Examining the psychometric properties of the CEAC (Comparing e-Cigarette and Cigarette) Questionnaire and its usefulness as a predictor of e-cigarette use

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Introduction

Electronic cigarettes (e-cigarettes) represent the most important recent innovation in the smoking market. They are battery-operated devices that do not contain tobacco, but operate by heating nicotine and other chemicals into an aerosol that is inhaled. Since their introduction to the market, e-cigarette use has increased rapidly among adult populations in many countries (Ash, 2018; Hue et al., 2016) as e-cigarettes are perceived healthier, less addictive, and more socially acceptable than conventional cigarettes (Patel et al., 2016; Peters et al., 2015). Indeed, current available evidence indicate that e-cigarettes are likely to be less harmful than conventional cigarettes (Ash, 2018), while there is increasing evidence that e-cigarette use is an effective smoking cessation tool (Russell, Haseen & McKeganey, 2019; Zhu et al., 2017). On the other hand, the long-term health effects of e-cigarette use are still being examined, while some studies suggest some negative health consequences of e-cigarette use, including negative influences on cardiovascular health and reduced immune defence in the lung (Glatz & Bareham, 2018). Additionally, longitudinal studies have shown that e-cigarette use is predicitive of increased cigarette consumption (Dunbar et al., 2018) and the uptake of cigarette use in young adults and adolescents (Spindle et al., 2017). Owing to conflicting information about the effects of e-cigarettes, combined with the increased rates of e-cigarette use, research is needed to better determine risk factors for e-cigarette use.

E-cigarettes are marketed as alternatives to conventional cigarettes, thus the comparison between e-cigarettes and cigarettes is inevitable. Such comparison is significant because the more that individuals perceive e-cigarettes as being more beneficial than cigarettes, the more likely they may be to transition from cigarettes to e-cigarettes, or even transition from non use to e-cigarette use. Cross-sectional studies also indicate that holding favourable attitudes towards e-cigarettes is associated with e-cigarette use among adult smokers (Blake et al., 2015; Pepper & Brewer, 2015). These findings were confirmed in a longitudinal study in the UK of smokers and former smokers, who were more likely to use e-cigarettes one year later if they perceived them to be less harmful and more socially acceptable than cigarettes at baseline (Brose, Brown, Hitchman, & McNeill, 2015). Thus, attitudes towards e-cigarette use could be considered a potential risk factor for e-cigarette use.

Hershberger, Karyadi, VanderVeen, & Cyders (2017) adopted a more structured approach to assess e-cigarette attitudes by directly comparing them to cigarette attitudes.

They developed and tested in a US population a 17-item questionnaire empirically derived from the existing e-cigarette belief literature: the Comparing E-cigarette And Cigarette (CEAC) questionnaire (Hershberger, Karyadi, et al., 2017). They conducted exploratory factor analysis on these 17 items, eventually retaining 10 items and identifying three factors: General benefits from e-cigarette use compared to cigarette smoking; general effects e-cigarette use has compared to cigarette smoking; and health benefits of e-cigarette use compared to cigarettes. The present study is utilizing this recently developed measure in order to assess participants' attitudes towards e-cigarette use. Prior to this, it aims to replicate the factor structure of the CEAC and assess its psychometric properties in a different population. If we can do so, this will help establish the CEAC as a robust and reliable measure of attitudes towards e-cigarettes to help and uncover why individuals across different populations might be more likely to use e-cigarettes.

Another factor potentially associated with e-cigarette use is trait impulsivity, given the association of this trait with cigarette smoking (Kale, Stautz & Cooper, 2018). Trait impulsivity, conceptualized as a tendency to engage rapidly in behavior without thinking about the consequences of this behavior (Evenden, 1999), is now widely seen as a multidimensional construct. It comprises five separate, but related, impulsive traits (UPPS-P model; Cyders & Smith, 2007; Cyders et al., 2007): negative urgency (the tendency to act rashly in intense negative emotional states); positive urgency (the tendency to act rashly in intense positive emotional states); lack of premeditation (the tendency to act without planning); lack of perseverance (the tendency not to finish tasks); and sensation seeking (the tendency to seek out novel and exciting experiences). Research examining the relationship between e-cigarette use and the impulsivity-related traits based on the UPPS-P model has been limited. Some recent work suggests that sensation seeking and lack of perseverance are positively related to e-cigarette use (Cohn et al. 2015; Doran & Tully, 2018; Spindle et al., 2017), while a study conducted by Hershberger, Connors et al. (2017) provide initial support for a model in which impulsivity is related to e-cigarette use through positive e-cigarette attitudes. In particular, their findings suggest that higher levels of urgency are related to more positive e-cigarette use attitudes, and that the endorsement of these attitudes is related to greater likelihood of e-cigarette use. Individuals reporting higher levels of deficits in conscientiousness, as measured by two facets from the UPPS-P (lack of premeditation and lack of perseverance), held less positive attitudes towards e-cigarettes. The data for the Hershberger, Connors, et al study was obtained from a US population, where e-cigarettes are regulated as tobacco products (US Food and Drug Administration, 2016), and there is no regulation for e-cigarette nicotine content.

In the current study, we seek to replicate and extend the work by Hershberger, Connors et al by utilising a sample from a different population, based in Europe, where e-cigarette regulations are more liberal and e-cigarettes can be described as a Nicotine Replacement aid for cigarette smokers trying to quit. Additionally, e-cigarette nicotine content is capped at 20 mg/ml (McNeil, Brose, Calder, Bauld & Robson, 2019). On that basis, the structure of attitudes towards e-cigarettes in Europe might be different from that in a US population. Thus, the aims of the present study are, firstly, to examine the psychometric properties of the CEAC by testing its purported factor structure, reliability and its measurement invariance across e-cigarette use groups in a European sample. Secondly, we

sought to examine whether the relationship between impulsivity-related personality traits and e-cigarette use would be mediated by positive attitudes towards e-cigarettes.

Hypothesis one is that e-cigarette users will hold more positive attitudes towards e-cigarette use, and will exhibit higher levels of impulsivity-related traits, than non e-cigarette users. Hypothesis two is that the relationship between impulsivity-related traits and e-cigarette use will be mediated by positive attitudes towards e-cigarettes. It is important to understand the relationship between attitudes, trait impulsivity and e-cigarette use in order to design effective prevention and intervention strategies that can be generalized to any target population.

Methods

Participants

Participants were recruited as part of a larger research study on e-cigarette use and its relationships with impulsivity, smoking and other risk factors. Recruitment occurred online using three different methods; the Goldsmiths Psychology Department's research participation scheme, where participants took part in exchange for course credits, notice boards in social media and via Prolific, which is an online web service that connects researchers with individuals willing to complete tasks for a wage. Prolific participants were paid £0.90 in return for 10 minutes participation time.

We recruited 529 participants living in Europe; however, four participants were removed from the study prior to data analysis for not completing any items from the CEAC questionnaire, resulting in a final sample size of 525.

The study received ethical approval from the Goldsmiths, University of London, Department of Psychology Ethics Committee. Data collection occurred between November 2017 and May 2018.

Measures

Demographics and product use status

Participants reported their age, gender, ethnicity, and employment status. For the purposes of the present study, e-cigarette use was assessed with the following question: "Do you currently use any of the following products (select all that apply)." (cigarettes, e-cigarettes, cigars, hookah, smokeless tobacco, other tobacco product 'even 1 puff', none of these)."

We first conducted analyses using all participants split in to two groups, defined as follows: those choosing e-cigarettes, including those who used any other product on the above list, were designated as 'e-cigarette users', while those choosing any other response apart from e-cigarettes were designated as 'non e-cigarette users'. We then conducted two other sets of similar analyses with a subset of the total number of participants. One set including those participants who use e-cigarettes only and none of the other products (exclusive e-cigarette users), and those who replied 'none of these' (non users), and another set including exclusive e-cigarette users, and exclusive cigarette smokers. All sets of analyses showed similar results, so we present here only the first set of analyses referred to above as conducted using all participants.

Attitudes towards e-cigarettes

The 10-item CEAC questionnaire (Hershberger, Karyadi et al. 2017) was used to assess attitudes towards e-cigarettes compared to cigarettes. Item were rated on a 5-point likert scale (1=strongly disagree to 5 strongly agree). Less than 0.01% of CEAC data was missing, and it appeared to be missing at random. Missing data were imputed using multiple imputation.

Impulsivity

Impulsivity was measured using the 59-item UPPS-P Impulsive Behavior Scale (Cyders et al., 2007; Whiteside & Lynam, 2001), which assesses five dimensions of impulsivity: negative urgency, positive urgency, lack of planning, lack of perseverance, and sensation seeking. The dimension measures have been shown to display good convergent and discriminant validity (Smith et al., 2007). The alpha reliabilities in the present sample were: lack of premeditation=0.88, lack of perseverance=0.84, sensation seeking=0.85, negative urgency=0.90, positive urgency=0.96, which are similar to past published studies. Correlations between the UPPS-P subscales showed modest correlations between the subscales, range 0.02 to 0.75 with the highest correlation between negative urgency and positive urgency. Less than 0.01% of UPPS-P data was missing, and it appeared to be missing at random. Missing data were imputed using multiple imputation.

Analytic procedure

General descriptive analyses were performed to describe the whole sample and the two groups of participants; e-cigarette users and non e-cigarette users. Group differences were identified by performing Chi-square tests or independent sample t-tests as appropriate. Confirmatory factor analysis was performed to examine the structure of the CEAC questionnaire. Additionally, we assessed between-group e-cigarette use invariance for this questionnaire by testing configural, metric (constraining loadings to be equal across groups), and scalar (constraining loadings and intercepts to be equal across groups) invariance (Widaman & Reise, 1997).

Finally, a structural path analysis was conducted to replicate the model identified by Hershberger, Connors et al (2017). In order to replicate this model, each item from the UPPS was left free to load on its respective *a priori* facet only. Two higher order impulsive personality latent variables were then further defined: urgency, with loadings from positive and negative urgency, and deficits in conscientiousness, with loadings from lack of premeditation and lack of perseverance. The sensation-seeking latent factor was simply defined by its constituent items from the UPPS-P. Similarly, the ten items from the CEAC were left free to load on their respective *a priori* factor only. These three factors, general benefits, health benefits, and general effects, then loaded on a higher order e-cigarette attitudes latent factor. E-cigarette use was modelled as a measured dichotomous variable (e-cigarette use or no e-cigarette use). We included pathways from each of the three higher order latent impulsivity variables to 2) the latent variable of e-cigarette attitudes based on the three scales of CEAC questionnaire to 3) the measured variable of e-cigarette use (See Figure 1).

We used maximum likelihood estimation of the covariance matrix to ascertain statistical fit and we report the following fit indices for each analysis (Bentler, 1990; Hu & Bentler, 1999): model χ^2, the comparative fit index (CFI), the Tucker-Lewis index (TLI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR). Rules of thumb for CFI and TLI values suggest that values between 0.90 and 0.95 indicate acceptable fit, and values above 0.95 indicate good fit (Hu & Bentler, 1999). RMSEA values of <0.05 are taken as good fit, 0.05-0.08 as moderate fit, 0.08-0.10 as marginal fit, and >0.10 as poor fit (Hu & Bentler, 1999), and SRMR values of less than 0.08 indicate acceptable fit, while a value of zero indicates perfect fit (Hu & Bentler, 1999). However, it has been argued that the cut off values of these indices are arbitrary and lower values do not necessarily indicate that the data did not fit the model well. In particular, it has been suggested that inconsistencies in the results of the RMSEA and CFI indices can occur because these two indices are designed to evaluate fit of the model from different perspectives (Lai & Green, 2016).
Confirmatory factor analyses and path analysis were conducted using the lavaan package in R3.0.1 (Rosseel, 2012), the remaining analyses were conducted using IBM SPSS version 23.

Results

Preliminary analysis and participant characteristics

Overall the mean age of participants was 33.42 (SD=11.27), ranging from 18 years to 68 years, the majority were female (59.45%), of white ethnicity (92.2%), and in full-time employment (61.6%). The participants comprised of 244 (46.5%) e-cigarette users and 281 (53.5%) non e-cigarette users. Table 1 provides descriptive statistics by e-cigarette use status.

Average scores on the UPPS-P scales ranged from 1 to 4, where 4 indicates higher trait expression. E-cigarette users differed significantly only on positive urgency and lack of perseverance than non e-cigarette users, with e-cigarette users scoring higher on positive urgency ($t(523)=-2.50$, $p=0.013$), but lower on lack of perseverance, than non users ($t(523)=2.07$, $p=0.039$).

Confirmatory Factor analysis and measurement invariance for the CEAC

Confirmatory factor analysis (Table 2) of the *a priori* structure for the CEAC questionnaire on the whole sample showed an adequate fit for the model : $\chi^2(df=32)=172.85$, CFI=0.94, TLI=0.91, RMSEA=0.09 (0.08-0.11, 90% Confidence Interval), SRMR= 0.06. All items had robust factor loadings on their respective factor, and the three factors correlated positively and strongly with each other (range r=0.60 to r=0.79).

Table 3 shows the results of the analyses for testing measurement invariance across e-cigarette users and non e-cigarette users. As shown for the configural (1) and metric (2) models, CFI, and SRMR values indicated moderately good model fit, while RMSEA values indicated marginal model fit. The difference in CFI values between the full metric invariance model (2) and configural model (1) was less than 0.01, suggesting that invariance can be assumed based on recommendations by Cheung and Rensvold (2002). They suggest that the ΔCFI is a robust statistic for testing the between-group invariance of CFA models, and invariance can be assumed when this value is 0.01or less.

The model (3) assessing scalar invariance met the SRMR criteria for acceptable fit, the RMSEA criteria for marginal fit, while the CFI value indicated a less than ideal model fit. CFI difference of model (3) and model (2) indicates that full scalar invariance cannot be assumed. Modification indices were then used to identify which item intercepts were non-invariant. Results showed that item 8 (Compared to traditional cigarettes, electronic cigarettes can improve health), had an intercept that was non-invariant across groups. We then identified a model (3a), where partial invariance was allowed by freeing the intercept of item 8. Results indicated a better fitting model, where the CFI difference between model (3a) and model (2) was 0.009. We then assumed partial scalar invariance and the latent mean differences were estimated. After allowing for partial invariance, e-cigarette users scored higher on all three factors compared to non e-cigarette users ($p<0.001$).

The average scores of each CEAC subscale were then calculated for e-cigarette users and non e-cigarette users (Table 4). These scores ranged from 1 to 5, where 5 indicates more favourable attitudes towards e-cigarettes. Comparison of e-cigarette users with non e-cigarette users in CEAC subscales showed that e-cigarette users scored significantly higher in all CEAC subscales than non e-cigarette users.

Structural Path analysis

Fit indices for the model (Figure 1) examining the relationship between impulsive personality traits, e-cigarette attitudes and e-cigarette use were as follows: χ^2(df=2325)=5516.97, RMSEA=0.051 (0.049-0.053, 90% Confidence Interval), SRMR=0.075, CFI=0.84, TLI=0.83. These results shows that the model met the RMSEA criteria for good fit, and also met the SRMR criteria for an adequate fit, but CFI and TLI values indicated a less than ideal model fit.

Urgency was significantly and positively related to e-cigarette attitudes ($\beta=0.19$, $p=0.018$). Deficits in conscientiousness were significantly negatively related to e-cigarette attitudes ($\beta=-0.20$, $p=0.01$). Sensation seeking did not show any significant relationship to e-cigarette attitudes ($\beta=0.06$, $p=0.27$). E-cigarette attitudes scores were significantly higher for e-cigarette users than non-users ($\beta=0.59$, $p<0.001$). There were no significant direct paths from impulsivity traits to e-cigarette use (urgency: $\beta=0.08$, $p=0.18$; deficits in conscientiousness: $\beta=-0.05$, $p=0.41$; sensation seeking: $\beta=-0.06$, $p=0.17$).

Discussion

Results of the present study confirmed the factor structure of the CEAC questionnaire and showed full configural and metric measurement invariance, and partial scalar measurement invariance across e-cigarette use groups. Additional analysis identified one item (8. Compared to traditional cigarettes, e-cigarettes can improve health) that is potentially affected by product status use. E-cigarette users had higher latent means for this questionnaire item than non e-cigarette users.

The present study also examined the relationship between impulsivity-related traits, as described by the UPPS-P, attitudes towards e-cigarettes and e-cigarette use. Our findings are comparable to the Hershberger, Connors et al (2017) study and suggest that higher levels of

conscientiousness are related to more positive attitudes towards e-cigarettes, and subsequent e-cigarette use. Urgency is positively related to e-cigarette attitudes and subsequently to e-cigarette use, while no significant relationship is found between sensation seeking and e-cigarette use. Moreover, the results of the present study show that there is no significant direct effect of impulsivity-related traits on e-cigarette use.

The fit of the structural model tested, as judged by standard fit indices, is not as good as the one described by Hershberger, Connors et al (2017). The discrepancies found could be the result of the model definition. The present study used the individual item scores to compute the five latent variables of UPPS-P scale and subsequently the higher order variables of impulsivity-related traits, and the three latent factors of e-cigarette attitudes. Hershberger, Connors et al used the mean score across all items of each sub-scale to construct their latent variables. It has been suggested that the optimal way of computing latent variables is to use individual item level indicators, rather than parcels or aggregates of items (Marsh, Ludtke, Nagengast, Morin, & VonDavierrtf, 2013), so the present study is likely to give a better indication of model fit.

A significant indirect path from urgency to e-cigarette use via attitudes towards e-cigarettes was found, providing preliminary evidence that urgency is related to the development of positive e-cigarette use expectancies, which subsequently may contribute to elevated risk of e-cigarette use. Negative and positive urgency have been previously linked to positive substance use expectancies, and subsequently to problematic substance use (Settles, Cyders & Smith, 2010). Theoretically, urgency combines two facets of behavior considered to be more prominent in those at greater risk for substance use disorders: the inability to control one's actions and the inability to regulate one's emotions (Tarter et al., 2003). It is suggested that high-urgency individuals are particularly vulnerable to engaging in risky behaviors, especially under conditions of high emotional intensity (Dinc & Cooper, 2015; Cyders & Smith, 2008). One possible explanation for such behavior is that individuals high in positive urgency have increased expectations that substance use has positive, arousing effects, and these expectations lead to actual substance use. Additionally, negative urgency leads individuals to hold increased motives to use addictive substances to cope with subjective distress (Settles, Cyders, & Smith, 2010).

Our findings also suggest that higher levels of conscientiousness, as measured by two facets from the UPPS-P (lack of premeditation and lack of perseverance), are related to more favourable attitudes towards e-cigarettes compared to cigarettes. Conscientiousness involves strong will, determination, responsibility and the observance of rules, and has been linked to healthier lifestyles; regarding cigarette smoking, high conscientious individuals tend to be non-smokers (Terracciano & Costa, 2004). Available evidence does seem to indicate that e-cigarettes are likely less harmful than traditional cigarettes (Public Health England, 2015). Thus, it might be the case that people high in conscientiousness hold more favourable attitudes towards e-cigarettes compared to cigarettes based on such evidence.

The pattern of differential links between UPPS-P factors and e-cigarette use found in the present study might suggest that trait impulsivity affect e-cigarette attitudes via two distinct pathways; cigarette smokers higher in conscientiousness engage with e-cigarette use because of the perceived health benefits of e-cigarette use compared to cigarette smoking,

whereas those higher in urgency engage with e-cigarettes because of positive expectancies of e-cigarette use.

There are some limitations to the current study which mean that the conclusions above need to be treated with some caution. The data were self-reported and relied on participants' ability and willingness to report accurately about their behaviour. However previous studies have shown that self-reported smoking was validated strongly by biological markers (Wong, Shields, Leatherdale, Malaison, & Hammond, 2012). Additionally, the cross-sectional nature of this study does not allow one to draw causal interpretations with confidence. Though we hypothesized that the direction of the mediational pathway runs from impulsivity-related personality traits to e-cigarette attitudes to e-cigarette use, it could be the case that e-cigarette use may influence the attitudes towards e-cigarettes.

Findings of the present study support our hypotheses as they showed that e-cigarette users hold more positive attitudes towards e-cigarettes, while they exhibit higher levels of positive urgency. It was also found that positive attitudes towards e-cigarettes mediate the relationship between impulsivity-related traits and e-cigarette use. Additionally, the present study showed that the CEAC questionnaire could be considered a valid and reliable questionnaire to measure attitudes towards e-cigarettes use across different populations. It also suggests that impulsivity-related traits and attitudes towards e-cigarettes are likely important risk factors for e-cigarette use. Future prospective and experimental studies should test if the causal model described in this study predicts risk for e-cigarette use, and whether this model could therefore be used to guide strategies for reducing risk for e-cigarette use among those who are non-smokers, and especially young adults and adolescents, as recent surveys have shown that e-cigarette experimentation and use has risen the last few years in this group of people (Wang, King, Corey, Arrazola, Johnson, 2014; Bauld et al., 2017). Consideration should also be given to the prevention strategies which might prove effective, such as focusing on changing overly positive views of e-cigarettes by communicating the risks associated with e-cigarette use both to non smokers and smokers. Reducing cigarette consumption, but sustained dual use of cigarettes and e-cigarettes may still confer substantial disease risk and could increase one's risk for cardiovascular disease and lung cancer. E-cigarettes might function best as a valuable harm reduction tool for addicted smokers, if this results in complete smoking cessation.

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Table1. Descriptive statistics, and mean and standard deviations for the UPPS-P Impulsive Behavior Scale by e-cigarette use status

Variable	Non e-cigarette users n= 281		E-cigarette users n= 244			
	Mean	SD	Mean	SD	t(df)	*p*-value
Age	31.33	10.87	35.83	11.26	-4.65 (523)	<0.001
UPPS-P						
Negative Urgency	2.48	0.62	2.47	0.60	0.23 (523)	0.815
Positive Urgency	2.05	0.70	2.19	0.60	-2.50 (523)	0.013
Lack of Premeditation	2.03	0.48	2.00	0.45	0.88 (523)	0.378
Lack of Perseverance	2.14	0.50	2.05	0.50	2.07 (523)	0.039
Sensation Seeking	2.52	0.59	2.56	0.61	-0.66 (523)	0.510
	No	%	No	%	Chi^2(df)	*p*-value
Gender						
Male	95	33.8	118	48.6	11.75 (1)	0.001
Female	186	66.2	125	51.4		
Ethnicity						
White	258	91.8	224	92.6	0.100 (1)	0.751
Other	23	8.2	18	7.4		
Occupation						
Student	116	41.3	22	9.1	69.77 (2)	<0.001
Employed	138	49.1	185	76.1		
Unemployed	27	9.6	36	14.8		

n=number of participants, SD=standard deviation, df=degrees of freedom

Table 2. Factor loadings for confirmatory factor analyses of CEAC questionnaire

Thematic Facets	1. General benefits	2. Health benefits	3.General effects
1. General benefits			
1.Electronic cigarettes can be used to quit or cut down on smoking traditional cigarettes	0.81	0[a]	0
2. Electronic cigarettes are less expensive than traditional cigarettes	0.59	0	0
3. Electronic cigarettes are more convenient or easier to use than traditional cigarettes	0.41	0	0
4. Electronic cigarettes are more enjoyable to use than traditional cigarettes	0.45	0	0
5. Electronic cigarettes are more socially acceptable to use than smoking traditional cigarettes	0.40	0	0
2. Health benefits			
6. Electronic cigarettes are less harmful to the user's health than traditional cigarettes	0	0.88	0
7. Electronic cigarettes are less harmful to the health of those in close proximity to the user than traditional cigarettes	0	0.87	0
3. General effects			
8. Compared to traditional cigarettes, electronic cigarettes can improve health	0	0	0.64
9. Using electronic cigarettes, compared to traditional cigarettes, can improve my general sense of smell	0	0	0.91
10. Using electronic cigarettes, compared to traditional cigarettes, can improve my sense of taste	0	0	0.90
Factor Correlations			
1. General benefits	-		
2. Health benefits	0.79*	-	
3. General effects	0.65*	0.60*	-

*p<0.001

[a] Confirmatory Factor Analysis: each item is restricted to load only on its corresponding scale, while its loadings to the other scales are constrained to be 0.

Table 3. Measurement invariance by e-cigarette use

Model	χ^2	df	CFI	RMSEA (90%CI)	SRMR	ΔCFI	$\Delta\chi^2$	Δdf	$\Delta\chi^2 p$
1. Configural	192.04	64	0.926	0.09(0.07-0.10)	0.06				
2. Metric	213.59	71	0.918	0.09(0.07-0.10)	0.08	0.008	21.55	7	0.001
3.Scalar	266.79	78	0.892	0.10(0.08-0.11)	0.08	0.026	53.20	7	<0.001
3a. Scalar with partial invariance (item 8)	237.55	77	0.909	0.09(0.08-0.10)	0.08	0.009	23.96	6	<0.001

df=degrees of freedom; CFI=comparative fit index; RMSEA=root mean square error of approximation; CI=confidence interval; Δ = difference.

Table 4. Mean and standard deviations for the Comparing E-cigarettes and Cigarette questionnaire (CEAC) by e-cigarette use status

Subscale	Non e-cigarette users n= 281		E-cigarette users n= 244			
	Mean	SD	Mean	SD	t(df)	*p*-value
General benefits	3.16	0.62	3.89	0.61	-13.47 (523)	<0.001
Health benefits	3.37	0.98	4.16	0.78	-10.03 (523)	<0.001
General effects	2.83	0.93	3.70	0.81	-11.32 (523)	<0.001

n=number of participants, SD=standard deviation, df=degrees of freedom

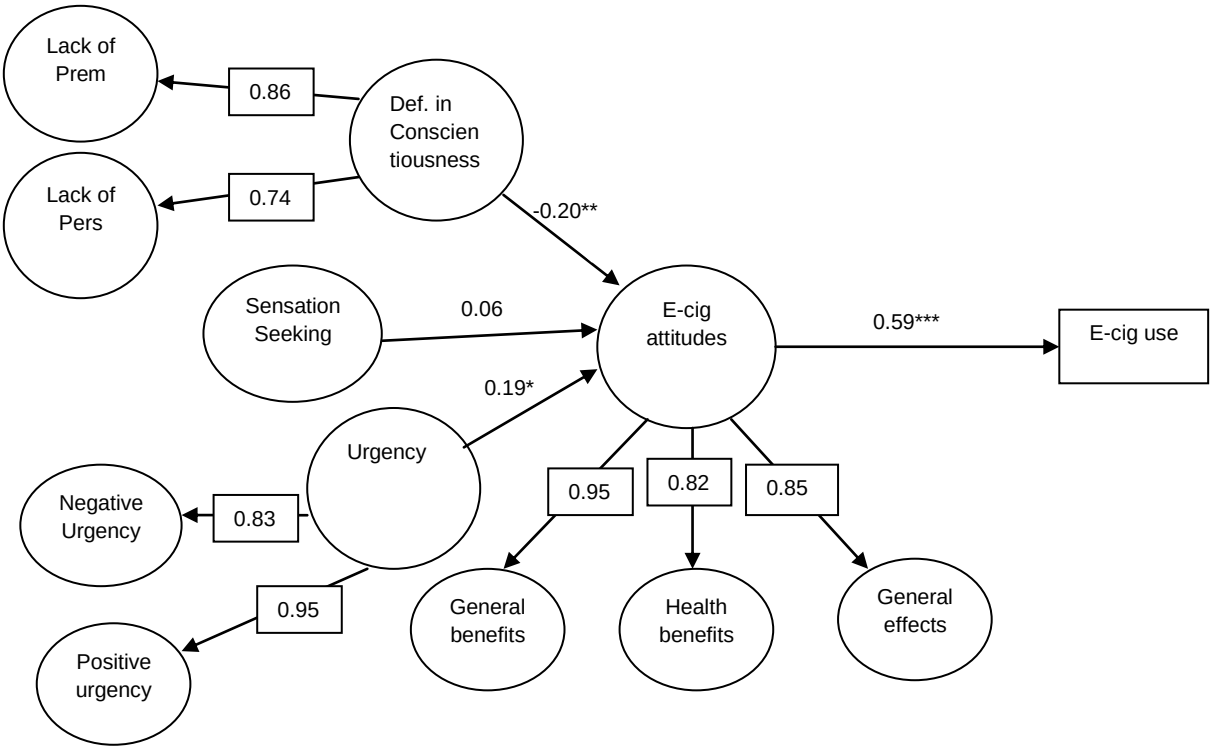

Figure 1. Structural path analysis examining the relationship between impulsive personality traits, e-cigarette attitudes and e-cigarette use, χ^2 (df=2325) =5516.97, CFI=0.84, TLI=0.83, RMSE=0.051 (0.049-0.053, 90% Confidence Interval), SRMR=0.075

*p<0.05, **p<0.01, ***p<0.001

There were no significant direct paths from impulsivity traits to e-cigarette use.

Prem=Premeditation, Pers=Perseverance, Def=Deficits, E-cig= E-cigarette