The Onset Time Delaying Effect: Smokers vs Non-Smokers Place the Adverse Consequences of Smoking further in the Future

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Despite all the information about the risks, many people still smoke. Several studies investigated risk perceptions in smokers. The adequate perceptions of the risks from smoking is particularly important and this study investigated the risk perception of young smokers vs non-smokers by a new time-estimation task in which we required participants (smokers and non-smokers) to estimate the onset time of smoking-related conditions in an average young smoker. The findings supported our main hypothesis that smokers, compared to non-smokers, postponed the onset of both mild and severe smoking-related conditions. The results also revealed that the onset time estimates for mild conditions given by both smokers and non-smokers were associated with their self-perceptions of risk and level of fear of developing smoking-related conditions. The findings cast light on smokers’ distorted temporal perception of the health-damaging consequences of smoking. Implications for the adequacy of risk perception in smokers are discussed.

Keywords: smoking; risk perception; fear; time delaying.

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Introduction

Tobacco use causes more than 7 million annual deaths worldwide (World Health Organization, 2017). In Italy, where the present study was conducted, there are 11.7 million smokers out of 52.4 million people aged 15 years or older (22.3% of the population), 16.2% aged between 15 and 24 years and 28% between 25 and 44 years according to a survey by DOXA/ISS in 2017 (Pacifici, 2017). The World Health Organization estimated that 23.3%, 95% CI [19.5, 27.2], of the population in Italy were smokers in 2010 and it projects that 20.3%, 95% CI [14.8, 25.6], of the population will be smokers in 2025 if tobacco control is maintained at the same level (World Health Organization, 2015). Despite the worldwide reduction in prevalence of daily smoking between 1990 and 2015, smoking represents one of the main risk factors for early death and disability (Reitsma et al., 2017).

Notwithstanding the health-damaging consequences of smoking, many people decide to smoke. The question arises of whether smokers adequately perceive the harmful consequences of smoking and, more generally, whether they are risk under-sensitive or insensitive. This question is relevant as it might ultimately bear on the issue of whether smokers are “rational” decision makers with respect to smoking behaviour. In the literature, a debate has arisen around people’s adequacy of risk perceptions and, consequently, the soundness of people’s decisions. Viscusi (Viscusi & Hakes, 2008; Viscusi, 1990, 1992, 2000) reported data from surveys which varied in terms of the specific health outcome inquired about (i.e., lung cancer, smoking mortality risk, and life expectancy loss). The main finding was a consistent overestimation of the levels of risk associated with smoking compared to the scientific reference point (computed based on estimates of the US Surgeon General). In particular, the overestimation of the lung cancer risk was the greatest among younger people aged 16 to 21 (Viscusi, 2000). Viscusi explained the higher risk perceptions among young individuals as the result of their greater exposure to antismoking campaigns compared to older smokers. In turn, these high perceptions of the risks of smoking have an impact on society because they reduce the probability of smoking (Viscusi & Hakes, 2008; Viscusi, 1990). Indeed,
Viscusi estimated that accurate, rather than overestimated, risk perceptions would raise the smoking rates by 6.5 to 7.5 percentage points (Viscusi, 2000).

Viscusi’s conclusion that young smokers are well-informed and operate rationally given the information available to them and their preferences has been criticized by Slovic (1998, 2000a, 2000b, 2001). Slovic’s critique is based on four main points: Viscusi’s questions fail to take into account the cumulative nature of risks from smoking and young people’s misperceptions of the addictive nature of smoking; they do not convey the severity of the consequences of smoking, and they are phrased so that they are prone to “optimism bias” (Slovic, 2000b). His critique is based on the influence of rapid and automatic experienced feelings (i.e., the “affect heuristic”; Finucane, Alhakami, Slovic, & Johnson, 2000; Slovic, 2001; Slovic, Peters, Finucane, & MacGregor, 2005) on human judgement and decision making. Experiential and affective thinking would lead young people to believe that smoking for only a few years is safe (they would thus ignore the cumulative risk from smoking), also because they underestimate the risk of becoming addicted and thus not being able to stop smoking (Arnett, 2000; Slovic, 1998, 2001). Slovic based his arguments on data from a survey that showed that the majority of the young and adult smokers thought a little or not at all about health risks when they first started to smoke, and they did not think about or they underestimated how long they would continue to smoke. Furthermore, most of young and adult smokers planned to quit smoking within the subsequent year and they thought they would successfully quit smoking in a year from the interview even though they had unsuccessfully attempted to quit 10 or more times before (Slovic, 2001).

Slovic (1998), in line with other authors (Peretti-Watel et al., 2007), also argues against the interpretation of risk in terms of probability rather than the probability and the severity of consequences. People would judge the risk of catching a cold as higher than the risk from smoking if the risk estimate is elicited in terms of probability only rather than being phrased so that the severity of the smoking-related conditions is also transparent. Finally, Slovic criticizes Viscusi’s choice to ask people about the risk from smoking to others (i.e., “Among 100 cigarette smokers,
how many of them do you think will get lung cancer because they smoke?”) and not to themselves. This question phrasing could induce an optimism bias, whereby people judge others’ risk to be higher than their own given the same conditions (Slovic, 1998; Weinstein, 1989, 1998). In particular, there is evidence that smokers underestimate their risk of lung cancer compared to non-smokers and average smokers (Weinstein, Marcus, & Moser, 2005). More in general, smokers underestimate their health risks despite being aware of the harmful consequences of smoking (Arnett, 2000; Peretti-Watel et al., 2007, 2014). Optimism bias correlates with negative consequences because optimistic smokers have been found to hold rationalizing beliefs about lung cancer and to be less interested in quitting smoking (Dillard, McCaul, & Klein, 2006).

In the current study the dependent variable was participants’ assessment of the onset time of smoking-related conditions (SRCs) such as yellow teeth, hypertension, lung cancer in an average smoker, and not directly of their own risk of mortality, life expectancy loss or developing a disease. The use of such new measures of the perceptions of the risks from smoking (e.g., measures different from risk preference questions) could help overcome some of the issues that could have affected previous measures (see, for example, the critical views on intertemporal choice tasks by Frederick, Loewenstein, & O’Donoghue, 2002; Scholten & Read, 2010; Van den Bos & McClure, 2013). It could also clarify whether smokers’ beliefs of the smoking risks are adequate or not.

**Time Perception in Smokers vs Non-Smokers**

Our focus on time perception as a way to get insights into smokers’ risk perceptions is in keeping with theorising about the role of time considerations in addictions (Becker & Murphy, 1988; Hall & Fong, 2007). Furthermore, in the attempt to account for smoking behaviour, several studies in the literature have provided empirical evidence for different time-related perceptions in smokers compared to non-smokers and ex-smokers. In their Theory of Rational Addiction, Becker and Murphy show that addiction is more likely for individuals who are present orientated rather than future orientated. In line with this model, tobacco addiction has been found to be associated with time perspective, which is a process whereby decisions are influenced by a focus on past,
future or present considerations (Adams, 2009b; Zimbardo & Boyd, 1999). In a cross-sectional study, Keough and co-workers found that individuals who are higher in present time perspective report higher use of tobacco (Keough, Zimbardo, & Boyd, 1999). However, there are mixed findings on the causal link between future orientation and successful smoking cessation (Beenstock, Lindson-Hawley, Aveyard, & Adams, 2014; Hall, Fong, & Meng, 2014).

Related to future orientation is the concept of time preference. Smokers, compared to non-smokers and ex-smokers, exhibit greater time discounting, whereby smaller, immediate rewards are preferred over larger, delayed ones (Adams, 2009a, 2009b; Baker, Johnson, & Bickel, 2003; Barlow, McKee, Reeves, Galea, & Stuckler, 2016; Bickel et al., 2011; Bickel, Odum, & Madden, 1999; Businelle, McVay, Kendzor, & Copeland, 2010; Friedel, Dehart, Madden, & Odum, 2014; Johnson, Bickel, & Baker, 2007; Mitchell, 1999; Ohmura, Takahashi, & Kitamura, 2016; Reynolds, Richards, Horn, & Karraker, 2004; Rezvanfard, Ekhtiar, Mokri, Djavid, & Kaviani, 2010). In other words, the perceived value of a reward (e.g., better health) decreases with its delay and this discount is faster in smokers vs non-smokers (Adams, 2009b; Barlow et al., 2016). Time discounting associated with smoking behaviour has been mainly studied by means of forced choices about hypothetical trade-offs at different times (e.g., a smaller amount of an outcome sooner vs a larger amount later) and across outcomes (e.g., cigarettes, money, health, food). A meta-analysis conducted by MacKillop and colleagues has found significantly higher time discounting in either clinical or subclinical groups of tobacco users than in control groups for 79% (15 out of 19) of the studies they analysed, with a medium-sized effect, Cohen’s $d = .57$, $p < .0001$ (MacKillop et al., 2011).

The studies on time discounting have focused on intertemporal choices and the value assigned to commodities over time. They tapped into a process that has been suggested to be indicative of the impulsivity of smokers (Friedel et al., 2014; Mitchell, 1999; Rezvanfard et al., 2010) and that might be trait-like (Odum, 2011).
Smokers’ perceptions of the time at which the risks from smoking might develop could reveal an additional aspect of smokers’ time perception that is distinct from their time perspective and preferences. Smokers could perceive the negative consequences of smoking as delayed compared to non-smokers. The work by Hall and colleagues provides ground for this hypothesis by showing that young adults perceive the costs of smoking as being more distal than its benefits (Hall & Fong, 2007, Figure 3). Whether the adverse consequences of smoking are perceived as delayed not only relatively to the positive ones, but also in absolute terms is a question that we addressed in our study.

**The Present Study**

Although previous research has shown that smokers, compared to non-smokers and ex-smokers, place less value on events that will occur in the future (Adams, 2009b), no study has yet shown that smokers also place the adverse consequences of smoking further in the future compared to non-smokers. Perceived benefits of smoking occur early, while the health-related costs of smoking come at a delay (Barlow et al., 2016; Hall & Fong, 2007). Smokers, compared to non-smokers, could perceive the costs of smoking as further delayed in a similar way as they tend to overly devalue the delayed benefits of smoking. More precisely, to the best of our knowledge, there is no empirical investigation on the perceptions of smokers, compared to non-smokers, of the onset time of SRCs. Examining the perceptions of the risks of smoking from the standpoint of their perceived time onset could provide a novel perspective on smokers’ judgement and decision making. In particular, such an investigation could provide insights into smokers’ choices of starting, quitting smoking, and screening for SRCs. In the current study, we used this new, indirect measure of risk perception in combination with direct measures of participants’ perceptions of their own risk and fear to develop SRCs. Fear-related reactions have mostly been investigated in relation to the influence of fear appeals and threat communication on behaviour change (Cameron, Pepper, & Brewer, 2015; Kok, Bartholomew, Parcel, Gottlieb, & Fernández, 2014; Peters, Ruiter, & Kok, 2013; Witte & Allen, 2000). A novel contribution of the current study was to consider risk and fear
separately and to investigate the association of one’s own risk perception (RP) and level of fear (LF) of developing SRCs with the estimated onset time of those conditions in an average smoker.

Based on previous findings on smokers’ impatience for rewards (Ert, Yechiam, & Arshavsky, 2013; Yamane et al., 2013), we hypothesized a reverse effect where the negative consequences of smoking are concerned. Specifically, we expected that smokers should delay the onset time of SRCs compared to non-smokers. We also explored whether the RP and LF of developing SRCs could be associated with the onset time delaying. In particular, one’s own RP and LF could be differently associated with the onset time delaying as a function of the severity of the consequences of smoking. In particular, we hypothesized that smokers would perceive the severe consequences of smoking (e.g., lung cancer) as more temporally remote than the mild ones (e.g., yellow teeth) and, accordingly, the associated perceived own risk and fear could play a different role for the two different types of SRCs.

Method

Participants

One hundred and seventy-two participants with an age comprised between 18 and 35 were recruited with a snowball sampling method for the present study. There were a total of 60 smokers, 102 non-smokers, and 10 former smokers. Since former smokers were too few, they were excluded from the analysis, thus the total sample comprised 162 participants. Beside age, the following participation criteria were established: smokers had to be habitual consumers (at least one cigarette per day for at least one year) of packed or hand-made cigarettes, whereas non-smokers were enrolled only if they had no history of smoking. For the purpose of simplicity, we will refer to the two subsamples (smokers vs. non-smokers) as “smoking status”.

The smokers sample was composed of 30 males and 30 females (M_age = 24.22, SD_age = 2.68). They smoked from 2 to 25 cigarettes a day (M = 10.23, SD = 5.43). The score at the
Fagerström Test of Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerström, 1991) indicated that smokers had a low dependence level ($M = 2.37$, $SD = 1.52$). The non-smokers sample was composed of 19 males and 83 females ($M_{\text{age}} = 25.64$, $SD_{\text{age}} = 3.71$). All the participants were volunteers.

**Materials and procedure**

The present study was advertised by social networks. Individuals interested in participating were contacted via email and they were given a link to a survey on SurveyMonkey,® an internet-based survey tool. At that link, participants found a brief introduction about the kind of questions included in the survey, some instructions to complete it (e.g., read the questions carefully, be sincere, etc.), and the consent form approved by the ethical committee of a large Italian university.

The following 15 SRCs were selected from a list of commonly perceived outcomes of smoking by two scholars who have worked on smoking dependence for years: “Gingivitis”, “Asthma”, “Sore throat”, “Shortness of breath”, “Yellow teeth”, “Tachycardia”, “Halitosis”, “Premature skin aging”, “Chronic bronchitis”, “Sexual dysfunctions”, “Pulmonary emphysema”, “Hypertension”, “Lung cancer”, “Heart attack”, “Ictus”. The SRCs were then used as items in three instruments developed ad hoc for the present study.

The first two instruments aimed at measuring risk perception (RP) and level of fear (LF) for the SRCs on 5-point Likert scales. RP was assessed by asking participants to evaluate their own likelihood to develop each SRC, from 1 “Not likely at all” to 5 “Extremely likely”. LF was measured asking participants how much they were afraid of developing each SRC, from 1 “Not at all” to 5 “Extremely”. Thus, while the RP measure was meant to tap into participants’ perceived likelihood of developing the SRCs, the LF measure aimed at gauging the magnitude of fear participants felt about developing them.

The third instrument aimed at measuring the onset time delaying (OTD) of the SRCs, that is, the perceived onset time of each SRC. With reference to an individual who starts smoking 10
cigarettes a day, participants were asked to estimate the temporal distance between smoking initiation and the onset of a SRC on a 9-point Likert scale with the following options: one month (1), three months (2), one year (3), five years (4), ten years (5), twenty years (6), thirty years (7), more than thirty years (8), never (9). We did not use open-ended questions as they could be problematic. Given that this type of time estimates is not routinely required from individuals in their everyday life, there could be an increase in statistical noise in this measure if open-ended questions were used. Thus, similarly to the temporal proximity measure (Hall & Fong, 2007), we provided participants with pre-set options to select in order to facilitate their task (for a similar argument regarding measures of time and risk preference see Goto, Takahashi, Nishimura, & Ida, 2009). Not only anchors could facilitate participants’ task, but they also provided us with a common response scale for all the participants, which was crucial to compare the predictions between smokers and non-smokers on the same basis. The difference between response options was larger for references that were temporally remote than for the proximal ones. This is a common strategy adopted by several authors to avoid issues caused by the vividness of events in measures that involve time (Arnold, McDermott, & Szpunar, 2011; Caruso, Van Boven, Chin, & Ward, 2013; Rinaldi, Locati, Parolin, & Girelli, 2017; Rinaldi, Vecchi, Fantino, Merabet, & Cattaneo, in press). However, to avoid any possible bias in participants’ estimates of the onset time of a smoking-related condition, the anchors spanned a wide timeline, from one month to never.

Finally, participants were asked to provide their age, gender, and their current smoking status (SS) choosing one of the following options: current smoker, former smoker, never smoker. The questionnaire ended for the two latter smoking status, whereas smokers were asked to complete the FTND (Heatherton et al., 1991) in order to assess their nicotine dependence. The FTND is a 6-item questionnaire validated in an Italian sample (Ferketich, Fossati, & Apolone, 2008) and it is the most widely used self-reported measure of nicotine dependence.
Data analysis

The analysis was conducted in two steps. In the first step, we performed an exploratory factor analysis (EFA) for each instrument (i.e.: RP, LF, and OTD scales) in order to identify a small number of dimensions that could account for the SRCs. The EFAs were performed on the polychoric correlation matrices, using the principal axis factoring method. The optimal number of factors was determined through a parallel analysis (Horn, 1965), comparing the extracted empirical eigenvalues with those obtained by 100 simulations. As indicated in the literature (Cota, Longman, Holden, Fekken, & Xinaris, 1993; Glorfeld, 1995), we retained only the factors associated to eigenvalues higher than 95th percentile of those computed by the simulations. The rotation method was chosen according to the correlations between the extracted factors. The ultimate aim of the EFAs was to find a common dimensionality for the three scales, which was essential to explore possible differences between smoking-related conditions. In other words, we needed to identify items that showed clear loadings on the same factor in each of the EFAs. Loadings were evaluated computing the marker index (Gallucci & Perugini, 2007): values lower than 0.40 indicate low primary loading and/or multiple loadings, suggesting the possibility to delete the item and rerun the EFA without it. Once the common factors were identified, factors’ scores were computed as the mean of the responses to their items. Factors means within each construct (i.e., RP, LF, OTD) were then compared to detect differences and Cronbach’s alpha was computed to assess the internal consistency of the subscales.

In the second step of the analysis, we performed a stepwise backward regression analysis for each common factor identified in the EFAs. Specifically, OTD was considered as dependent variable, whereas RP, LF, and SS as predictors (the non-smokers group was used as reference category). Besides main effects, we included the second- and third-order interaction terms. Thus, starting from the full model, non-significant higher order terms were eliminated one at a time, in order to obtain a final, more parsimonious model. Simple slope analysis was performed to
investigate the interactions, in order to test the effect of RP on OTD for the two groups (smokers and non-smokers), using LF at one standard deviation above and below its mean. As suggested by Jaccard and Turrisi (2003), the continuous independent variables (i.e., RP and LF) were mean-centered.

Data were analyzed using IBM SPSS Statistics, version 23 (IBM Corp., 2015), and R statistical software, version 3.2.3 (R Core Team, 2013).

Results

Dimensionality of the instruments

The parallel analyses (Horn, 1965) conducted on the three instruments that we introduced for this study (i.e., RP, LF, and OTD scales) yielded the same results, indicating that the first two empirically extracted factors were associated to eigenvalues higher than the 95th percentile of the simulated eigenvalues. Accordingly, we performed an EFA for each of the scales extracting two factors. The correlation between the two factors was moderate for the LF instrument (r = .46) and strong for RP and OTD instruments (.67 and .62, respectively), thus a promax oblique rotation was applied.

Table 1 shows the results of the EFAs performed on the three instruments. A careful examination of the loadings and marker indices was carried out, comparing the EFAs results in order to identify the items that commonly constitute the two factors in all the instruments. Four items with complex loadings were detected. “Asthma”, “Chronic bronchitis”, “Premature skin aging”, and “Sexual dysfunctions” showed multiple loadings and an unacceptable marker index at least for one of the instruments, thus they were considered complex items and excluded from the computation of the factors’ scores. In contrast, the remaining items showed adequate marker indices and clear primary loadings for all of the instruments. Specifically, the first common factor (F1) was loaded by the following items: “Gingivitis”, “Sore throat”, “Shortness of breath”, “Yellow teeth”,
“Halitosis”, “Tachycardia”, and “Hypertension”. These items represent mild SRCs relative to physical appearance, with the exception of the latter. Indeed, hypertension is a serious disease, but its scarce impact on everyday activities could have led participants to assimilate hypertension to the other mild SRCs. Based on these considerations, F1 was called “Mild SRCs”. The second common factor (F2) was loaded by “Pulmonary emphysema”, “Lung cancer”, “Heart attack”, and “Ictus”. These items represent very severe SRCs; hence F2 was called “Severe SRCs”.

Based on these results, we computed the means of the items that loaded on the identified factors, thus obtaining six scores, three regarding the Mild SRCs common factors (RP\textsubscript{Mild}, LF\textsubscript{Mild}, and OTD\textsubscript{Mild}) and three regarding the Severe SRCs common factor (RP\textsubscript{Severe}, LF\textsubscript{Severe}, and OTD\textsubscript{Severe}). Paired samples t-tests detected significant differences between mild and severe SRCs for RP \[ t(161) = 5.50, p < .001, d = 0.43 \], LF \[ t(161) = 16.17, p < .001, d = 1.27 \], and OTD \[ t(161) = 28.94, p < .001, d = 2.27 \]. In particular, RP\textsubscript{Mild} (M = 2.96, SD = 0.82) was higher than RP\textsubscript{Severe} (M = 2.62, SD = 0.86), LF\textsubscript{Mild} (M = 2.50, SD = 0.88) was lower than LF\textsubscript{Severe} (M = 3.88, SD = 1.04), and OTD\textsubscript{Mild} (M = 3.88, SD = 1.31) was lower than OTD\textsubscript{Severe} (M = 6.59, SD = 1.15). The identified factors showed high internal consistency, yielding Cronbach’s alpha coefficients between .86 (for RP\textsubscript{Mild}) and .91 (for OTD\textsubscript{Severe}).

**Onset time delaying**

Based on the analysis of dimensionality, we conducted two distinct but equivalent regression models, one related to mild SRCs (M1) and the other one to severe SRCs (M2). Before performing these models, a correlation analysis was carried out on the whole sample to exclude any possible confounding effect related to the participants’ gender. In addition, a correlation analysis was conducted on the subsample of smokers, in order to check whether the number of cigarettes smoked per day or the dependence level measured using the FTND were associated with the study variables. Results indicated that none of the factors identified in the previous dimensionality analysis were
significantly correlated with gender, the number of cigarettes or the FTND score (please, see Table 2), thus there was no need to include these variables in the following models.

[Table 2 about here]

For both M1 and M2, full models were initially tested, excluding non-significant higher order predictors one at a time. Table 3 shows the results of the final, most parsimonious models, which are also graphically displayed in Figure 1 and Figure 2.

[Table 3 about here]

[Figures 1 and 2 about here]

Both models were significant: M1 explained about 17% of OTD\text{Mild} variance [$R^2 = .17$, $F(4,157) = 8.10$, $p < .001$], whereas M2 accounted for about 6% of OTD\text{Severe} variance [$R^2 = .06$, $F(3,158) = 3.52$, $p = .02$]. Smoking status showed a significant main effect in both M1 and M2. As can be seen in Figure 1, the perceived onset time was delayed for smokers vs. non-smokers regardless of the severity of the smoking-related conditions. The remaining predictors did not show any significant main effect, neither for M1 nor for M2. Moreover, in both models no higher order effects were detected, except for the significant interaction between RP\text{Mild} and LF\text{Mild}. A simple slope analysis was conducted on the interaction term for M1 to test whether it was significant at both high and low levels of the moderator, thus at one standard deviation above and below the LF mean. On one hand, when the level of fear was low, the perceived risk of mild diseases did not affect the disease onset estimates [$b = .18$, $t(157) = 1.26$, $p = .21$]. On the other hand, when the level of fear was high, the higher the perceived risk, the closer the estimated onset time [$b = -.48$, $t(157) = -2.83$, $p = .01$].

**Discussion**

This is the first study to illustrate an onset time delaying of the adverse consequences of smoking in smokers compared to non-smokers. We asked participants to estimate the months or years that occur before a SRC might develop in a person who starts smoking 10 cigarettes a day at 18 years
old. We categorized SRCs into mild (e.g., yellow teeth, halitosis) vs severe (e.g., lung cancer, ictus) ones based on the two factors extracted from EFAs conducted on three newly introduced instruments that measure risk perception (RP), level of fear (LF), and onset time delaying (OTD), respectively. The main finding was that smokers, compared to non-smokers, delayed onset times for both mild and severe SRCs. This result provides evidence for a difference between smokers and non-smokers in the time perception of the adverse consequences of smoking. It thus adds to the literature by showing that the onset time delay is another time-related concept that could discriminate between smokers and non-smokers and thus it could represent another cognitive risk factor for smoking along with time discounting (Barlow et al., 2016). Not only smokers do place less value on future rewards than non-smokers, but they also place the adverse consequences of smoking further in the future compared to non-smokers. This finding dovetails with the greater perceived temporal proximity for the benefits vs costs of smoking found by Hall and Fong (2007). It also further specifies Slovic’s data showing the inadequate time expectations of smokers, in particular young smokers, as to how long they would keep smoking before any smoking-related health damage could occur (Slovic, 2001).

**Optimism Bias**

We introduced the onset time measure to get insights into the perceptions of the risks from smoking in smokers vs non-smokers. Past research has shown that smokers believe that they are less at risk of the health-damaging consequences of smoking than the average smoker, thus they show an optimism bias (Slovic, 1998; Weinstein, 1989, 1998; Weinstein et al., 2005). Asking smokers questions about the risk of others and not of themselves might prevent scholars from detecting inadequate risk perceptions in smokers because of such an optimism bias. In our study too we asked participants to make onset time estimates with reference to an average smoker and not to themselves. Thus, the optimism bias could have affected our smoker participants’ estimates. We do not have data to compare smokers’ estimates with reference to themselves vs an average smoker, and thus we cannot draw conclusions about the role of optimism bias in participants’ estimates.
However, an optimism bias would entail more delayed (and thus associated with lower risks) estimates of the onset of SRCs for oneself compared to an average smoker. We found that smokers’ estimates were more delayed, and thus optimistic, if compared to non-smokers’ estimates. This suggests that even in the case of optimistic estimates about themselves, the smokers’ estimates about the average smoker would still be not as conservative as the non-smokers’ estimates. To more squarely test the optimism bias in this context, future research should investigate whether the onset time delaying effect is even larger (even more delayed estimates are given) when smokers refer to themselves rather than an average smoker, and thus they might be more optimistic about the onset time of SRCs for themselves compared to that for an average smoker. Nevertheless, we could expect a similar but more extreme pattern of results when smokers refer to themselves, suggesting that the optimism bias could be found for both the smokers themselves as well as an average smoker.

The Role of Self Perceptions of Risk and Fear

Although we found the onset time delaying effect for both mild (M1) and severe (M2) SRCs, we detected an association between OTD and RP and LF only in M1. For both smokers and non-smokers, RP significantly interacted with LF in predicting the onset time of mild SRCs. For low levels of fear, RP was not associated with the onset time estimates of mild SRCs. Conversely, for high levels of fear, the increase of RP was associated with a decrease in the onset time estimates, which means that onset times for mild SRCs were less delayed. This result shows that one’s own RP and LF are jointly associated with the time perception of the health consequences of smoking in others. In particular, the health consequences are perceived as closer in time only when both one’s own risk and fear are perceived as high. Furthermore, these self-perceptions are associated with the time perception of others’ mild SRCs regardless of the smoking status. Unfortunately, the study design did not make it possible to establish any causal relationship between the self-perceptions of risk and fear and the onset times for mild SRCs. Although it is possible that the onset time estimates determine the self-perceptions of risk and fear, the interpretation of the interaction between RP and
LF in the opposite way would be in line with some studies that have investigated the effect of warning labels on packets of cigarettes (Borland et al., 2009; Hammond, Fong, McDonald, Brown, & Cameron, 2004). These studies found that the stronger the warnings the greater the reaction of smokers to them, and this mechanism positively influences the likelihood of quitting attempts and of an actual cessation. In other words, fear provokes some reactions that have an impact on both cognition (e.g., development of an intention to quit) and smoking behaviour (e.g., reduction or cessation). Future studies could investigate whether fear could cause a cognitive reaction represented by the moderation of the relationship between risk perception and the onset time estimate of smoking-related conditions. The consequences of fear on time perception in relation to a change in smoking behaviour could also be the object of future research given the possible implications for interventions.

However, the interaction between RP and LF was detected only when mild SRCs were considered. This result could depend on the difference between the onset time estimates for mild vs severe SRCs. Severe pathologies such as lung cancer are usually developed after a relatively long smoking history, whereas mild SRCs such as yellow teeth or halitosis are very common among smokers, even after a few months of smoking. Thus, it is not surprising that participants estimated the onset time of mild SRCs as more proximal than the onset of severe ones (Figures 1-2), mainly because participants were asked to refer to a medium smoker who started smoking at 18 years old. We argue that for severe SRCs the onset was perceived so temporally remote from smoking initiation that the levels of one’s own fear and risk were not differentially associated with the onset-time estimates.

Implications for Interventions and Future Directions

Our study further specifies past research that shows that time perception can be distorted in smokers. Not only smokers devalue delayed rewards (Bickel et al., 1999; Reynolds et al., 2004; Yamane et al., 2013), they are less future orientated (Keough et al., 1999), and they perceive the costs from smoking as more temporally remote than its benefits (Hall & Fong, 2007), but smokers,
compared to non-smokers, also postpone the onset of the health-damaging consequences of smoking. Future studies should investigate whether this result could be replicated when participants are asked to refer to themselves and also to smokers with different smoking histories. Along the same lines, these results could pave the way for future investigations looking at more finer-grained aspects. Our sample encompassed smokers with a low dependence level according to the FTND. Future studies should investigate the onset time delaying effect at higher levels of tobacco dependence to cast light on whether this effect is moderated by the smokers’ dependence level. Furthermore, other self-report measures of smoking dependence (e.g., the Cigarette Dependence Scale; Etter, Le Houezec, & Perneger, 2003) that have been found to be significantly more informative than FTND (Courvoisier & Etter, 2008) could be used to obtain a more precise measure of the exact level of smokers’ dependence. Relaterly, the motives behind tobacco dependence and the corresponding types of smokers could interact with RP and LF to shape different temporal perceptions of SRCs (Pancani et al., 2015; Piper et al., 2008).

Our findings bear implications on cessation-promotion interventions. Previous research has shown that valuing future outcomes is associated with an increased likelihood of smoking cessation and a decreased likelihood of relapse (e.g., Adams, 2009b). Interventions based on the manipulation of the perceived onset time of the adverse consequences of smoking could be tested to assess their efficacy in preventing smoking initiation and promoting smoking cessation. Furthermore, our measure of the temporal perception of SRCs’ onset could be used to access smokers’ beliefs about screening programmes, their perceived barriers to screening and the factors underlying their intention to screen. Indeed, Silvestri and colleagues have shown that smokers have different perceptions from non-smokers about screening for lung cancer (Silvestri, Nietert, Zoller, Carter, & Bradford, 2007). Furthermore, it could give us insights into whether and why people consider or not starting or quitting smoking. This is the first study that shows that the adverse consequences of a health-damaging behaviour (smoking) are considered as more temporally remote by people who adopt that behaviour than people who refrain from it. This onset time delay effect could extend
beyond smoking behaviour. It has been argued that another phenomenon of time misperception, namely time discounting, characterises several disorders and maladaptive behaviours, from drug addiction to gambling and risky sexual behaviours, and it has thus been called “trans-disease process” (Bickel, Jarmolowicz, Mueller, Koffarnus, & Gatchalian, 2012). Whether the time misperception of the negative consequences of a unhealthy behaviour could similarly represent a “trans-disease process” shared between different disorders and health-damaging behaviours needs to be addressed in future investigations (Barlow et al., 2016; Bickel et al., 2012). Specifically, the perceived delay of negative consequences might be observed for behaviours such as excessive alcohol use or high-calorie food consumption, but also for new problematic behaviours such as Internet addiction or smartphone overuse.
References


https://doi.org/10.1007/BF02884459

https://doi.org/10.1126/science.2686031


https://doi.org/10.1177/109019810002700506


https://doi.org/10.1037//0022-3514.77.6.1271
Table 1 – Results of the three exploratory factor analyses: rotated factor loadings and marker indices of the items were displayed for each scale.

<table>
<thead>
<tr>
<th></th>
<th>RP scale</th>
<th></th>
<th></th>
<th>LF scale</th>
<th></th>
<th></th>
<th>OTD scale</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F1</td>
<td>F2</td>
<td>MI</td>
<td>F1</td>
<td>F2</td>
<td>MI</td>
<td>F1</td>
<td>F2</td>
<td>MI</td>
</tr>
<tr>
<td>Gingivitis</td>
<td>.696</td>
<td>-.056</td>
<td>.691</td>
<td>.925</td>
<td>-.159</td>
<td>.824</td>
<td>.507</td>
<td>.236</td>
<td>.453</td>
</tr>
<tr>
<td>Sore throat</td>
<td>.762</td>
<td>-.198</td>
<td>.690</td>
<td>.826</td>
<td>-.201</td>
<td>.734</td>
<td>.799</td>
<td>-.066</td>
<td>.788</td>
</tr>
<tr>
<td>Shortness of breath</td>
<td>.841</td>
<td>-.007</td>
<td>.841</td>
<td>.676</td>
<td>.126</td>
<td>.652</td>
<td>.859</td>
<td>-.104</td>
<td>.825</td>
</tr>
<tr>
<td>Yellow teeth</td>
<td>.726</td>
<td>-.035</td>
<td>.724</td>
<td>.792</td>
<td>-.192</td>
<td>.717</td>
<td>.728</td>
<td>-.138</td>
<td>.695</td>
</tr>
<tr>
<td>Tachycardia</td>
<td>.608</td>
<td>.106</td>
<td>.594</td>
<td>.517</td>
<td>.354</td>
<td>.401</td>
<td>.689</td>
<td>.053</td>
<td>.685</td>
</tr>
<tr>
<td>Halitosis</td>
<td>.602</td>
<td>.069</td>
<td>.596</td>
<td>.741</td>
<td>-.011</td>
<td>.741</td>
<td>.663</td>
<td>-.008</td>
<td>.663</td>
</tr>
<tr>
<td>Hypertension</td>
<td>.454</td>
<td>.203</td>
<td>.417</td>
<td>.540</td>
<td>.307</td>
<td>.447</td>
<td>.592</td>
<td>.157</td>
<td>.563</td>
</tr>
<tr>
<td>Pulmonary emphysema</td>
<td>.056</td>
<td>.771</td>
<td>.764</td>
<td>-.008</td>
<td>.839</td>
<td>.839</td>
<td>.088</td>
<td>.760</td>
<td>.744</td>
</tr>
<tr>
<td>Lung cancer</td>
<td>-.063</td>
<td>.845</td>
<td>.833</td>
<td>-.217</td>
<td>.861</td>
<td>.742</td>
<td>-.006</td>
<td>.896</td>
<td>.880</td>
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<tr>
<td>Heart attack</td>
<td>-.010</td>
<td>.839</td>
<td>.810</td>
<td>-.075</td>
<td>.894</td>
<td>.870</td>
<td>-.074</td>
<td>.926</td>
<td>.895</td>
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<tr>
<td>Ictus</td>
<td>-.108</td>
<td>.871</td>
<td>.832</td>
<td>-.083</td>
<td>.797</td>
<td>.781</td>
<td>-.139</td>
<td>.938</td>
<td>.848</td>
</tr>
<tr>
<td>Asthma</td>
<td>.351</td>
<td>.321</td>
<td>.276</td>
<td>.538</td>
<td>.247</td>
<td>.476</td>
<td>.603</td>
<td>.145</td>
<td>.577</td>
</tr>
<tr>
<td>Chronic bronchitis</td>
<td>.376</td>
<td>.443</td>
<td>.328</td>
<td>.274</td>
<td>.562</td>
<td>.483</td>
<td>.433</td>
<td>.374</td>
<td>.321</td>
</tr>
<tr>
<td>Premature skin aging</td>
<td>.489</td>
<td>.243</td>
<td>.434</td>
<td>.582</td>
<td>.145</td>
<td>.558</td>
<td>.339</td>
<td>.405</td>
<td>.225</td>
</tr>
<tr>
<td>Sexual dysfunctions</td>
<td>.306</td>
<td>.408</td>
<td>.334</td>
<td>.182</td>
<td>.461</td>
<td>.431</td>
<td>.129</td>
<td>.481</td>
<td>.465</td>
</tr>
</tbody>
</table>

*Note.* RP = risk perception; LF = level of fear; OTD = onset time delaying; F1 = mild smoking-related conditions factor; F2 = severe smoking-related conditions factor.
Table 2 – Correlation analysis between gender, smoking indicators (number of cigarettes smoked per day and FTND score) and the study variables (risk perception, level of fear, and onset time delaying for both mild and severe smoking-related conditions).

<table>
<thead>
<tr>
<th></th>
<th>RP\textsubscript{Mild}</th>
<th>RP\textsubscript{Severe}</th>
<th>LF\textsubscript{Mild}</th>
<th>LF\textsubscript{Severe}</th>
<th>OTD\textsubscript{Mild}</th>
<th>OTD\textsubscript{Severe}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (N = 162)</td>
<td>$r = .03$</td>
<td>$r = -.004$</td>
<td>$r = .11$</td>
<td>$r = .05$</td>
<td>$r = -.04$</td>
<td>$r = -.09$</td>
</tr>
<tr>
<td></td>
<td>$p = .67$</td>
<td>$p = .96$</td>
<td>$p = .16$</td>
<td>$p = .57$</td>
<td>$p = .62$</td>
<td>$p = .27$</td>
</tr>
<tr>
<td>N\textsuperscript{o} of cigarettes per day (n = 60)</td>
<td>$r = .13$</td>
<td>$r = .10$</td>
<td>$r = -.14$</td>
<td>$r = .08$</td>
<td>$r = .17$</td>
<td>$r = .19$</td>
</tr>
<tr>
<td></td>
<td>$p = .32$</td>
<td>$p = .48$</td>
<td>$p = .30$</td>
<td>$p = .53$</td>
<td>$p = .21$</td>
<td>$p = .17$</td>
</tr>
<tr>
<td>FTND score (n = 60)</td>
<td>$r = .12$</td>
<td>$r = .15$</td>
<td>$r = .001$</td>
<td>$r = .17$</td>
<td>$r = .06$</td>
<td>$r = .08$</td>
</tr>
<tr>
<td></td>
<td>$p = .35$</td>
<td>$p = .27$</td>
<td>$p = .99$</td>
<td>$p = .18$</td>
<td>$p = .64$</td>
<td>$p = .53$</td>
</tr>
</tbody>
</table>

Note. RP\textsubscript{Mild} = risk perception for mild smoking-related conditions; RP\textsubscript{Severe} = risk perception for severe smoking-related conditions; LF\textsubscript{Mild} = level of fear for mild smoking-related conditions; LF\textsubscript{Severe} = level of fear for severe smoking-related conditions; OTD\textsubscript{Mild} = onset time delaying for mild smoking-related conditions; OTD\textsubscript{Severe} = onset time delaying for severe smoking-related conditions.
Table 3 – Results of the final regression models for mild smoking-related conditions (M1) and severe smoking-related conditions (M2): F statistics, unstandardized coefficients with standard errors, t statistics, 95% confidence intervals, and partial eta squared are displayed for each parameter.

<table>
<thead>
<tr>
<th>Model</th>
<th>Parameter</th>
<th>$F$ (p-value)</th>
<th>$b$ (SE)</th>
<th>$t$ (p-value)</th>
<th>95% CI</th>
<th>$\eta^2_p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>Intercept</td>
<td>4.54 (.04)</td>
<td>-0.28 (.12)</td>
<td>-2.24 (.03)</td>
<td>-0.52, -0.03</td>
<td>.028</td>
</tr>
<tr>
<td></td>
<td>$\text{RP}_{\text{Mild}}$</td>
<td>1.42 (.24)</td>
<td>-0.15 (.13)</td>
<td>-1.19 (.24)</td>
<td>-0.40, 0.10</td>
<td>.009</td>
</tr>
<tr>
<td></td>
<td>$\text{LF}_{\text{Mild}}$</td>
<td>0.01 (.94)</td>
<td>-0.01 (.12)</td>
<td>-.08 (.94)</td>
<td>-0.25, 0.23</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>$\text{SS}$</td>
<td>22.20 (&lt;.001)</td>
<td>0.99 (.21)</td>
<td>4.71 (&lt;.001)</td>
<td>0.58, 1.41</td>
<td>.124</td>
</tr>
<tr>
<td></td>
<td>$\text{RP}<em>{\text{Mild}} \times \text{LF}</em>{\text{Mild}}$</td>
<td>12.61 (.001)</td>
<td>-0.39 (.11)</td>
<td>-3.55 (.001)</td>
<td>-0.60, -0.17</td>
<td>.074</td>
</tr>
<tr>
<td>M2</td>
<td>Intercept</td>
<td>0.68 (.41)</td>
<td>-0.22 (.11)</td>
<td>-1.91 (.06)</td>
<td>-0.44, 0.01</td>
<td>.004</td>
</tr>
<tr>
<td></td>
<td>$\text{RP}_{\text{Severe}}$</td>
<td>1.54 (.22)</td>
<td>-0.14 (.11)</td>
<td>-1.24 (.22)</td>
<td>-0.36, 0.08</td>
<td>.010</td>
</tr>
<tr>
<td></td>
<td>$\text{LF}_{\text{Severe}}$</td>
<td>1.12 (.29)</td>
<td>0.09 (.09)</td>
<td>1.06 (.29)</td>
<td>-0.08, 0.27</td>
<td>.007</td>
</tr>
<tr>
<td></td>
<td>$\text{SS}$</td>
<td>9.34 (.003)</td>
<td>0.58 (.19)</td>
<td>3.06 (.003)</td>
<td>0.21, 0.96</td>
<td>.056</td>
</tr>
</tbody>
</table>

*Note.* CI = confidence interval; $\text{RP}_{\text{Mild}}$ = risk perception for mild smoking-related conditions; $\text{LF}_{\text{Mild}}$ = level of fear for mild smoking-related conditions; SS = smoking status; $\text{RP}_{\text{Severe}}$ = risk perception for severe smoking-related conditions; $\text{LF}_{\text{Severe}}$ = level of fear for severe smoking-related conditions.
**Figure captions**

Figure 1 – Graphical representation of the final regression model M1 for mild smoking-related conditions: time labels (and scale points) are reported on the Y-axis.

*Note.* Error bars represent the standard error of the mean.

Figure 2 – Graphical representation of the final regression model M2 for severe smoking-related conditions: time labels (and scale points) are reported on the Y-axis.

*Note.* Error bars represent the standard error of the mean.