost, and quality control. Although these motivations are useful, additional research is needed to further probe how information exchange is enabled by these motivations and the kinds of information individuals exchange. These formative questions build on current research on ENDS-related information exchange.

Research has shown that health information regarding tobacco products often promotes tobacco use. For ENDS products, information seeking research demonstrates that marketing techniques that promote the comparative safety of ENDS relative to combustible cigarettes create a discounting effect where readers underassess the danger of ENDS use (Jun et al., 2019). Yang et al. (2019) found that individuals who seek ENDS-related information are most likely to seek pro-ENDS related content. Moreover, the act of seeking ENDS-related information was shown to be positively associated with intention to use ENDS products. Together, these findings suggest information seeking on ENDS products has a high risk of promoting ENDS use. The extent to which seeking information on DIY eJuice perpetuates these same risks is presently unknown.

While research exists regarding the outcomes of information seeking, exploratory research gathering formative data on the communicative processes surrounding the behavior of DIY eJuice mixing among young adult ENDS users is needed. Although the reviewed research provides a framework for anticipating these processes, such as the role of motivation and information exchange, the unique hobbyist and social learning characteristics of DIY eJuice mixing suggest additional communicative processes surrounding the behavior. Grounded theory is a methodological approach well suited to formatively exploring this underdeveloped and emerging phenomena and thusly was selected to guide this exploration.

Grounded theory

Grounded theory (Glaser & Strauss, 1967) is a social-scientific approach that borrows interpretive components to facilitate an inductive research process that allows for the discovery of theoretical explanations (Corbin & Strauss, 1990). Unlike a deductive approach that outlines expected theoretical constructs and parameters, the grounded theory approach allows researchers to “generate a general explanation (a theory) of

a process, an action, or an interaction shaped by the views of a large number of participants” (Creswell, 2013, p. 83).

Regarding the communicative processes surrounding DIY eJuice mixing, grounded theory is most appropriate for a number of reasons. First, the behavior is a new trend with little to no scientific understanding of the social processes surrounding the behavior. Although broader ENDS-related research provides a framework for anticipating these processes, such as the role of motivation and information management, the hobbyist mentality combined with the unique online forums suggest potentially new communicative aspects of the behavior. Second, Creswell (2013) argues that the grounded approach can be most appropriate when a research study is focused on a process or action that has distinct implications for practices. The focus on DIY eJuice mixing has numerous implications for practicing, the most central being communication interventions seeking to promote tobacco prevention behaviors, public health researchers seeking to reduce tobacco use, and tobacco control advocates seeking to effectively regulate tobacco products.

Historically, grounded theory has been employed by communication scholars to explore a variety of topics, including a breadth of health-related behaviors (Glaser, 1999). Although grounded theory is not a common approach in the broader area of tobacco prevention, the approach has been employed in this area by at least one team of communication scholars. Bigman et al. (2016) employed grounded theory to explore reactions to FDA graphic warning labels among vulnerable groups. The grounded approach allowed the researchers to confirm the roll of exemplar theory when creating graphic warning labels. Regardless of commonality, grounded theory has the capacity to provide a unique theoretical understanding of the communicative processes surrounding trends in tobacco behavior, such as DIY eJuice mixing among ENDS users.

Purpose

ENDS use among young adults continues to increase worldwide (WHO, 2019). Unique behaviors, products, and approaches to consuming ENDS outpaces the research produced regarding how ENDS users are engaging with the products. Recent studies suggest that mixing DIY eJuice is an emerging global trend among ENDS users stemming from reasons surrounding novelty, nicotine concentration level, cost, and control (Cox et al., 2019) as well as surrounding reactions to increased regulation of nicotine concentration levels (Ward et al., 2020). This study seeks to provide deeper formative evaluation for anticipating an emergent public health need to have a deeper understanding of the behavior of DIY eJuice mixing. Specifically, the guiding research question was to employ a grounded approach to qualitatively examine the underlying communicative processes surrounding DIY eJuice mixing.

Method

Procedures

Following IRB approval, the qualitative data pulls from two forms of data collection: focus groups and open-ended survey

questions. These two sampling approaches were employed due to the challenge of reaching members of the DIY eJuice mixing population, who do not share consistent geographic or social locations of access. A key element of a grounded approach is the ongoing data collection process and the iterative way in which qualitative-based questions are formed (Corbin & Strauss, 1990). Thus, focus groups served as a pilot test and were held first with nine broad questions asked of participants, including *where did you first hear about creating your own liquid for vaping, also known as DIY-eJuice?; what places have you turned for additional information on creating your own eJuice?; why did you first decide to make your own eJuice?; how has your juice flavor preferences changed since you started making your own eJuice?; and what do you think are the primary differences between your own DIY version and what you can buy?* Building on these sessions, and as outlined by the grounded approach, five questions were developed for open-ended items in an international survey.

In the pilot test, focus group participants were invited via SONA, an online research recruitment system at a large university in the Southwest, that compensates participants with extra credit in their courses. The SONA system is comprised of approximately 2,000 undergraduate students from all majors on campus with most from communication and journalism. Two focus group sessions were held with students that (a) were at least 18 years old and (b) had mixed their own DIY eJuice at least once in the last three years. Participants signed-up for sessions in SONA and, at the start of their scheduled session, were emailed a short survey in Qualtrics to confirm eligibility and gather demographic data. At the end of the survey, participants were provided the Zoom link and password for the focus group session. The longest session lasting 30 minutes, and all were recorded with transcripts created via Zoom's auto-transcribing feature. Transcript files were compared to the Zoom recording and inaccuracies were corrected. These data were used to develop the five items to be included in the second portion of data collection, which gathered data from an online international survey.

For the open-ended survey questions, participants were recruited as part of a larger, international study looking to explore nuances and predictive variables of DIY eJuice mixing. Participant recruitment occurred through Prolific, an online research recruitment system that recruits participants from around the world in exchange for monetary compensation. To participate, individuals had to (a) be at least 18 years old, (b) have reported in their demographics to Prolific that they had ever vaped, and (c) had mixed their own DIY eJuice at least once in the last three years. Prolific identified 582 of their 148,648 enrolled participants as meeting the eligibility criteria of age and vaping history. All 582 participants were invited to complete an eligibility survey to identify fit for the DIY eJuice mixing criteria, among which 311 were identified as eligible. The final 311 participants were invited to complete the entire study, including five open-ended questions. The open-ended questions are as follows: *Why did you first decide to mix your own eJuice?; Why have you decided to continue mixing your own instead of buying?; What advice for preparing eJuice would you give to vapers who have only ever bought their own eJuice, but are thinking about mixing their own?; What safety*

precautions would you recommend to anyone mixing their own eJuice for their first time?; and Are there any phrases or indicators you look for when assessing the quality/reliability of a recipe/recipe website?.

Participants

Four participants engaged in one of the two pilot test sessions (two per session). Given these low recruitment numbers, the focus group sessions became mini focus groups (Litosseliti, 2003). Following the CDC (2017) classification of smoker (i.e., smoked at least a puff of a cigarette once and smoked at least 100 cigarettes in lifetime), two participants identified as a cigarette smoker. Three participants had vaped on less than ten of the last 30 days and one reported vaping daily. All participants preferred a regulated temperature control ENDS device (as opposed to a variable voltage/watt device) and a medium size device or smaller. None of the participants reported having ever sold their mixed DIY eJuice. Participant ages ranged from 20 to 34 with most participants identifying as female, non-Hispanic, and White. All four participants reported first hearing about DIY eJuice from a friend or family member.

Among the 311 participants identified as eligible for the survey study, 215 participants completed the survey with 138 completing at least one open-ended question and being included in this study. Among the 138 included participants, most identified as male ($n = 104$, 75%), non-Hispanic ($n = 115$, 83%), White ($n = 123$, 89%), and a student ($n = 122$, 88%). Participant age was gathered from Prolific and reported as either 18 or 19 for all participants. Among participants, 59% preferred a regulated temperature control ENDS device, 58% preferred a medium size device, 29% reported having ever sold their mixed DIY eJuice, and 71% reported first hearing about DIY eJuice from a friend or family member. Participant nationality was most commonly described as Polish ($n = 98$, 71%), with representation from 15 additional nations (i.e., Australia, Canada, Estonia, Finland, Germany, Hungary, Italy, Mexico, Norway, Portugal, Russian Federation, Slovenia, Sweden, United Kingdom, and United States).

Thematic coding

To employ a comprehensive review of all data, the transcripts from both modes of data collection were merged for analysis. All files underwent the same coding processes, which followed Strauss and Corbin's (1990) systematic procedures for grounded approach. First, data were read from start to finish to familiarize the researchers with the responses. Researchers took notes on reoccurring ideas and initial reactions. From these notes, open coding (see Corbin & Strauss, 1990) identified initial categories of motivations/benefits, barriers, and cues to action. Next, using Nvivo (2020), data were read again and axial coding (see Corbin & Strauss, 1990s) began by thematically coding within the identified categories. Following Creswell's (2013) processes for employing grounded theory, the final step was that of *memoing*, where the researchers attempted to formulate a process from the thematically coded data. Focus group participants were given pseudonyms

to protect their identity. To enhance readability of participant quotes, filler words (e.g., um, non-verb use of like) were removed.

Results

The grounded theory approach of thematic analysis and flow sketching revealed three thematic processes. First, communication influences from online and social sources were critical to the initiation and continuation of DIY eJuice mixing. Second, personal perceptions surrounding mixing curiosity and control served as primary motivations to mix DIY eJuice. Finally, behavior was enacted stemming from personal analysis of the benefits and barriers to mixing, especially surrounding experiences with cost. Although grounded theory allows for the creation of new theoretical explanations (Creswell, 2013), it is possible for the memoing process to reveal existing theoretical frameworks. Upon closer examination of the themes, it became clear that the determinants of mixing DIY eJuice mirrored key determinants of social cognitive theory (Bandura, 1986).

Social cognitive theory views human behavior as an interdependent relationship between personal, behavioral, and environmental factors that can be influenced by either mediated or non-mediated communication. Specifically, the theoretical propositions outline the following four processes that determine behavioral modeling: attentional (i.e., selected observation), retention (i.e., active processing for memory representation), production (i.e. memory patterns are enacted as behavior), and motivational (i.e., specific forms of behavioral performance reward; Bandura, 1986). From this perspective, humans are “self-developing, proactive, self-regulating, and self-reflecting, not just reactive organisms shaped and shepherded by environmental events or inner forces” (Bandura, 2009, p. 94). These underlying processes are exhibited through three reciprocal, causal determinants: personal, behavioral, and environmental. In turn, these determinants reflect a collective efficacy, where the product of a group is “not only of shared knowledge and skills of its different members, but also of the interactive, coordinative, and synergistic dynamics of their transactions” (Bandura, 2000, pp. 75–76). As displayed in Figure 1, the processes revealed in the analysis maps onto social cognitive determinants and reflect strong collective efficacy among the DIY eJuice mixing community. The following will explore each theme through the lens of social cognitive theory.

Environmental: Social influences & online spaces

Data revealed two distinct environmental factors: social influences and online spaces. For both factors, these environmental sources were central to initiation, cited as the primary reason for first mixing DIY eJuice. In addition, these sources were also key facilitators in the decision of whether to continue mixing.

Social influences were conceptualized as offline, person-to-person influences, most commonly from friends or family members. Beginning with the focus group participants, all four participants reported having learned about DIY eJuice mixing from a friend. For instance, Hannah reflected on the

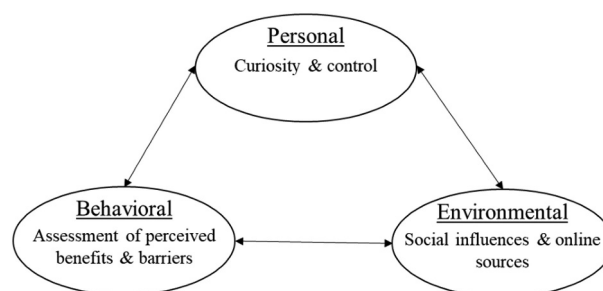


Figure 1. Social cognitive-based theoretical determinants of DIY eJuice mixing behaviors.

first time she encountered DIY eJuice: “They just kind of told me that they made their own liquid. And I was like, oh, I thought you bought liquid. And that’s kind of where I heard about it.” Similarly, Carl, now a junior in college, shared, “When I first heard it, it was back in high school, like I’m at my graduation parties and many of my friends do.” Patti echoed these experiences with her story: “I heard about it from my friend because he was in a frat so he heard his friends talking about this kind of thing. So, we were just chatting and he shared this experience with me.” Even more than just hearing about DIY eJuice mixing from a friend, most of the participants reported their first friend being a primary reference for how to try to mix on their own. Hannah best exemplifies this when she says,

I look at the Internet occasionally, but whenever I did make eJuice it was with him because he kind of knew what he was doing and, also, he was 21 at the time, too. So, he was able to buy things legally and all that. So mostly, it was just learning through him so normally he would mix it and be like, hey, do you want to try it.

Survey participants were also asked to reflect on why they first decided to engage in DIY eJuice mixing. Like the focus group participants, social influences were the most common source for first learning about mixing. Underscoring the decision of focus group participants to have their friends show them how to mix their own eJuice, one survey participant strongly encouraged relying on a peer entirely when first mixing: “Do it only if someone has showed you how to do it; if you try this on your own, you will only lose time and ingredients.” In addition, the role that peer influences played in the DIY eJuice mixing process was frequently mentioned as a means to assess quality recipes and products. To this end, survey participants said, “opinions of other people matter a lot to me,” “I rarely check recipes online, I usually ask my friends about it,” “my friends recommended to me good recipes,” and “I usually ask my experienced friend for an opinion.” Thus, social influences were not only central to learning about and initiating DIY eJuice mixing, they were also critical to participants’ exploring different recipes and product combinations.

Once participants were made away of the option of DIY eJuice mixing, it was clear that most turned to online spaces for additional information and ideas. During focus groups, Jennifer repeatedly reflected on how, after learning about mixing from a friend, she turned to YouTube for additional information. She recalled a particular YouTube influencer that she found especially helpful in learning how to mix:

It's an influencer who she gets paid to vape . . . she saying that you could save money, basically, and that there was different flavors, like the coastal clouds. And then you can have it, like, you can make it with nicotine or without nicotine and there's differences. You can make with percentage wise.

Interestingly, multiple survey participants referenced YouTube as an important source of information that new mixers should consider before trying to make their own eJuice. Participants explicitly cited the platform in statements such as, "Watch a tutorial on YouTube first," "I saw some YouTube videos about vapers saying how more cheap it was to mix," and "It's not complicated and is fun to do, watch some guides on YouTube to get started" whereas other most other participants generally gave non-platform specific advice of, "watch online videos." Another participant suggested that YouTube could even serve as an alternative to beginning with someone who has mixed before: "Start slow and make sure you have somebody who knows what they're doing. Or at least watch a YouTube video." In addition to the reoccurring reliance on YouTube, survey participants repeatedly noted the extensive availability of information on DIY eJuice mixing across the internet.

Personal: Curiosity & control

Participants across both sampling pools cited two distinct personal sources of motivation to either try DIY eJuice mixing or as a reason to continue mixing. These were curiosity and control. First, reinforcing the assumption that DIY eJuice mixing is a trending topic akin to that of a hobbyist community, participants found their own personal curiosity of the trend to lead to wanting to see what the hype was about. For instance, during focus groups, Carl shared "For me, really, it was just curiosity. Honestly, that's the only thing that got me to try it." The simplicity of the role of curiosity was echoed by Patti, who said, "I was just curious." Hannah more explicitly shared that her curiosity stemmed from wondering how DIY mixes would compare to store-bought eJuice: "I just kind of was curious what it was like to compare it from because I used to have a Juul or whatever. So, compare the Juul, like the pods, to what he created." Some survey participants expressed similar forms of general curiosity with statements such as, "I thought it would be fun," "I was curious about the process," and "interested in something new." Most survey participants more explicitly stated curiosity surrounding trying different flavors: "I could experiment with myself to find the best flavors for ME," "to try something new," and "try flavors that were otherwise unavailable." Thus, participants were mostly moved by the novelty of the trend and the possibility of new and unique flavor combinations.

In addition to curiosity, the ability to control the chemical makeup of the liquid, particularly regarding the level of nicotine concentration, was consistently discussed as a primary motivator for, and benefit to, mixing DIY eJuice. During a focus group session, Jennifer compared the increased control that DIY eJuice mixing provides to a level of freedom in vaping when she said, "I didn't really think about the possibility that you could have that I guess that freedom to mix like nicotine and then the CBD." Survey participants echoed these sentiments

with statements such as, "get the flavor/nicotine level I want as well as higher amount of glycerin," "bought eJuices were too weak," "more control to the flavor you want to experience," and "I can control the nicotine level." On the other side of the coin, a few survey participants did caution that new mixers should "not put too much nicotine," "remember about good proportion," "be careful when wanting a certain amount of nicotine and make sure you have the right ratio that you want," and "be careful calculating how much nicotine they want to add."

Although most participants were broad and nonspecific in their reference to heightened control over the level of nicotine, some participants more explicitly made the connection to the control of nicotine allowing those addicted to have a more enjoyable experience. For instance, Patti recognized that the increased control would assist her personal nicotine addiction:

For me, it was the nicotine, you can add the different grade of nicotine. And I thought that was kind of crazy. So that was just the difference for me. That nicotine addiction or that you can add nicotine to it . . . I'll focus on the higher concentration because I'm a cigarette smoker. So, the more, like sometimes if there's not enough nicotine, then I just hit it a lot during the day. But if there's enough nicotine, then it's more likely for me to reduce the level of having an e-cigarette.

Similarly, Hannah also articulated the allowance that DIY eJuice mixing provided for those most addicted to nicotine when she said, "the main difference is you have more control and how much percent of nicotine you want to include. So basically my friend was super addicted. So, he would amp it up as much as he could." Outside of carefully considering the nicotine level, participants did not explicitly mention the risk that liquid concentration levels could be mislabeled or that different chemical combinations might have unexpected reactions.

Behavioral: Perceived benefits & barriers

ENDS users articulated the behavioral motivators of mixing to stem from an internal analysis of perceived benefits and barriers. For some participants, the barriers were not worth the perceived benefits and resulted in verbalized discouragement of mixing. For instance, survey participants noted that DIY eJuice mixing is a "time consuming" endeavor. Repeatedly, participants stated that DIY eJuice mixing was a "hassle" and that buying premade eJuice was "just easier." Jennifer echoed these sentiments in a focus group session when she shared that she is "just too lazy to do eJuice." Carl agreed, citing "too much chemistry" as a reason to just buy eJuice instead of mixing. One survey participant put it simply when they said, "mixing takes a lot of extra work. Sometimes it's just better to find a juice that you take a liking to."

For other participants, the benefits outweighed the barriers and resulted in recommending that it is worth trying or arguing for continued behavioral performance. For instance, one survey participant said, "everyone should give it a try at least once." Typically, these participants did note some cautions and words of advice. For instance, survey participants recommended that mixers "learn some basic chemistry calculations (concentration conversion)," "don't do this alone," "make sure you get the proportions of ingredients right," "be exact with

the weight,” and “make sure that you know exactly where your liquid is coming from.”

The benefits-barriers analysis is best exemplified in participant discussions of the cost of DIY eJuice mixing. Participants frequently cited the perceived cheaper cost of DIY mixing as a personal motivation to mix. Most participants appeared confident, or at least assumed, that DIY eJuice mixing is cheaper than purchasing premixed eJuice. Although this perception was frequent, the rationale was less clear. Patti believed that the cost benefit stemmed from creating higher concentrations of nicotine, which would allow the mix to last longer and save the user money. Survey participants who believed mixing was cheaper were less clear on why they believed that to be true, with statements such as *“it was cheaper,” “price is more affordable,”* and *“I found out its cheaper”*. Other participants referenced social sources as confirmation of the cost benefit, such as *“a friend told me that it’s generally more affordable to mix than to buy”* and *“friend told me it’s cheaper.”*

Interestingly, many survey participants articulated that the perception of mixing being cheaper was a misnomer about DIY eJuice mixing, with statements such as *“it’s cheaper to buy ready eJuice.”* One survey participant suggested that this perception use to be true, but is no longer accurate: *“I’m no longer mixing cause it isn’t cheaper anymore.”* Similarly, during a focus group session, Hannah suggested that there is not a notably different of cost when she said, *“it’s actually not much cheaper. Honestly, when you’re buying all the ingredients and stuff like that, it costs money at the end of the day, it’s like pretty much the same price as what you get from the store.”* More importantly, numerous survey participants warned that any cost benefit is not worth over purchasing pre-mixed products. For instance, one survey participant said,

I am no longer mixing my own eJuice because I am unsure if it is safe for me. I was told by another friend that it is wiser to spend a little more for something that had been tested/that has proven to be safe for people.

In the same vein, other survey participants shared, *“I would buy the eJuice – the main concern was money, but when money is not the problem, bought eJuice are of better quality and flavor”* and *“don’t try to get everything that is cheapest cause it can be bad for you.”* Thus, cost varied slightly but, despite no real evidence, was mostly perceived as a reason to engage in DIY eJuice mixing over purchasing readymade eJuice.

Discussion

The purpose of this study was to employ a grounded theory approach to gather formative data on the communicative processes surrounding the behavior of DIY eJuice mixing among international, young adult ENDS users. Through this lens, data analysis revealed the underlying processes of mixing to be parallel with the behavioral determinants outlined in social cognitive theory (Bandura, 1986). These results present important theoretical implications for the role of health communication constructs in understanding contemporary trends in ENDS use and practical implications for tobacco prevention messaging and tobacco control regulations.

From the lens of social cognitive theory, the environmental, personal, and behavioral determinants are interrelated and interdependent influences (Bandura, 1986). This assumption can be seen within the context of DIY eJuice. For instance, the behavioral determinants were often influenced by the social and online perceptions (i.e., environmental determinants) to which users were exposed. Similarly, personal experiences engaging in mixing, such as cost and control, often provided a conclusion counter to the initial perspective provided by those environmental influences. The themes from this data often served as both the influential factors on initiation, as well as motivational factors on behavioral continuation. This social cognitive theory lens allows tobacco prevention scholars and advocates to better understand the interdependent relationships, motivations, and experiences of ENDS users engaging in the growing trend of DIY eJuice. This formative information provide persuasive leverage points for health campaign efforts seeking to reach, educate, and discourage DIY eJuice mixing.

From a regulatory perspective, the legality of flavors in ENDS products continues to be a primary focus of ongoing conversations. For instance, in the US, Drazen et al. (2019) explicitly called for the FDA to ban flavored ENDS products. As demonstrated in past research (Berg, 2016; Bold et al., 2016; Kong et al., 2015; Morean et al., 2018) and here, flavors continue to motivate exploratory use of ENDS as well as interest in trying new trends in ENDS use. Given Ward et al.’s (2020) findings of how ENDS users responded to the European Union enhancing regulatory oversight of the chemical makeup of eJuice, any regulatory discussion on flavors should anticipate similar backlash resulting in stockpiling flavors for mixing in lieu of regulatory change. Findings from the present study suggest flavor mixing would be a welcomed hobby for many ENDS users.

Consistent with the findings from Cox et al. (2019), the present study found curiosity, perceived lower cost, and control of nicotine levels to be the primary motivators for mixing DIY eJuice. Interestingly, quality control was not mentioned as a pro for mixing as often as it was mentioned as a con against mixing. This is opposite of what Cox et al. (2019) found and suggestive of users’ potential awareness of the inconsistencies in the chemical makeup of mixing materials. Regardless, as more users continue to explore this trend, the lack of quality control guidelines risks the safety of DIY mixers (Davis et al., 2015). The fact that many participants in the present study were vocal about risks and harms associated with mixing suggests that many ENDS users recognize the potential dangers of mixing. Thus, ENDS users might welcome some oversight that could reduce anxiety surrounding mixing uncertainty, such as stricter regulation of concentration levels and approved chemical mixes that have low to no known risk of EVALI. Moreover, these cautionary narratives could be persuasive messaging strategies for health campaigns.

Finally, data revealed the importance of online channels, particularly YouTube, for providing DIY eJuice mixers with information related to content. Should health communication and public health advocates seek to disseminate eJuice-related information to ENDS users, YouTube should be a highly considered channel for communication and public health efforts seeking to reach this global audience. Similarly, should the federal agencies seek to regulate DIY eJuice mixing, YouTube will be an important channel for examining present content as

well as enforcing rules about content promotion in future eJuice-related videos.

Limitations

There are a few limitations that need to be acknowledged. First, although saturation was met in participant responses, the sample consists of a nonrandom, small group of participants. Consistent with the paradigmatic approach of qualitative research, findings from this are not intended to be generalized to other groups or samples. Second, most participants were from Poland. Future research should seek to diversify the global perspectives on DIY eJuice mixing. Finally, the open-ended survey approach did not produce exceptionally rich replies from the survey participants. Future studies should consider including timers with the questions to encourage more rich responses.

Future research

There are numerous directions for future research. First, given the ever-changing nature of Internet-based trends, research should continue to track the latest perspectives and practices in DIY eJuice mixing. Second, researchers should remain reading to support potential quick calls from federal agencies seeking to provide regulatory oversight of DIY eJuice mixing. Similarly, until safety regulations can be clearly provided for DIY eJuice mixers, researchers should explore persuasive approaches that promote use of regulated eJuice. Finally, the platform of YouTube clearly stood out as a central communication platform for this community. Future research should explore the DIY eJuice mixing content available on YouTube as a way to better understand the information and misinformation being promoted to ENDS user seeking to, or already engaging in, DIY eJuice mixing.

Conclusion

As trends in mixing DIY eJuice grow, so do concerns surrounding the labeled nicotine concentration levels in mixing products as well as uncertainty in the implications of inhaling unstudied chemical combinations. Over the last decade, research examining ENDS use has been consistently behind trends in use. The purpose of this study was to provide a social scientific understanding of the communicative processes surrounding DIY eJuice mixing. As this trend grows and regulatory oversight is undoubtedly needed, these findings will be helpful for health communication and public health researchers seeking to better understand, and communicate with, this audience. In addition, these findings will serve to prepare government agencies seeking to regulate DIY eJuice mixing with the types of resistance they are likely to face from this unique group of ENDS users.

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