**Discrete product choices made by young adults who vape regularly
reveal segments of flavor and nicotine focused users**

Allison N. Baker^{1,2} and John E. Hayes^{1,3,*}

¹Sensory Evaluation Center,

²Graduate Program in Neuroscience,

³Department of Food Science, College of Agricultural Sciences,

The Pennsylvania State University, University Park PA 16802

*Corresponding Author:

Dr. John E. Hayes
Department of Food Science
Pennsylvania State University
220 Food Science Building
University Park, PA 16802
814-863-7129 (voice)
Email: jeh40@psu.edu
Twitter: @TasteProf

Running Title: Drivers of eCig selection in adults who vape regularly

Key Words: eCig, vaping, flavor, conjoint analysis, choice-based experiment

Abstract

Introduction: Electronic cigarette ("eCig") use, or "vaping," is increasingly prevalent. Factors such as flavor and nicotine level may influence selection and use of eCigs. A better understanding of the role product attributes play in eCig preferences is necessary to inform evidence-based regulation of electronic nicotine delivery systems (ENDS).

Methods: Here, we used choice-based conjoint (CBC) analysis to quantify different attributes that influence eCig preferences, including flavors, nicotine level, cooling/"ICE" properties, and user reviews. Young adults aged 18 to 25 who had vaped at least once in the past 7 days completed 18 choice tasks, as well as the Penn State Electronic Cigarette Dependence Index (PSECDI). They also answered questions about other nicotine product use and perceived eCig risk. CBC analysis was used to determine utility scores for each attribute.

Results: Flavor was the most important attribute, followed by nicotine level. Sweet flavors, particularly candy ones, had the highest utility scores. Two segments of participants were identified via latent class analysis. The first segment was influenced predominately by nicotine level (with 5% nicotine receiving the highest utility score), whereas the second segment placed greater importance on sweet flavors. Segment 1 membership was associated with higher nicotine dependence, as well as greater likelihood of cigarette or cigar use.

Conclusion: In young adults who vape regularly, flavor is the most important factor in eCig preferences, and sweet flavors – especially candy themed–were most preferred. We also found evidence of two segments: one that appeared more nicotine-focused, and one that appeared more flavor-focused.

Implications: A discrete choice experiment revealed segments of flavor-focused and nicotine-focused eCig users. Strikingly, the more nicotine-focused users, defined strictly via their behavior in a choice task, were also more dependent and more likely to use combustible tobacco. Understanding why individuals choose particular eCig products can help inform public health efforts and policy making.

Introduction

Electronic cigarette (“eCig”) use, or “vaping,” is increasing in popularity, particularly among adolescents and young adults. From 2017 to 2018, eCig use in the past 30 days drastically increased among high school seniors, climbing from 11% to 21%¹. As of 2019, 11.7% of U.S. 12th graders report vaping daily². While federal regulations prohibit the use of flavors other than menthol in combustible tobacco cigarettes, no such rules apply to eCigs currently – meaning eLiquid manufacturers are unrestricted in the flavors they can provide. Thousands of flavors are sold, with diverse categories such as fruits, cocktails, candy, confectionery, and classic tobacco or menthol. It is clear that eCig flavors are a primary reason for product appeal and use in adults³. Although vaping may present less risk than smoking combustible tobacco cigarettes in current smokers, it still carries risk of nicotine use initiation and dependence in individuals who might not otherwise smoke⁴. Thus, it is crucial to improve understanding of the role of flavor in eCig preferences to provide an evidence base for policy making and evidence-based regulation of eCigs.

While there are many types of eCigs on the market, with varying shapes and sizes⁵, newer generations include pod-based devices which may be refillable for customizability. One pod-based device in particular, JUUL, is massively popular, comprising one third of the eCig market as of early 2018⁶. Ease of use and lack of an unpleasant smell have been cited as reasons for Juul use among college-aged individuals⁷. Moreover, data from the 2019 National Youth Tobacco Survey revealed pre-filled pods or cartridges, such as JUUL, make up 53.9% of the types of eCigs used by youths⁸. The present work focuses on pod-based devices, where users can easily swap out prefilled eLiquid pods for use with their eCig device.

A growing body of work has investigated reasons for using flavored eCigs. Soule and colleagues explored reasons for flavored eCig use and reported categories including Increased Satisfaction/Enjoyment, Better Feel/Taste than Cigarettes, Variety/Customization, Food Craving Suppression, and Social Impacts ⁹. Additionally, their participants suggested added flavors could increase the rewarding effects of eCigs. Findings from other studies also highlight the importance of flavor in eCig liking and use. For example, Kim and colleagues assessed liking/disliking of several eCig flavors and reported that sweet flavors were preferred ¹⁰. Litt, Duffy, and Oncken observed that vaping rates were significantly influenced by flavor: tobacco and cherry flavors had the highest vaping rates, whereas chocolate flavors had the lowest rates ¹¹. In a systematic review of consumer preferences for eCig attributes, Zare and colleagues found that adolescents, young adults, and older adults all showed interest in non-tobacco flavors, particularly candy, fruit, and sweet flavors ¹². Similarly, Shang and colleagues found that fruit, sweets, and beverage flavors significantly increased the probability of choosing ENDS in youth ¹³. A recent study by Cooper and colleagues reported that flavor enhances vaping-related initiation and reinforcement-related behaviors in male mice ¹⁴. Collectively, these studies support the idea that flavor is a major facet of eCig preference.

Here, we used a discrete choice experiment to quantify how different factors influence eCig preferences. We opted to use a type of discrete choice experimentation known as choice-based conjoint (CBC) analysis, as this method can be used to systematically quantify preferences for competing product attributes. CBC methods are advantageous because, rather than directly asking participants to explicitly declare which factors they find most important when choosing a product, they ask participants to respond holistically to a series of product vignettes, thereby revealing preferences

they might not even realize they have ^{15, 16}. For more information, see Moskowitz, Beckley, & Resurreccion, 2012 ¹⁷. Similar to prior work ¹⁸, we used a variant of CBC analysis where participants are shown multiple competing product profiles simultaneously and asked which of the products they would choose.

One of attribute we chose to study here was "cooling/ICE," in reference to the cooling sensation present in some eCig flavors. While we were broadly interested in this attribute, we were especially interested in the potential appeal of cooling properties of eLiquids among African Americans who use eCigs. Prior work indicates preference for menthol versus nonmenthol cigarettes is particularly high among African Americans who smoke, and menthol is known to impact smoking initiation rates ^{19, 20}; also, the tobacco industry has aggressively marketed menthol products to African Americans ²¹. Thus, we were interested in whether similar patterns might carry over to eCig flavor preferences.

The primary objective of this study was to investigate various product elements that drive eCig preferences in young adults and quantify their relative importance. Elements tested here were various flavor, cooling/ice sensations, nicotine level, and user reviews. CBC analysis is not intended for formal hypothesis testing per se; that said, we still expected to see several patterns within our data. First, we anticipated sweet flavors, such as fruit and candy, would receive more positive utility scores relative to classic tobacco and menthol flavors. Second, we expected cooling/ice sensations would be an important factor in eCig flavor choices, especially among participants who identified as African American or Black. Third, we had no specific expectations regarding 'user reviews.' Finally, we anticipated there would be different segments (clusters) of users, based on their individual choice behavior: we expected participants might segment in

the types of flavors they liked, but this was not supported by our data. Segments were compared in terms of dependence, and use of other nicotine containing products.

Methods

Participants

Participants between 18 and 25 years of age were recruited by a third-party market research agency (Lucid, LLC, based in New Orleans, LA). To qualify, individuals had to report that they lived in the United States, were fluent in English, and used an electronic cigarette (eCig) at least once in the past 7 days. All data were collected between July and August 2020. Participants provided implied informed consent and could leave the survey without penalty if they elected not to participate. All study procedures were approved by the Penn State Institutional Review Board.

Conjoint analysis

Briefly, in conjoint analysis, specific product elements are grouped into categories (sometimes called attributes or silos), and each category is composed of multiple elements that can be nominal or ordinal items (i.e., levels). Individual elements from each category are permuted via a factorial experimental design to create unique product profiles ('vignettes'). In a CBC task, participants are shown multiple product profiles and asked to select their preferred product. Here, each CBC task had 4 profiles to select from, and a fifth 'none of these' option was also provided, in line with recommended best practices ¹⁵. Individual product profiles contained 4 attributes; an example screenshot is shown in Supplemental Figure 1. Each participant completed a total of 18 CBC tasks. All possible combinations were presented across the entire cohort in a complete block design, though one combination (Menthol with Cooling/ICE) was manually locked as a pair in the design so that it would not be confusing for participants. Table 1 summarizes the product elements tested here; they were chosen

based on our previous experience with conjoint analysis, informal review of vaping websites, and prior literature (e.g. ²²). The User Reviews category was included primarily as a distractor. Elements were based on items used in a previous conjoint analysis study (Baker, et al., under review). All data were collected using Discover-CBC from Sawtooth Software (Orem, UT), a specialized conjoint analysis software platform. Participants were recruited by Lucid and completed the survey using their own devices. Utility scores for attributes (i.e., relative importance), and segmentation were performed within Discover (details below).

Table 1: Product Attributes and Levels

Flavor	Nicotine Level	Cooling/ICE*	User Reviews
Birthday Cake	0%	Present	Relaxes you
Cinnamon Roll	2%	– (Absent)	Reduces stress
Menthol Tobacco	5%		Produces big vapor clouds
Classic Tobacco			Discreet
Cubano			
Strawberry Watermelon			
Gum			
Blue Raspberry			
Sour Gummy			
Mojito			
Piña Colada			
Tropical Mango			
Gala Apple			
*Menthol Tobacco was always paired with Cooling/ICE, as it would not make sense to have menthol present without cooling properties.			

Demographic and Nicotine Use Information

After evaluating 18 CBC tasks, participants were asked to report their age, self-reported ethnicity, race, gender. They also answered questions concerning their use of nicotine-containing products both ever and in the past 7 days (e.g., combustible cigarettes, hookah, etc.) and the degree to which they perceived eCig use to be harmful.

Finally, participants completed the Penn State Electronic Cigarette Dependence Index (PSECDI), a validated dependence questionnaire tailored for eCig use ²³.

Statistical Analysis

Participants with incomplete data were excluded (details below). All CBC data collected in Sawtooth Discover-CBC were analyzed using vendor-provided tools (Sawtooth Lighthouse). Specifically, individual-level logit with Hierarchical Bayes estimation was used to determine utility values (relative importance) of individual elements, including flavor options, nicotine level, cooling/ice, and user reviews. Based on choice behavior, segmentation was performed using latent class analysis, resulting in two clusters (see results below). Using the PSECDI, dependence scores were calculated as a sum of participants' answers, as detailed by original authors ²³. Additional analyses were conducted in SAS University Edition 9.4. (Cary, NC). We used *proc glm* to determine whether PSECDI score could be predicted by segment and *proc logistic* to determine whether cigarette or cigar use (ever or past 7 days) was associated with segment membership.

Results

Participant characteristics

Complete data was available from 983 participants. Of these, 9 individuals self-identified as "another gender not listed here" and were excluded from further analyses due to the small sample size. The final n for analyses reported below was 974, with 673 (69.1%) identifying as White, 179 (18.4%) as Black or African American, 65 (6.7%) as Asian, 19 (1.9%) as American Indian or Alaska Native, 12 (1.2%) as Native Hawaiian or Other Pacific Islander, and 64 (6.6%) as Other. Overall, the sample was well balanced for gender, as 482 of 974 (49.5%) identified as male; inclusion of the 9 individuals who did not identify as either male or female did not meaningfully change the results reported below. The mean PSECDI score across the entire cohort was 8 ± 2.7 , which falls in the low dependence category²³. When categorized using published cutoffs, 34 (3.5%) were not dependent, 524 had low dependence (53.8%), 360 (37%) had medium dependence, and 56 (5.7%) had high dependence. Additional participant demographics are provided in Supplemental Table 1.

Top line results across the entire cohort (n=974)

Across all participants, flavor was the most important attribute in selecting an eCig product, followed by nicotine level; 'user reviews' (i.e., messaging included primarily as a distractor) was the next most important attribute category. Surprisingly, cooling/ice was the least important category. The utility scores for the individual flavor are depicted in Figure 1. Notably, candy (Sour Gummy, Blue Raspberry, Strawberry Watermelon Gum) flavors had the highest utility scores, along with Tropical Mango and Piña Colada. Classic menthol and tobacco flavors had the lowest utility scores. The

highest nicotine level (5%) was strongly positively, whereas 3% nicotine and 0% nicotine both had negative utility scores.

Figure 1: Summary of individual utility scores across the entire sample (n=974). A positive value to the right indicates a positive impact on preference, and a negative value to the left indicates a negative impact on preference. Larger values in either direction indicate a stronger influence on preferences.

As expected, 'user reviews' (i.e., product claims/messaging) were not particularly important for the group. We observed a negative utility score for "Produces big vapor clouds," consistent with prior work (Baker et al., under review). Counterintuitively however, the attribute "Discreet" had a negative utility score. Unsurprisingly, "Reduces stress" and "Relaxes you" both had positive utility scores. Finally, cooling/ice was the least important attribute, as the utility scores are quite small (near zero). Still, as might be expected, "cooling/ice" had a positive utility score and "Not cooling/ICE," indicated by a blank field for this attribute, had a negative utility score. These scores should not be overinterpreted given their small magnitude (i.e., their contribution to overall product selection is minor); still, they suggest participants prefer cooling eCig flavors slightly.

Black/African American participants (n=179) and Cooling/ICE flavors

Given the extensive literature on menthol cigarette use in African Americans (see ²¹), we anticipated cooling/ice might be an important factor in eCig choice for participants who identified as Black or African American. However, our data did not bear this out, as cooling/ice had a utility score of 6.72 for this group, compared to a mean utility score of 7.65 across the entire sample. This attribute also had a slightly lower relative importance compared to other attributes (3.36% in Black or African American participants vs. 3.83% across the entire sample).

Segmentation of participants using latent class analysis

We performed latent class analysis with 5 replications in Sawtooth Lighthouse. Two groups yielded the best segmentation based on group sizes and relative chi-square values. Segment 1 comprised 34.2% of our sample. Notably, participants in this group

showed smaller magnitude of flavor utility scores relative to Segment 2 and had strong positive utility scores for the 5% nicotine level as well as strong negative utility scores for the 0% nicotine level (Figure 2). Interestingly, while the utility scores for Cubano, Classic Tobacco, and Menthol Tobacco flavors were negative in this segment, they were less negative relative to the utility scores given for these same flavors by Segment 2. The magnitude of utility scores for the User Reviews category was also smaller for this group compared to Segment 2. Collectively, we concluded individuals in this group are focused predominately on nicotine level, and other attributes do not strongly influence product choices.

The remaining 65.8% of our sample comprised Segment 2. Individuals in this group showed much larger utility scores for flavor and slightly larger user reviews, relative to Segment 1. Also, they gave slight negative utility scores for both the 5% and 2% nicotine levels and a slight positive utility score for the 0% nicotine level. Participants in this group showed strong preference for the Tropical Mango, Piña Colada, Sour Gummy, Blue Raspberry, and Strawberry Watermelon Gum flavors, as well as a strong aversion to the Cubano, Classic Tobacco, and Menthol Tobacco flavors. Given these characteristics, we believe that this group consists of vapers who are drawn to sweet flavors; some may possibly be interested in no-nicotine eLiquids. Consistent with the topline results showing the cooling/ice attribute was not preference driving, Segments 1 and 2 did not differ in their utility scores for this attribute.

Figure 2: Utility scores for each element, compared across segment. Light blue bars correspond to Segment 1 and dark blue bars correspond to Segment 2.

Relationship between Segment and PSECDI score

To see if individual decisions in the discrete choice experiment – and the resulting segment assignment – would relate to an eCig specific measure nicotine dependence, we tested whether individuals in Segment 1 (the smaller nicotine motivated group) would to have a higher PSECDI score, on average, than Segment 2 (the larger flavor motivated group). Indeed, we found a significant difference in PSECDI score between Segment 1 and Segment 2 [$F(1,973) = 12.76, p = .0004$] in the expected direction: the means for Segments 1 and 2 were 8.57 and 7.92, respectively. Further, when the distribution of each segment's PSECDI scores were visually compared (Figure 3), the distribution was skewed towards greater dependence in Segment 1, consistent with the idea that people in this group are more nicotine dependent. This distributional difference was confirmed via a Kolmogorov-Smirnov test ($KSa = 2.01, p = .0006$).

Figure 3: PSECDI scores by segment. Segment 1 had more individuals in the Moderate Dependence category than Segment 2, and about the same percentage of individuals in the High Dependence category. Scoring is as follows: 0-3 = not dependent; 4-8 = low dependence; 9-12 = medium dependence; 13+ = high dependence.

Relationship between Segment and Combustible Tobacco use

Finally, we looked at whether Segment 1 membership was more likely to be associated with cigarette or cigar use. In logistic regression, members of Segment 1 were 78% more likely than members of Segment 2 to have ever used cigarettes (OR 1.78; Wald CI 1.34 to 2.35; $p < .0001$), and 51% more likely to have used cigarettes in the past 7 days (OR 0.65; Wald CI 0.47 to 0.89; $p < .0001$). Members of Segment 1 were also 95% more likely than members of Segment 2 to have ever used cigars (OR 1.64; Wald CI 1.24 to 2.16; $p < .0001$), and 73% more likely to have used cigars in the past 7 days (OR 0.55; Wald CI 0.34 to 0.9; $p < .0001$).

Discussion.

Here, we used CBC analysis to quantitatively compare eCig elements that are most important and preferred by young adults who vape regularly; these relative preferences were not declared per se, but were instead revealed through a discrete choice experiment. In this U.S.-based sample of young adults, flavor was the most important attribute, with candy flavors receiving the highest utility scores; fruits and alcohol beverage categories also had high utility, although scores were more item specific. The second most important attribute was nicotine level, with 5% nicotine garnering a high, positive utility score and 2% and 0% nicotine receiving negative utility scores across the entire cohort. We then segmented participants into two groups, the first of which showed strong preferences for 5% nicotine and less regard for flavor. The second larger segment appeared to prefer 0% nicotine and placed higher importance on flavors, particularly candy ones.

Across the entire cohort, sweet flavors (especially candy flavors such as Sour Gummy, Blue Raspberry, and Strawberry Watermelon Gum, and fruit flavors such as Tropical Mango) received the highest utility scores. These findings confirm previous work showing strong preference for sweet flavors ^{10, 12}. Here, we selected 12 flavors that were meant to cover fruit, beverage, candy, classic tobacco, and confectionery categories; this list was meant to be varied but not exhaustive, as there are thousands of available flavors to appeal to diverse preferences. Notably, while traditional combustible tobacco cigarette flavors (Classic Tobacco, Menthol Tobacco, and Cubano) received strong negative utility scores across the entire cohort, when split into groups, the first segment rated these three flavors less negatively than did the second segment, and this segment was also more likely to be nicotine dependent. Further, logistic regression

revealed that individuals in this segment were more likely to be (ever or past 7 days) cigarette or cigar smokers than individuals in the other larger segment, which was more flavor-focused. It is tempting to speculate that individuals in Segment 1 likely have greater familiarity with the flavor of combustible tobacco. Because we did not assess when users started using each product, we cannot know if they were former smokers who have now become dual users, or if they were more nicotine dependent vapers who then became smokers of combustible tobacco when eCigs are not available (i.e., the gateway hypothesis; ^{24, 25}). Nonetheless, sweet flavors were still strongly preferred over traditional combustible tobacco flavors in both segments. Importantly, sweet flavors may be perceived as less risky than other flavors ²⁶, which raises further concerns over the appeal and use of such flavors.

Limitations of present work should be noted. Here, we only tested individuals aged 18 to 25 years; thus, our results may not generalize to the broader population of people who vape. In particular, we anticipate underage vapers may have different preferences in eCig selection (see ¹²). Also, while we intentionally recruited individuals who vaped at least once in the past 7 days, we do not have an estimate of participants' daily nicotine intake. Regardless of their preferred nicotine level, individuals who vape also vary in the amount they vape per session and the frequency of sessions; that is, vaping topography may differ substantially (see ^{27, 28}). Thus, we cannot rule out that someone who vapes 2% nicotine frequently may be exposed to more nicotine per day than someone who prefers to vape 5% nicotine infrequently. Finally, many participants reported using other nicotine products, so it is possible that individuals who preferred lower nicotine levels still achieve their desired nicotine effect by using products other than eCigs.

To summarize, in a discrete choice experiment of eCig preferences using choice-based conjoint analysis, flavor was the most important factor in eCig appeal in a cohort of 18-to-25-year old adults in the United States, and sweet flavors – especially candy themed/inspired flavors –were most preferred. Based on choice behaviors, we also found clear evidence of two segments: one that appeared to be more nicotine-motivated and one that appeared to be more flavor-motivated. Notably, the nicotine focused segment was more nicotine dependent and was more likely to have used combustible tobacco than the flavor focused segment. Improved understanding of why individuals opt for particular eCig products may help inform public health efforts and nicotine policy making.

Acknowledgements

The authors wish to thank Stephen J. Wilson PhD for discussions of this work, Lucid for their help with participant recruitment, and our participants for their time.

Funding

This work was supported by the Pennsylvania State University, including the Sarah Chinn Kalser Faculty Research Assistance Endowment from the College of Agricultural Sciences, and a gift from James and Helen Zallie in support of Sensory Science. Dr. Hayes also receives support from the USDA National Institute of Food and Agriculture and Federal Appropriations (Hatch Project #PENo4708 and Accession # 1019852). The findings and conclusions in this publication are those of the author(s) and should not be construed to represent any official US Government determination or policy.

Conflict of interest disclosure

Ms. Baker has no conflicts to disclose. Dr. Hayes has received speaking and/or consulting fees from nonprofit organizations, corporate clients in the food and beverage industries, and federal agencies, including the US Food and Drug Administration Center for Tobacco Products. The FDA CTP was not involved in this project and the views shown here belong solely to the authors. The Sensory Evaluation Center at Penn State also conducts routine taste tests for the food industry to facilitate experiential learning for undergraduate and graduate students; Dr. Hayes is Director of this facility. None of these organizations have had any role in study conception, design or interpretation, or the decision to publish these data.

Author contributions

The project was conceived by ANB and JEH; ANB collected and analyzed the data; ANB and JEH interpreted the data, ANB drafted the manuscript, which was revised by JEH; both authors edited and approved of the final version.

References

1. National Adolescent Drug Trends in 2018. University of Michigan Institute for Social Research; 2018.
<http://www.monitoringthefuture.org//pressreleases/18drugpr.pdf>
2. Abuse NIO. Monitoring the Future 2019 Survey Results: Overall Findings. 2019.
<https://www.drugabuse.gov/drug-topics/trends-statistics/infographics/monitoring-future-2019-survey-results-overall-findings>
3. Meernik C, Baker HM, Kowitt SD, Ranney LM, Goldstein AO. Impact of non-menthol flavours in e-cigarettes on perceptions and use: an updated systematic review. *BMJ Open*. Oct 16 2019;9(10):e031598. doi:10.1136/bmjopen-2019-031598
4. Prevention CfDCA. Quick Facts on the Risks of E-cigarettes for Kids, Teens, and Young Adults. 2020. https://www.cdc.gov/tobacco/basic_information/e-cigarettes/Quick-Facts-on-the-Risks-of-E-cigarettes-for-Kids-Teens-and-Young-Adults.html
5. NIDA. Vaping Devices (Electronic Cigarettes)DrugFacts. 2020.
<https://www.drugabuse.gov/publications/drugfacts/electronic-cigarettes-e-cigarettes>.
6. Willett JG, Bennett M, Hair EC, et al. Recognition, use and perceptions of JUUL among youth and young adults. *Tob Control*. Jan 2019;28(1):115-116.
doi:10.1136/tobaccocontrol-2018-054273
7. Ickes M, Hester JW, Wiggins AT, Rayens MK, Hahn EJ, Kavuluru R. Prevalence and reasons for Juul use among college students. *J Am Coll Health*. Mar 26 2019:1-5.
doi:10.1080/07448481.2019.1577867
8. Association AL. Overall Tobacco Trends. <https://www.lung.org/research/trends-in-lung-disease/tobacco-trends-brief/overall-tobacco-trends>
9. Soule EK, Lopez AA, Guy MC, Cobb CO. Reasons for using flavored liquids among electronic cigarette users: A concept mapping study. *Drug Alcohol Depend*. Sep 1 2016;166:168-76. doi:10.1016/j.drugalcdep.2016.07.007
10. Kim H, Lim J, Buehler SS, et al. Role of sweet and other flavours in liking and disliking of electronic cigarettes. *Tob Control*. Nov 2016;25(Suppl 2):ii55-ii61.
doi:10.1136/tobaccocontrol-2016-053221
11. Litt MD, Duffy V, Oncken C. Cigarette smoking and electronic cigarette vaping patterns as a function of e-cigarette flavourings. *Tobacco Control*. Nov 2016;25:ii67-ii72. doi:10.1136/tobaccocontrol-2016-053223
12. Zare S, Nemati M, Zheng Y. A systematic review of consumer preference for e-cigarette attributes: Flavor, nicotine strength, and type. *PLoS One*. 2018;13(3):e0194145. doi:10.1371/journal.pone.0194145
13. Shang C, Huang J, Chaloupka FJ, Emery SL. The impact of flavour, device type and warning messages on youth preferences for electronic nicotine delivery systems: evidence from an online discrete choice experiment. *Tob Control*. Oct 2018;27(e2):e152-e159. doi:10.1136/tobaccocontrol-2017-053754
14. Cooper SYA, A.T., Henderson, B.J. Flavors enhance nicotine vapor self-administration in male mice. *Nicotine Tob Res*. 2020;doi:10.1093/ntr/ntaa165
15. Software S. What is Conjoint Analysis?
<https://www.sawtoothsoftware.com/products/conjoint-choice-analysis/conjoint-analysis-software>

16. Green P.E. KAM, Wind Y. Thirty Years of Conjoint Analysis: Reflections and Prospects. In: Wind Y. GPE, ed. *Marketing Research and Modeling: Progress and Prospects International Series in Quantitative Marketing*. Springer; 2004.
17. Moskowitz HRB, J.H.; Resurreccion, A.V.A. Developing Relevant Concepts. *Sensory and Consumer Research in Food Product Design and Development*. 2nd ed. ed. Blackwell Publishing Ltd.; 2012:chap 6.
18. Czoli CD, Goniewicz M, Islam T, Kotnowski K, Hammond D. Consumer preferences for electronic cigarettes: results from a discrete choice experiment. *Tob Control*. Apr 2016;25(e1):e30-6. doi:10.1136/tobaccocontrol-2015-052422
19. Rose JE. Nicotine and nonnicotine factors in cigarette addiction. *Psychopharmacology*. Feb 2006;184(3-4):274-285. doi:10.1007/s00213-005-0250-x
20. Administration USFaD. *Preliminary scientific evaluation of the possible public health effects of menthol versus nonmenthol cigarettes*. Food and Drug Administration; 2013.
21. CDC. African Americans and Tobacco Use. <https://www.cdc.gov/tobacco/disparities/african-americans/index.htm>
22. Du P, Fan T, Yingst J, et al. Changes in E-Cigarette Use Behaviors and Dependence in Long-term E-Cigarette Users. *Am J Prev Med*. Sep 2019;57(3):374-383. doi:10.1016/j.amepre.2019.04.021
23. Foulds J, Veldheer S, Yingst J, et al. Development of a questionnaire for assessing dependence on electronic cigarettes among a large sample of ex-smoking E-cigarette users. *Nicotine Tob Res*. Feb 2015;17(2):186-92. doi:10.1093/ntr/ntu204
24. Chapman S, Bareham D, Maziak W. The Gateway Effect of E-cigarettes: Reflections on Main Criticisms. *Nicotine Tob Res*. Apr 17 2019;21(5):695-698. doi:10.1093/ntr/nty067
25. National Academies of Sciences E, and Medicine; Health and Medicine Division; Board on Population Health and Public Health Practice; Committee on the Review of the Health Effects of Electronic Nicotine Delivery Systems. *Public Health Consequences of E-Cigarettes*. National Academies Press; 2018.
26. Strombotne K, Buckell J, Sindelar JL. Do JUUL and e-cigarette flavours change risk perceptions of adolescents? Evidence from a national survey. *Tob Control*. Apr 16 2020;doi:10.1136/tobaccocontrol-2019-055394
27. Cunningham A, Slayford S, Vas C, Gee J, Costigan S, Prasad K. Development, validation and application of a device to measure e-cigarette users' puffing topography. *Sci Rep*. Oct 10 2016;6:35071. doi:10.1038/srep35071
28. Lee YH, Gawron M, Goniewicz ML. Changes in puffing behavior among smokers who switched from tobacco to electronic cigarettes. *Addict Behav*. Sep 2015;48:1-4. doi:10.1016/j.addbeh.2015.04.003