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Initial Development of an E-cigarette Purchase Task: A Mixed Methods Study

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Abstract

Objectives—Behavioral economic purchase tasks, which estimate demand for drugs, have been successfully developed for cigarettes and are widely used. However, a validated purchase task does not yet exist for e-cigarettes. The aim of this project was to identify the relevant units for an e-cigarette purchase task (E-CPT).

Methods—Focus groups (N=28 participants in 7 groups, 2-7 participants per group) consisting of current e-cigarette users were conducted. Participants discussed their daily use patterns, completed a preliminary E-CPT which asked how many puffs of their e-cigarette they would consume per day at escalating prices, and discussed the extent to which the task accurately reflected their real-world behavior. Groups were recorded and transcribed; analysis focused on statements related to daily consumption and the E-CPT.

Results—Participants were unlikely to quantify their daily use in terms of puffs, and perceptions about the appropriate unit for an E-CPT varied across device type. Users of first-generation devices (eg, cigalikes) reported that the relevant unit was the individual device/cartridge; however, participants who purchased nicotine liquid for their device emphasized that e-liquid volume in milliliters would better reflect their use.

Conclusions—Multiple versions of the E-CPT may be necessary to provide valid measures of e-cigarette demand.

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Keywords

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Introduction

E-cigarettes, which are devices that heat a nicotine-containing liquid to a vapor that can be inhaled, are relatively new products that have greatly increased in popularity in recent years.¹ Their use is especially prevalent among current and former smokers.^{2,3} Thus far, the evidence suggests that e-cigarettes have lower abuse liability than tobacco cigarettes and are generally considered to be a reduced-harm product relative to tobacco cigarettes.^{4,5} However, few psychometrically-validated measures that are specific to e-cigarettes yet exist, and a great deal remains to be learned regarding the parameters of e-cigarette reinforcement.

E-cigarettes have rapidly evolved: initially, devices were designed to look similar to traditional tobacco cigarettes (“cig-a-likes”), were activated by drawing on the device, and were sold primarily in convenience stores and other outlets alongside cigarettes. These types of devices are often referred to as “first generation devices” (FGDs) or “closed system” devices, as users cannot easily modify the liquid type of other components.⁶ Recently, however, newer-style devices have moved away from resembling cigarettes, are activated by pressing a button, are highly customizable and offer many flavor options. These devices are often referred to as “advanced generation devices” (AGDs) or “open system” devices as users add their own liquids. This new group of users is growing rapidly yet much remains to be understood about this behavior, and about the relative reinforcing efficacy of vaping among all users of e-cigs.⁷

One powerful tool for assessing reinforcing efficacy is a behavioral economic purchase task.⁸ A behavioral economic purchase task is a measure of the reinforcing efficacy of a given drug, in which participants are asked to state how much of a given substance they would purchase in a typical day at increasing prices, ranging from \$0 (free) up to prohibitively high levels.⁸ These measures generate a demand curve from which several indices can be derived. Demand indices have been found to correlate strongly with real-world use of the substance and with dependence measures.⁹⁻¹¹ Though most purchase tasks are based on hypothetical choices, choice patterns on purchase tasks that result in actual rewards closely correspond to choice patterns for hypothetical rewards.^{12,13} Purchase tasks not only accurately model real-world behavior but also: provide a measure of individual difference in drug reinforcement sensitivity; predict treatment outcomes; reliably distinguish between important subpopulations of users; and are sensitive to the effects of experimental manipulations and drug abstinence.¹⁴⁻¹⁸ Overall, purchase tasks are a valid and reliable way to assess the reinforcing efficacy of a drug.¹⁹ However, to date a purchase task for use with e-cigarettes has not been developed.

Because purchase tasks assess reward value by asking participants how many units (eg, standard drinks, cigarettes) of a drug they would consume in a specified time period (eg, in a typical day) at varying prices, selection of an appropriate unit of consumption is central to developing a valid task. Specifically, the units of the drug must be appropriate for daily

consumption. The unit should permit enough variation to allow for changes in consumption as a function of price, and ideally should be closely related to what a user actually purchases in the real world. For cigarette users, the standard unit of consumption is cigarettes.⁹ However, for e-cigarette users, differences across device type pose a challenge. For example, AGDs are refilled with e-liquid that is purchased by the bottle and measured in milliliters, while FGD users purchase individual e-cigarettes or pre-filled refills. Thus, the purpose of the current study was to obtain qualitative feedback on a preliminary e-cigarette purchase task in order to refine and further develop the measure for use in this population.

Methods

Recruitment, Screening, and Consent

Participants were recruited via Craigslist and flyers left at vape shops and posted around town. To be eligible, participants had to be between 18 and 40 years of age and report using e-cigarettes at least 3 times per week for the last 3 months.²⁰ Age was capped at 40 to reduce a source of e-cigarette motive variability in the groups, while allowing gender and dual use status to vary within and across groups. After screening over the phone, participants were scheduled to attend a focus group. Prior to the beginning of the group, all group members signed informed consent forms and were able to ask any questions that they had about the research. One withdrawal occurred after consent, prior to the start of the focus group discussion, as the participant reported not feeling well. No other participants declined to participate following the consent process.

Design and Population

Seven focus groups were held in a private conference room within a research office suite. Focus groups were stratified by SES level, determined by both education and income level (3 low, 3 medium, one high group).²¹ Income was broken into 3 levels: \$30,000 or less per year, \$30,000-59,000, or \$60,000 per year and above; and education was divided into 3 categories: a high school education or less, some college/associates degree, and completion of a 4-year degree or higher. High SES was defined as greater than \$60,000 per year household income and completion of a 4-year college degree or higher, low SES was considered a high school education or less and an annual income less than \$30,000, and all other categorizations were defined as medium SES. This stratification variable was chosen as price and purchasing behaviors were to be a main theme of discussion in the groups, and these behaviors may be moderated by amount of discretionary income.² The groups included both men and women, and included users of both AGDs and FGDs. Focus groups lasted approximately 90 minutes.

Focus Group Procedures

Each focus group included two to 7 participants ($M = 4$). All focus groups were conducted by the first author, a doctoral level psychologist with expertise in applied behavior analysis and training in focus group facilitation. Discussion was moderated according to a guide developed by the first author, in consultation with the co-authors and other consultants with expertise in e-cigarettes. At the start of each focus group, participants were told that the purpose of the focus group was to gain an understanding of their e-cigarette use patterns.

Specifically, we let them know that we were interested in learning more about why they used e-cigarettes, where and how they buy them, how much they typically spend on them, and how they describe their e-cigarette use. The moderator also explained that the main purpose of the research was to develop a survey measure that asks people about how much they would spend on e-cigarettes if they cost different amounts of money, and to that end, we would be distributing a copy of the measure later on in the group and explaining it so that we could get their feedback. Next, participants introduced themselves and showed the type of e-cigarette device they used, and began a general discussion of why they had begun using e-cigarettes. Then, the moderator facilitated discussion about their motivations for using their e-cigarettes, quantity and frequency of use, and purchasing behaviors.

E-CPT administration—After approximately 30 minutes of discussion, participants were given a version of the E-CPT that asked about their use in terms of puffs per day. The task instructions were adapted from standard purchase tasks and were as follows:⁹

“Think about **HOW YOU ARE FEELING RIGHT NOW**. The following questions ask how many e-cigarette puffs you would take if they cost various amounts of money.

Assume that:

1. The available e-cigarettes are **YOUR USUAL TYPE OF E-CIGARETTE**.
2. You have the same income/savings that you have now and **NO ACCESS** to any other e-cigarettes, regular cigarettes or nicotine products other than those offered at these prices.
3. You can take the e-cigarette puffs without any restrictions and without factoring in what might occur in the next 24 hours.
4. You would take the e-cigarette puffs at this time, and you cannot “save” puffs for later.

Be sure to consider each price increment carefully.”

The task then asked participants how many puffs they would take if they were free, and in 17 increments up to \$5.00 per puff. We chose puffs because this unit applies across all device types, and represents what is actually consumed. The participants each silently filled out the task, and then the group came together to discuss aspects of the task that they liked, disliked, and how well the task represented their real-world behavior.

At the end of the group, participants filled out an exit questionnaire with further questions about their use behavior and demographic characteristics, including a text space where participants were asked to describe their device brand and type. From this information, participants were classified as current users of FGDs or AGDs based on whether their device requires separate purchase of e-liquid and was filled by the users (AGDs/open systems) or was pre-filled with e-liquid (FGDs/closed systems).

Data Analysis

The moderator took notes during the discussion, and all focus groups were recorded and later transcribed verbatim. Codes were developed inductively by the first author based on the moderator guide and substantive research questions. A codebook was developed for coding thematically distinct responses to each substantive research question. These codes were further refined during open coding of field notes. No new thematic codes were identified after coding of the second transcript, indicating that saturation had been reached by completion of the second group. Specifically, after group 2, no substantially new information relating to the substantive research questions was generated. Despite saturation having been reached early, a total of 7 groups were conducted to achieve adequate representation of each SES stratum. Using the codebook, the first and 4th authors each independently coded transcripts using NVivo version 10. Mean inter-rater agreement across all reported themes was 90.84%.

Codes—For the purposes of this analysis, we focused only on the themes relating to measuring quantity and frequency of use, and participant reactions to the E-CPT. The quantity and use themes were further split into “Describing daily use patterns”, “Puffs taken per day” and “Frequency of purchasing e-liquid/new e-cigarettes” subthemes. The E-CPT themes were further divided into subthemes of “Units of consumption”, which addressed what daily units were most appropriate to capture consumption behavior and “Effect of price on use”, which captured statements relating to how prices on the E-CPT impacted hypothetical purchases.

E-CPT demand analyses—From the purchase tasks completed during the focus groups, demand curves were generated by plotting estimated number of puffs consumed as a function of price to examine the range of the estimates of daily consumption that were entered by the participants with the exception of 3 participants: one participant who had substantial missing E-CPT data and two participants whose data were not sufficiently variable to fit a curve. For each participant, 4 indices were derived: Intensity, which is a measure of the number of puffs a person would take in one day if each puff was free; Breakpoint, which is the price at which a participant would no longer purchase any puffs, Omax, which is the maximum amount the participant reported spending per day, and Pmax, which is the price at which Omax occurs. Each of these indices was summarized using descriptive statistics.

Q represents consumption in puffs, C represents price, and Q_0 is a fitted intercept parameter representing consumption at price 0.²³ The scaling parameter k was set to 3 in all reported analyses, and the fitted parameter α describes the rate of decline across the function and is a measure of price sensitivity.

$$Q = Q_0 + k(e^{-\alpha(Q_0 C)} - 1), \quad 1$$

One further participant's data was excluded from curve fitting due to 0 consumption above \$0.02. For each participant, Q_0 , and α were generated and R^2 , an index of goodness of fit, was examined to determine if the equation adequately described the data.

Results

Characteristics of Group Members

A total of 28 participants completed the focus groups. They were 72% male, 27 years old on average ($SD = 7.08$), and 72% white. Participants reported an average time to first vape in the morning of 49.3 minutes ($SD = 73$), and 60% of the sample were primarily users of AGDs. The majority of the sample (67%) reported not smoking tobacco cigarettes at all, while 17.8% reported smoking daily and 14.2% reported smoking some days. (See Table 1 for data on the composition of the focus groups and information reported about device types).

Themes relating to describing quantity and frequency of use—Illustrative quotes related to each theme are given in Table 2.

Describing daily use patterns—Participants were asked to describe a typical daily pattern of e-cigarette use, including an estimate of about how many puffs they took in a day. Many individuals reported using their e-cigarette steadily throughout the day. A participant from FG01 stated: “I don't exactly understand how you want me to explain it [...] I use it, you know, throughout the day pretty much.” Other individuals reported using their e-cigarette at specific times, such as only a few times in the morning or evening, in their car, or only taking a few puffs at a time. Overall, considerable heterogeneity in terms of use patterns was evident across participants.

Puffs taken per day—Participants were asked, in the course of describing their daily use, to estimate to about how many puffs they took per day. Given that the purchase task we formulated asked about use in terms of puffs, we wanted to see if users could estimate their daily use in this way outside of the context of the task. Overall, participants were hesitant in describing their use this way, and it did not appear to come easily to them. Most answers appeared to be very general estimates rather than prior attempts to count or otherwise estimate number of puffs taken. In general, it appears that puffs are not how participants estimate their own daily use (see Table 1).

Frequency of purchasing e-liquid/new e-cigarettes—Participants who used AGDs reported that they most frequently bought bottles of e-liquid and used these as a gauge for how much they were using. For example, a participant from FG01 stated: “If I went through a 10 mL bottle in a few days I would be shocked.” In contrast, FGD users purchase either individual disposable e-cigarettes or packages or refill cartridges which they would replace after a few days. Overall, both groups reported that they didn't typically buy new cartridges or bottles of e-juice on consecutive days, but rather a bottle or pack of refills would last several days and sometimes longer.

Themes related to e-cigarette purchase task—See Table 3 for a sampling of illustrative quotes.

Units of consumption—In keeping with the theme relating to describing their daily use, participants often reported that estimating consumption in terms of puffs was difficult. For example, a participant from FG01 stated: “I just think puffs is a really hard measurement for this.” Similarly, a participant from FG07: “It’s very hard to put a measurement on puffs”; and another participant from FG03 said: “Like, just units of actual puffs, it just varies so widely, it would be really hard to gauge.” During the discussion of the E-CPT, a distinction between AGD and FGD users emerged in terms of how they thought about their quantity of use. AGD users, in contrast to FGD users, often reported that mLs of liquid would more accurately reflect their daily unit of consumption, as some FGD users felt that puffs were reasonable while others felt that cartridges or refills would be more accurate.

Effect of price on use—Participants described their sensitivity to the increasing prices of puffs, and their statements were generally consistent with their self-reported behavior on the task. Some participants reflected on the value of e-cigarettes relative to tobacco cigarettes, and used the price of cigarettes per day as an anchor for interpreting e-cigarette prices; particularly in terms of amount spent per day. As amount spent per day increased to be closer to the amount a person would spend on a pack of cigarettes, consumption behavior decreased. As one participant from FG01 stated:

“Yeah, if the price increased, once it gets to a certain price it’s like no. Because it’s a big thing with switching because it saves you so much money, so that’s one of the big catches of why you want to smoke the e-cigarette versus regular cigarettes.”

Themes related to SES level—No consistent differences emerged across SES level in terms of E-Cigarette Purchase Task themes. Overall, device type was a crucial variable which impacted how participants viewed the task and how to best report their consumption.

Demand indices—Table 4 summarizes the demand indices that were calculated from the puffs version of the E-CPT. In general, the indices—particularly intensity and Omax—revealed a large range, indicating a great deal of variability across participants. The intensity parameter revealed a number of puffs at price 0 that is inside the range of biological plausibility (ie., it is certainly possible to take 100 puffs in a day). Intensity was significantly correlated with number of puffs per day reported on the exit questionnaire ($r = .45$, $p < .05$). Figure 1 plots the group-average demand curves generated by FGD ($N = 10$) and AGD users ($N = 15$) as a function of price. An extra sum-of-squares F test revealed that the two groups were significantly different across both fitted parameters, and the curves did not share an α or Q_0 parameter. Overall, AGD users had greater price sensitivity (as measured by a larger average α value) but higher Q_0 , which indicates a greater initial motivation to vape relative to FGD users. When comparing parameters generated from each individual curve fit, however, R^2 did not differ significantly across groups as measured by t-tests (all p ’s $> .05$), indicating that both groups’ data were well-described by the demand equation.

Discussion

The current study used a mixed methods approach to help inform the development of an e-cigarette purchase task. During the focus groups, participants were asked to describe their daily use patterns. In this study, many participants reported using the device often throughout the day, while others reported using it only a few times per hour. These data are somewhat in alignment with Cooper and colleagues who, in a qualitative study with e-cigarette users, found that use patterns were variable; more often, participants reported using their device only a few times per hour, but at least one participant reported using it steadily throughout the day.²⁴ Differences in use patterns may reflect a number of variables, including device type and cigarette smoking status. As a puffs-based version of the task was used as an exemplar during the focus groups, participants were first asked to try to define their daily use in terms of the number of puffs taken per day. However, this did not appear to be an easy or natural way of determining daily use frequency for the participants. Instead, differences emerged across device type: the frequency of using up “juice” was one method of estimating consumption for AGD users, while FGD users were more likely to describe their use frequency in terms of frequency of replacing cartridges or individual e-cigarettes. Another qualitative study recently reported that e-cigarette users found it difficult to quantify their use, both in terms of daily frequency and even when asked in terms of more specific device and e-juice characteristics.²⁵

Differences between FGD and AGD users in terms of how they described their use continued to be salient during discussion of the E-CPT. Many, though not all, users in both groups found the puff unit to be lacking. For FGD users, the unit that they purchased was the cartridge refill or individual device. In contrast, AGD users consistently reported that units such as milliliters would more accurately reflect their use behavior, as they typically purchased bottles of e-liquid that are categorized according to volume (eg, a standard sized bottle is 15mLs). For AGD users, milliliters (mLs) of liquid are what is actually purchased, and as purchase tasks equate demand to money spent, this unit may best reflect AGD user behavior. However, given the relatively large number of puffs an individual can receive from 1 mL of liquid, mLs may be a relatively imprecise measure of daily consumption. These data, coupled with the difficulty participants had in estimating their consumption in terms of daily puffs outside the context of the E-CPT, strongly suggest that not only are puffs an inadequate method for estimating daily consumption but that the E-CPT unit of consumption may need to be tailored to device type. In contrast, however, the demand data generated from both groups were well-described by a demand equation, indicating overall plausibility of the data generated by the puffs version of the E-CPT. This may indicate that puffs are an adequate measure of the underlying demand processes, despite the fact that participants did not often describe their own consumption in terms of puffs. Comparing the current set of demand indices with data generated by traditional cigarette smokers is somewhat difficult. To compare intensity across e-cigarette users in the current sample and intensity generated by smokers of traditional cigarettes, we can assume that 100 puffs of a traditional cigarette, assuming 10 puffs per cigarette, would be equivalent to 10 cigarettes; which is generally lower than the number of cigarettes smokers would purchase at price 0.^{26,27} In contrast, the reported Omax for the current group is somewhat higher than what has been reported for

cigarette smokers.²⁸ This may reflect a lower intensity of demand but lesser price sensitivity relative to cigarettes; or it may reflect a limitation of the instrument. Further refinements and validation of the instrument against real-world behavior will be needed to clarify this issue.

Another related issue relevant for the development of the purchase task is the frequency of purchasing refills or new devices. The exemplar task used in this study asked about use in a 24-hr period. For both groups, daily purchases seemed to be less common than every few days or weekly buying patterns. FGD users reported that the most relevant unit for them was the individual device or cartridge; however, they often reported rarely consuming (ie, finishing) more than one per day. This could lead to binary response outcomes (ie, E-CPT respondents likely would report purchasing either 0 or 1 unit per day), which poses a problem for demand curve data analyses that require a graded function of consumption. Most AGD users reported that a standard-sized bottle of liquid would last more than a day. If, however, single milliliters could be used as a unit, this may be an acceptable unit of daily consumption that could generate a viable demand curve across a range of prices. Additionally, recent versions of hypothetical purchase tasks for consumer items have used *probability* of purchase rather than number of units purchased and this method could potentially be adapted for use with e-cigarette users.²⁹ However, this method has not yet been used for assessing hypothetical purchases of drugs of abuse. Another possibility is including pictures of the device in question, which has been shown to facilitate comprehension of e-cigarette-related questions, or, in the case of millileters of e-juice, by providing a visual aid in the form of a labeled, standard-sized bottle.²⁵

The two groups of users that we observed may be distinguished not only by their device types, but also by other variables. In support of this hypothesis, Yingst and colleagues recently reported that AGD users use their device more often and report greater e-cigarette dependence than FGD users; were less likely to be using tobacco cigarettes and more likely to be using a lower nicotine concentration than FGD users.⁶ Similarly, several other recent reports have found that AGD users were more likely to have quit smoking cigarettes.^{30,31} In short, differences between groups may reflect more than superficial differences in device type, and in fact reflect different maintaining variables and value of the behavior to the user.

This study has several limitations. The first is the non-independence of the E-CPT and the focus group data. During the group, participants were asked about their use in terms of puffs and the group often anchored their estimates around the estimates of others. Therefore, when the E-CPT was presented, it is likely that the estimates generated were influenced by the prior discussion. Therefore, caution must be exercised when interpreting the quantitative data from the preliminary E-CPT. Furthermore, our small sample is not representative of all users of e-cigarettes. Many participants were recruited from local vape and smoke shops, which may have over-represented the subpopulation of users who purchase supplies in specialty shops rather than convenience stores or online. FGD users in particular made up a smaller portion of the sample, and as noted above, FGD and AGD users may have different motivations for using these products. This preliminary investigation provides an initial basis for further optimizing this task in a larger, representative sample. Furthermore, participants were asked to describe their devices using open-ended text-based questions, which led to a great deal of variation in the specificity of responses. Future research should use a

standardized assessment approach, such as the Electronic Nicotine Product Device Type assessment, which is currently being used in the Population Assessment of Tobacco and Health (PATH) Study.³² This will allow for more detailed comparison of product characteristics in a large sample.

The challenge remains for researchers to tailor purchase task measures to a unit that best reflects real-world behavior. The individual daily unit of consumption is puffs, and puffs per day may be a reasonably sensitive and accurate measure of e-cigarette consumption. It is important to note that in spite of the noted limitations of puffs as a unit, the demand analyses showed that overall participants were able to estimate their consumption in terms of “number of puffs” and were sensitive to the increasing prices on the E-CPT. Ultimately, puffs are a unit of consumption generalizable to all e-cigarette users, regardless of the type of device used. Puffs also have the benefit of a large daily range within and across users. On the other hand, puffs may be a less standardized unit than other options; puff magnitude may vary widely across and even within person due to device voltage, user topography, and other characteristics.³³ Another concern regarding the use of puffs to quantify consumption is that they may not be the most accurate unit for AGD users. In summary, it is not yet clear whether puffs or mLs will more accurately capture the behavior of this growing subgroup of e-cigarette users. The two units should be directly compared to determine which unit best describes vaping behavior. Our future research will examine the predictive and discriminant validity of these two units in the context of an E-CPT across both FGD and AGD users.

Implications for Tobacco Regulation

The regulatory state of e-cigarettes is rapidly developing. As of August 6th, 2016, all e-cigarette devices fall under the regulatory authority of FDA. E-cigarette manufacturers, including small-scale producers of e-liquids such as independent vape shops, are required to submit applications to the FDA in order to determine if these products are fit for public consumption.³⁴ The amount of information and safety data required by the FDA, is, as written in the current deeming rule, may be prohibitive for small and artisanal producers of e-liquids and specialty AGD parts. These regulations, if enforced as written, may substantially reduce the number of AGD producers, particularly small and independent producers; while e-cigarette producers owned by larger tobacco companies may be better positioned to respond to the FDA'S requirements. However, the current deeming rule has been challenged by a number of e-cigarette companies, and the outcome of these challenges may ultimately reduce the regulatory burden on small producers.³⁵ In short, it is not yet clear how the landscape of e-cigarette use may change in the next few years as regulation evolves and what this may mean for the diversity of products available. However, for the near-term future, the mix of products currently on the market will remain available for consumers. Thus, the current study findings have relevance for the short term, and may continue to inform future research.

Research on e-cigarette use is a priority interest area for the FDA Center for Tobacco Products, and a purchase task can provide useful information about both relative and absolute reinforcing efficacy of these products, as well as provide a proxy of motivation to use these products. A validated E-CPT, tailored to device type, will be an important measure

for future studies of the reinforcing efficacy of e-cigarettes. Future psychometric validation will allow the task to be incorporated into future studies of e-cigarette use across various research protocols. Such knowledge will contribute to the science base that may inform future policy decisions.

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Figure 1. Group averaged demand curves generated from AGD and FGD users

Table 1
Composition of the Focus Groups and Descriptions of Participant E-Cigarette Devices

Group 1 Mid SES		
ID#	Sex	Classification and Participants' Description of Device
007	Female	AGD: Ego
009	Female	FGD: Blu
011	Male	AGD: Ego
017	Male	AGD: Vision/Kanger Tank
Group 2 Low SES		
015	Male	FGD: Disposable
021	Female	AGD: Elo T
Group 3 High SES		
005	Male	FGD: Blu
016	Male	AGD: Kanger Tech, White Horse Refillables
025	Male	FGD: Green Smoke
Group 4 Low SES		
019	Female	AGD: Vape Pen
020	Male	FGD: Disposable
030	Male	AGD: Ke Cig 101, Stillare RDS
031	Male	FGD: Disposable
035	Male	AGD: Ego
037	Male	AGD: Mt. Baker Vapor Juice
038	Male	AGD: 18650 Mod Clone
Group 5 Mid SES		
051	Male	AGD: Sigelei 150
057	Male	AGD: itaste MVP with GCB tank
058	Male	FGD: Vuse (Regular)
060	Female	AGD: iStick 30w
Group 6 Low SES		
045	Female	AGD: Ex Ohm V2.1+Herakles Tank
046	Male	AGD: Vapor Shark RDVA 40
090	Male	FGD: Logic
Group 7 Mid SES		
077	Female	AGD: Dovpo
078	Male	AGD: Sigelei 150 with Turbo RDA

092	Female	FGD: Vaporfi Express
093	Male	FGD: NJoy
095	Male	FGD: White Horse brand disposables

Table 2
Illustrative quotes from focus groups relating to measuring quantity and frequency of use

Theme	Illustrative Quotes
Describing daily use patterns	<p>FG01: "I don't exactly understand how you want me to explain it [...] I use it, you know, throughout the day pretty much."</p> <p>FG07: "So you know it's just periodically throughout the day, and I can vape at work too."</p> <p>FG02: "I use it consistently all day long."</p> <p>FG05: "It's usually just consistent throughout the day."</p> <p>FG 03: "I find myself taking a few drags every hour or so. Whereas with a normal cigarette it's an experience in and of itself where you sit there for 5-10 minutes and chill there with it. This I can just casually puff it and then put it away."</p> <p>FG07: "I'm usually like once or twice a day, usually in the morning and sometimes at night, sometimes it's both. But I actually work from home [...], but I still don't really like to do it throughout the day, you know what I'm saying? Like it's just once or twice, you know."</p>
Puffs taken per day	<p>FG03: "Uhh, I don't know, 50? 60?" "If I had to guess, like I'd be so bold as to say like 75-100." "I'd say it varies, you know, it really does. But yeah I mean if I'm really not caring I could have 50% of my inhales. But yeah I mean probably around that like 50-70 number. Maybe less, probably less actually because if you think of the disposables they say you can get like 200 puffs out of them?"</p> <p>FG05: "I can actually check." <i>[Moderator: Oh, you have a counter?]</i> "I'd say more than ten for me." "Yeah I have no idea, I mean it's way more than ten, but I'm not using like I'm not dripping or anything like that, so there's a difference. So I don't know, I'd say like 50." <i>"/Checks device puff counter/</i> Well I feel bad, mine's like 310." FG07: "I'm probably only between 2 and 4 but that's because I only do it once or twice a day." "Too many to count." "I'd say about 12-15." "I'd have to be between 100-200, somewhere in there. I love vaping." "It would probably be under 100, but it would be up there."</p>
Frequency of purchasing	<p>FG01, AGD users <i>[referring to e-liquid purchasing]:</i> "Yeah it's probably like probably once a week maybe, once every other week." "Once every other week, yeah."</p> <p>FG07, AGD user: "I mean this thing was supposed to save me money and it has not saved me money at all whatsoever. I mean I'm looking at about \$15-20 a day on liquid. I mean like I said that bottle I just got it, it was like \$22 and, you know, I'll kill that whole thing on a good day, or a bad day depending on your perspective."</p> <p>FG03, FGD User: "Well, what I would do is, so a pack of them would contain 5 cartridges and that was \$15, so I would buy two of those at a time at the start of each month. That would last, each package that would last me two weeks each so I'm trying to like do the math what that would be."</p>

Table 3
Illustrative quotes from focus groups relating to the E-CPT

Theme	Illustrative Quotes
Units of consumption	<p>FG06: “I go by, looking at this, I have to put in my head how much money I would be willing to spend a day to vape, you know what I mean.” “Yeah, considering how much is a bottle of juice. [...] Like a bottle, I would go through a 30 mL bottle in like a couple days. So what's that cost like \$20, you know so I'm thinking I would spend, but I'm not going to spend that for 5 puffs.”</p> <p>FG04: “I would still say mL is the best bet. That would be a lot better than the puffs because no one really counts how many puffs.” “Yeah, I would totally pay 5 cents a mL.” “I did the math for a typical bottle I buy, it's 80 cents a milliliter for me.”</p> <p>FG05: “Have you ever considered using price per milliliter?” <i>[Moderator: Would that be more helpful?]</i> “Yeah this is really sort of confusing because like for 10 puffs for him that's like a half a mL, for me it would be like maybe a milliliter.” “I think milliliters would be easier too. I thought I was the only one that was confused.”</p> <p>FG03: “I think number of disposables would be good, for one day; well it takes about two days to go through like one disposable for me.”</p> <p>FG05: “I was just trying to figure, for instance, I broke it down to each filter comes out of about 50 puffs. <i>[So you were trying to convert it to your cartridges?]</i> Yes I was trying to envision that for me.”</p> <p>FG01: “Well I'm saying if you use like a standard, if you use a standard ten mL bottle I mean use that as like, you know, how many of those would you go through in a week, an hour, how often do you buy them? You know, or how often do you buy a disposable? I think that would make sense.”</p>
Effect of Price on Use	<p>FG03: “Personally my cut off point was like after 50 cents each, that's just ridiculous.” “Yeah from 60 onward I was just like zero, zero, zero.” “Mine was 40 cents, that's when I hit zero.” “Yeah mine was at 60 cents, I put like two puffs or something.”</p> <p>FG04: “I think if it came down to it and it ended up being \$30 for a 15mL, I wouldn't even vape anymore, it's ridiculous. It's too expensive.” “I would probably stop too.”</p> <p>FG06: “d quit, I'd have to. I mean I wouldn't have to but it would be crazy. \$50 for 10 puffs and you take 80 puffs a day!? Come on.”</p> <p>FG01: “I would not spend more than 1- bucks.” “I probably wouldn't spend more than 7.”</p>

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Table 4

Preliminary demand indices from puff version of E-CPT

	M	SD	Median	Min	Max
Intensity (puffs/day)	119.7	112.2	100	4	500
Breakpoint	\$1.40	\$1.50	\$0.90	\$0.05	\$5.00
O _{max}	\$15.20	\$17.90	\$12.00	\$2.00	\$90
P _{max}	\$0.50	\$0.70	\$0.40	\$0.05	\$4.00