Drug and Alcohol Dependence 177 (2017) 14–22

Contents lists available at ScienceDirect

Drug and Alcohol Dependence

journal homepage: www.elsevier.com/locate/drugalcdep

Full length article

Behavioral economic substitution between conventional cigarettes and e-cigarettes differs as a function of the frequency of e-cigarette use

Sarah E. Snider[a], K. Michael Cummings[b], Warren K. Bickel[a,*]

[a] Addiction Recovery Research Center, Virginia Tech Carilion Research Institute 2 Riverside Circle, Roanoke, VA, 24016, USA
[b] Department of Psychiatry and Behavioral Sciences, Medical University of South Carolina, 68 President Street, Charleston, SC, 29425, USA

ARTICLE INFO

Keywords:
E-cigarettes
Behavioral economics
Demand
Substitution
Frequency of use
Cigarettes

ABSTRACT

Background: Models measuring the interactions between consumption of conventional cigarettes and electronic cigarettes (e-cigarettes) in the marketplace are becoming vital forecast tools as the popularity of e-cigarettes increases and policy on tobacco products changes. Behavioral economics, which involves the integration of psychology and consumer demand, can be used to measure individuals' purchase behavior under different marketplace conditions. Our goal was to measure hypothetical conventional cigarette and e-cigarette purchasing among smokers with varying e-cigarette use patterns.

Methods: Daily cigarette smokers were recruited using Amazon Mechanical Turk, an online crowdsourcing tool. Participants were asked about their frequency of e-cigarette use and to complete hypothetical single and cross-commodity purchase tasks.

Results: Frequency of e-cigarette use differentially affected how individuals consumed both conventional and e-cigarettes in different hypothetical marketplace conditions. The present study demonstrates four main findings: 1) the demand for conventional cigarettes was the lowest in those with greater frequency of e-cigarette use, 2) the demand for e-cigarettes was the highest in those with greater frequency of e-cigarette use, 3) when both products were available together, daily e-cigarette users purchased more e-cigarettes, but e-cigarettes served as a substitute for cigarettes in all groups regardless of frequency of use, and 4) the demand for conventional cigarette demand was lower in frequent e-cigarette users when e-cigarettes were concurrently available.

Conclusions: Together, these data suggest that price and marketplace conditions will impact purchasing behavior of conventional and e-cigarettes users heterogeneously. Therefore, frequency of use patterns should be considered when implementing novel policies and/or marketplace changes.

1. Introduction

In the present tobacco marketplace, the product landscape is shifting such that prices for conventional cigarettes are increasing at the same time that alternative nicotine delivery products, like electronic cigarettes (e-cigarettes), are becoming more prevalent (King et al., 2013; McMillen et al., 2015). In fact, based on the recent Population Assessment of Tobacco and Health (PATH) data, the prevalence of e-cigarette use was 5.5% of adults, which represents approximately 13.7 million people in the U.S. (Kasza et al., 2016). Moreover, frequent e-cigarette use (using 20 out of the past 30 days) was reportedly 1.5%, which would represent approximately 3.7 million Americans. Interestingly, adults who are most likely to use e-cigarettes are those who are current cigarette smokers, compared to former and never smokers (Caraballo et al., 2016; Delnevo et al., 2016). Consequently, most e-cigarette users are, to some degree, dual users who are faced with many choices in the marketplace.

When making purchasing choices in the tobacco marketplace, the extent to which (i.e., frequency) an individual uses conventional or e-cigarettes or both, can impact their demand for different products. For example, greater conventional cigarette valuation was demonstrated by those who smoke cigarettes more frequently (Mackillop et al., 2008; Murphy et al., 2011). A gap in our knowledge, however, is how different frequency of use patterns for *e-cigarettes* will influence consumer behavior in the marketplace under various conditions. Therefore, forecast tools to model interactions between individuals' product use patterns, types of products (e.g., conventional cigarettes and e-cigarettes), and their prices, are needed to clarify their effects on consumer behavior on a greater scale.

Behavioral economics, which involves the integration of psychology and consumer demand, can measure hypothetical purchase behavior for a commodity under different market conditions (Hursh, 1984). The

* Corresponding author.
E-mail addresses: wkbickel@vtc.vt.edu, patsym@vt.edu (W.K. Bickel).

http://dx.doi.org/10.1016/j.drugalcdep.2017.03.017
Received 18 October 2016; Received in revised form 23 February 2017; Accepted 7 March 2017
Available online 19 May 2017

hypothetical purchase task, for example, can be implemented to examine the number of commodities (e.g., cigarettes or e-cigarettes) an individual may hypothetically purchase at increasing prices (Jacobs and Bickel, 1999). Consistent with consumer-demand theory, commodity consumption has been demonstrated to decline with greater prices, generating what is known as a demand curve (Hursh, 1984; Mackillop et al., 2008). A behavioral economic demand curve can yield two important parameters that describe an individuals' valuation for cigarettes, 1) the intensity of the demand (i.e., Q_0; total purchases at free price); and 2) the elasticity of demand (i.e., alpha; sensitivity to price) (Hursh, 1984; Hursh and Silberberg, 2008). Consequently, this procedure can be used to experimentally demonstrate decreases in consumption of conventional or e-cigarettes as a function of increasing price (Grace et al., 2015a; Huang et al., 2014; MacKillop et al., 2012).

Behavioral economic procedures can also assess the interaction of multiple commodities available concurrently. That is, as the price of commodity A increases, a concurrently available and constantly priced commodity B can act as a substitute (i.e., consumption increases), complement (i.e., consumption decreases), or not impact consumption of the other product (i.e., independence) (Bickel et al., 1995). The interaction that emerges between the two commodities is a product of the valuation of the alternative as defined by its magnitude and the relative prices of both commodities (Bickel et al., 1995). Therefore, in addition to empirical measurement of conventional and e-cigarettes alone, identifying how alternative nicotine products interact when available together can help to predict the way in which consumers, may substitute, complement, or alter purchasing independently as a function of the valuation and relative prices of the products in a variety of marketplace conditions.

Several reports have previously demonstrated that conventional and e-cigarettes interact. For example, a study conducted in New Zealand (N = 210) reported that daily smokers substituted concurrently available e-cigarettes for conventional cigarettes when the price of cigarettes increased (Grace et al., 2015a). Moreover, purchasing patterns can differ based on the availability of alternative products. Previous studies have shown that consumption of conventional cigarettes is reduced when alternative commodities (i.e., e-cigarettes, de-nicotinized cigarettes, gum, and/or money) are available (Grace et al., 2015b; Johnson et al., 2004; Johnson and Bickel, 2003; Quisenberry et al., 2016). This second finding emphasizes an additionally relevant variable for predicting consumer behavior − marketplace availability of alternative products.

Examination of these interactions may help shed light on the impact of conventional cigarette taxation or bans, and or e-cigarette subsidies/vouchers. However, such price modifications will not impact the market homogeneously. That is, perhaps increasing cigarette price will cause some smokers to quit smoking entirely and others to increase consumption of alternatives more readily. Importantly, hypothetical purchases are correlated with purchases of laboratory-based real and potentially real cigarettes (Wilson et al., 2016). Therefore, hypothetical purchases provide reasonable indications for how individuals may consume these products in the real world.

Therefore, the present study examines how an individual will purchase both conventional cigarettes and e-cigarettes alone and in combination as a function of price and the frequency with which they currently use e-cigarettes. Based upon our earlier studies with conventional cigarettes, we hypothesized that the frequency of e-cigarette use would 1) reduce demand (lower intensity and raise elasticity) for conventional cigarettes, 2) increase demand for e-cigarettes, and 3) interact with conventional cigarettes whereby demand would decrease for cigarettes giving rise to increased substitution for e-cigarettes.

2. Material and methods

2.1. Participants

Participants (N = 385) who were U.S. registrants of Amazon Mechanical Turk, a crowd-sourcing service, accessed the Human Intelligence Test (HIT) titled "Hypothetical purchase research on cigarettes and e-cigarettes". Participant eligibility requirements included being at least 18 years of age, smoke 10 or more cigarettes per day, and have at least a 90% approval rating from previous HITs. The participants who were eligible to accept the HIT implied consent when the participant indicated they understood the study description and accepted the HIT. No personally identifiable data were collected. All procedures in this study were reviewed and approved by Virginia Tech's Institutional Review Board.

2.2. Procedure

Participants were first asked to provide some general demographic information (i.e., age, gender, income, race). Participants were asked to indicate all races that applied to them, including American Indian or Alaskan Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, White/Caucasian, and/or Other.

Next, participants were asked to provide answers to several brief questionnaires including how many cigarettes they smoked per day, the Fagerstrom test for nicotine dependence (FTND) (Heatherton et al., 1991), perceived health risk of cigarettes (Hatsukami et al., 2016), whether or not they were trying to quit smoking cigarettes (or had immediate plans to do so), and how frequently they used e-cigarettes. The participants then completed a series of hypothetical purchase tasks based on the cigarette purchased task (Jacobs and Bickel, 1999; described in detail below). Participants also completed a series of other behavioral tasks as part of a larger unpublished study, the results of which did not influence the current data and are not reported here.

2.2.1. Frequency of E-cigarette use

Participants were asked to indicate their frequency of use of e-cigarettes from one of the following options: "More than 20 times per day", "11-20 times per day", "1-10 times per day", "4-6 times a week", "1-3 times week", "1-3 times a month", "Less than once a month", "I did not use e-cigarettes in the past six months, but I have in the past", or "Never". These choices were then combined to create "Daily", "Weekly", "Monthly", Less than once in 6 months", and "Never user" frequency groups for data analysis.

2.2.2. Hypothetical purchase tasks

2.2.2.1. Cigarettes alone. During this task, participants were asked to indicate how many single cigarettes they would purchase if they were available at incrementally increasing prices ($0, $0.12, $0.25, $0.50, $1). Participants were asked to assume they were purchasing cigarettes for their own consumption in a 24-h period and that they did not have access to cigarettes outside of the present task. Participants were also instructed not to assume they could stock-pile or give away any of the hypothetical cigarettes they were purchasing.

2.2.2.2. E-cigarettes alone. Participants were asked to indicate how many disposable e-cigarettes they would purchase if they were available at incrementally increasing prices ($0, $3, $6, $12, $24). Participants were asked to assume they were purchasing e-cigarettes for their own consumption over a 24-h period and that they did not have access to any other nicotine product outside of the present task. Again, participants were instructed not to assume they could stock-pile or give away any of the hypothetical e-cigarettes they were purchasing.

2.2.2.3. Cigarettes and E-cigarettes available concurrently. Participants completed a hypothetical cross-price purchase task. In this task