

Environmental reward and depressive symptoms in the relationship between avoidance and cigarette dependence in treatment-seeking smokers

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Abstract

Background: The current study sought to further examine the relation between avoidance, environmental reward, depressive symptoms and cigarette dependence. **Method:** The sample included 275 adult treatment-seeking daily smokers ($M_{age} = 45.36$, $SD = 10.96$; 61.5% female). To examine the relationships between the study variables, correlation and serial mediation analyses were conducted. **Results:** A significant positive relationship between cigarette dependence, avoidance, and depressive symptoms, and a negative relationship with environmental reward was found. Mediation analysis revealed a significant indirect pathway from avoidance to cigarette dependence through depressive symptoms; and also a significant indirect serial pathway from avoidance to cigarette dependence through environmental reward and depressive symptoms. **Conclusions:** Our findings suggest the importance of avoidance, environmental reward and depressive symptoms in cigarette dependence. Our findings contribute to the understanding of behavioral and psychological factors related to cigarette dependence, which is a well-known barrier to abstinence. Thus, it could be useful to assess and address such variables in the context of smoking-cessation interventions.

Keywords: Cigarette dependence, avoidance, depressive symptoms, perceived environmental reward.

Resumen

Reforzamiento ambiental percibido y sintomatología depresiva en la relación entre la evitación conductual y la dependencia del tabaco en fumadores que buscan tratamiento para dejar de fumar. Antecedentes: el presente estudio tiene como objetivo examinar la relación entre la conducta de evitación, el reforzamiento ambiental percibido, la sintomatología depresiva y la dependencia del tabaco. **Método:** la muestra estaba formada por 275 fumadores que demandan tratamiento para dejar de fumar ($M_{edad} = 45,36$, $DT = 10,96$; 61,5% mujeres). Para examinar la relación entre las variables de estudio se realizaron análisis de correlación y de mediación serial. **Resultados:** se encontró una correlación positiva significativa entre la dependencia del tabaco, la evitación y la sintomatología depresiva, y una correlación negativa significativa con el reforzamiento ambiental percibido. El análisis de mediación serial reveló una vía indirecta significativa entre la evitación y la dependencia del tabaco a través de la sintomatología depresiva; así como entre la evitación y la dependencia del tabaco a través del reforzamiento ambiental percibido y la sintomatología depresiva. **Conclusiones:** los resultados de este estudio contribuyen a la comprensión de factores conductuales y psicológicos implicados en la dependencia del tabaco, la cual es considerada una barrera para lograr la abstinencia. Por lo tanto, la evaluación y abordaje de estas variables podría considerarse un aspecto relevante en el contexto de las intervenciones para dejar de fumar.

Palabras clave: dependencia del tabaco, evitación, sintomatología depresiva, reforzamiento ambiental percibido.

Smoking is considered by the World Health Organization as the most significant preventable cause of death and disease worldwide (World Health Organization [WHO], 2017). Despite the well-known consequences for quality of life and physical and mental health, the prevalence of tobacco smoking among adults still reaches 28% in Europe (WHO, 2017) and 15.5% in

the U.S. (Jamal et al., 2018), constituting a major public health challenge.

Smokers tend to report that one of the primary motives for smoking is to cope with, escape from, and/or avoid negative emotional states, and stressful situations (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004). According to behavioral theories, avoidance is defined as attempts to prevent, escape from, or diminish contact with aversive or minimally rewarding internal (e.g., thoughts, emotions) or external stimuli. Previous research has suggested that avoidance could be considered a transdiagnostic process that is implied in substance use (Aldao, Nolen-Hoeksema, & Schweizer, 2010; Chawla & Ostafin, 2007). In fact, avoidance could be considered as a negative reinforcement mechanism, that contributes to smoking dependence

(Baker, Brandon, & Chassin, 2004). For instance, research has shown that, among anxious/depressed smokers, avoidance of smoking-specific negative internal states is positively associated with smoking dependence and certain cognitive-affective processes such as, for example, perceived barriers to smoking cessation (Zvolensky, Farris, Schmidt, & Smits, 2014).

It has also been proposed that access, availability, and engagement in alternative positive reinforcers are decisive to smoking behavior (Bickel et al., 2014). In this regard, it seems more probable that an individual will choose to smoke if the environmental reward is low, due to the expectation of a positive reinforcement obtained through smoking, as well as the increase in the rewarding value of cigarette smoking (Perkins et al., 2017). In fact, recent research has found that engagement in non-smoking-related rewarding activities, is related to smoking abstinence at short and long-term (Schnoll et al., 2016).

Both avoidance and the perception of environmental reward are related to depressive symptomatology (Wagener et al., 2016). Studies suggest that avoidance strategies used to cope with psychological distress lead to a reduced frequency of positively reinforced behavior and to a limited contact with alternative and healthy reward resources, which in turn produces, maintains, or worsens depressive symptomatology (Jacobson et al., 2006). Moreover, reduced positive reward explains, at least partially, the relationship between avoidance and depressive symptoms (Carvalho & Hopko, 2011).

Research indicates that depressive symptomatology is clearly related to smoking, and to tobacco dependence (Bakhshaei et al., 2015). Studies have shown that cigarette-dependent smokers are more likely to suffer from depression (at clinical and subclinical levels), and the presence of depressive symptoms, even at minimum levels, is related to smoking persistence and cessation failure (Cooper et al., 2016; Leventhal, Ramsey, Brown, LaChance, & Kahler, 2008; Niaura, Shadel, Goldstein, Abrams, & Brown, 2001). Additionally, depressive symptoms tend to be more severe in cigarette-dependent smokers than in non-dependent smokers (Jamal et al., 2012). Among treatment-seeking smokers, depressive symptoms are a relevant concern due to their high prevalence in this population and the associated clinical implications (Leyro et al., 2016). Concretely, past major depression or the presence of depressive symptoms at baseline, are associated with a lower likelihood of abstinence achievement during and after smoking-cessation (Hitsman et al., 2013).

The previous data highlight the relevance of investigating the relationship between avoidance, environmental reward, depressive symptoms and cigarette dependence among treatment-seeking smokers; as such variables could be related to abstinence outcomes. Thus, the main objective of the present study was to determine whether avoidance exerts, at least partially, its influence on cigarette dependence through environmental reward and depressive symptoms. We hypothesized that (i) cigarette dependence would show significant positive correlations with avoidance and depressive symptoms, and significant negative correlations with environmental reward; and (ii) both environmental reward and depressive symptoms would mediate the relationship between avoidance and cigarette dependence.

Method

Participants

The sample included 275 adult treatment-seeking daily smokers ($M_{age} = 45.36$, $SD = 10.96$; 61.5% female) recruited from

the community to participate in a randomized controlled trial (RCT) (clinicaltrials.gov#NCT02844595). This study adhered to CONSORT guidelines and the research design and methods of the RCT have been described in detail in the RCT protocol published previously (Becoña et al., 2017).

Individuals were eligible if they were at least 18-years-old; wished to participate in the treatment program; provided written informed consent; and smoked at least 8 cigarettes per day. Exclusion criteria were: a diagnosis of severe mental disorder (bipolar disorder and/or psychotic disorder); concurrent substance use disorder (alcohol, cannabis, stimulants, hallucinogens and/or opioids); having participated in the same or similar treatment over the previous year or having received pharmacological treatment to quit smoking over the previous year; presence of a high life-risk pathology (i.e., recent myocardial infarction); and/or smoking tobacco products other than cigarettes.

Instruments

Two baseline assessment sessions were carried out in a face-to-face interview examining demographics, cigarette use, and depression treatment history. The above-described validated instruments were also administered.

- Smoking Habit Questionnaire (Becoña, 1994), consisting of 56 items designed to gather information both on sociodemographic variables (sex, age, marital status, educational level) and tobacco use (i.e., number of cigarettes smoked per day).
- Avoidance Subscale of the Behavioral Activation for Depression Scale (BADSD; Kanter et al., 2007; Spanish version of Barraca et al., 2011). This subscale consists of eight items that represents a tendency to avoid negative aversive thoughts and feelings, and to engage in rumination rather than active problem solving. This BADSD subscale has demonstrated high internal consistency and has shown high correlations with the Acceptance and Action Questionnaire (AAQ; Hayes et al., 2004), which focuses on a similar concept of “experiential avoidance” (avoidance of thoughts, feelings, and other private events). The internal consistency of this subscale in this sample, as measured with Cronbach’s alpha, was .81.
- Fagerström Test of Cigarette Dependence (FTCD; Fagerstrom, 2012; Spanish version of Becoña & Vázquez, 1998). It is made up of six items for the assessment of cigarette dependence, yielding a total score between 0-10. Scores ≥ 6 are considered to be indicative of dependence. In the present sample, the internal consistency obtained by Cronbach’s alpha was .62.
- The Environmental Reward Observation Scale (EROS; Armento & Hopko, 2007; Spanish version of Barraca & Pérez-Álvarez, 2010). This is a self-report designed to obtain information on the amount and availability of environmental reward perceived by the individual. The instrument assesses: (i) the amount of events that are potentially reinforcing; (ii) the availability of reinforcement in the environment; and (iii) the instrumental behavior of an individual to elicit reinforcement. It consists of 10 items that are rated on a 4-point Likert scale. The internal consistency obtained in this sample with Cronbach’s alpha was .79.

- Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996; Spanish version of Sanz & Vázquez, 2011). This is a 21-item self-report scale measuring current depressive symptoms. Each item has four options, from 0 to 3, referring to how the participant has felt over the last two weeks. The total score may range from 0 to 63, with higher scores indicating higher level of depressive symptoms. It has been proposed that scores on the BDI-II can be classified as follow: no depression = 0-13, mild depression = 14-19, moderate depression = 20-28, and severe depression = 29-63. The internal consistency obtained in this sample with Cronbach's alpha was .91.

Procedure

Participants were recruited between January 2016 and April 2017 via study advertisements in the media, recommendations by previous participants in the smoking-cessation treatment, and referral from their primary care physician or other services of the healthcare system. All participants provided written informed consent prior to initiation of any study procedures. The study was approved by the Bioethics Committee of the University of Santiago de Compostela. The current study is based on secondary analysis of baseline data.

Data analysis

All statistical analyses were performed using the software SPSS version 24. We used the direct scores of the questionnaires assessing study variables. Descriptive data were conducted and are reported as means with standard deviations (Table 1). Correlations among study variables were also examined.

To test the mediation hypothesis, we used the PROCESS macro for SPSS (Model 6). This analysis allows examining the relations between one independent variable (X: avoidance), one dependent variable (Y: cigarette dependence), and two simultaneous serial mediator variables (MV₁: environmental reward; MV₂: depressive symptoms). In serial mediation, mediators are assumed to have a direct effect on each other (Hayes 2013), and the independent variable (avoidance) is assumed to influence mediators in a serial mode which, subsequently, influences the dependent variable (cigarette dependence). PROCESS macro also allows mean centering the variables included in the analysis in order to avoid problems related to measurement scales of the instruments used. Bootstrap resampling techniques were performed (with 20,000 re-samples), and a 95% bias-corrected confidence interval (CI) was used to evaluate indirect effects (Preacher & Hayes, 2008). The indirect effect is presumed to be significant if the CIs do not include zero.

Analyses were conducted unadjusted and adjusted by covariates. In the adjusted analysis we included sex, age, marital status,

education, employment status, and lifetime depression treatment, which are commonly reported variables related to tobacco smoking (Caponnetto & Polosa, 2008).

Results

Descriptive and correlation results

Descriptive data of self-reported measures are presented in Table 1. It is noteworthy that, of the total sample, 16.4% had mild depression, and 13.8% had moderate/severe depression according to BDI-II scores. In addition, 43.3% had undergone lifetime depression treatment, and 42.5% were cigarette dependent according to the FTCD (scores ≥ 6).

The bivariate correlations showed that cigarette dependence was positively and significantly associated with depressive symptoms and avoidance; and negatively and significantly with environmental reward (Table 1).

Regarding hypothetical mediating variables, environmental reward correlated inversely with depressive symptoms ($r = -.516, p < .001$), and this correlation remained significant after controlling for avoidance ($pr = -.374, p < .001$), suggesting that one variable affects the other, which supports the use of serial multiple mediational analysis (Hayes, 2013).

Serial mediation results

Serial multiple mediation analysis was conducted in order to examine whether the effects of avoidance on cigarette dependence were serially mediated by environmental reward and depressive symptoms in this sample of treatment-seeking smokers. Analyses were conducted adjusted and unadjusted by the following covariates: sex, age, marital status, education, employment status, and lifetime depression treatment. No differences were found for adjusted and unadjusted analysis, thus we reported data for adjusted analysis. In addition, results are reported completely standardized coefficients for indirect effects and standardized coefficients for direct effects.

The total effect model was significant ($R^2 = .097, F [6, 268] = 4.800, p < .001$), as was the full model with mediators ($R^2 = .122, F [8, 266] = 4.619, p < .001$). In the full model, lifetime depression treatment was significantly predictive of higher scores on cigarette dependence ($b = .151, p = .014$). The direct effect (path c') of avoidance on cigarette dependence was non-significant (Figure 1).

Regarding indirect effects, the total indirect effect was statistically significant, as the 95% confidence interval (CI) of the point estimate did not cross zero (Table 2). Specific significant indirect effects were also found. First, there was a significant indirect pathway from avoidance to cigarette dependence through depressive symptoms (effect a_2*b_2). Greater avoidance scores were related to greater depressive symptoms, which was associated with higher scores on cigarette dependence. Second, there was a significant indirect serial pathway from avoidance to cigarette dependence through environmental reward and depressive symptoms (effect $a_1*a_3*b_2$). There was no significant indirect effect between avoidance and cigarette dependence through environmental reward (effect a_1*b_1).

Due to the limitations related to the use of mediation analysis with cross-sectional data, we also conducted an alternative model

Table 1
Descriptive data and bivariate correlations between study variables

| | Mean (SD) | | | | |
|--------------------------------|---------------|---------|---------|---------|---|
| 1. FTCD ^a | 4.78 (2.16) | – | | | |
| 2. BADS Avoidance ^b | 14.26 (10.31) | .175** | – | | |
| 3. EROS ^c | 27.92 (4.51) | -.177** | -.503** | – | |
| 4. BDI-II ^d | 10.46 (9.14) | .235** | .447** | -.516** | – |

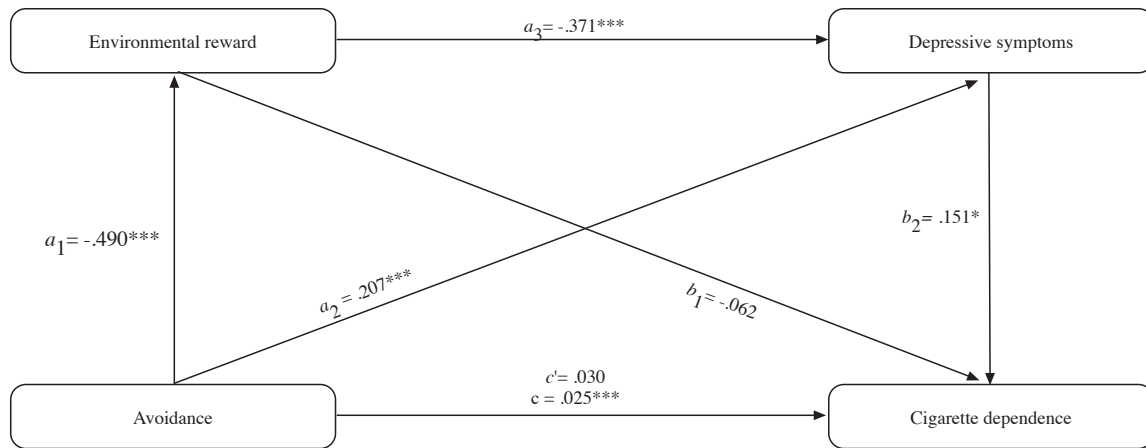


Figure 1. Illustration of the indirect effects model for serial mediation
 Mediator variables: Environmental reward and Depressive symptoms. a_1 =Direct effect of avoidance on environmental reward; a_2 =direct effect of avoidance on depressive symptoms; a_3 =direct effect of environmental reward on depressive symptoms; b_1 =direct effect of environmental reward on cigarette dependence; b_2 =direct effect of depressive symptoms on cigarette dependence; c' = direct effect; c = total effect.
^{*} $p < .05$; ^{**} $p < .01$; ^{***} $p < .001$

Table 2
Serial multiple mediational analysis results controlled by covariates

| Direct ¹ | | | | | |
|--|----------|-----------------------|----------------------------|----------------------------|-------------------------|
| | b | SE^a | p | LLCI^b | ULCI^c |
| BADS avoidance → EROS (a_1) | -.490 | .022 | ≤ .001 | -.264 | -.174 |
| BADS avoidance → BDI-II (a_2) | .207 | .051 | ≤ .001 | .115 | .319 |
| EROS → BDI-II (a_3) | -.371 | .118 | ≤ .001 | -1.02 | -.554 |
| EROS → FTCD (b_1) | -.062 | .036 | .218 | -.115 | .026 |
| BDI-II → FTCD (b_2) | .151 | .017 | .010 | .010 | .080 |
| BADS avoidance → FTCD (c') | .030 | .014 | .305 | -.138 | .043 |
| Indirect ² | | | | | |
| | b | SE^a | BooLLCI^b | BooULCI^c | |
| Total indirect effect | .089 | .036 | .019 | .161 | |
| BADS avoidance → EROS → FTCD | .031 | .034 | -.037 | .100 | |
| BADS avoidance → BDI-II → FTCD | .031 | .016 | .003 | .065 | |
| BADS avoidance → EROS → BDI-II → FTCD | .027 | .014 | .002 | .056 | |
| Note: | | | | | |
| ¹ The reported effects are standardized coefficients | | | | | |
| ² The reported effects are completely standardized coefficients | | | | | |
| ^a Standard Error | | | | | |
| ^b Lower Limit Confidence Interval | | | | | |
| ^c Upper Limit Confidence Interval | | | | | |
| ^d Beck Depression Inventory-II | | | | | |
| ^e Behavioral Activation for Depression Scale | | | | | |
| ^f Environmental Reward Observation Scale | | | | | |
| ^g Fagerström Test for Cigarette Dependence | | | | | |
| ^h Bootstrap Lower Limit Confidence Interval | | | | | |
| ⁱ Bootstrap Upper Limit Confidence Interval | | | | | |

examining whether avoidance was related to cigarette dependence through depressive symptoms and then environmental reward. This analysis showed that such indirect path was not significant (standardized coefficient = .009 $SE = .010$; 95% CI [-.010 – .031]).

Discussion

The present study sought to investigate the mediating role of environmental reward and depressive symptoms in the association between avoidance and cigarette dependence in a sample of treatment-seeking smokers.

Supporting our first hypothesis, our results showed that cigarette dependence was significantly related to greater levels of avoidance. This is coherent with studies that had suggested that smoking could serve as a strategy to cope with and/or avoid negative internal states (Baker, Piper et al., 2004). We also found a significant negative relation between cigarette dependence and environmental reward. Such a result is in line with research showing that reinforcement processes play a central role in the onset, and maintenance of substance use (Higgins, Heil, & Lussier, 2004). Regarding the relation between cigarette dependence and depressive symptoms, our data yielded a positive and significant correlation which is consistent with research that suggests that greater severity of cigarette smoking is related to depressive symptomatology (Fergusson, Goodwin, & Horwood, 2003).

Concerning our second hypothesis, through serial multiple mediation analysis, we found that greater levels of avoidance were indirectly associated with cigarette dependence through two pathways: via depressive symptoms, and via environmental reward plus depressive symptoms. These results are in consonance with behavioral conceptualizations of depression, in which avoidance is related to a pattern of withdrawal that is associated with a lower perception of environmental reward and/or with a reduction of the frequency of positively reinforced behavior or reduced contact with positive experiences or stimuli, which in turn maintain, or even worsen, depressive symptoms (Carvalho & Hopko, 2011; Jacobson et al., 2001). Interestingly, our results showed that there was no significant indirect effect between avoidance and cigarette dependence through environmental reward when controlling for depressive symptoms. Therefore, this finding extends previous literature by showing that depressive symptoms could be the key for low environmental reinforcement to influence the relationship between avoidance and cigarette dependence. Additionally, these

results are in line with previous works highlighting the influence of experiential avoidance on smoking-related variables (Garey, Farris, Schmidt, & Zvolensky, 2016; Minami, Bloom, Reed, Hayes, & Brown, 2015).

The current study has important implications for smoking-cessation intervention efforts. Our data suggest that in treatment-seeking smokers, higher avoidance is related to lower perception of environmental reward, which is associated to greater depressive symptoms, and subsequently, to a higher likelihood of cigarette dependence. Depressive symptoms and cigarette dependence constitute relevant and well-known barriers to achieve abstinence in smoking-cessation treatments. In this regard, our findings are in line with previous literature showing that Behavioral Activation (BA) intervention approaches, which include strategies as scheduling positive and pleasant activities to make the environment more rewarding, as well as therapeutic approaches as Contingency Management (CM), which also attempt to increase the availability of smoking-alternatives sources of reinforcement, have shown positive smoking cessation outcomes (González-Roz, Secades-Villa, & Alonso-Pérez, 2019; Macpherson et al., 2010; Martínez-Vispo et al., 2019; Petry, Alessi, Olmstead, Rash, & Zajac, 2017).

Moreover, our results go further suggesting that smoking-cessation interventions could benefit if clinicians consider not only increasing rewarding opportunities, but also integrating avoidance as a treatment target. For example, BA-based treatments, in which avoidance behavior is central to the treatment model, could be suitable in smoking-cessation interventions (Dimidjian, Barrera, Martell, Muñoz, & Lewinsohn, 2011; Jacobson, Martell, & Dimidjian, 2001; Martell, Dimidjian, & Herman-Dunn, 2013). Future research is needed to examine whether the inclusion of specific avoidance-related strategies on BA, but also on voucher-based interventions and CM approaches, could improve smoking cessation outcomes.

Some limitations to our study should be mentioned. First, the cross-sectional nature of this study precludes causal and temporal interpretations of the relationships presented. Secondly, it remains unclear whether these findings could be generalized to smokers from the general population, as this sample was comprised of treatment-seeking smokers. Third, the assessment instruments

were self-report questionnaires, which can be influenced by social desirability or recall bias. Lastly, we have analyzed the effect of depressive symptoms in a non-clinical sample. It remains unclear whether focusing on participants with more severe depressive symptoms would strengthen the magnitude of the effects found. Future research is needed to elucidate this question.

Despite these limitations, the present study has a number of strengths. To our knowledge, this is the first study that examines the relation between avoidance, environmental reward and depressive symptoms in the relation with cigarette dependence in a sample of treatment-seeking smokers. A large percentage of cigarette dependent people who seek smoking-cessation treatment present depressive symptoms (Leyro et al., 2016), but research investigating other behavioral depression-related variables that could be influencing cigarette dependence remains scarce (Fluharty, Taylor, Grabski, & Munafò, 2017). In this sense, our results contribute to the understanding of cigarette dependence, which may help to develop targeted smoking-cessation interventions. Second, we included both results unadjusted and adjusted analysis, including several covariates to control for potential confounding effects. Lastly, we used a large sample of smokers seeking smoking-cessation treatment.

Overall, the present study explores the relation between avoidance and cigarette dependence, highlighting the explanatory utility of environmental reward and depressive symptoms in this relation. Specific treatment components targeting not only depressive symptoms, but also, avoidance and environmental reward could increase abstinence rates and decrease the probability of relapse. Future research is needed to explore these variables and their influence on smoking-cessation treatment outcomes.

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