Psychiatry Research ■ (■■■■) ■■■–■■■

Contents lists available at ScienceDirect

Psychiatry Research

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

Does smoking abstinence influence distress tolerance? An experimental study comparing the response to a breath-holding test of smokers under tobacco withdrawal and under nicotine replacement therapy

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ARTICLE INFO

Article history:
Received 13 September 2014
Received in revised form
20 July 2015
Accepted 22 July 2015

Keywords:
Discomfort
Biological challenge
Stressful behavioral laboratory tasks

ABSTRACT

Distress tolerance has been operationalized as task persistence in stressful behavioral laboratory tasks. According to the distress tolerance perspective, how an individual responds to discomfort/distress predicts early smoking lapses. This theory seems weakly supported by experimental studies since they are limited in number, show inconsistent results, do not include control conditions. We tested the response to a stressful task in smokers under abstinence and under no abstinence to verify if tobacco abstinence reduces task persistence, thus distress tolerance. A placebo-controlled, double-blind, randomized, cross-over design was used. Twenty smokers underwent a breath holding test after the administration of nicotine on one test day and a placebo on another test day. Physiological and psychological variables were assessed at baseline and directly before and after each challenge. Abstinence induced a statistically significant shorter breath holding duration relative to the nicotine condition. No different response to the breath holding test was observed when nicotine and placebo conditions were compared. No response to the breath holding test was found when pre- and post-test values of heart rate, blood pressure, Visual Analogue Scale for fear or discomfort were compared. In brief, tobacco abstinence reduces breath holding duration but breath holding test does not influence discomfort.

1. Introduction

General distress tolerance has been operationalized as task persistence in physically/emotionally stressful behavioral laboratory tasks (Quinn et al., 1996). Such tasks have shown correlations with relevant smoking measures. Models of early lapse posit that it is not just the severity of tobacco withdrawal but also how an individual responds to discomfort and distress that predicts early smoking lapses (Brown et al., 2005; Hughes, 2007).

A number of studies have provided data consistent with a distress tolerance perspective on early lapse but experimental research is still limited. Hajek and colleagues (1987) found a longer breath holding duration for successors than for failures (37.8 ± 12.2 vs 26.2 ± 9.9 s; $p < 0.05$) and a positive correlation between endurance in breath holding and treatment outcome ($r = 0.44$; $p < 0.001$) in smokers who received 5 sessions of group pressure to enhance motivation to quit ($n = 56$). Brown et al. (2002) observed that immediate relapsers (i.e., had never quit for more than 24 h) had a shorter breath holding duration than delayed relapsers (i.e., had quit for at least 3 months). In a following study, they found that greater breath holding duration ($RR = 0.98$; $p = 0.035$) and inhalation of a gas mixture enriched of carbon dioxide (CO_2) ($RR = 0.55$; $p = 0.031$) were associated with a significantly lower risk of smoking lapse in smokers following an unaided quit attempt (Brown et al., 2009). Finally, Brandon and co-authors (2003) found that tolerance to the distress induced via the Mirror Tracing Persistence Task (MTPT) was a significant predictor of sustained tobacco abstinence throughout 12 months of follow up (Wald = 6.17; $p = 0.01$; hazard ratio = 0.998; 95%CI = 0.996–0.999) ($n = 144$).

These studies suggest that a shorter duration of breath holding is associated with early lapse or failure in quitting smoking. However, they were not confirmed by Cameron et al. (2013) who found no correlation between time to relapse ($r = -0.05$) and the level of distress induced by the MTPT ($n = 40$); and by Zvolensky et al. (2001) who found no difference in breath holding duration

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http://dx.doi.org/10.1016/j.psychres.2015.07.065
0165-1781/

between smokers with a previous quit attempt ≥7 days ($n=10$) and smokers with a previous quit attempt shorter than 7 days ($n=12$). In addition, none of the aforementioned studies (Brandon et al., 2003; Brown et al., 2002, 2009; Hajek et al., 1987) measured distress tolerance in smokers while quitting. Thus, they do not clarify whether the individual response to distress while quitting predict early smoking lapses.

Only one experimental study (Kahler et al., 2013), according to our knowledge, evaluated the breath holding duration while quitting, that is in abstinent smokers. Very low breath holding and no significant correlations with IDQ-S (i.e., Smoking Abstinence Discomfort Questionnaire) subscales scores ($r=0.02$ and $r=0.05$; $p=$n.s.) were found ($n=96$) (Kahler et al. 2013). However, the participants were randomized to alcohol administration in a 2×2 balanced placebo design; a double-blind design was not used, being subjects presented with 8 cigarettes and instructed to initiate smoking at any point over the following 50 minutes; because cigarette smoke contains carbon monoxide (CO) and CO_2, nicotine inhalation was confounded with exposure to these gases; the abstinence condition may last from 5 to 50 min according to the individual urge to smoke; a control condition was not included; physiological or psychological measures to evaluate the response to the breath holding test were not used.

In this framework, we studied whether smoking abstinence influences breath holding duration trying to overcome the limitations described for Kahler et al. (2013). We compared the response to a breath holding test of smokers who refrained from smoking for 4 h and wear once a nicotine patch (i.e., no abstinence) and once a placebo patch (i.e., abstinence) according to a cross-over design. The patches allowed to use a double-blind procedure and have a control condition. Nicotine was trans-dermally administered to avoid confounds related to the awareness of having recently smoked and exposure to CO and CO_2. Smokers were also asked to refrain from drinking alcohol in the 24 h preceding each breath holding test in order to eliminate any influence of alcohol on the breath holding response. The response to the breath holding was evaluated on the basis of the duration of the breath holding as well as on the basis of physiological (i.e., heart rate, blood pressure, respiratory rate) and psychological variables (i.e., fear/discomfort) experienced as a response to the challenge.

We expected that smoking abstinence would decrease breath holding duration, thus distress tolerance.

2. Methods

The current study was part of a larger investigation studying the effects of nicotine withdrawal on panic-like response to breath holding. A more detailed methodology can be found in Cosci et al. (2013).

2.1. Participants

Twenty regular smokers (i.e., smoking more than 10 cigarettes per day for at least the last year) were recruited among the Florentine general population through newspaper advertisements and flyers posted in local businesses, academic places, and on community bulletin boards. Smoking status was confirmed by a carbon monoxide (CO) exhalation reading of at least 10 ppm (Cocores, 1993). Exclusion criteria were assessed via the Mini International Neuropsychiatric Interview (MINI) (Sheehan et al., 1998) and a supplemental set of screening questions (Cosci et al., 2006). Participants were excluded based on evidence of psychiatric disorders; instable medical conditions; history of cerebral aneurysm; skin diseases/nicotine skin hypersensitivity; pregnancy/lactating; psychotropic medication use/psychotherapy; family history of panic disorder (van Beek and Griez, 2000).

Approval for this study was granted by the local Medical Ethics Review Board.

2.2. Measures

The following self-administered scales were used: 1. the Fagerstrom Test for Nicotine Dependence (FTND), assessing nicotine dependence (Heatherton et al., 1991); 2. the Smoke Compliant Scale (SCS) (Schneider et al., 1984), a measure of tobacco withdrawal symptoms; 3. the Positive Affect Negative Affect Scale (PANAS) (Watson et al., 1988), because negative affect may influence the challenge response (Vujanovic and Zvolensky, 2009); 4. the State Trait Anxiety Inventory for state anxiety (STAI-1) (Spielberger et al., 1970) and the Zung Self rating Anxiety Scale (SAS) (Zung, 1971), because anxiety may influence the challenge response (Nardi et al., 2002); 5. the Visual Analogue Scale for fear (VAS-f) and the Visual Analogue Scale for discomfort (VAS-d), assessing subjective fear (from 0=no fear at all to 100=worst fear imaginable) or discomfort (from 0=no discomfort at all to 100=worst discomfort imaginable), respectively.

Heart rate, blood pressure, respiratory rate, and carbon monoxide (CO) upon exhalation (ppm) were also measured. Heart rate (beats per minute) and blood pressure (millimeter of mercury) were measured via an automatic electronic sphygmomanometer. Respiratory rate was manually measured at rest by counting the number of breaths (i.e., how many times the chest rises) for one minute (the minute was measured via a chronometer). CO was assessed by means of an automatic electronic breath carbon monoxide analyzer.

2.3. Procedure

A cross-over design was applied: each subject received a nicotine patch on one test day and a placebo patch on the other test day according to a randomized, double blind, counterbalanced, order. The dose of nicotine delivered was 21 mg/24 h which, according to current guidelines (US Department of Health and Human Services, 2008) ensures adequate nicotine replacement (Paoletti et al., 1996).

The study consisted of pre-screening, screening, and two days of test.

At pre-screening, participants were contacted by phone and instructed not to consume caffeinated products or alcohol for 24 h prior to each test day.

At screening they were evaluated with the MINI and a set of medical screening interview, the smoking status was confirmed by a CO analysis of breath samples. Those eligible completed the informed written consent and were asked to smoke one of their own cigarettes to standardize nicotine exposure and minimize tobacco withdrawal effects. Thereafter, they entered the first test day.

At first test day, subjects completed the FTND, SCS, PANAS, STAI-1, SAS, VAS-f, VAS-d; heart rate, blood pressure, respiratory rate, and carbon monoxide were measured. According to a randomized, double-blind design they received a placebo patch or a nicotine patch. Pre-test occurred 4 h later, when plasma nicotine levels would be expected to have reached a plateau (Chan et al., 1990), and after verifying the absence of recent smoking (i.e., CO level <10 ppm) (Cocores, 1993). Immediately before the breath holding test (here called pre-test), heart rate, blood pressure, and respiratory rate were measured, and the SCS, STAI, VAS-f, VAS-d were administered. Immediately after the breath holding test (here called post-test), heart rate, blood pressure, and respiratory rate were measured, and VAS-f and VAS-d were administered.

The second test day occurred at least one week after the first one and the same procedure was repeated, participants who had

Please cite this article as: Cosci, F., et al., Does smoking abstinence influence distress tolerance? An experimental study comparing the response to a breath-holding test of smokers under tobacco withdrawal and under nicotine replacement therapy. Psychiatry Research (2015), http://dx.doi.org/10.1016/j.psychres.2015.07.065