The role of time and risk preferences in smoking inequalities: A population-based study

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HIGHLIGHTS

► The mediating role of preferences in smoking inequalities has been little studied.
► We measured preferences with subjective scales in a nationwide survey.
► Time preference and risk aversion partially mediated the smoking inequalities.
► Time preference was more strongly associated with smoking in men than in women.
► Risk aversion was more strongly associated with smoking in women than in men.

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ABSTRACT

Heterogeneity in time and risk preferences has been proposed as one of the mechanisms involved in the educational gradient in smoking, but this mechanism has scarcely been explored empirically. Subjective scales were introduced in the 2008 French National Health, Health Care and Insurance Survey in order to elicit measures of time and risk preferences for a representative sample of 5188 men and 5684 women. Men and women were treated separately. First, logistic regressions were used to test the associations between preferences and education and between preferences and smoking. Second, nested logistic models were built to investigate the mediating role of preferences in the educational gradient in smoking, with an econometric treatment of the rescaling problem. Preference for the present and risk loving were found to be: inversely related to educational level; strongly related to each other, and; strongly associated to current smoking, even after adjustment for educational level. There was a weakening of the educational gradient after the control for preferences, which supports the role of these two preferences as partial mediators in the educational gradient in smoking. Among men, time preference was more strongly associated with smoking than risk aversion, while the reverse was found for women. We provide convincing evidence in favour of the mediating role of time preference and risk aversion in educational inequalities in smoking and highlight the connection between those two dimensions. Gender patterns are discussed and potential implications in terms of designing targeted anti-tobacco programmes are delineated.

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1. Introduction

Risk behaviours constitute a major public health issue through their contribution to chronic diseases and to the related social inequalities in health. Modifying those behaviours is therefore an essential component of the fight against chronic disease and of the progress toward health equity. And yet, it is a very difficult enterprise, given that those behaviours are often supported by the social environment and that personal tastes strongly contribute to their adoption and maintenance. The consideration of individual taste may open up new perspectives for the understanding of social determinants of health and the design of relevant preventive policies.

Of particular interest as a component of tastes is the economic concept of time preference, which represents the preference for immediate satisfaction over delayed satisfaction (Frederick, Loewenstein, & O'Donoghue, 2002). The more an individual values short-term satisfaction over more remote satisfaction, and the more he or she is focused on present well-being, the stronger is his or her present orientation. Time preferences are modelled mathematically in the discount function, which expresses the variation in preference for events according to the time delay. Another related psychological concept is time perspective, which refers to the tendency to give value to present versus future consequences of one's own actions (Adams, 2009a, 2009b; Hall et al., 2012; Strathman, Gleicher, Boninger, & Edwards, 1994; Zimbardo & Boyd, 1999).

Many studies have indeed established that future orientation was stronger at the top of the social ladder than at the bottom (Becker, 1962;

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Dom, D'haene, Hulstijn, & Sabbe, 2006; Jaroni, Wright, Lerman, & Epstein, 2004; Wardle & Steptoe, 2003), but the interpretation of that gradient is not straightforward (Cutler & Lleras-Muney, 2010). On one hand, future orientation could favour the pursuit of higher studies, given that, as suggested by human capital models, education is an investment decision (Becker, 1962). On the other hand, it has been hypothesized that future orientation could be a trait learned by children growing up in more structured and predictable environments was put forward (Petry, 2002; Singh-Manoux & Marmot, 2005; Zimbardo & Boyd, 1999). Moreover, instruction itself may reinforce future orientation (Becker & Mulligan, 1997). Under this second scenario, future orientation would be one of the factors underlying the social reproduction pathways along the lifecourse (Singh-Manoux & Marmot, 2005).

Interestingly, the concept of time preference is also theoretically relevant in relation with health-related and addictive behaviours, as those involve a compromise between immediate satisfaction and delayed losses in health capital (Apostolidis, Fieulaine, & Soulé, 2006; Becker & Murphy, 1988; Grossman, 1972; Gruber & Köszegi, 2001). Most of the empirical research to date relates to addictions (Henson, Carey, Carey, & Maisto, 2006), and particularly smoking, be it current smoking or smoking cessation (Adams, 2009c; Adams & Nettle, 2009; Adams & White, 2009; Fieulaine & Martinez, 2010; Goto, Takahashi, Nishimura, & Ida, 2009; Hall et al., 2012; Khwaja, Silverman, & Sloan, 2007). Although findings were not always consistent, there is now a fair amount of evidence on the association of smoking behaviours with time preference.

Building on those theoretical and empirical premises, time preference may be hypothesized as a predictor of both educational achievement and investment in health capital, and from there as a mediator of the socioeconomic gradient in health (Fuchs, 1982; Guthrie, Butler, & Ward, 2009; Singh-Manoux & Marmot, 2005). And yet, this question has been hardly empirically explored. Regarding smoking, two studies did not support a mediating role of time perspective (Adams & White, 2009; Cutler & Lleras-Muney, 2010), while two others found limited support (Adams, 2009c; Cutler & Lleras-Muney, 2010; van der Pol, 2011).

Another component of tastes is risk aversion, a psychological and economical concept which theorizes the preference of a person for a bargain with a certain payoff over a bargain with an uncertain, but possibly higher payoff (Arrow, 1970). It has been hypothesized, but not verified, that education may lead people to become more risk adverse (Cutler & Lleras-Muney, 2010), but there are arguments to support the contrary. On the other hand, risk aversion is theoretically related to addictive behaviours as their consequence on health status is never certain (Orphanides & Zervos, 1995). A few empirical studies have found tobacco use to be related to risk taking tendencies (Barsky, Juster, Kimball, & Shapiro, 1997; Coogan et al., 1998; Dalton et al., 2010; Epstein & Botvin, 2002). Those concepts may be very fruitful in terms of advancing knowledge on social determinants of smoking behaviour. Further to that, many public health policy implications could be envisaged for reducing inequalities in tobacco smoking.

In France, the vigorous anti-tobacco policy which has been implemented since 1976 has been quite successful in lowering tobacco consumption in the population as a whole. This decline was accompanied by a widening of social inequalities in smoking (Legleye, Khlat, Beck, & Peretti-Watel, 2011). Moreover, there is a recent "tobacco crisis" in this country, as a rise in smoking prevalence has been observed in 2010 in comparison with 2005, particularly among women and lower educated people (Beck, Guignard, Richard, Wilquin, & Peretti-Watel, 2011). This undesirable trend calls for further attention and targeting of anti-smoking policies.

The purpose of this study is to investigate, based on the 2008 wave of the nationally representative Health, Health Care and Insurance Survey from France, the roles of time preference and risk aversion as mediators of the educational gradient in smoking. We focus on several aspects which have been under-researched to date: the relation

between time preference and risk aversion at the individual level, their joint effects as mediators of the social inequalities in smoking, with particular attention to the underlying gendered patterns.

1.1. The National Health, Health Care and Insurance Survey

The National Health, Health Care and Insurance Survey (ESPS: "Enquête sur la Santé et la Protection Sociale") is a biannual health interview survey coordinated by the Institute for Research and Information on Health Economics (IRDES), with a sample based on an ongoing random sample of French major health insurances' beneficiaries (covering over 95% of the household community). In 2008, about 26.5% of the households sampled could not be reached (mostly due to incomplete or wrong addresses) and 66% of the contacted households agreed to participate (Allonier, Dourgnon, & Rochereau, 2010). Health behaviour and preferences were collected by a self completion questionnaire and the remaining information by telephone interviewing. The final study sample consisted of 5188 men and 5684 women (Table 1).

1.2. Time preference and risk aversion measures

We introduced in the survey self-completion questionnaire two 11-point scales for measuring self-perceptions of the respondents of their own attitudes toward the risk and the future. Those scales have been elaborated for the INSEE-DELTA survey which was especially designed for measuring time and risk preferences. In addition, they were found to be strongly correlated with other measurements of preferences and related behaviours (Arrondel & Masson, 2007; Arrondel, Masson, & Verger, 2004).

The question related to time preference was:

"Concerning your attitude towards the future, would you indicate on a scale ranging from 0 to 10 your degree of proximity with the following stereotypes:

0: individuals living on a daily basis and taking life as it comes, not thinking about the future and not projecting themselves in the future

10: individuals concerned by their future (even distant), who have articulate ideas on what they want to do and become later.

The question related to risk aversion was:

"Concerning your attitude toward risk, would you indicate on a scale ranging from 0 to 10 your degree of proximity with the following stereotypes:

0: very cautious individuals who limit risks in their life and want a well-ordered life without surprise

10: adventurous individuals who look for novelty and challenges, like to take risks and place bets in their life

We have explored different categorizations and cutting points in preliminary analyses. Both preferences were treated in turn as: continuous variables; ordinal variables with eleven levels; ordinal variables with five levels (0,1,2/3,4/5,6/7,8/9,10); and dichotomous variables (0,1,2/3–10 for time preference and 0–7/8–10 for risk aversion). The different analyses were very convergent, as they all demonstrated a very strong association of smoking with both extreme present orientation and extreme risk loving.

We next investigated the association between preferences and education based on the first specification (continuous variables) and the last one (dichotomous variables). For time preference, the two approaches led to similar findings, with stronger future orientation among the most educated. The relation of risk aversion to education

Table 1
Sample description.

Characteristics	Men	Women
	Frequency (%)	Frequency (%)
Current smoker	30.82	23.08
Present oriented	13.92	12.67
Risk lover	5.84	3.17
Primary education	22.74	25.58
Secondary education: 1st level	36.58	30.58
Secondary education: 2nd level	14.84	17.03
University	25.83	26.81
Inactive	5.96	9.98
Farmer	4.32	2.96
Craftsmen and self employed	8.02	3.68
Highly qualified occupations	15.77	7.95
Associate professional	19.89	19.60
Office worker	8.62	42.03
Elementary jobs	36.74	13.21
Lone	9.87	12.77
Lone parent with children	3.86	9.29
Couple without children	31.82	28.64
Couple with children	51.29	45.60
Non nuclear family	3.16	3.69
In employment	60.49	53.38
First quintile of income per CU	14.32	17.65
Second quintile of income per CU	15.81	16.59
Third quintile of income per CU	17.37	16.68
Fourth quintile of income per CU	19.28	18.54
Fifth quintile of income per CU	20.97	18.86
Unknown income	12.26	11.68
18–29	17.93	18.31
30–39	17.08	17.22
40–49	19.64	20.23
50–59	27.79	26.41
60–69	10.37	9.38
70 and over	7.19	8.44
Total sample	5188	5684

was however not monotonous: the least educated were more likely to have an extreme position on the scale, whereas the most educated were more concentrated in the middle part of the scale. Interestingly, the least educated were particularly well represented among risk lovers.

We therefore decided to focus on the dichotomous categorization of the preferences, in order to assess the mediator role of extreme patterns of preference with respect to the educational gradient in smoking. Individuals grading their attitude towards the future from 0 to 2 were considered as "present oriented", while individuals grading their attitude towards risk from 8 to 10 were considered as "risk lovers".

2. Other variables of interest

The question related to smoking was formulated as "Do you usually smoke?". From there, we categorized individuals into current smokers (having answered "yes") and current non smokers (having answered "no"). We considered four educational levels, based on the highest diploma reported: primary education, first level of secondary education, second level of secondary education, and university degree. To control for other socioeconomic characteristics, three self-reported indicators were used: household income per unit of consumption (quintiles), employment status (active vs. inactive or unemployed), and type of household composition (lone person; lone mother or father with children; couple without children; couple without children and other types of family).

3. Method

The potential mediating role preferences in the educational gradient in smoking was assessed as in (Adams, 2009a), following the rationale proposed by Baron & Kenny (1986):

1. Education must be related to smoking;
2. Education must be related to the potential mediating variables (time preference and risk aversion)
3. The potential mediating variables (time preference and risk aversion) must be related to smoking after control for education.

There is complete mediation if controlling for the mediating variable leads to the vanishing of the relationship of the independent and dependent variables, and partial mediation when there is attenuation of the relationship rather than extinction.

The mediator role of the preferences was explored for men and women separately. In order to assess condition 1, a logistic regression was used to test the association between education and smoking, controlling for age. In order to assess condition 2, two-step logistic regression models were used to test the association between education and preference controlling only for age, and then for age, occupation, employment status, income level and family situation. Lastly, two-step logistic regression models were used to test the association between education and smoking, controlling for preferences and age, and then for other socioeconomic variables.

The exploration of the mediating role of preferences in the relationship between education and smoking is based on the comparison of the estimated coefficient for education in the model without the preferences to the estimated coefficient for education in the larger model with the preferences. The two terms of the comparison are not directly comparable due to a scaling problem, as they belong to different regressions. We used the methodology proposed by Karlson, Holm, & Breen, (2010) in order to fix that issue and allow comparisons across model estimates. It consists of introducing in the first model (the one without the mediating variable) the residuals of auxiliary models regressing the mediating variables on the independent variables, in such a way that the estimated coefficients from the two models of interest (the one without the mediating variable ant the one with) are measured on the same scale. As our mediating variables were binary variables, we could not estimate directly the residuals of the auxiliary equations. We therefore computed generalised residuals, which corresponded to the conditional expected value of the residuals given the outcomes (Gourieroux, Monfort, Renault, & Trognon, 1987).

The contribution of time preference and risk aversion to the explanation of the educational gradient in smoking was quantified by the index Delta defined as the percentage of decrease in the excess risk of smoking (Adams, 2009b; Strathman et al., 1994) associated with education obtained by the introduction of time and risk preferences in the regression. Delta is calculated as follows for each educational level:

$$\text{Delta } ij = (\text{OR model } i - \text{OR model } j)/(\text{OR model } i - 1)$$

where model i is a model with the generalised residuals of time and risk preferences and model j a model including time and risk preferences.

4. Results

Thirty-one percent of the men were current smokers, as opposed to 23% of the women (Table 1), and this gender difference in consumption was paralleled by a difference in attitude towards risk (6% of risk lovers in men, vs. 3% in women), while the prevalence of present orientation was around 13% in both men and women.

The educational gradient in current smoking was very pronounced for men and for women (Table 2, Condition 1), even after control for the full range of socio-demographic variables. An even stronger educational gradient in present orientation was found for men and for women (Table 2, Condition 2), also after the control for the full range of socio-demographic variables. The same type of patterning was found for risk loving, but the gradient in that case was not as

Table 2
Associations between education and smoking (condition 1) and between education and preferences (condition 2).

		Men				Women			
		Controlled for age only		Fully controlled (b)		Controlled for age only		Fully controlled (b)	
		O.R. (a)	C.I.	O.R. (a)	C.I.	O.R. (a)	C.I.	O.R. (a)	C.I.
Condition 1	*Dependent variable:*								
	current smoker (1) versus current non smoker (0)								
	Primary education	2.91***	[2.40–3.54]	1.88***	[1.48–2.40]	2.02***	[1.65–2.48]	1.92***	[1.48–2.47]
	Secondary education: 1st level	2.35***	[2.00–2.78]	1.66***	[1.36–2.04]	1.96***	[1.65–2.32]	1.90***	[1.54–2.34]
	Secondary education: 2nd level	1.38**	[1.12–1.70]	1.17	[0.93–1.47]	1.4**	[1.13–1.67]	1.40**	[1.13–1.74]
	University	1							
Condition 2	*Dependent variable:*								
	present oriented (1) versus future oriented (0)								
	Primary education	3.41***	[2.64–4.40]	1.87***	[1.36–2.57]	3.73***	[2.85–4.88]	2.34***	[1.68–3.25]
	Secondary education: 1st level	2.18***	[1.72–2.76]	1.46**	[1.10–1.94]	2.52***	[1.95–3.25]	1.82**	[1.35–2.45]
	Secondary education: 2nd level	1.22	[0.90–1.65]	0.94	[0.68–1.31]	1.51**	[1.11–2.04]	1.24	[0.89–1.71]
	University	1		1		1		1	
	Dependent variable:								
	risk lover (1) versus risk averse (0)								
	Primary education	2.16***	[1.48–3.16]	1.71*	[1.08–2.71]	1.96**	[1.23–3.12]	1.83*	[1.02–3.28]
	Secondary education: 1st level	1.78***	[1.28–2.47]	1.50*	[1.01–2.23]	1.60*	[1.06–2.40]	1.61	[0.98–2.66]
	Secondary education: 2nd level	1.61	[1.08–2.38]	1.43	[0.94–2.19]	1.20	[0.74–1.93]	1.23	[0.72–2.08]
	University	1		1		1		1	

(a) Significance levels: *5%, **1%, ***0.1%.
(b) Controlled for age, occupation, employment status, income level and family situation.

sharp as the one observed for present orientation. Present orientation and risk loving were also found to be related, independently of education (Table 3), and much more so in women than in men.

Lastly, present orientation and risk loving were found to be significantly associated with smoking when entered jointly in the regression, with a control for education (Table 4, Condition 3). Risk loving, which was less prevalent among women, was more strongly associated with smoking among them than present orientation.

Given that the three conditions outlined above were met, the findings support the hypothesis of a mediating role of the preferences in the educational gradient in smoking, for both genders. The contribution of those mediators to the gradient was quantified by the Delta indices, which ranged from 8–11% for primary education to 6–9% for secondary education 1, and to 3–6% for secondary education 2.

5. Discussion

Smoking is a much stronger risk factor for mortality than most other risk factors, including obesity, and is one of the most important contributors to socioeconomic inequalities in mortality (Mackenbach, 2011). To our knowledge, this study, which is the first of its kind in France, is also among the first in the literature to consider the joint effects of time preference and attitude towards risk on smoking behaviour in a nationally representative population sample, with a focus on their mediating roles in educational inequalities in smoking, and a

gender perspective. We find that the two types of preferences are strongly correlated at the individual level and that they are correlated with smoking. Further, our analyses support the hypothesis of a joint role of time preference and risk loving as partial mediators of the educational gradient in smoking. Regarding gender effects, we also highlight that for women risk loving is less prevalent and more strongly associated with current smoking than for men.

There are a number of studies in the literature on time preference in relation with health and lifestyle factors, but very few specifically concern the role of preference in social inequalities in health. None of the two studies from the United States, one based on a small non representative sample (Guthrie et al., 2009), the other on very large nationally representative samples (Cutler & Lleras-Muney, 2010), found evidence for a role of time preference or perspective as mediators of the education gradient in smoking. Based on a representative sample of the city of Newcastle upon Tyne in England, Adams & White (2009) did not either find evidence in favour of this hypothesis, but Adams (2009c) found a partial mediating role of time perspective based on the nationally representative sample of the English Longitudinal Study of Ageing. The only study which considered jointly time preference and risk attitude was that conducted by van der Pol (2011) based on a nationally representative survey of Dutch households. The latter found some evidence for a mediator effect of the two types of preferences, and called for further research on the inter-relationship between time preference and risk attitude.

Table 3
Association between time preference and risk aversion.

Dependent variable:	Men				Women			
present oriented (1) versus future oriented (0)	Controlled for age only		Fully controlled (b)		Controlled for age only		Fully controlled (b)	
	O.R. (a)	C.I.	O.R. (a)	C.I.	O.R. (a)	C.I.	O.R. (a)	C.I.
Risk lover	1.88***	[1.41–2.50]	1.85***	[1.39–2.47]	2.42***	[1.69–3.46]	2.36***	[1.64–3.40]
Risk adverse	1		1		1		1	
Primary education	3.31***	[2.57–4.28]	1.83***	[1.33–2.51]	3.65***	[2.78–4.77]	2.28***	[1.64–3.17]
Secondary education: 1st level	2.12***	[1.67–2.69]	1.43*	[1.07–1.89]	2.48***	[1.92–3.20]	1.79***	[1.33–2.41]
Secondary education: 2nd level	1.19	[0.88–1.62]	0.92	[0.67–1.28]	1.50**	[1.11–2.04]	1.23	[0.89–1.71]
University	1		1		1		1	

(a) Significance levels: *5%, **1%, and ***0.1%.
(b) Controlled for age, occupation, employment status, income level and family situation.

Table 4
Association between preferences and smoking, controlling for education (condition 3).

Dependent variable: current smoker (1) versus current non smoker (0)	Model 1 controlled for age only		Model 2 controlled for age only			Model 3 fully controlled (b)		Model 4 fully controlled (b)		
	O.R. (a)	C.I.	O.R. (a)	C.I.	Delta in % (c)	O.R. (a)	C.I.	O.R. (a)	C.I.	Delta in % (c)
Men										
Primary education	2.91***	[2.39–3.54]	2.72***	[2.23–3.31]	−9.9	1.93***	[1.51–2.46]	1.82***	[1.43–2.32]	−11.8
Secondary education: 1st level	2.35***	[1.99 6–2.78]	2.26***	[1.92–2.67]	−6.7	1.69***	[1.38–2.07]	1.63***	[1.33–2.00]	−8.7
Secondary education: 2nd level	1.38**	[1.12–1.70]	1.36**	[1.10–1.68]	−5.3	1.18	[0.94–1.48]	1.17	[0.93–1.46]	−5.6
University	1		1			1		1		
Generalised residual of preference for present	1.47***	[1.24–1.76]				1.38	[1.16–1.66]			
Generalised residual of preference for risk	1.28(*)	[1.00–1.64]				1.27(*)	[0.99–1.64]			
Present oriented			1.49***	[1.25–1.77]				1.40***	[1.17–1.67]	
Future oriented			1					1		
Risk lover			1.29*	[1.01–1.66]				1.29*	[1.00–1.66]	
Risk averse			1					1		
Women										
Primary education	2.01***	[1.64–2.46]	1.91***	[1.56–2.35]	−9.9	1.92***	[148–2.48]	1.85***	[1.43–2.39]	−7.6
Secondary education: 1st level	1.95***	[1.64–2.31]	1.89***	[1.59–2.24]	−6.3	1.91***	[1.54–2.35]	1.86***	[1.50–2.29]	−5.5
Secondary education: 2nd level	1.37**	[1.13–1.67]	1.36**	[1.11–1.65]	−2.7	1.40**	[1.13–1.75]	1.39**	[1.12–1.73]	−2.5
University	1		1			1		1		
Generalised residual of preference for present	1.22*	[1.00–1.48]				1.13	[0.92–1.38]			
Generalised residual of preference for risk	2.72***	[1.98–3.74]				2.65***	[1.91–3.66]			
Present oriented			1.23*	[1.01–1.50]				1.14	[0.93–1.39]	
Future oriented			1					1		
Risk lover			2.74***	[1.99–3.76]				2.66***	[1.92–3.68]	
Risk averse			1					1		

(a) Significance levels: *5%, **1%, and ***0.1%.
(b) Controlled for age, occupation, employment status, income level and family situation.
(c) Delta = percentage decrease in odds ratios associated to education between models 1 and 2, and models 3 and 4 respectively.

It is worth noting that none of the cited studies was there an exploration of gender effects, as gender was taken as a covariate, and that those studies are hard to compare as they differed in many aspects. Discrepancies could be attributed to different sampling strategies, different approaches to controlling socio-demographic variables and different definitions of the smoking outcome (smoking cessation, current smokers, heavy smokers, non smokers with or without ex-smokers). As pointed out by Adams and White(Adams & White, 2009), there are also cultural differences across countries in the different terms of provision of health care, higher education and social welfare, which may influence the role of time perspective in determining behaviours.

Another aspect which differed across studies was the approach to measuring preferences. Several methodologies have been proposed to elicit information on time and risk preferences (Andersen, Harrison, Lau, & Rutström, 2008; Arrondel & Masson, 2007; Coller & Williams, 1999; van der Pol, 2011). The revealed preference method consists in inferring preferences from actual choice behaviours of individuals, such as saving behaviours or risky financial investments. However, it is difficult empirically to separate the effects of time preference or risk aversion from all of the other variables that influence individuals' choices. The stated preference method consists of eliciting individuals' preferences from asking individuals what they would do in particular hypothetical circumstances. To assess time preferences, they are usually asked to trade off outcomes over time,[1] and to assess risk aversion, they are usually asked to trade off several lotteries with various risks.[2] The stated preference methods are more appropriate for experimental or quasi-experimental designs than for large scale interview surveys. Furthermore, as tradeoffs are expressed in monetary terms, the comparison across income groups is questionable. Independently of their respective attitude towards the future, the value of 100£ for the poor could be equivalent to the value of 110£ for the rich. The use of this type of method could then lead to an overestimation of preference for the present among the poorest. This is the reason why we preferred to use self-perceptions of the respondents of their own attitudes towards future and risk taking. Subjective data have been previously used for eliciting time preference in the National Survey of Midlife Development (MIDUS) in the United States (Cutler & Lleras-Muney, 2010) and for eliciting risk aversion in the Socioeconomic Panel (SOEP) in Germany (Dohmen, Falk, Huffman, & Sunde, 2005) and their validity has been shown according to be their consistency with more usual measures of preferences. In the French context, the subjective scales used in our study have been validated, particularly for predicting wealth accumulation behaviours (Arrondel, Calvo-Pardo, & Oliver, 2010; Arrondel & Masson, 2007; Arrondel et al., 2004).

Although our findings provide convincing evidence in favour of an association between preferences and smoking, the interpretation in terms of causal relationships is complex. There are indeed unobserved factors which may explain both preferences and smoking, such as past health status or family background. In order to address this endogeneity issue, we have run a trivariate probit model for estimating simultaneously both equations of preference and equations of smoking. This kind of modelling takes into account common unobserved heterogeneity potentially causing endogeneity bias, by allowing correlations between the error terms of the different equations. The results demonstrated the robustness of the significance of the influence of preferences on smoking and the strength of the correlation between time and risk preference, given that the correlation coefficient between the error terms of the first and second equations was significantly different

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[1] For example, they may be asked whether they prefer £100 now or £110 in 1 year's time. Individuals who choose the £100 now have higher time preference rate than individuals who choose £110 in 1 year and are then more present oriented.

[2] For instance, they may be asked whether they prefer a lottery A with a certain gain of £100, or a lottery B with 50% probability to have £160 or 50% probability to have £60. The expected gain of lottery A is 100£ and the expected gain of lottery B is £110. Thus, individuals who prefer the lottery A have higher risk aversion than individuals who prefer the lottery B, since they accept a reduced expected gain to obtain a reduced risk.

from zero. Furthermore, the absence of significant correlation between the error terms of the smoking equation and each of the preference equations argued against the existence of a significant endogeneity bias.

We found that women were more averse to risk than men, which is in agreement with the commonly accepted idea that men are more prone to risk-taking behaviours, and the epidemiological evidence on the increased risks of injuries, accidents and violent deaths among them. We also provide evidence for an interesting gender pattern in that risk taking is more strongly associated with current smoking in women than in men, while time preference is more strongly associated with current smoking in men than in women. This original finding deserves to be investigated further, and if confirmed could be used for improving health message delivery. Gender targeting would be particularly relevant in countries, such France, which are still in stage three of the tobacco epidemic, and in which smoking prevalence starts to decline in men while it goes on rising in women.

Our empirical finding of a strong correlation between time preference and risk attitude accords with the preliminary report of van der Pol (2011), and is interesting from both theoretical and practical standpoints. Indeed, it suggests that those two types of preferences, although they are theoretically distinct, may have some common personality precursor or determinant, and this deserves further elaboration within the field of psychology of self-regulation. Further to that, the fact that they are correlated indicates that they could be handled jointly if they are to be addressed within health education messages or through training programmes.

Large-scale initiatives to promote healthy behaviours advertising campaigns are very costly for the public finances and have variable success, particularly in the most disadvantaged segments of the population. Among the approaches which have been developed for better efficiency of health communication is message tailoring (Myers, 2010; Noar, Grant Harrington, & van Stee, 2011), which involves customization of messages to the characteristics and needs of specific recipients. The findings in this study, by supporting the hypothesis of time preference and risk attitude as predictors of adoption of regular smoking, suggests that those two personal characteristics could be considered for the tailoring of messages to fit the recipients' profiles. Another promising avenue could be the manipulation of those traits within the frame of smoking cessation programmes in order to reach better effectiveness. This could have multiple benefits as time preference has been related to different health outcomes among which obesity, and as it touches upon the different spheres of life, from family to work. Enhancement of patience and "long-termism" from childhood through the school programme could contribute to the reduction of social inequalities and to progress towards better health equity.

Contributorship statement

This study was jointly conceived and designed by Florence Jusot and Myriam Khlat. Florence Jusot ran the statistical analyses and the results were jointly interpreted by the authors. Florence Jusot and Myriam Khlat co-wrote the paper.

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