

**Universidade Federal do Rio de Janeiro**

**Abordagem experimental no estudo de eficácia de advertências sanitárias pictóricas para controle do tabaco: comparação entre dois grupos de advertências no Brasil**

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**Ao meu filho Mathias.**

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## RESUMO

**Introdução:** Estudos cerebrais e comportamentais sugerem que a motivação para usar objetos com características agradáveis é diminuída quando os objetos também apresentam características desagradáveis. Este conceito foi aplicado a embalagens que apresentam advertências sanitárias. O objetivo deste estudo foi comparar um grupo inovador de advertências pictóricas desenvolvido por uma equipe multidisciplinar no Brasil com o anterior, que não recebeu tal apoio acadêmico, avaliando predisposições motivacionais automáticas (valência hedônica, ativação emocional e conduta comportamental) e percepção de eficácia para o controle do tabagismo.

**Métodos:** Foi utilizado um dispositivo desenvolvido especificamente para testar objetos reais para comparar a potência do grupo inovador em relação ao anterior. Os testes utilizaram maços de cigarros comerciais com advertências pictóricas em 100% de uma face, conforme exigido pela legislação brasileira. Os participantes (N = 63, 45 não-fumantes) avaliaram o conteúdo emocional das advertências e sua eficácia para prevenção e cessação do tabagismo. Uma tarefa comportamental estimou o impacto das advertências sobre a motivação dos fumantes em manipular os maços de cigarros.

**Resultados:** O grupo de advertências inovadoras foi classificado como mais desagradável e emocionalmente ativante, e mais eficaz para o controle do tabagismo, em comparação com o grupo anterior (desprovida de inovações). As representações de lesões explícitas foram essenciais para esses resultados. Além disso, o grupo inovador exerceu mais restrição sobre a motivação dos fumantes em manipular os maços.

**Conclusões:** Este trabalho reforça os benefícios da abordagem multidisciplinar na produção de rótulos de advertências sanitárias mais eficazes e apoia o uso de advertências mais aversivas nos esforços para reduzir a prevalência do tabagismo.

**Palavras-chave:** controle do tabaco; rótulos de advertências sanitárias; motivação; tempo de reação; valência e ativação; IAPS; figuras afetivas.

## ABSTRACT

**Introduction:** Brain and behavioral studies suggest that the drive to use objects with pleasant features is curbed when the objects present unpleasant features as well. This concept has been applied to packs depicting warnings. The purpose of this study was to compare an innovative round of pictorial warnings developed by a multidisciplinary team in Brazil with the previous one, which received no such academic support, by assessing automatic motivational predispositions (hedonic valence, emotional arousal and behavioral drive), and their perceived effectiveness for tobacco control.

**Methods:** A specialized device designed to test emotion-laden objects was used to compare the strengths of the innovative round relative to the previous one. The tests used physical commercial cigarette packs showing pictorial warnings on 100% of one face, as required by Brazilian legislation. Participants (N=63, 45 non-smokers) rated the warnings' emotional content and their effectiveness for smoking prevention and cessation. A behavioral task estimated the warnings' impact on smokers' appetitive drive towards cigarette packages.

**Results:** The innovative warnings were rated more unpleasant and emotionally arousing, and more efficacious for tobacco control, compared with the previous round (devoid of innovations). Depictions of explicit lesions were essential for these results. In addition, the innovative round exerted more curbing on the smokers' appetitive drive towards packs.

**Conclusions:** This work reinforces the benefits of multi-disciplinary approaches in producing more efficacious health warning labels and supports the use of avoidance-evocative warnings in efforts to reduce smoking prevalence.

**Key words:** tobacco control; Health warning labels; Motivation; Reaction time; Valence and arousal; IAPS; Affective pictures.

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## 1 INTRODUÇÃO

A Organização Mundial de Saúde e as Nações Unidas reconhecem que as doenças não transmissíveis estão entre as principais causas de mortalidade evitável e que a prevenção deve ser o pilar da resposta global a essas doenças. A resolução aprovada pela Assembleia Geral das Nações Unidas em 2011 [1] reconheceu a importância de reduzir o nível de exposição dos indivíduos e das populações a fatores de risco comuns para as doenças não transmissíveis, nomeadamente: o tabagismo, a dieta pouco saudável, a falta de atividade física e a ingestão alcoólica.

A resolução reconhece o conflito de interesses básico entre a indústria do tabaco e a saúde pública e compromete-se a acelerar a implementação da Convenção-Quadro da Organização Mundial de Saúde para o Controle do Tabaco [2]. O controle do tabaco foi identificado como a "prioridade mais urgente e imediata" para reduzir as doenças não transmissíveis [1, 3]. A Convenção-Quadro para o Controle do Tabaco é o primeiro tratado global de saúde negociado sob os auspícios da Organização Mundial de Saúde e visa reduzir o crescimento e a propagação da epidemia global de tabagismo [2]. A inclusão de advertências sanitárias pictóricas proeminentes em pacotes de cigarros é uma das suas disposições (Artigo 11). As embalagens de produtos de tabaco devem conter advertências de saúde amplas, claras, visíveis e legíveis que descrevem os efeitos nocivos do uso do tabaco e devem ser substituídas por novas periodicamente. Como resultado, advertências sanitárias para controle do tabaco têm sido efetivamente implementadas em muitos países [4].

A eficácia das advertências sanitárias é geralmente medida através de inquéritos populacionais com base na resposta publicitária auto referida (por exemplo, conhecimento dos efeitos do produto na saúde) ou respostas mais estreitamente ligadas aos resultados da prevenção da doença associada ao produto. A introdução de novos grupos de rótulos de advertência ao longo do tempo, conforme recomendado pela Convenção-Quadro para o Controle do Tabaco e seguida por muitos países, cria uma oportunidade para validar novos métodos para determinar o impacto preditivo de uma exposição sobre os resultados comportamentais, ou como complemento das medidas de avaliação mais comuns.

A importância das embalagens de cigarros como principal instrumento para a promoção do tabaco tem aumentado devido às crescentes restrições à publicidade do tabaco, motivo pelo qual as embalagens foram tornadas mais atraentes e apelativas, especialmente para os jovens

adultos. Rótulos de advertência pictóricos procuram desfazer esse apelo e revelar os riscos à saúde associados ao produto.

O Brasil, o segundo país (após o Canadá) a introduzir advertências pictóricas em maços de cigarros, lançou três grupos de advertências pictóricas desde 2001, representando um bom modelo para testar as melhores práticas em relação à Convenção-Quadro para o Controle do Tabaco [2].

Devido a várias políticas de controle do tabagismo que foram implementadas, o Brasil tem experimentado um grande declínio na prevalência de tabagismo - caindo de 34,8% em 1989 para 14,7% em 2013 [5]. Uma dessas intervenções eficazes, adotada desde 2001, é a apresentação de rótulos de advertência sanitária pictórica sobre as embalagens de todos os produtos de tabaco para informar a população sobre os efeitos nocivos do tabaco. A legislação brasileira exige que as advertências pictóricas cubram 100% de uma face do pacote [6]. No Brasil, o primeiro grupo de advertências pictóricas de saúde vigorou entre 2001 e 2004; e o segundo grupo de advertências, de 2004 a 2008 [7].

Com o objetivo de aumentar a eficácia das advertências, uma equipe multidisciplinar de pesquisadores de uma ampla gama de campos científicos - psicologia experimental, neurociência, saúde pública e design, trabalharam juntos para produzir um novo layout e conteúdo para o terceiro grupo de advertências brasileiro [8].

As inovações incluíram o uso de técnicas de design que melhoram a captura dos elementos mais importantes das imagens [9]. Além disso, para atingir o efeito emocional pretendido e facilitar o impacto sobre os espectadores, foram utilizados recursos psicofisiológicos para a elaboração das principais características e componentes da imagem: (i) com base em estudos que mostram que a exposição a imagens que representam lesões corporais ativa sistemas motivacionais defensivos cerebrais [10, 11] e desencadeiam reações de tipo defensivo [12, 13], a apresentação dos danos físicos do tabaco foi tornada mais viva; (ii) foram evitados os danos viscerais apresentados unicamente por fragmentos de órgãos, difíceis de serem compreendidos por quem não conhece anatomia; (iii) a presença de sinais de tabagismo, que são apetitivos para os fumantes [14, 15], foram minimizados. Cenas vívidas dando informações sobre danos relacionados ao tabaco foram produzidas em protótipos pictóricos. De acordo com as diretrizes da Convenção-Quadro para o Controle do Tabaco [2], foi realizado um teste de pré-comercialização desses protótipos (Volchan et al, Experimento 1 [8]). Um protocolo de classificação bem estabelecido [16, 17] foi utilizado para pesquisar o impacto

emocional dos protótipos através de uma dimensão de valência hedônica (agradável = positivo, desagradável = negativo) e uma dimensão de ativação. A seleção do terceiro grupo de advertências para o controle do tabagismo no Brasil foi baseada nessa triagem. Vários estudos têm mostrado que imagens que são avaliadas com valência negativa, incluindo aquelas que representam lesões corporais, capturam significativamente a atenção, interferem com outras tarefas e induzem reações do tipo defensivo (ver [10–13, 18]). Assim, os critérios de seleção objetivaram incorporar protótipos associados com classificações altas sobre desagrado e ativação. Após o lançamento, o terceiro grupo de advertências pictóricas foram submetidas a testes avaliativos e comportamentais no laboratório sendo apresentadas como estímulos em suas próprias embalagens comerciais, o resultado deste experimento demonstrou sua potência no controle do tabagismo (Volchan et al, Experimento 2).

### 1.1 JUSTIFICATIVA

O desenvolvimento de um aparato inovador para estudos de processos motivacionais e comportamentais relacionados às interações com objetos tridimensionais (Oliveira et al, 2012), permitiu a sua aplicação a investigação do impacto emocional de advertências pictóricas em maços de cigarro.

Este projeto permitiu pela primeira vez realizar testagens experimentais em ambiente controlado de laboratório comparando um grupo de advertências, elaborado apoiado em bases científicas, em relação ao grupo anterior. Se as inovações produzidas através dos esforços conjuntos de diferentes campos de pesquisa se mostrarem efetivas, os resultados têm potencial de contribuir para uma maior eficácia no controle do tabagismo.

### 1.2 OBJETIVO

Comparar as predisposições motivacionais automáticas provocadas pelo segundo e terceiro grupo de advertências brasileiras apresentadas em maços de cigarros comerciais.

#### 1.2.1 OBJETIVOS ESPECÍFICOS:

Comparar os dois grupos de advertências nos parâmetros:

- valência hedônica,
- ativação emocional,
- percepção de eficácia na prevenção do início do tabagismo e à cessação do tabagismo.
- Impacto comportamental (tempo de reação).

## **2 DESENVOLVIMENTO**

Uma vez que esta dissertação foi construída a partir de um artigo, esta parte do trabalho inicia-se com a apresentação integral do artigo que a compõe e que pode ser lido a partir da próxima página.

## **Title:**

**Raising the efficacy of pictorial tobacco health warnings: positive findings from experimental assessment comparing two rounds in Brazil.**

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## ABSTRACT

**Introduction:** Brain and behavioral studies suggest that the drive to use objects with pleasant features is curbed when the objects present unpleasant features as well. This concept has been applied to packs depicting warnings. The purpose of this study was to compare an innovative round of pictorial warnings developed by a multidisciplinary team in Brazil with the previous one, which received no such academic support, by assessing automatic motivational predispositions (hedonic valence, emotional arousal and behavioral drive), and their perceived effectiveness for tobacco control.

**Methods:** A specialized device designed to test emotion-laden objects was used to compare the strengths of the innovative round relative to the previous one. The tests used physical commercial cigarette packs showing pictorial warnings on 100% of one face, as required by Brazilian legislation. Participants (N=63, 45 non-smokers) rated the warnings' emotional content and their effectiveness for smoking prevention and cessation. A behavioral task estimated the warnings' impact on smokers' appetitive drive towards cigarette packages.

**Results:** The innovative warnings were rated more unpleasant and emotionally arousing, and more efficacious for tobacco control, compared with the previous round (devoid of innovations). Depictions of explicit lesions were essential for these results. In addition, the innovative round exerted more curbing on the smokers' appetitive drive towards packs.

**Conclusions:** This work reinforces the benefits of multi-disciplinary approaches in producing more efficacious health warning labels and supports the use of avoidance-evocative warnings in efforts to reduce smoking prevalence.

# INTRODUCTION

The World Health Organization and the United Nations acknowledge that non-communicable diseases are among the leading causes of preventable mortality and that prevention must be the cornerstone of the global response to these diseases. The resolution adopted by the General Assembly of the United Nations in 2011 [1] recognized the critical importance of reducing the level of exposure of individuals and populations to common modifiable risk factors for non-communicable diseases, namely, tobacco use, unhealthy diet, physical inactivity and the harmful use of alcohol.

The resolution recognizes the fundamental conflict of interest between the tobacco industry and public health and commits to accelerate the implementation of the World Health Organization Framework Convention on Tobacco Control [2]. Tobacco control was identified as the “most urgent and immediate priority” to reduce non-communicable diseases [1, 3]. The Framework Convention on Tobacco Control is the first global health treaty negotiated under the auspices of the World Health Organization, and aims to reduce the growth and spread of the global tobacco epidemic [2]. The inclusion of prominent pictorial health warning labels on cigarette packages is one of its provisions (Article 11). Tobacco product packaging must carry large, clear, visible and legible health warnings describing the harmful effects of tobacco use, and they should be rotating. As a result, strong health warnings have been effectively implemented in many countries [4].

The effectiveness of health warnings is commonly measured by population-based surveys based on self-reported advertising response (e.g., knowledge of health effects) or answers more closely linked to disease prevention outcomes. The introduction of new rounds of warning labels over time, as recommended by the Framework Convention on Tobacco Control and followed by many countries, creates an opportunity to validate new methods for

determining the predictive impact of an exposure on behavioral outcomes, which could be used alone or as a complement to the most common assessment measures.

The importance of cigarette packs as a primary instrument for tobacco promotion has increased because of growing restrictions on tobacco advertising, so packs were made more attractive and appealing, especially to young adults. Pictorial warning labels seek to undo this appeal, and uncover the health risks associated with the product.

Brazil, the second country (after Canada) to introduce pictorial warnings on cigarette packs, has launched three rounds of pictorial warnings since 2001, representing a good model to test for best practices in relation to the Framework Convention on Tobacco Control recommended provisions on package labeling [2].

Due to several tobacco control policies that have been implemented, Brazil has experienced a large decline in smoking prevalence - falling from 34.8% in 1989 to 14.7% in 2013 [5]. One such effective intervention, adopted since 2001, is the depiction of pictorial health warning labels on the packages of all tobacco products to inform the population about the harmful effects of tobacco. Brazilian legislation requires that pictorial warnings cover 100% of one face of the package [6]. In this country, the first round of pictorial health warnings was in effect from 2001 to 2004 and the second round of warnings from 2004 to 2008 [7].

Aiming to increase the efficacy of warnings, a multidisciplinary team of researchers from a wide range of scientific fields - experimental psychology, neuroscience, public health and design sciences; worked together to produce a new layout and content for the third Brazilian round [8].

Innovations included the use of design techniques which improve the capture of the most important elements from pictures [9]. Moreover, to achieve the intended emotional effect and facilitate the impact on viewers, psychophysiological resources were used in addressing picture features and components: (i) based on studies showing that exposure to pictures



depicting body lesions activates brain motivational defensive systems [10, 11] and triggers defensive-like reactions [12, 13], the presentation of tobacco's physical harms were made more vivid; (ii) visceral harms solely presented by organ fragments, difficult to be grasped by non-biomedical specialists, were avoided; (iii) the presence of smoking cues, which are appetitive for smokers [14, 15], were minimized. Graphic scenes giving information about tobacco-related harms were produced in pictorial prototypes. In agreement with the guidelines of Framework Convention for Tobacco Control [2], a pre-marketing testing of these prototypes was performed (Volchan et al, Experiment 1 [8]). A well-established rating protocol [16, 17] was employed to screen for prototypes' emotional impact through a hedonic valence dimension (pleasant = positive; unpleasant = negative) and an arousal dimension. Selection of final third warnings round for tobacco control in Brazil was based on this screening. Several studies have shown that negative-valence arousing pictures, including those depicting injuries to the body; significantly capture attention, interfere with other tasks and induce defensive-like reactions (see [10–13, 18]). So, selection criteria aimed to incorporate prototypes associated with high ratings on unpleasantness and arousal. After launch, the third round of pictorial warnings, presented in commercial physical packs, were subjected to evaluative and behavioral tests in the laboratory, which demonstrated these warnings' potency in tobacco control (Volchan et al, Experiment 2 [8]).

To establish whether innovations produced through the joint efforts from different research fields lead to more efficacy, an explicit comparison of the third round weighed against the previous one (second round) which received no such academic support, is of great importance. In an extension of the work by Volchan and collaborators (Experiment 2) [8], we now compare automatic motivational predispositions elicited by the Brazilian second and third warnings rounds presented in commercial physical cigarette packs (100% of one face), in a laboratory setting attempted to reproduce a “real world” context.

For the comparisons of the two rounds, we compiled data on evaluations of hedonic valence, emotional arousal, and perceived effectiveness on preventing smoking initiation and helping cessation. Additionally, we compared the rounds using behavioral tests that estimated the impact of warnings on smokers' appetitive drive towards cigarette packs. If the multidisciplinary approach employed in the elaboration of the Brazilian third warnings round does lead to more efficacious health warning labels, it may serve as a procedure model for tobacco health warning production in other countries.

## **METHODS**

### **Participants**

Prevention efforts focused on young adults (which are more vulnerable to initiate smoking) have been recommended [19, 20]. To compare second and third rounds warnings, participants were recruited for the experiment in the laboratory through posters on the University campus. The sample, of which 55% participants were women, had 45 never-smokers and 18 current-smokers with a mean age of 22.5 ( $\pm$  5.23).

The study was approved by the Ethics Review Board of the Federal University of Rio de Janeiro (Brazil). All participants provided written informed consent before assessment.

### **Stimuli**

Stimuli comprised 40 Brazilian commercial cigarette packs with regular size. Only one face of the physical pack was visible to the participants during each test, displaying either a

warning image (N=20) or a brand image (N=20) on 100% of its area (see Apparatus for more details). At the time of the experiments, Brazilian legislation required that pictorial warnings cover 100% of one face of the package [6] and the other face showed the brand devoid of warnings (after experiments have ended a new legislation was approved adding a warning text on 30% of the brand face).

The warning images used were from the second Brazilian round launched in 2004 (N=10) and from the third Brazilian round launched in 2009 (N=10) [7]. For the experiments, the pictorial warnings on one face of physical packs were devoid of any text. Cigarette brands were selected from among the most popular and so that they matched in color content each of the second round warnings (N=10) and each of the third round warnings (N=10). The total 40 different packs were distributed into four categories: the pictorial warnings of the second round, and their respective matched brands; the pictorial warnings of the third round, and their respective matched brands.

## **Apparatus**

The experiment was conducted in a dimly lit room and employed the “Box for Interaction with Objects” (BIO) [21], a device that allows the analysis of visual and motor events associated with the motivational and behavioral processes that drive overt interaction with three-dimensional objects. Here the objects were cigarette packs. The BIO is a prism-shaped hollow box with an opening in the lower part of its front. The participant sat facing the front of the BIO with their forearms inserted through the opening. A reflective film prevented the participant from seeing the pack inside the BIO unless it is illuminated from within. An opening in the back of the box allows the experimenter access. The experimenter sat behind the BIO and

controlled visibility by turning the internal lights on and off. An electric pulse was sent to a recording system each time the lights were switched on, determining the stimulus onset.

## **Evaluative reports**

### **Valence & arousal**

The emotional impact of the warnings were assessed through hedonic valence and arousal ratings based on the normative protocol to evaluate affective pictures of the International Affective Picture System [16] and the paper-and-pencil version of the Self-Assessment Manikin [17]. Three previous studies applied this protocol to pictorial tobacco health warnings presented on a screen, two of them employed images of warnings [14, 22] and the other one tested warnings photographed from commercial packs [23]. Here, the protocol was adapted for testing warnings in physical cigarette packs (see also Volchan et al, Experiment 2 [8]). The scale of the hedonic valence dimension is composed of pictorial drawings of manikins with expressions ranging from “smiling-happy” to “frowning-unhappy”. For the arousal dimension, the expressions of the manikins range from an excited, wide-eyed figure to a relaxed, sleepy figure. For analyses purposes, the ratings in the arousal dimension are conventionally attributed to numbers ranging from 1 (low arousal) to 9 (high arousal) [8, 14, 16, 22]. For the valence dimension, some studies attribute values ranging from 1 (extremely unpleasant) to 9 (extremely pleasant), with 5 being neutral [16, 22]; while others, including the present study, attribute values from -4 (extremely unpleasant) to 4 (extremely pleasant), with zero being neutral [8, 14].

### **Familiarity**

The third warnings round had been recently launched at the time the experiments were performed. To control for a possible interference due to familiarity in the putative differential ratings for valence and arousal between second and third warnings rounds, participants evaluated previous exposure to warnings by answering the question “Is this picture familiar to you?” on 10-point Likert-like scale ranging from “no” to “very”.

## **Cessation & prevention**

Fong et al [24] studied the perceived effectiveness of warnings by showing cards with photographs of the images to the participants who were asked to rate each one separately, and also to rank them in ascending order. They observed similar results through both evaluations. In the present study, the ranks were obtained on 10-point Likert-like scales ranging from “not effective at all” to “very effective”, on which participants graded the perceived effectiveness of individual warnings in smoking prevention, and in smoking cessation.

## **Behavioral task: reaction time**

Simple reaction time is the elapsed time between the presentation of a sensory stimulus and the subsequent behavioral response. The behavioral task was designed to simulate smokers’ manipulation of packs. Reaction time was the dependent variable for comparisons between second and third warnings rounds.

A holder designed to accommodate the cigarette pack was tethered to the bottom of the BIO apparatus. The participant, with the holder in his/her dominant hand, rested the back of the

hand on a weight sensor. Each time the pressure on the weight sensor was released, it triggered an electric pulse to the recording system, determining the response onset.

For each trial, participants were instructed to bring the pack toward them as quickly as possible when the internal light of the BIO was switched on (stimulus onset) revealing the pack face. When participants started the movement of bringing the pack towards them, the pressure on the weight sensor was released, and triggered an electric pulse to the recording system, determining the response onset. Thus, in this experiment, reaction time is the delay in milliseconds between stimulus onset (illumination of the pack) and response onset (initiation of the movement). The behavioral parameter of interest, “warning impact”, was calculated as the difference in reaction time between packs showing warnings and packs showing matched brands but without warnings. Warnings are expected to impose a cost on the initiation of the movement of bringing the pack towards the participant, which would be revealed by longer reaction times for warnings compared to matched brand. As the appetitive drive towards cigarettes is expected to be present only for smokers (see Volchan et al. [8]), the behavioral analyses for comparisons between the second and third rounds were conducted for smokers.

## **Procedure**

### **Behavioral Session**

To start the session the participant was asked to take the holder into his/her dominant hand and then rest the back of that hand on the weight sensor. Each test began with the internal lights of the BIO turned off, while the experimenter inserted a cigarette pack into the holder, with either the warning or the brand face showing up. Then the experimenter turned on the lights and the participant performed the task. When the participant returned the holder to its

initial position, the experimenter turned off the internal lights and changed the cigarette pack, and a new test began using a different pack. The sequence of the appearance of the 40 different packs was pseudo-randomized prior to each experimental session with no more than two consecutive presentations of the same category. For training purposes, participants performed seven trials at the beginning of the experimental session. These trials were not analyzed. The packs used during the training sessions were different from the 40 packs used for the behavioral task analyses.

## **Evaluation Session**

After the behavioral session, there was a short interval to change the setup for the evaluation session. A frame designed to accommodate one pack was fixed inside the BIO apparatus. With the internal lights off, the experimenter placed a pack into the frame. Only one face of the physical pack was visible to the participant during each test. Only the warnings faces were presented for the participant evaluations and they were displayed in a pseudo-randomized sequence. A booklet positioned next to the frame was used to record on each page the participant's ratings of valence, arousal, familiarity, cessation and prevention for each warning. The warning was made visible for approximately 6 seconds, after which the participant filled out the evaluation. The experimenter then turned off the internal lights, changed the cigarette pack and a new test began.

## **Data analysis**

Evaluative reports were analyzed using two approaches, "whole set" and "individual warnings". For whole set analyses, reports for the ten warnings belonging to each round were

averaged, that is, the mean value of the ten warnings from the second round and the mean value of the ten warnings from the third round were calculated and used in data analyses. For individual warnings analyses, participants' reports for each individual warning belonging to each round were averaged.

### **Evaluation session: valence & arousal (whole sets)**

Valence and arousal ratings attributed to warnings of the third round and to warnings of the second round were averaged separately for each participant. We compared the two rounds through Student t-tests for dependent samples, separately for valence and arousal.

### **Evaluation session: familiarity x valence; familiarity x arousal (whole sets)**

Differences between third and second rounds were calculated separately for mean ratings of valence, arousal and familiarity. Spearman correlation tests were conducted between differential valence and differential familiarity, and between differential arousal and differential familiarity.

### **Evaluation session: aversion (individual warnings)**

A joint analysis of valence and arousal was applied to individual warnings, as described in Nascimento et al. [14] and Volchan et al. [8]. The analyses were performed independently for the warnings of third and second rounds. First, mean ratings for each warning on valence and on arousal dimension were calculated. Mean valence (y-axis) and mean arousal (x-axis) for



each warning was displayed as a point in Cartesian coordinates. Next, a linear regression line was fitted for the points associated with warnings (separately for the second and third rounds). Then, each point was orthogonally projected onto the straight line. The intersection of the line with the y-axis was taken as the origin of the “aversion vectors”. The magnitudes of the vectors indicate the degree of aversion attributed to each warning.

For each round, vector magnitudes were sorted in ascending order, from the least to the most aversive warning, so that equivalent “ranks” could be compared. Wilcoxon matched pairs test was employed to compare AVERSION between the two rounds.

### **Evaluation session: prevention & cessation (individual warnings)**

For each warning, the average ratings attributed to perceived effectiveness in smoking prevention and those attributed to perceived effectiveness in smoking cessation were computed. Prevention ratings attributed to each warning were averaged across participants and computed separately for third and second rounds. For each round, prevention ratings were sorted in ascending order, from the least to the most efficacious warning, so that equivalent “ranks” could be compared. The same procedure was applied to cessation ratings. Wilcoxon matched pairs tests were employed to compare the two rounds in perceived effectiveness for PREVENTION and in perceived effectiveness for CESSATION.

### **Correlation of effectiveness versus aversion (individual warnings)**

For each warning, ratings attributed to prevention and cessation scales were averaged to create a single index of perceived EFFECTIVENESS. Perceived EFFECTIVENESS was contrasted with the mean AVERSION attributed to each warning using Spearman correlation tests, separately for the second and third rounds.

## **Behavioral Session**

Each participant performed 40 trials of bringing the pack toward them, resulting in 40 values of reaction times. Reaction times for each category (warnings of the second round, their respective matched brands; warnings of the third round, their respective matched brands) were calculated as the median values of the 10 trials. Trials with responses longer than 1000 ms or shorter than 100 ms were considered errors. These were replaced by the global average value from all conditions (as proposed by Lachaud et al. [25]). The same procedure was undertaken for missing data related to acquisition failure, which were replaced by the global average reaction time. Shapiro-Wilk W tested the normality of the reaction time distribution profiles and natural logarithmic transformation was applied to normalize data distribution. The reaction times differences between warnings of each round and their respective matched brands were calculated. As stated before, this difference in reaction times between the warnings of each round and their respective matched brands is the warning impact, which is the behavioral parameter of interest. Warning impacts were statistically compared between the third and second rounds through paired two-tailed Student's t-test.

The threshold of statistical significance employed for all analyses was a p-value of 0.05.

# RESULTS

## Evaluative Session

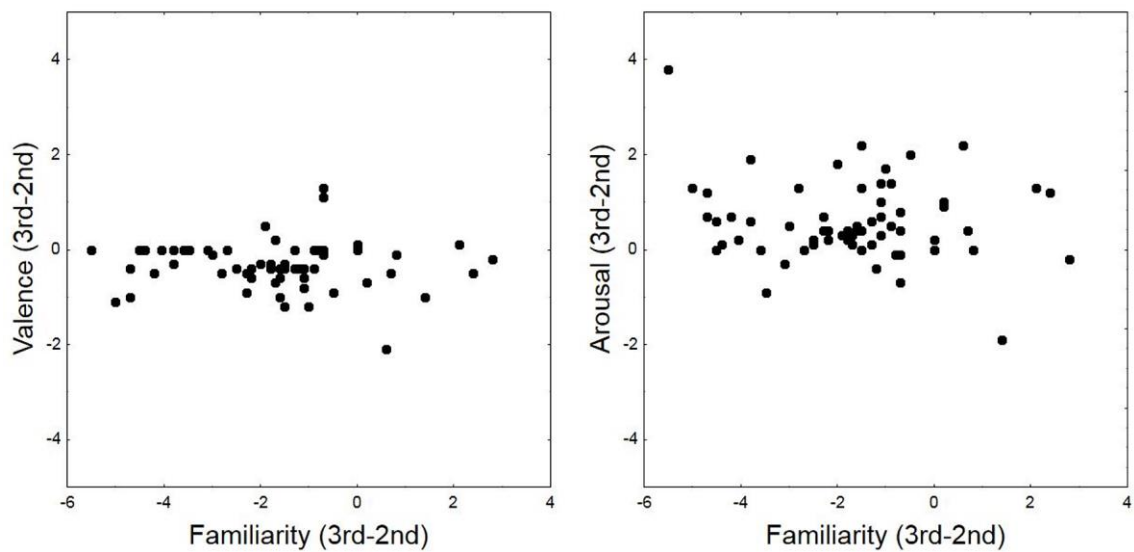
### Valence & arousal (whole sets)

Warnings of the third round were rated significantly more arousing than warnings of the second round ( $t(62) = 5.47, p < 0.001, \text{standardized effect} = 0.69, \text{power} = 0.999$ ). Warnings of the third round were also rated significantly more unpleasant (more negative) than warnings of the second round ( $t(62) = 5.35, p < 0.001, \text{standardized effect} = 0.67, \text{power} = 0.999$ ).

Mean ratings for whole set warnings of third and second rounds were, respectively,  $5.78 \pm 1.793$  and  $5.20 \pm 1.613$  for arousal; and  $-2.59 \pm 0.995$  and  $-2.23 \pm 0.947$  for valence.

### Familiarity (whole sets)

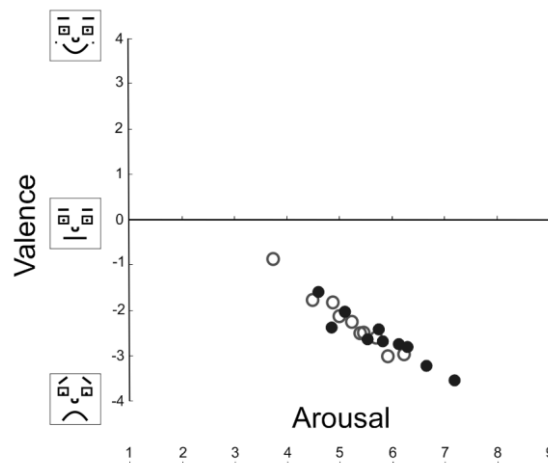
Spearman correlation coefficient comparing differential familiarity and differential valence between the two rounds was very low ( $\rho = -0.09, p = 0.49, N = 63$ ). Spearman correlation coefficient between differential familiarity and differential arousal between the two rounds was also very low ( $\rho = -0.03, p = 0.82, N = 63$ ). These comparisons indicate that a link between differential familiarity and either differential valence or differential arousal is unlikely. Scatter plots are depicted in Fig 1.



**Fig 1. Familiarity, valence and arousal.** Familiarity, valence and arousal ratings attributed to warnings of the third round and to warnings of the second round were averaged separately for each participant. Differential values obtained between third and second warning rounds ( $3^{\text{rd}} - 2^{\text{nd}}$ ) for valence (left) and arousal (right) are plotted against differential values between third and second warning rounds ( $3^{\text{rd}} - 2^{\text{nd}}$ ) obtained for familiarity.

### **Valence & arousal (individual warnings)**

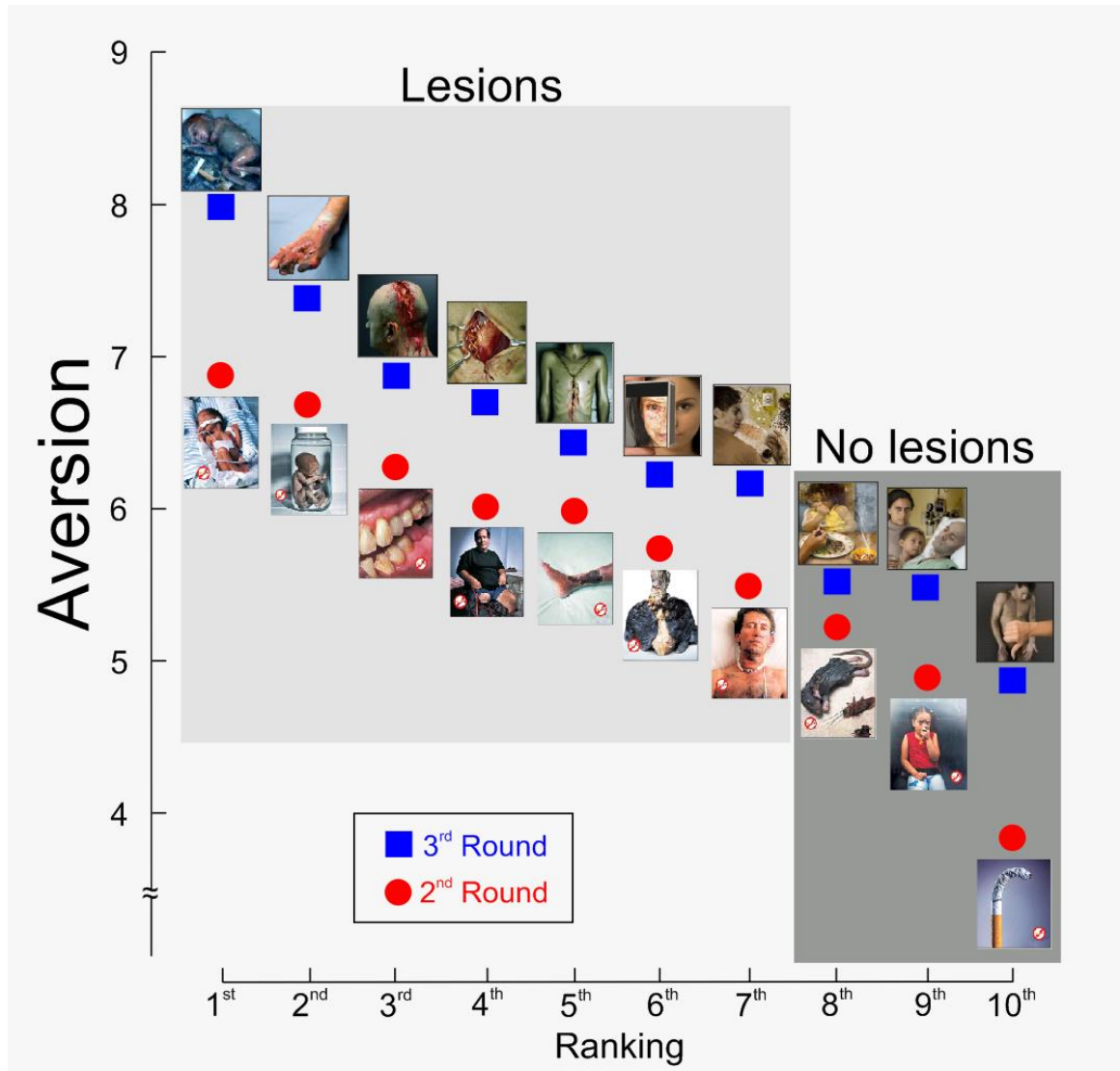
Fig 2 illustrates, for the second and third rounds, the mean valence and the mean arousal ratings for each warning in Cartesian coordinates. Ratings for the 10 warnings of each round are distributed in the negative-valence domain, with third round warnings sliding towards more negative and arousing ratings.



**Fig 2. Distribution of warnings ratings on a two-dimensional affective space.** Valence is depicted in the y-axis and arousal in the x-axis. Each point in the plot represents an individual warning. For valence, the three schematic faces represent the neutral (zero) and the extreme ranges of pleasantness (+4) and unpleasantness (-4). Arousal is depicted from 1 (lowest arousal) to 9 (highest arousal). The third round warnings are shown in solid disks, and the second round warnings, in empty disks. Ratings for both rounds are distributed in the negative-valence domain, with third round warnings sliding towards more negative and arousing ratings.

### **Aversion (individual warnings)**

Aversion magnitudes associated with warnings of the third round were greater than those of the second round. Wilcoxon matched pairs comparisons of AVERSION magnitudes for ranked individual warnings showed significantly higher values for the third compared to the second round ( $Z=2.80$ ,  $p=0.005$ ). Fig. 3 depicts the pictorial warnings of the third and second rounds ordered by their respective values of aversion. Importantly, warnings showing body lesions were rated more aversive than warnings with no lesions in both rounds.













**Fig 3. Illustration of third and second round pictorial warnings ordered by aversion (vectors) magnitudes.** For each round, ranking of warnings (1<sup>st</sup> to 10<sup>th</sup>) depicted along the horizontal axis was derived from the highest to the lowest magnitudes of aversion vectors. Values of vector magnitudes for each warning are presented vertically. Ranked vector magnitudes of third round warnings are beyond those of the second round ones. Warnings not depicting body injuries are the least aversive (8<sup>th</sup> - 10<sup>th</sup>).

## Prevention & cessation (individual warnings)

Ratings of perceived effectiveness in smoking prevention and cessation for the ranked 10 individual warnings from each round significantly favored the third round. Wilcoxon matched pairs tests showed significantly higher ratings for third compared to second round in PREVENTION ( $Z = 2.50$ ,  $p = 0.013$ ) and in CESSATION ( $Z = 2.29$ ,  $p = 0.022$ ).











Table 1 (third round warnings) and Table 2 (second round warnings) each depict, for individual warnings, the vector magnitudes of aversion; the mean values of valence, arousal, cessation and prevention; and the effectiveness index.

**Table 1. Third round warnings.**

THIRD ROUND						
	AVERSION Vector Magnitude	VALENCE Mean $\pm$ SD <sup>a</sup>	AROUSAL Mean $\pm$ SD <sup>a</sup>	CESSATION Mean $\pm$ SD <sup>a</sup>	PREVENTION Mean $\pm$ SD <sup>a</sup>	EFFECTIVENESS Index
	8.0	-3.5 $\pm$ 1.06	7.2 $\pm$ 2.30	7.9 $\pm$ 2.31	7.5 $\pm$ 3.14	7.7
	7.4	-3.2 $\pm$ 1.07	6.7 $\pm$ 2.33	7.6 $\pm$ 2.65	7.6 $\pm$ 2.60	7.6
	6.9	-2.8 $\pm$ 1.31	6.3 $\pm$ 2.55	6.2 $\pm$ 2.96	6.2 $\pm$ 3.03	6.2
	6.7	-2.7 $\pm$ 1.35	6.1 $\pm$ 2.43	6.9 $\pm$ 2.58	6.8 $\pm$ 2.90	6.8
	6.4	-2.7 $\pm$ 1.33	5.8 $\pm$ 2.58	7.1 $\pm$ 2.48	7.1 $\pm$ 2.75	7.1
	6.2	-2.4 $\pm$ 1.24	5.7 $\pm$ 2.49	7.2 $\pm$ 2.35	7.1 $\pm$ 2.75	7.2
	6.1	-2.6 $\pm$ 1.25	5.5 $\pm$ 2.40	6.2 $\pm$ 2.98	6.5 $\pm$ 2.94	6.3
	5.4	-2.0 $\pm$ 1.61	5.1 $\pm$ 2.35	5.1 $\pm$ 2.95	4.9 $\pm$ 3.10	5.0
	5.4	-2.4 $\pm$ 1.32	4.8 $\pm$ 2.25	6.5 $\pm$ 2.77	5.9 $\pm$ 2.91	6.2
	4.8	-1.6 $\pm$ 1.71	4.6 $\pm$ 2.30	6.3 $\pm$ 2.82	6.3 $\pm$ 2.74	6.3

<sup>a</sup>SD: standard deviation

**Table 2. Second round warnings.**

SECOND ROUND						
	AVERSION Vector Magnitude	VALENCE Mean $\pm$ SD <sup>a</sup>	AROUSAL Mean $\pm$ SD <sup>a</sup>	CESSATION Mean $\pm$ SD <sup>a</sup>	PREVENTION Mean $\pm$ SD <sup>a</sup>	EFFECTIVENESS Index
	6.9	-3.0 $\pm$ 1.31	6.2 $\pm$ 2.49	7.2 $\pm$ 2.24	6.6 $\pm$ 2.97	6.9
	6.7	-3.0 $\pm$ 1.31	5.9 $\pm$ 2.59	6.8 $\pm$ 2.65	6.8 $\pm$ 2.94	6.8
	6.2	-2.6 $\pm$ 1.39	5.7 $\pm$ 2.59	7.0 $\pm$ 2.85	7.2 $\pm$ 2.87	7.1
	6.0	-2.5 $\pm$ 1.19	5.4 $\pm$ 2.21	6.8 $\pm$ 2.60	6.7 $\pm$ 2.66	6.7
	6.0	-2.5 $\pm$ 1.31	5.4 $\pm$ 2.39	6.4 $\pm$ 2.75	6.3 $\pm$ 3.10	6.4
	5.7	-2.2 $\pm$ 1.66	5.2 $\pm$ 2.42	6.8 $\pm$ 3.00	6.7 $\pm$ 3.01	6.7
	5.4	-2.1 $\pm$ 1.06	5.0 $\pm$ 2.11	6.6 $\pm$ 2.42	6.6 $\pm$ 2.62	6.6
	5.2	-1.8 $\pm$ 1.61	4.9 $\pm$ 2.74	4.1 $\pm$ 2.94	4.5 $\pm$ 3.24	4.3
	4.9	-1.8 $\pm$ 1.46	4.5 $\pm$ 2.16	5.2 $\pm$ 2.63	4.6 $\pm$ 2.82	4.9
	3.8	-0.9 $\pm$ 1.59	3.7 $\pm$ 2.11	4.8 $\pm$ 3.28	5.0 $\pm$ 3.29	4.9

<sup>a</sup>SD: standard deviation

### **Aversion versus effectiveness for tobacco control within each round**

Spearman's tests revealed significant correlations between AVERSION and the indices of perceived EFFECTIVENESS, for the second round (Rho = 0.87, p=0.001), and for the third round (Rho = 0.70, p=0.025). These results show that, in addition to promote increased effectiveness between the rounds, within each round the depiction of explicit smoking harms both increases aversion vector magnitudes and effectiveness indices.



## **Behavioral Session**

For each trial, reaction time was measured as the latency between the stimuli onset (illumination of the pack on participant's hand) and the response onset (bringing the pack toward the participant's chest). All trials except two were found within the 100-1000ms range and there were twelve missing trials across conditions and participants, corresponding to 1.9% of the total.

The warnings impact was defined here as the cost (i.e., the difference in reaction times) to approach a cigarette pack when the participant is faced with a pictorial warning in relation to facing a brand without warnings. Comparison between the warnings impact from the third and second rounds through Student t-test revealed longer reaction time (larger costs) for warnings of the third round ( $t(17) = 2.53$ ,  $p=0.022$ , standardized effect=0.60, power=0.665) indicating that the third round was more effective than the second round in reducing the smokers' appetitive drive towards the packs.

## **DISCUSSION**

Previously, three studies evaluated the hedonic valence and emotional arousal of tobacco health warning pictures projected on a screen (Brazilian warnings [14]; European warnings [22] and Colombian warnings [23]). Here, with the use of a specialized device designed to test emotion-laden objects, and employing physical cigarette packs, the goal was to compare the emotional impact of two warning rounds from Brazil. An innovative (third) round, elaborated through a multidisciplinary approach, was compared against a previous (second) round devoid of such academic support. The two warning rounds were compared on hedonic

valence, emotional arousal, and perceived effectiveness for smoking prevention and cessation. Also, the relative impact on curbing smokers' behavioral drive toward packs was compared between the rounds.

The third warning round was rated significantly more unpleasant and more arousing than the second warning round. Comparisons of aversion and of effectiveness attributed to individual warnings showed the third round as more aversive and more effective than the second round. Behaviorally, third round warnings exerted more curbing on the smokers' appetitive drive towards packs by adding a higher cost in bringing packs closer.

The Brazilian third round was designed to trigger stronger aversive emotions toward tobacco products and, as a result, it was expected to contribute in smoking prevention and cessation [8]. The inclusion of more aversive arousing pictorial warnings in the third round followed the premises of several psychophysiological works on emotion, which showed that the most threatening and arousing pictures, including those depicting injuries to the body, prompt the greatest level of defensive activation [10–13, 26]. This is in line with the present results, showing that the innovative third round, compared to the second round, was considered more unpleasant and arousing, more effective in smoking prevention and cessation, and in behaviorally curbing the smokers' appetitive drive toward cigarette packs.

Previous studies on psychophysiological reactions to pictures of injuries revealed that body and brain responses are attenuated if the injuries scenes are portrayed as less intense and as presenting lower risk [27–30]. This was taken into account when producing the innovative third round and the depiction of more vivid tobacco harms may have contributed to the higher emotional impact of the third round.

Importantly, even within each round, third or second, the presence of more explicit lesions increased aversion which in turn correlated with reports of perceived effectiveness for tobacco control. Indeed, the presence of graphic contents associated with reports of higher

perceived effectiveness for tobacco control is a consistently reliable finding among studies of pictorial warnings from different countries [4, 31–34].

The present work unprecedentedly compared the two different rounds using a method that replicates the way smokers usually handle their cigarette packs. This was accomplished using a specialized device to test emotion-laden objects [21], which allowed reaction time measurements, i.e. the latency between the stimuli onset (illumination of the pack on participant's hand) and the response onset (bringing the pack toward the participant's chest). Reaction times to cigarette packs showing warnings from the third round on the entire visible face (in relation to showing respective matched brands without warnings) were significantly longer compared to reaction times to cigarette packs showing warnings from the second round (in relation to showing respective matched brands without warnings). This means that third warnings round impose larger costs to perform a task movement which simulates a habitual smoker's action. Behaviorally relevant actions seem to be associated with preset cerebral motor repertoires (see electrophysiological evidence in monkeys [35] and humans [36, 37]). It was shown that exposure to pleasant objects recruit pre-set brain motor repertoires directed to the compatible movement of approaching them; while, when individuals are exposed to unpleasant objects and are instructed to approach them, the task was shown to be more costly, probably due to an incompatibility or conflict between the required action and the preset brain networks to repel them [37]. Cigarette packs are pleasant relevant stimuli for smokers and they probably pre-activate motor repertoires to manipulate them. Stronger aversive warnings - third round ones - shown on the entire visible face of the pack, caused greater interference in the automatic drive toward the packs, translated behaviorally into longer reaction times; suggesting that those warnings might have evoked a brain motor conflict between "approaching" and "repelling" cigarette packs.

## CONCLUSIONS

The present results showed that the innovative third warnings round achieved the expected outcomes. Participants rated the third round warnings as more unpleasant and arousing, and as more effective for tobacco control compared to second round warnings. Further, the third warnings round was more successful in curbing smokers' appetitive drive toward cigarette packs. These results reinforce the benefits of a multi-disciplinary approach to improve the development of more efficacious health warning labels for tobacco control, which may serve as a procedure model for their production in other countries. The present experimental work, which attempted to reproduce a "real world" context in laboratory settings, may help to reduce the gap between the results obtained in controlled settings, and those observed at population level.

## REFERENCES

1. UN General Assembly (2012) Political Declaration of the High-level Meeting of the General Assembly on the Prevention and Control of Non-communicable Diseases. A/RES/66/2. UN New York 49777:1–13
2. World Health Organization (2003) WHO (2003) Framework convention on tobacco control. In: *Framew. Conv. Tob. Control*. WHO Document Production Services, Geneva, p Volume: 45, Issue: 3
3. Beaglehole R, Bonita R, Horton R, et al (2011) Priority actions for the non-communicable disease crisis. *Lancet* 377:1438–1447
4. Hammond D (2011) Health warning messages on tobacco products: a review. *Tob Control* 20:327–337
5. Szklo AS, de Souza MC, Szklo M, de Almeida LM (2015) Smokers in Brazil: who are they? *Tob Control* tobaccocontrol-2015-052324
6. Ministry of Health of Brazil. (2004) *Graphic health warning labels about the harms associated with tobacco use*. Rio de Janeiro
7. Ministry of Health of Brazil. (2009) *Brazil: Health warnings on tobacco products-2009*. Instituto Nacional de Câncer – INCA, Rio de Janeiro

8. Volchan E, David IA, Tavares G, et al (2013) Implicit Motivational Impact of Pictorial Health Warning on Cigarette Packs. *PLoS One* 8:4–9
9. Nascimento BEM, Gamba Jr N, Oliveira O, Pereira MG, Spitz R, Gleiser S, Perez C, Vianna C, Cavalcante T, Volchan E (2010) Neurosciences, graphic arts, and public health: new health warnings on cigarette packaging. *História, Ciências, Saúde-Manguinhos* 17:243–252
10. Lang PJ, Bradley MM (2010) Emotion and the motivational brain. *Biol Psychol* 84:437–450
11. Pereira MG, de Oliveira L, Erthal FS, Joffily M, Mocaiber IF, Volchan E, Pessoa L (2010) Emotion affects action: Midcingulate cortex as a pivotal node of interaction between negative emotion and motor signals. *Cogn Affect Behav Neurosci* 10:94–106
12. Azevedo TM, Volchan E, Imbiriba LA, Rodrigues EC, Oliveira JM, Oliveira LF, Lutterbach LG, Vargas CD (2005) A freezing-like posture to pictures of mutilation. *Psychophysiology* 42:255–260
13. Pereira MG, Volchan E, de Souza GGL, Oliveira L, Campagnoli RR, Pinheiro WM, Pessoa L (2006) Sustained and transient modulation of performance induced by emotional picture viewing. *Emotion* 6:622–634
14. Nascimento BEM, Oliveira L, Vieira a S, Joffily M, Gleiser S, Pereira MG, Cavalcante T, Volchan E (2008) Avoidance of smoking: the impact of warning labels in Brazil. *Tob Control* 17:405–409
15. Harris JL, Pierce M, Bargh J a. (2013) Priming effect of antismoking PSAs on smoking behaviour: a pilot study. *Tob Control* 1–6
16. Lang P, Bradley M, Cuthbert B (2008) International Affective Picture System (IAPS): Digitized Photographs, Instruction Manual and Affective Ratings. Technical Report A-6. Gainesville, FL
17. Bradley M, Lang PJ (1994) Measuring Emotion: The Self-Assessment Semantic Differential Manikin and the. *J Behav Ther Exp Psychiatry* 25:49–59
18. Bradley MM, Keil A, Lang PJ (2012) Orienting and emotional perception: Facilitation, attenuation, and interference. *Front Psychol* 3:1–6
19. Hammond D (2005) Smoking behaviour among young adults: beyond youth prevention. *Tob Control* 14:181–5
20. Freedman KS, Nelson NM, Feldman LL (2012) Smoking initiation among young adults in the United States and Canada, 1998-2010: a systematic review. *Prev Chronic Dis* 9:E05
21. Oliveira JM, Volchan E, Vargas CD, Gleiser S, David I a. (2012) Box for interaction with objects (BIO): A new device to synchronize the presentation of objects with electrophysiological recordings. *Behav Res Methods* 1115–1120
22. Muñoz M a, Viedma-Del-Jesús MI, Rosselló F, Sánchez-Nácher N, Montoya P, Vila J (2013) The emotional impact of European tobacco-warning images. *Tob Control* 22:123–9
23. Gantiva C, Guerrero L, Rico A, Ramirez N, Diaz M, Gonzalez M, Romo-Gonzalez T (2016) Influence of cigarette package brand on the emotional impact of tobacco-warning images that cover 30% of cigarette packs in smokers and Nonsmokers. *Nicotine Tob Res* 18:1324–1330

24. Fong GT, Hammond D, Jiang Y, Li Q, Quah a. CK, Driezen P, Yan M (2010) Perceptions of tobacco health warnings in China compared with picture and text-only health warnings from other countries: an experimental study. *Tob Control* 19:i69–i77
25. Lachaud CM, Renaud O (2011) A tutorial for analyzing human reaction times: How to filter data, manage missing values, and choose a statistical model. *Appl Psycholinguist* 32:389–416
26. Volchan E, Rocha-Rego V, Bastos AF, et al (2017) Immobility reactions under threat: A contribution to human defensive cascade and PTSD. *Neurosci Biobehav Rev* 1–10
27. Mocaiber I, Perakakis P, Pereira MG, Pinheiro WM, Volchan E, de Oliveira L, Vila J (2011) Stimulus appraisal modulates cardiac reactivity to briefly presented mutilation pictures. *Int J Psychophysiol* 81:299–304
28. Mocaiber I, Sanchez TA, Pereira MG, Erthal FS, Joffily M, Araujo DB, Volchan E, de Oliveira L (2011) Antecedent descriptions change brain reactivity to emotional stimuli: A functional magnetic resonance imaging study of an extrinsic and incidental reappraisal strategy. *Neuroscience* 193:241–248
29. Mocaiber I, Pereira MG, Erthal FS, Machado-Pinheiro W, David IA, Cagy M, Volchan E, de Oliveira L (2010) Fact or fiction? An event-related potential study of implicit emotion regulation. *Neurosci Lett* 476:84–88
30. Oliveira LAS, Oliveira L, Joffily M, Pereira-Junior PP, Lang PJ, Pereira MG, Figueira I, Volchan E (2009) Autonomic reactions to mutilation pictures: Positive affect facilitates safety signal processing. *Psychophysiology* 46:870–873
31. Hammond D, Thrasher J, Reid JL, Driezen P, Boudreau C, Santillán EA (2012) Perceived effectiveness of pictorial health warnings among Mexican youth and adults: a population-level intervention with potential to reduce tobacco-related inequities. *Cancer Causes Control* 23 Suppl 1:57–67
32. Thrasher JF, Carpenter MJ, Andrews JO, Gray KM, Alberg AJ, Navarro A, Daniela B, Cummings KM (2013) Cigarette Warning Label Policy Alternatives and Smoking-Related Health Disparities. *Am J Prev Med* 43:590–600
33. Cameron LD, Williams B (2015) Which Images and Features in Graphic Cigarette Warnings Predict Their Perceived Effectiveness? Findings from an Online Survey of Residents in the UK. *Ann Behav Med* 49:639–649
34. Szklo AS, Volchan E, Thrasher JF, Perez C, Szklo M, de Almeida LM (2016) Do more graphic and aversive cigarette health warning labels affect Brazilian smokers' likelihood of quitting? *Addict Behav* 60:209–212
35. Graziano M (2006) the Organization of Behavioral Repertoire in Motor Cortex. *Annu Rev Neurosci* 29:105–134
36. Campagnoli RR, Krutman L, Vargas CD, Lobo I, Oliveira JM, Oliveira L, Pereira MG, David I a., Volchan E (2015) Preparing to caress: a neural signature of social bonding. *Front Psychol* 6:1–9
37. de Oliveira LAS, Imbiriba LA, Russo MM, Nogueira-Campos AA, Rodrigues E de C, Pereira MG, Volchan E, Vargas CD (2012) Preparing to Grasp Emotionally Laden Stimuli. *PLoS One*. doi: 10.1371/journal.pone.0045235

### 3 DISCUSSÃO

Anteriormente, três estudos avaliaram a valência hedônica e o impacto emocional de imagens de imagens de advertências sanitárias antitabaco projetadas em uma tela (advertências brasileiras [14], advertências europeias [19] e advertências colombianas [20]). Neste estudo foi utilizado um dispositivo especializado, projetado para testar objetos que deflagram emoções, empregando maços de cigarros comerciais como estímulos. O terceiro grupo inovador de advertências, elaborado por meio de uma abordagem multidisciplinar, foi comparado com o grupo anterior, desprovido de tal apoio acadêmico. Os dois grupos foram comparados em termos de valência hedônica, ativação emocional e percepção de eficácia para prevenção e cessação do tabagismo. Além disso, o impacto na redução da motivação dos fumantes em manipular os maços também foi comparado.

O terceiro grupo de advertências brasileiro foi projetado para desencadear emoções aversivas mais fortes em relação aos produtos do tabaco e, como resultado, esperava-se que ele contribuísse na prevenção e na cessação do tabagismo [8]. A inclusão de advertências pictóricas mais aversivas no terceiro grupo seguiu as premissas de vários trabalhos psicofisiológicos sobre a emoção, que mostraram que as imagens mais ameaçadoras e ativantes, incluindo aquelas que representam lesões corporais, induzem o maior nível de ativação defensiva [13, 21]. Isso está de acordo com os resultados obtidos neste estudo, mostrando que o terceiro grupo inovador, em comparação com o segundo grupo, foi considerado mais desagradável e ativante, mais eficaz na prevenção e cessação do tabagismo e na contenção comportamental da motivação dos fumantes em manipular os maços de cigarros.

O tempo de reação maior, apresentado pelo terceiro grupo de advertências durante a realização da tarefa comportamental, revela que este grupo exerceu maior restrição à motivação dos fumantes em manipular maços.

Estudos anteriores sobre reações psicofisiológicas a imagens de lesões revelaram que as respostas corporais e cerebrais são atenuadas se as cenas de lesões são retratadas como menos intensas e apresentando menor risco [22–25]. Isso foi levado em conta quando se produziu o terceiro grupo inovador e a representação de danos mais vivos causados pelo tabaco pode ter contribuído para o maior impacto emocional do terceiro grupo.

Importante observar que mesmo dentro de cada grupo, terceiro ou segundo, a presença de lesões mais explícitas aumentou a aversão relatada pelos participantes, que por sua vez se correlacionou com relatos de percepção de eficácia para o controle do tabagismo. De fato, a

presença de conteúdos vívidos associados a relatos de maior eficácia percebida para o controle do tabagismo é um achado consistente nos estudos de advertências pictóricas de diferentes países [26–30].

O presente trabalho, sem precedentes, comparou dois grupos de advertências sanitárias usando um método que replica a forma como os fumantes geralmente lidam com seus maços de cigarros. Isto foi realizado usando um dispositivo especializado para testar objetos carregados de emoção [31], o que permitiu medidas de tempo de reação, ou seja, a latência entre o início dos estímulos (iluminação do maço na mão do participante e o início do movimento de aproximação ao corpo). Os tempos de reação às embalagens de cigarros que apresentavam advertências do terceiro grupo com a totalidade da face visível (em relação à apresentação de marcas correspondentes sem advertências) foram significativamente mais longos do que os tempos de reação aos maços de cigarros com advertências do segundo grupo (em relação à respectiva face mostrando a marca sem advertências). Isto significa que o terceiro grupo de advertências impõe custos maiores para executar um movimento de tarefa que simula a ação de um fumante habitual. As ações comportamentais relevantes parecem estar associadas a repertórios motores cerebrais predefinidos (ver evidência eletrofisiológica em macacos [32] e humanos [33, 34]). Mostrou-se que a exposição a objetos agradáveis recruta repertórios predefinidos de motores cerebrais dirigidos ao movimento compatível de aproximar-se deles; enquanto que, quando os indivíduos são expostos a objetos desagradáveis e são instruídos a aproxima-los, a tarefa mostra-se mais dispendiosa, provavelmente devido a uma incompatibilidade ou conflito entre a ação realizada e as redes pré-ativadas no cérebro, voltadas a repeli-los. As embalagens de cigarros são estímulos relevantes para os fumantes e provavelmente pré-ativam os repertórios motores para manipulá-los. As advertências mais aversivas do terceiro grupo, mostradas em toda a face visível da embalagem, causaram maior interferência na motivação em manipular os maços, traduzidos comportamentalmente por tempos de reação mais longos; sugerindo que essas advertências podem ter evocado um conflito motor cerebral entre "aproximar" e "repelir" os maços de cigarros.



## 4 CONCLUSÕES

Os resultados atuais mostraram que o terceiro grupo de advertências alcançou os resultados esperados. Os participantes classificaram as advertências do terceiro grupo como mais desagradáveis e ativantes e como mais eficazes para o controle do tabagismo em comparação com as advertências do segundo grupo. Além disso, o terceiro grupo de advertências foi mais bem-sucedido na contenção do apetite dos fumantes em manipular os maços de cigarros. Esses resultados reforçam os benefícios de uma abordagem multidisciplinar para o desenvolvimento de advertências de saúde mais eficazes para o controle do tabagismo.

O presente trabalho experimental, que tentou reproduzir um contexto de "mundo real" em ambientes laboratoriais, pode ajudar a reduzir o hiato entre os resultados obtidos em ambientes controlados e os observados em nível populacional.

## 5 REFERÊNCIAS

1. UN General Assembly (2012) Political Declaration of the High-level Meeting of the General Assembly on the Prevention and Control of Non-communicable Diseases. A/RES/66/2. UN New York 49777:1–13
2. World Health Organization (2003) WHO (2003) Framework convention on tobacco control. In: *Framew. Conv. Tob. Control*. WHO Document Production Services, Geneva, p Volume: 45, Issue: 3
3. Beaglehole R, Bonita R, Horton R, et al (2011) Priority actions for the non-communicable disease crisis. *Lancet* 377:1438–1447
4. Hammond D (2011) Health warning messages on tobacco products: a review. *Tob Control* 20:327–337
5. Szklo AS, de Souza MC, Szklo M, de Almeida LM (2015) Smokers in Brazil: who are they? *Tob Control* tobaccocontrol-2015-052324
6. Ministry of Health of Brazil. (2004) Graphic health warning labels about the harms associated with tobacco use. Rio de Janeiro
7. Ministry of Health of Brazil. (2009) Brazil: Health warnings on tobacco products-2009. Instituto Nacional de Câncer – INCA, Rio de Janeiro
8. Volchan E, David IA, Tavares G, et al (2013) Implicit Motivational Impact of Pictorial Health Warning on Cigarette Packs. *PLoS One* 8:4–9
9. Nascimento BEM, Gamba Jr N, Oliveira O, Pereira MG, Spitz R, Gleiser S, Perez C, Vianna C, Cavalcante T, Volchan E (2010) Neurosciences, graphic arts, and public health: new health warnings on cigarette packaging. *História, Ciências, Saúde-Manguinhos* 17:243–252
10. Lang PJ, Bradley MM (2010) Emotion and the motivational brain. *Biol Psychol* 84:437–450
11. Pereira MG, de Oliveira L, Erthal FS, Joffily M, Mocaiber IF, Volchan E, Pessoa L (2010) Emotion affects action: Midcingulate cortex as a pivotal node of interaction between negative emotion and motor signals. *Cogn Affect Behav Neurosci* 10:94–106
12. Azevedo TM, Volchan E, Imbiriba LA, Rodrigues EC, Oliveira JM, Oliveira LF, Lutterbach LG, Vargas CD (2005) A freezing-like posture to pictures of mutilation. *Psychophysiology* 42:255–260
13. Pereira MG, Volchan E, de Souza GGL, Oliveira L, Campagnoli RR, Pinheiro WM, Pessoa L (2006) Sustained and transient modulation of performance induced by emotional picture viewing. *Emotion* 6:622–634
14. Nascimento BEM, Oliveira L, Vieira a S, Joffily M, Gleiser S, Pereira MG, Cavalcante T, Volchan E (2008) Avoidance of smoking: the impact of warning labels in Brazil. *Tob Control* 17:405–409
15. Harris JL, Pierce M, Bargh J a. (2013) Priming effect of antismoking PSAs on smoking behaviour: a pilot study. *Tob Control* 1–6
16. Lang P, Bradley M, Cuthbert B (2008) International Affective Picture System (IAPS): Digitized Photographs, Instruction Manual and Affective Ratings. Technical Report A-

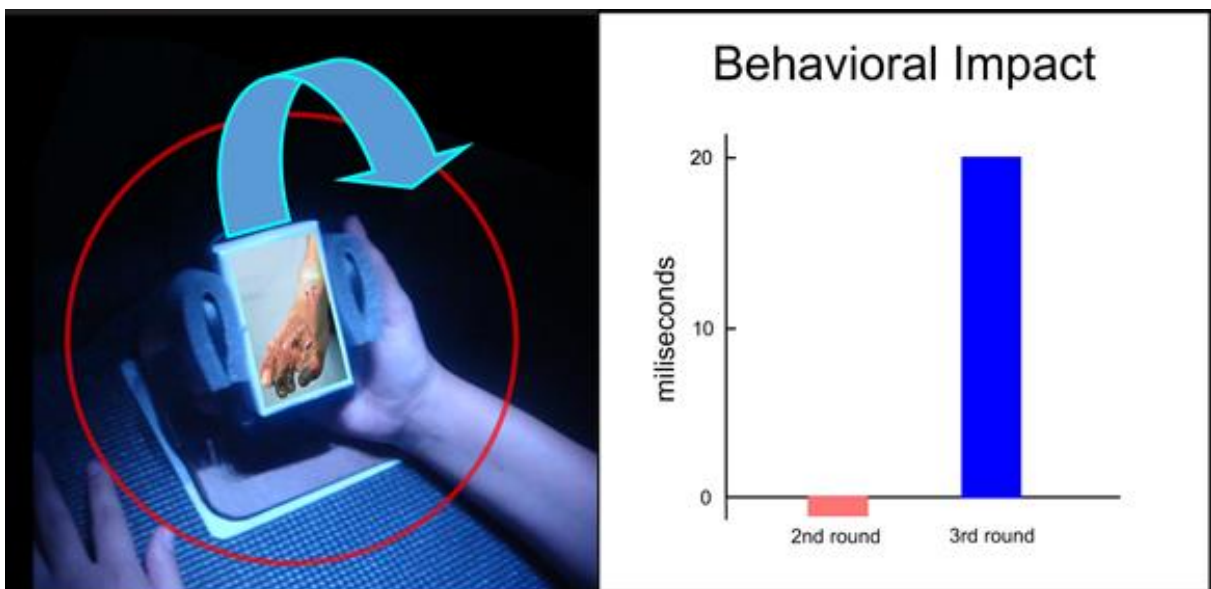
6. Gainesville, FL
17. Bradley M, Lang PJ (1994) Measuring Emotion: The Self-Assessment Semantic Differential Manikin and the. *J Behav Ther Exp Psychiatry* 25:49–59
  18. Bradley MM, Keil A, Lang PJ (2012) Orienting and emotional perception: Facilitation, attenuation, and interference. *Front Psychol* 3:1–6
  19. Muñoz M a, Viedma-Del-Jesús MI, Rosselló F, Sánchez-Nácher N, Montoya P, Vila J (2013) The emotional impact of European tobacco-warning images. *Tob Control* 22:123–9
  20. Gantiva C, Guerrero L, Rico A, Ramírez N, Díaz M, González M, Romo-González T (2016) Influence of Cigarette Package Brand on the Emotional Impact of Tobacco-Warning Images That Cover 30% of Cigarette Packs in Smokers and Nonsmokers. *Nicotine Tob Res* 18:1324–30
  21. Volchan E, Rocha-Rego V, Bastos AF, et al (2017) Immobility reactions under threat: A contribution to human defensive cascade and PTSD. *Neurosci Biobehav Rev* 1–10
  22. Mocaiber I, Sanchez TA, Pereira MG, Erthal FS, Joffily M, Araujo DB, Volchan E, de Oliveira L (2011) Antecedent descriptions change brain reactivity to emotional stimuli: A functional magnetic resonance imaging study of an extrinsic and incidental reappraisal strategy. *Neuroscience* 193:241–248
  23. Mocaiber I, Perakakis P, Pereira MG, Pinheiro WM, Volchan E, de Oliveira L, Vila J (2011) Stimulus appraisal modulates cardiac reactivity to briefly presented mutilation pictures. *Int J Psychophysiol* 81:299–304
  24. Mocaiber I, Pereira MG, Erthal FS, Machado-Pinheiro W, David IA, Cagy M, Volchan E, de Oliveira L (2010) Fact or fiction? An event-related potential study of implicit emotion regulation. *Neurosci Lett* 476:84–88
  25. Oliveira LAS, Oliveira L, Joffily M, Pereira-Junior PP, Lang PJ, Pereira MG, Figueira I, Volchan E (2009) Autonomic reactions to mutilation pictures: Positive affect facilitates safety signal processing. *Psychophysiology* 46:870–873
  26. Hammond D (2011) Health warning messages on tobacco products: a review. *Tob Control* 20:327–37
  27. Hammond D, Thrasher J, Reid JL, Driezen P, Boudreau C, Santillán EA (2012) Perceived effectiveness of pictorial health warnings among Mexican youth and adults: a population-level intervention with potential to reduce tobacco-related inequities. *Cancer Causes Control* 23 Suppl 1:57–67
  28. Thrasher JF, Carpenter MJ, Andrews JO, Gray KM, Alberg AJ, Navarro A, Daniela B, Cummings KM (2013) Cigarette Warning Label Policy Alternatives and Smoking-Related Health Disparities. *Am J Prev Med* 43:590–600
  29. Cameron LD, Williams B (2015) Which Images and Features in Graphic Cigarette Warnings Predict Their Perceived Effectiveness? Findings from an Online Survey of Residents in the UK. *Ann Behav Med* 49:639–649
  30. Szklo AS, Volchan E, Thrasher JF, Perez C, Szklo M, de Almeida LM (2016) Do more graphic and aversive cigarette health warning labels affect Brazilian smokers' likelihood of quitting? *Addict Behav* 60:209–212

31. Oliveira JM, Volchan E, Vargas CD, Gleiser S, David I a. (2012) Box for interaction with objects (BIO): A new device to synchronize the presentation of objects with electrophysiological recordings. *Behav Res Methods* 1115–1120
32. Graziano M (2006) the Organization of Behavioral Repertoire in Motor Cortex. *Annu Rev Neurosci* 29:105–134
33. Campagnoli RR, Krutman L, Vargas CD, Lobo I, Oliveira JM, Oliveira L, Pereira MG, David I a., Volchan E (2015) Preparing to caress: a neural signature of social bonding. *Front Psychol* 6:1–9
34. de Oliveira LAS, Imbiriba LA, Russo MM, Nogueira-Campos AA, Rodrigues E de C, Pereira MG, Volchan E, Vargas CD (2012) Preparing to Grasp Emotionally Laden Stimuli. *PLoS One*. doi: 10.1371/journal.pone.0045235

## 6 APÊNDICE A – FIGURAS COMPLEMENTARES.



**Figura complementar 1:** Aparato utilizado para a medição do impacto emocional das advertências sanitárias para o controle do tabagismo. À esquerda, sentada à frente do aparato, a participante aguarda o aparecimento do estímulo para realizar a tarefa. À direita, sentado atrás do aparato, o experimentador posiciona o estímulo (maço de cigarro) no interior do dispositivo e acende a luz interna que permite sua visualização.



**Figura complementar 2:** À esquerda, ilustra a tarefa realizada para a medição do impacto comportamental provocado pelas advertências sanitárias para o controle do tabagismo. À direita, gráfico representando, em vermelho, o impacto comportamental médio provocado pelo segundo grupo de advertências e, em azul, o impacto comportamental médio provocado pelo terceiro grupo de advertências.